



July 2023

TELEWORK

Growth Supported Economic Activity during the Pandemic, but Future Impacts are Uncertain

Accessible Version

GAO Highlights

Highlights of [GAO-23-105999](#), a report to congressional committees

Why GAO Did This Study

For many years, employers have used telework to manage their business operations and to promote a better work-life balance for their employees. In this report, telework refers to a flexible work arrangement under which employees perform their duties from a worksite—often at home—other than the location from which they would otherwise work. More recently, telework became an important part of the national response to the COVID-19 pandemic, which emerged in the U.S. in early 2020.

GAO was asked to examine the impact of telework, both as it pertains to the workforce and various sectors of the economy. This report is the first in a series of reports that will respond to this request, and examines: (1) changes in the extent of telework in the United States before and during the COVID-19 pandemic, and (2) reported impacts of teleworking on worker productivity and firm performance. Subsequent reports will focus on public policies affecting telework, among other issues.

GAO used the ACS and ATUS to describe trends in the use of telework from 2010 through 2021, the most recent data available at the time of the analysis in May 2023, and the growth of telework by select worker characteristics between 2019 and 2021. GAO also reviewed 44 studies that met GAO criteria for methodological rigor and examined the relationship between telework and worker productivity and firm performance.

View [GAO-23-105999](#). For more information, contact Michael Hoffman at (202) 512-6445 or hoffmanme@gao.gov, or John Sawyer at (202) 512-7215 or sawyerj@gao.gov

July 2023

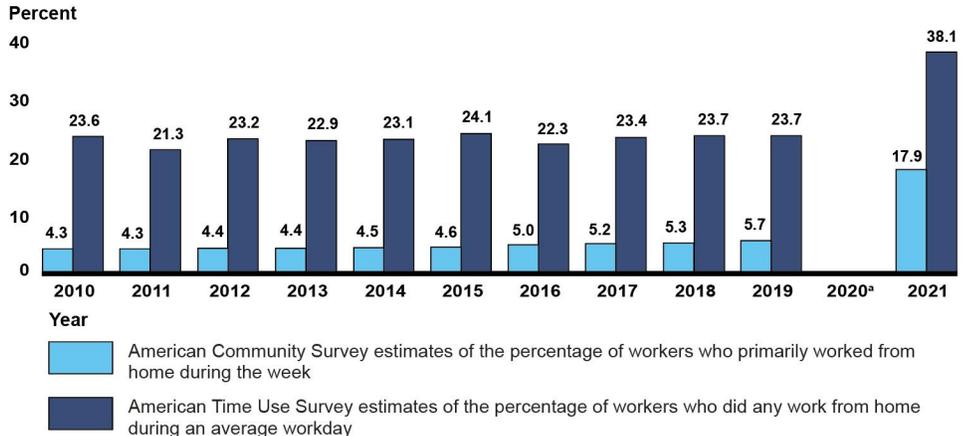
TELEWORK

Growth Supported Economic Activity during the Pandemic, but Future Impacts Are Uncertain

What GAO Found

The percentage of workers who worked from home (teleworked) rose sharply between 2019 and 2021 (see figure). The increase was concentrated among workers with higher earnings and education and in certain occupations, according to GAO's analysis of nationally representative survey data. Specifically, GAO's analysis of the American Time Use Survey (ATUS) found that the estimated percentage of workers who teleworked for any portion of an average workday increased from 24 percent in 2019 to 38 percent in 2021. Similarly, GAO's analysis of the American Community Survey (ACS) found that the estimated percentage of workers who primarily teleworked in the prior work week more than tripled from 5.7 percent in 2019 to 17.9 percent in 2021. The extent of telework also varied across occupations. For example, 28 percent of workers in management and related occupations primarily worked from home in 2021 compared to 7.5 percent of workers in service occupations. Despite increases in telework, most workers did not telework in 2021.

Estimated Percentage of U.S. Workers Who Primarily Worked from Home and Who Did Any Work at Home on an Average Workday, and during the Week, 2010–2021



Source: GAO analysis of data from the Census Bureau's American Community Survey (ACS) and the Bureau of Labor Statistics' American Time Use Survey (ATUS). | GAO-23-105999

Accessible Data for Estimated Percentage of U.S. Workers Who Primarily Worked from Home and Who Did Any Work at Home on an Average Workday, and during the Week, 2010–2021

| Year | American Community Survey estimates of the percentage of workers who primarily worked from home during the week (percent) | American Time Use Survey estimates of the percentage of workers who did any work from home during an average workday (percent) |
|------|---|--|
| 2010 | 4.3 | 23.6 |
| 2011 | 4.3 | 21.3 |
| 2012 | 4.4 | 23.2 |
| 2013 | 4.4 | 22.9 |
| 2014 | 4.5 | 23.1 |

| Year | American Community Survey estimates of the percentage of workers who primarily worked from home during the week (percent) | American Time Use Survey estimates of the percentage of workers who did any work from home during an average workday (percent) |
|-------------------|--|---|
| 2015 | 4.6 | 24.1 |
| 2016 | 5 | 22.3 |
| 2017 | 5.2 | 23.4 |
| 2018 | 5.3 | 23.7 |
| 2019 | 5.7 | 23.7 |
| 2020 ^a | | |
| 2021 | 17.9 | 38.1 |

Source: GAO analysis of data from the Census Bureau’s American Community Survey (ACS) and the Bureau of Labor Statistics’ American Time Survey (ATUS). | GAO-23-105999

^aData for 2020 are not shown because ACS 2020 1-year data and the 2020 annual ATUS estimates failed to meet Census Bureau’s quality standards for publication.

Studies GAO reviewed found that telework generally had a positive impact on worker productivity and firm performance in certain sectors, but methodological issues complicate efforts to estimate its long-term impacts. For example, a study of a Chinese call center found that telework increased productivity by 13 percent. Some studies also found that telework mitigated the negative impact of the pandemic on firm performance and the economy. Estimating the long-term impacts of telework is difficult however because some economic effects may emerge only over time. For example, studies GAO reviewed identified potential cost savings from reduced office space needs and potential collaboration challenges that could impact worker productivity or firm performance in the longer run.

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Abbreviations

| | |
|------|----------------------------|
| BLS | Bureau of Labor Statistics |
| ATUS | American Time Use Survey |
| ACS | American Community Survey |

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July 26, 2023

The Honorable Bobby Scott
Ranking Member
Committee on Education and the Workforce
House of Representatives

The Honorable Jamie Raskin
Ranking Member
Committee on Oversight and Accountability
House of Representatives

The Honorable Mark DeSaulnier
Ranking Member
Subcommittee on Health, Employment, Labor and Pensions
Committee on Education and the Workforce
House of Representatives

For many years, employers have used telework to manage their business operations and to promote a better work-life balance for their employees.¹ More recently, telework became an important part of the national response to the COVID-19 pandemic, which emerged in the United States in early 2020.² While many offices and businesses allowed employees to telework extensively to help employees stay safe and assist the nation in combatting the pandemic, this expansion in telework was an abrupt and unprecedented change in the nature of work. The ongoing use of telework, even in the absence of many of the initial challenges presented by the onset of the COVID-19 pandemic, has raised questions and concerns about its effects on workers, businesses, and the economy.

You requested that GAO conduct a review of the impact of telework, both as it pertains to the workforce and various sectors of the economy. This report represents the first in a series of reports that will respond to this

¹In this report, telework refers to a flexible work arrangement under which employees perform their duties from a worksite, often at home, other than the location from which they would otherwise work.

²On January 31, 2020, the Department of Health and Human Services declared a public health emergency for COVID-19 in the United States. The public emergency was lifted on May 11, 2023.

request, and examines (1) changes in the extent of telework in the United States before and during the pandemic, and (2) reported impacts of teleworking on worker productivity and firm performance.³ Our subsequent reports will focus on public policies affecting telework, and how telework has affected various sectors, including housing and transportation, among other issues.

To address our first objective, we analyzed two nationally representative datasets: the Bureau of Labor Statistics' (BLS) *American Time Use Survey* (ATUS) and the Census Bureau's *American Community Survey* (ACS).⁴ We used ATUS and ACS data to describe trends in the use of telework from 2010 through 2021, the most recent data available at the time that we completed our analysis in May 2023, and to describe the growth of telework by select worker characteristics during the years 2019 and 2021, the time period in which the COVID-19 pandemic began. We excluded ATUS and ACS data from 2020 because the ACS year 2020 data and ATUS 2020 annual estimates failed to meet the Census Bureau's quality standards for publication due to the impact of the COVID-19 pandemic on data collection.

To assess the reliability of these datasets, we interviewed BLS officials with knowledge of both the ATUS and ACS data. Also, to ensure the robustness and consistency of our results, we performed analyses using different measures of telework from ATUS and ACS. In addition, we compared our results with peer-reviewed studies and official reports such as those from BLS. We found that the data were sufficiently reliable for the purposes of our reporting objectives.

³A firm is a business entity that produces goods and services to make a profit.

⁴The annual American Time Use Survey (ATUS), sponsored by the Bureau of Labor Statistics and conducted by the Census Bureau, provides annual, nationally representative estimates of the amount of time people spend doing various activities such as paid work, child care, volunteering, and socializing. For this report, we use ATUS's measure of the percentage of respondents who worked from or near their home for any amount of time on the previous day. The Census Bureau's American Community Survey (ACS) is a national survey that annually collects population and housing information from a random sample of about 3.5 million households. For this report, we use ACS's measure of the percentage of workers who primarily worked from home over the past week.

To better understand the impact of telework on worker productivity and firm performance, we conducted a review of relevant empirical research.⁵ To ensure that we identified an appropriate number of relevant studies with strong causal research design, we included studies from the United States and other countries and included both public and private sector workers. We identified 181 studies and reports from a literature search using related keywords such as “telework” or “work from home” and “productivity” or “firm performance” in various databases such as EconLit, Business Source Corporate Plus, and ProQuest Dialog.⁶ We focused specifically on studies and reports published between 2015 and 2022 that examined the relationship between telework or flexible work arrangements and various measures of worker productivity and firm performance. We chose this time period to ensure an appropriate number of recent and relevant studies for further review. We developed a shortlist of 71 studies based on review of the abstracts of 181 studies.

When reviewing the shortlisted studies, we evaluated the quality and robustness of their methodology. For example, we examined whether each study included a relevant control group. We also evaluated the validity and robustness of the key outcome indicators used for each study. For example, we examined whether the studies used small sample sizes or outcome indicators that may not effectively measure productivity. We prioritized studies with a strong causal research design that included an appropriate control group. We also considered the studies’ relevance to our objective to provide additional contextual information as corroborating evidence.

Forty-four studies met our criteria for inclusion in the literature review. We used 32 of these 44 studies to provide primary supporting evidence for our findings related to the impacts of telework on worker productivity and firm performance. We used 12 of these 44 studies to provide additional contextual information as corroborating evidence. Appendix I provides a more detailed description of the objectives, scope, and methodology of our review.

⁵We will describe later in the report the methodological challenges of assessing the impacts of telework on worker productivity during the COVID-19 pandemic and in the longer run.

⁶EconLit, Business Source Corporate Plus, and ProQuest Dialog are library databases that contain scholarly economic, business, and other more general trade literature.

We conducted this performance audit from April 2022 to July 2023 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

Practice of Telework

With the advancement of information technology, employers are able to allow employees to telework on regularly scheduled days or on unscheduled days or hours in response to a situational need such as inclement weather or personal well-being. Telework usually includes a work arrangement where an employee works from an alternative location mutually agreeable to the employee and the employer, such as a telework site or an employee's home. Actual telework arrangements may vary in that employees may be able to telework beyond their routine work hours, or employees may be able to work at a worksite other than their home.

The term telework is often used interchangeably with terms such as remote work, work from home, virtual work, telecommute, or flexi-work to refer to various telework arrangements.⁷ For example, telework sometimes is used to describe hybrid arrangements that include both work at home and at an office.

Whether an employee's tasks or duties are suitable for telework is an important factor employers consider in whether and how to implement telework. For example, jobs where tasks primarily involve working on a computer are typically more suitable for telework compared to certain service industry jobs requiring direct contact with customers. Employers may consider many other factors in their decision regarding whether and how to implement telework such as retention of employees. Moreover,

⁷While these different terms are not synonymous, unless otherwise specified, we will use telework as a collective term to describe the various telework arrangements referred to by these other terms including work from home, remote work, virtual work, telecommuting, flexi-work, work from everywhere, or hybrid work throughout this report.

researchers have attempted to classify occupations based on their relative suitability for telework.⁸

Worker Productivity and Firm Performance

According to BLS, across the U.S. economy as a whole, aggregate worker or labor productivity is defined as real output (amount or real value of goods or services produced) divided by labor hours (total number of work hours).⁹ At an individual level, employers may assess workers' productivity by calculating some measure of their output per work hour. For example, in a call center business, the employer may measure the workers' productivity by observing the average calls by hour. However, in businesses or occupations where outputs are harder to measure, subjective evaluations are often used.

A firm's performance can also be measured in various ways. Researchers often use financial indicators such as profits, sales, and stock market performance for this purpose, as well as other measures such as retention, attrition, recruitment, or innovation to assess a firm's performance.

⁸For example, one study classified the feasibility of working from home for all occupations and found that 37 percent of all U.S. jobs could be performed entirely at home, with significant variation across cities and industries. See Jonathan I. Dingel and Brent Neiman, "How Many Jobs Can be Done at Home?" NBER Working Paper No. 26948 (April 2020). Another study found that rates of lost work during the COVID-19 pandemic varied by an occupation's suitability for telework. Matthew Dey, Harley Frazis, David S. Piccone Jr, and Mark A. Loewenstein, "Teleworking and Lost Work during the Pandemic: New Evidence from the CPS," *Monthly Labor Review* (Bureau of Labor Statistics, July 2021).

⁹For example, BLS calculates labor productivity for the nonfarm business sector by combining real output from the National Income and Product Accounts produced by the Bureau of Economic Analysis with BLS's measures of hours worked for all persons. The primary source of data on hours is the average-weekly-hours-paid series for production workers in goods-producing industries and for nonsupervisory workers in service-providing industries.

Telework Grew Significantly between 2019 and 2021 and Was Concentrated among Certain Workers, Industries, and Occupations

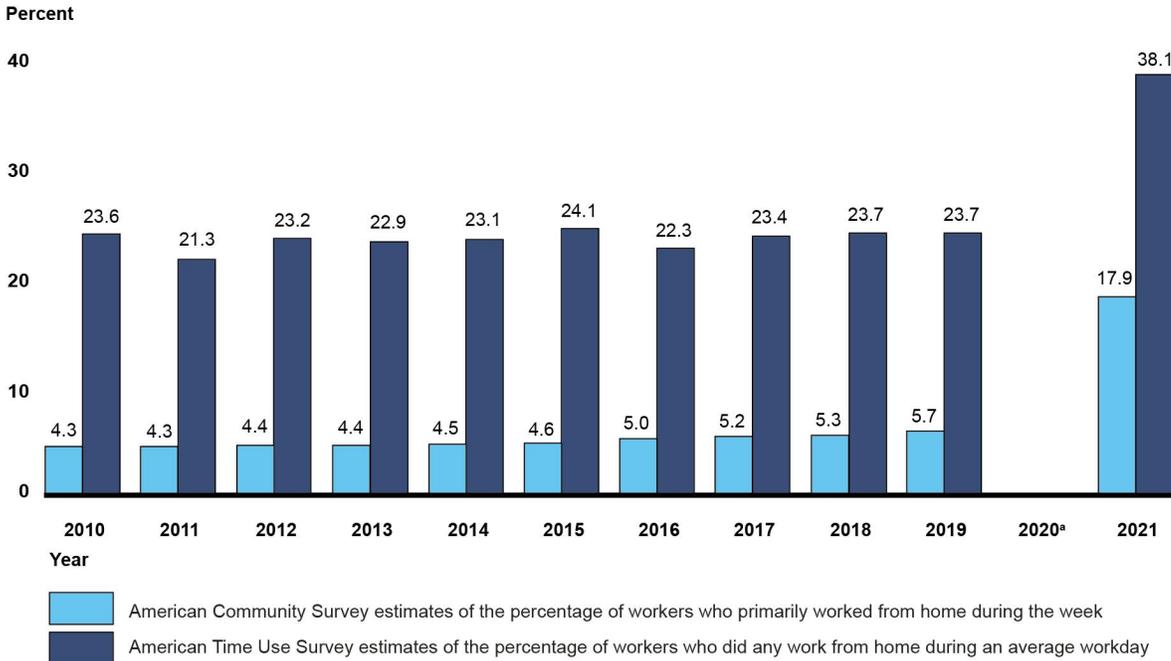
Telework Increased Substantially between 2019 and 2021, Although Most Workers Continued In-person Work According to Recent Survey Data

The percentage of U.S. workers who teleworked increased substantially between 2019 and 2021 compared to the decade preceding the pandemic; however, most continued in-person work on most days in 2021, according to two surveys we examined (see fig. 1).¹⁰ Specifically, American Community Survey (ACS) data showed that the percentage of workers who primarily teleworked during the week more than tripled from an estimated 5.7 percent in 2019 to an estimated 17.9 percent in 2021. The American Time Use Survey (ATUS) showed that the percentage of workers who teleworked for any portion of an average workday increased by 14 percentage points, from an estimated 24 percent in 2019 to an estimated 38 percent in 2021. These two measures reflect a range of telework experiences: the ACS measure provides a conservative estimate of the number of teleworkers because it excludes people who work at home on an occasional basis, while the ATUS measure provides a more expansive estimate of telework because it includes those who only spend short periods of time working at home.¹¹

¹⁰Data from 2021 is the most recent data available for the ACS and ATUS at the time of our reporting. See appendix I for more information.

¹¹For more information on the telework measures used in this report, as well as an alternate measure of telework based on ATUS that shows comparable levels of telework to the ACS measure, see appendix II.

Figure 1: Estimated Percentage of Workers Who Primarily Worked from Home and Estimated Percentage Who Did Any Work at Home on an Average Workday, and during the Week, 2010–2021



Source: GAO analysis of data from the Census Bureau's American Community Survey (ACS) and the Bureau of Labor Statistics' American Time Use Survey (ATUS). | GAO-23-105999

Accessible Data for Figure 1: Estimated Percentage of Workers Who Primarily Worked from Home and Estimated Percentage Who Did Any Work at Home on an Average Workday, and during the Week, 2010–2021

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|-------------------|---|--|
| 2010 | 4.3 | 23.6 |
| 2011 | 4.3 | 21.3 |
| 2012 | 4.4 | 23.2 |
| 2013 | 4.4 | 22.9 |
| 2014 | 4.5 | 23.1 |
| 2015 | 4.6 | 24.1 |
| 2016 | 5 | 22.3 |
| 2017 | 5.2 | 23.4 |
| 2018 | 5.3 | 23.7 |
| 2019 | 5.7 | 23.7 |
| 2020 ^a | | |
| 2021 | 17.9 | 38.1 |

Source: GAO analysis of data from the Census Bureau's American Community Survey (ACS) and the Bureau of Labor Statistics' American Time Use Survey (ATUS). | GAO-23-105999

Note: The bars for the American Time Use Survey show the annual average estimated percentage of respondents who participated in work at home, on an average day, among those who were employed, on days they worked. Respondents who indicated that they performed work (for their main job) at their home for any amount of time on a diary report of the previous 24 hour day were classified as teleworkers. This measure includes "incidental" work from home (for example, people who conduct 15 minutes of work from home, potentially unpaid, after a workday in the office). The bars for the American Community Survey show the estimated percentage of respondents who are identified as teleworking based on their response to a question about their primary means of transportation to work over the past week. We classified respondents who replied "worked from home" as teleworkers. Margins of error for all estimates in this figure are within +/- 2 percentage points.

^aData for 2020 are not shown because, due to the impact of the COVID-19 pandemic on data collection, the ACS 2020 1-year data and the 2020 annual ATUS estimates failed to meet Census Bureau's quality standards for publication.

Unlike the significant increase in telework between 2019 and 2021—driven largely by the pandemic—the decade prior to the pandemic showed no increase or a gradual increase in telework, depending on the telework measure. For example, the ATUS showed that the estimated percentage of workers who worked from home for any amount of time during an average day remained about the same at 24 percent between 2010 and 2019. Conversely, according to the ACS, the estimated percentage of workers who primarily worked from home gradually grew from 4.3 percent in 2010 to 5.7 percent in 2019.

While the measures for ACS and ATUS show a significant economy-wide increase in telework in response to the pandemic, most workers did not telework on most days in 2021. Using ATUS data, we found that less than an estimated 40 percent of all workers teleworked for any amount of time during an average day in 2021. This may reflect a range of possibilities including that the work for many jobs either could not readily be conducted from home, or telework was not permitted or encouraged by employers.

Growth in Telework between 2019 and 2021 Was Concentrated among Workers with Higher Earnings and More Education, and in Certain Industries and Occupations

Earnings

Prior to the pandemic, in 2019, we found that workers with higher earnings were far more likely to telework than those with lower earnings, and this gap in telework between workers in different earnings quartiles

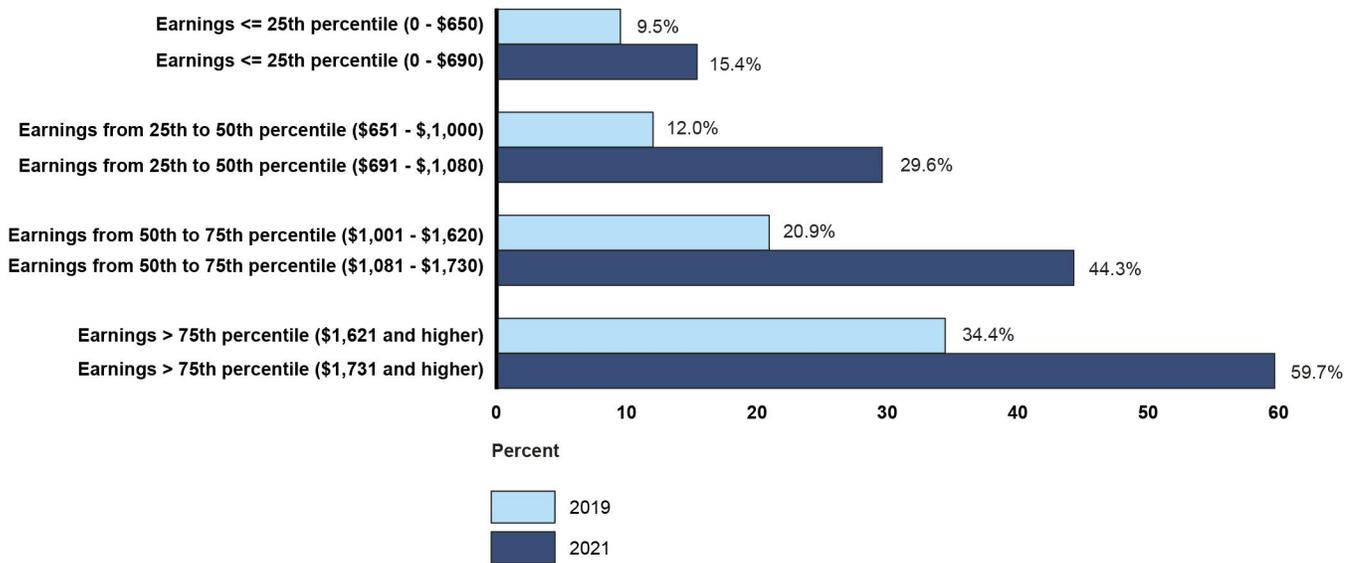
increased between 2019 and 2021.¹² For example, less than 10 percent of workers in the lowest quartile of earners (those earning \$650 or less per week) teleworked on an average day in 2019. In comparison, an estimated 21 percent of workers in the third quartile (those earning \$1,001 to \$1,620 or over per week) teleworked, and over a third (34 percent) of workers in the top quartile of earners teleworked (those earning over \$1,620 per week) (see fig. 2).

While telework increased significantly in every quartile between 2019 and 2021, the largest percentage point growth occurred among the highest earners. For example, the percentage of workers in the lowest quartile of earnings who teleworked grew by about 6 percentage points between 2019 and 2021, compared to an estimated 25 percentage point growth for workers in the highest earning quartile for the same period (see fig. 2).

¹²For our analyses of telework by earnings, we measured telework using the ATUS estimate of the percentage of workers who did any work from their home during the previous day's 24 hour diary period, on days they were employed at their main job. This measure is our least restrictive measure of telework as it includes incidental, and potentially unpaid, work at home. We use this measure because the ACS data tables for means of transportation to work—the source for our more restrictive measure of telework, the percentage of workers who worked from home most days of the week—contain less useful measures of earnings than the American Time Use Survey; see appendix I for more information. Earnings estimates represent the usual weekly earnings of full-time wage and salary workers with one job only, before taxes and other deductions, and including any overtime pay, commissions, or tips usually received.

Figure 2: Estimated Percentage of Workers Who Did Any Work at Home on an Average Day, 2019 and 2021, by Quartiles of Weekly Earnings

Telework by earnings



Source: GAO analysis of Bureau of Labor Statistics' American Time Use Survey data. | GAO-23-105999

Accessible Data for Figure 2: Estimated Percentage of Workers Who Did Any Work at Home on an Average Day, 2019 and 2021, by Quartiles of Weekly Earnings

- 2019 Earnings <= 25th percentile (0 - \$650): 9.5%
- 2021 Earnings <= 25th percentile (0 - \$690): 15.4%
- 2019 Earnings from 25th to 50th percentile (\$651 - \$1,000) 12%
- 2021 Earnings from 25th to 50th percentile (\$691 - \$1,080) 29.6%
- 2019 Earnings from 50th to 75th percentile (\$1,001 - \$1,620) 20.9%
- 2021 Earnings from 50th to 75th percentile (\$1,081 - \$1,730) 44.3%
- 2019 Earnings > 75th percentile (\$1,621 and higher) 34.4%
- 2021 Earnings > 75th percentile (\$1,731 and higher) 59.7%

Source: GAO analysis of Bureau of Labor Statistics' American Time Use Survey data. | GAO-23-105999

Note: Data for 2020 are not shown because, due to the impact of the COVID-19 pandemic on data collection, the Census Bureau did not publish 2020 annual American Time Use Survey (ATUS) estimates. The telework measure by earnings shows the annual average estimated percentage of employees who did any of their work at home, on an average day, among those who were employed full time, on days worked at their main job, among wage and salary workers who were single jobholders. This measure captures "incidental" work from home (for example, people who conduct 15 minutes of unpaid work from home at the end of a workday in the office) and therefore indicates a

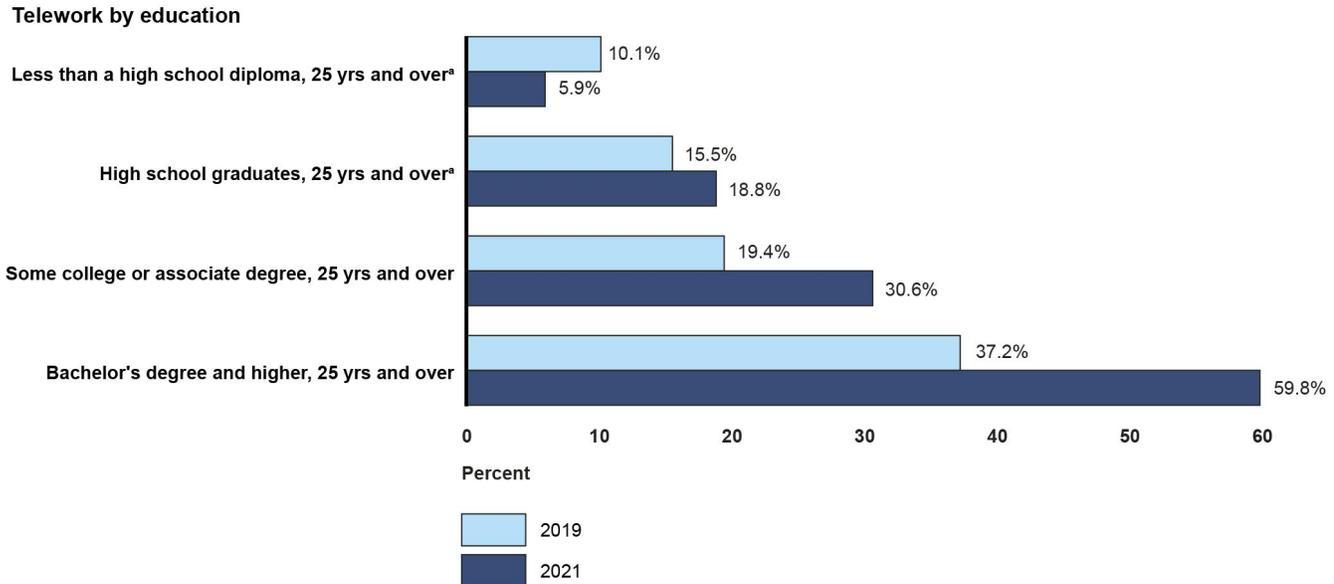
higher overall incidence of working from home than measures that avoid the inclusion of “incidental” work; see appendix II for more detail. Earnings estimates represent the usual weekly earnings of full-time wage and salary workers with one job only. Within every earnings category, increases in telework from 2019 to 2021 were statistically significant. All differences in telework across earnings categories within a year are statistically significant except for the difference between the first and second quartile of earners in 2019. All earnings ranges are reported in nominal dollars. Margins of error for all estimates in this figure are within +/- 4.9 percentage points.

Education

Prior to the pandemic, in 2019, workers with more years of education engaged in telework at a higher rate than workers with fewer years of formal education, and these gaps increased from 2019 to 2021.¹³ For example, about 10 percent of workers with less than a high school diploma teleworked on an average day in 2019, compared to an estimated 19 percent of workers with some college or an associate’s degree, and an estimated 37 percent of workers with a bachelor’s degree or higher (see fig. 3). From 2019 to 2021, among workers with less than a high school diploma and workers with only a high school diploma, there was not a statistically significant change in the percentage who teleworked. In contrast, among workers with some college or an associate’s degree, the percentage who teleworked increased by an estimated 11 percentage points between 2019 and 2021. In addition, among workers with a bachelor’s degree or higher, the percentage of workers who teleworked increased by almost 23 percentage points between 2019 and 2021 (see fig. 3).

¹³For our analyses of telework by education, we measured telework using the ATUS estimate of the percentage of employed workers who did any work from their home on an average day, on days they worked. This measure is our least restrictive measure of telework as it includes incidental, and potentially unpaid, work at home. We use this measure because the ACS data tables for means of transportation to work—the source for our more restrictive measure of telework, the percentage of workers who primarily worked from home during the week—does not contain any information on means of transportation to work by educational attainment.

Figure 3: Estimated Percentage of Workers Who Did Any Work at Home on an Average Day, 2019 and 2021, by Education, for Individuals 25 Years Old and Over



Source: GAO analysis of Bureau of Labor Statistics' American Time Use Survey data. | GAO-23-105999

Accessible Data for Figure 3: Estimated Percentage of Workers Who Did Any Work at Home on an Average Day, 2019 and 2021, by Education, for Individuals 25 Years Old and Over

| Telework by education | 2019 | 2021 |
|---|-------|-------|
| Less than a high school diploma, 25 years and over ^a | 10.1% | 5.9% |
| High school graduates, 25 years and over ^a | 15.5% | 18.8% |
| Some college or associate degree, 25 years and over | 19.4% | 30.6% |
| Bachelor's degree and higher, 25 years and over | 37.2% | 59.8% |

Source: GAO analysis of Bureau of Labor Statistics' American Time Use Survey data. | GAO-23-105999

Note: Data for 2020 are not shown because, due to the impact of the COVID-19 pandemic on data collection, the Census Bureau did not publish 2020 annual American Time Use Survey (ATUS) estimates. The telework measure by education shows the annual average estimated percent of employees who did any of their work at home, on an average day, among those who were employed on days they worked. This measure captures "incidental" work from home (for example, people who conduct 15 minutes of unpaid work from home at the end of a workday in the office) and therefore indicate a higher overall incidence of working from home than measures that avoid the inclusion of "incidental" work; see appendix II for more detail.

^aAll differences across education categories within a year are statistically significant, except for the difference between those with less than a high school diploma and high school graduates, and high school graduates compared to those with some college or an associate's degree in 2019. Margins of error for all estimates in this figure are within +/- 6.3 percentage points.

Industry

While telework increased across all industries as a result of the pandemic, certain industries experienced much greater growth than others.¹⁴ For example, in 2019, the estimated percentage of workers who primarily teleworked was under 5 percent in six out of 11 major industries.¹⁵ In particular, about 3.5 percent of workers in the manufacturing industry primarily teleworked—since many jobs in manufacturing do not lend themselves to telework. In the remaining five industries, the percentage of workers who primarily teleworked ranged from an estimated 7 percent (in wholesale trade) to an estimated 13 percent (in the professional, scientific, and management services industries) (see fig. 4). Thus, even in those industries with the highest rates of telework, close to 90 percent of workers did not primarily telework.

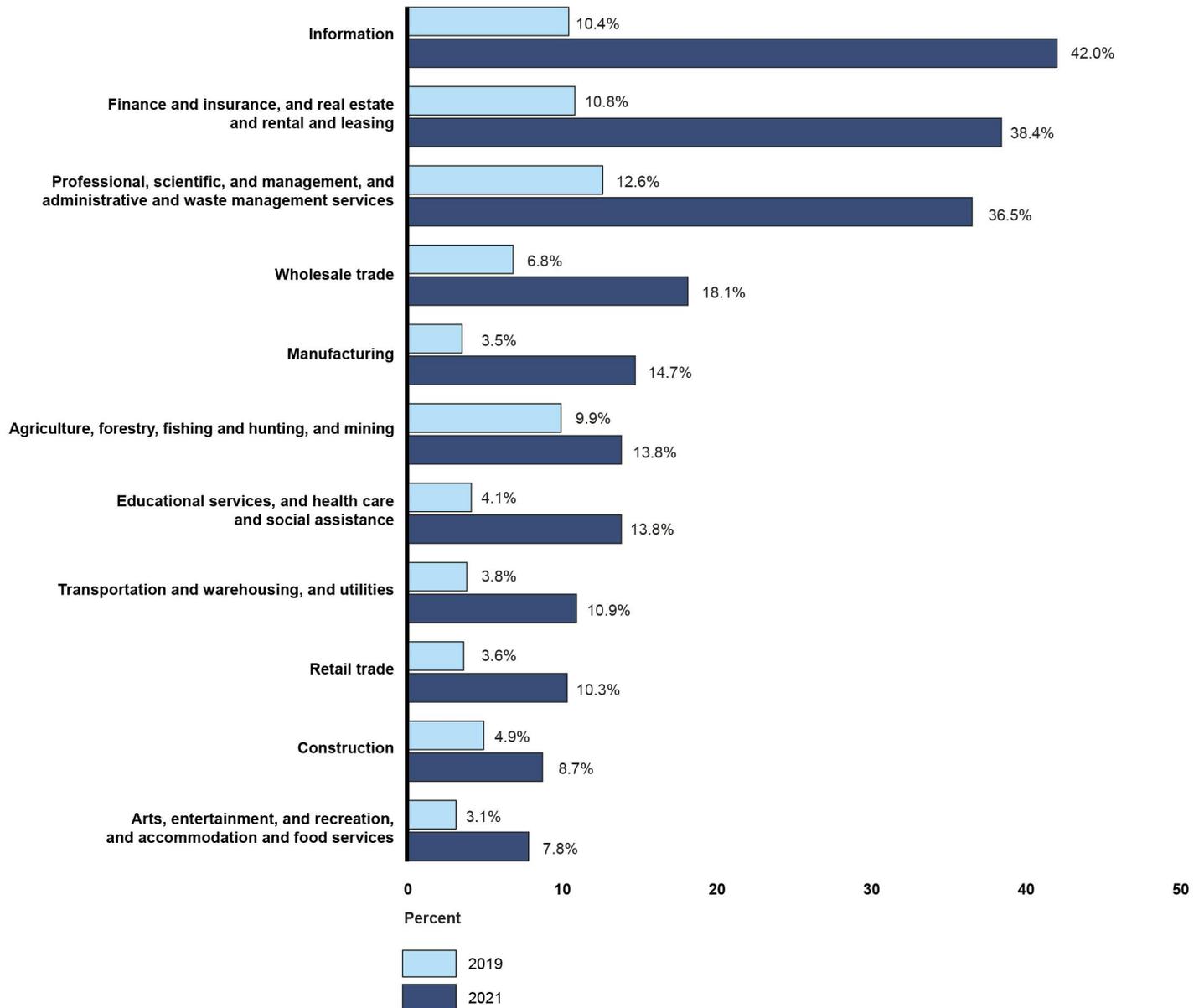
Well after the onset of the COVID-19 pandemic, in 2021, over one-third of workers in the three industries with the highest rates of telework primarily teleworked. Specifically, an estimated 42 percent of workers in the information industry teleworked, as well as an estimated 38 percent of workers in the finance, insurance, and real estate and rental and leasing industry (see fig. 4). In contrast, less than 10 percent of workers in some industries (such as the construction industry, and the arts, entertainment,

¹⁴For our analyses of telework by industry, we measured telework using the ACS, our more conservative measure of telework. Where possible, we used the ACS measure to analyze the variation in telework prevalence across groups because it does not include incidental telework. For more information, see Appendix I. In addition to the findings of cross-industry variation presented here, it is important to note the prevalence of within-industry variation also. BLS's *2021 Business Response Survey* found variation of prevalence of telework within the same industry. For example, businesses paying a high average wage in the same industry used more telework than those paying a lower wage. See Michael Dalton and Jeffrey A. Groen, "Telework during the COVID-19 Pandemic: Estimates using the 2021 Business Response Survey," *Monthly Labor Review* (Bureau of Labor Statistics, March 2022).

¹⁵Industries are broad groupings of firms that are grouped together based on the type of product or service that the firms create. Thus, many different types of jobs exist within each industry. For example, the construction industry contains all workers who are employed by construction firms: this includes workers physically involved in construction, as well as the managers, office support staff, and other workers who are employed by construction firms. We report on 11 major industries in this report. We do not include data on public administration and armed forces in our figures, because the focus of this objective is the private sector civilian labor force. However, for reference, in the public administration industry category, the percentage of workers who primarily worked from home rose from 3 percent in 2019 to 19.8 percent in 2021. We excluded the "other services" category because it is a miscellaneous category that contains workers employed in widely varied industries.

recreation, and accommodation and food services industry) primarily teleworked in 2021.

Figure 4: Estimated Percentage of Workers Who Primarily Worked from Home during the Week, by Industry, 2019 and 2021



Source: GAO analysis of Census Bureau's American Community Survey data. | GAO-23-105999

Accessible Data for Figure 4: Estimated Percentage of Workers Who Primarily Worked from Home during the Week, by Industry, 2019 and 2021

| Category | 2019 | 2021 |
|--|-------|-------|
| Information | 10.4% | 42% |
| Finance and insurance, and real estate and rental and leasing | 10.8% | 38.4% |
| Professional, scientific, and management, and administrative and waste management services | 12.6% | 36.5% |
| Wholesale trade | 6.8% | 18.1% |
| Manufacturing | 3.5% | 14.7% |
| Agriculture, forestry, fishing and hunting, and mining | 9.9% | 13.8% |
| Educational services, and health care and social assistance | 4.1% | 13.8% |
| Transportation and warehousing, and utilities | 3.8% | 10.9% |
| Retail trade | 3.6% | 10.3% |
| Construction | 4.9% | 8.7% |
| Arts, entertainment, and recreation, and accommodation and food services | 3.1% | 7.8% |

Source: GAO analysis of Census Bureau's American Community Survey data. | GAO-23-105999

Note: Data for 2020 are not shown because, due to the impact of the COVID-19 pandemic on data collection, the American Community Survey (ACS) 2020 1-year data failed to meet Census Bureau's statistical quality standards. Respondents are identified as teleworking based on their response to a question about their primary means of transportation to work over the past week. Respondents who replied "worked from home" are classified as teleworkers. All changes from 2019 to 2021 are statistically significant. American Community Survey industry categories are defined in the ACS 2021 code list in this document on pages 32- 41: <https://www.census.gov/programs-surveys/acs/technical-documentation/code-lists.html>. The following industries are not included in this figure: public administration, armed forces, and other services (excluding public administration). We excluded public administration and armed forces because the focus of this report is the private sector civilian labor force. We excluded the "other services" category because it is a miscellaneous category that contains workers employed in widely varied industries. Margins of error for all estimates in this figure are within +/- 0.8 percentage points.

Occupation

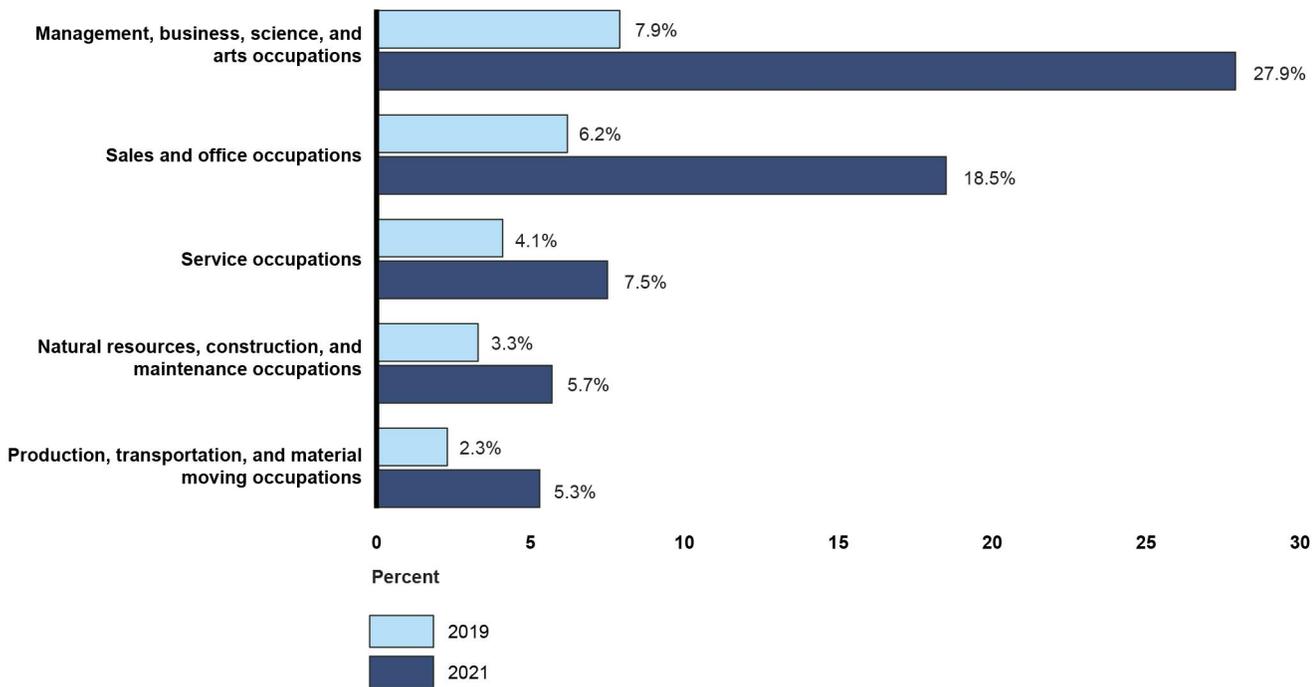
Rates of telework also increased across all occupations between 2019 and 2021, but certain occupations experienced much greater growth than others.¹⁶ Prior to the pandemic, in 2019, the percentage of workers who primarily worked from home ranged from an estimated 2 to 8 percent,

¹⁶For our analyses of telework by occupation we measured telework using ACS, our more conservative measure of telework. Where possible, we used the ACS measure to analyze the variation in telework prevalence across groups because it does not include incidental telework. For more information, see appendix I. It should be noted that occupations with low rates of telework are not necessarily characterized by work that is inherently difficult to perform from home; low rates of telework in individual firms or in specific occupations may reflect management priorities that are unrelated to how feasible it is to perform work from home, among other cultural- and preference-related issues.

depending on the broad occupational category.¹⁷ The lowest rates of telework in 2019 were found among workers in production, transportation, and material moving—these occupations do not readily lend themselves to telework, as they rely heavily on the physical presence of workers. In 2021, only about 5 percent of workers in these occupations primarily worked from home. The highest rate of telework in 2019 was found in the broad occupational category that included management, business, science, and arts occupations. In this occupational category, almost 28 percent of workers primarily teleworked in 2021 after the onset of the COVID-19 pandemic (see fig. 5).

¹⁷This analysis uses five broad occupational classifications because these are the categories that are available in the ACS public tables with data on primary mode of transportation to work, which was our source for identifying workers who primarily worked from home during the week. We excluded “military specific occupations” from this percentage because the focus of this objective is the private sector civilian labor force. These broad categories aggregate multiple finer occupational categories, likely masking considerable variation in telework penetration across finer occupational groups. In contrast to industries, occupations refer specifically to the kind of work that a person does on the job. Occupational groupings are more directly predictive of whether the jobs in that grouping are suitable to telework, compared to industrial groupings which reflect the type of output a firm creates.

Figure 5: Estimated Percentage of Workers Who Primarily Worked from Home during the Week, by Occupation, 2019 and 2021



Source: GAO analysis of Census Bureau's American Community Survey data. | GAO-23-105999

Accessible Data for Figure 5: Estimated Percentage of Workers Who Primarily Worked from Home during the Week, by Occupation, 2019 and 2021

| Category | 2019 (percent) | 2021 (percent) |
|--|----------------|----------------|
| Management, business, science, and arts occupations | 7.9 | 27.9 |
| Sales and office occupations | 6.2 | 18.5 |
| Service occupations | 4.1 | 7.5 |
| Natural resources, construction, and maintenance occupations | 3.3 | 5.7 |
| Production, transportation, and material moving occupations | 2.3 | 5.3 |

Source: GAO analysis of Census Bureau's American Community Survey data. | GAO-23-105999

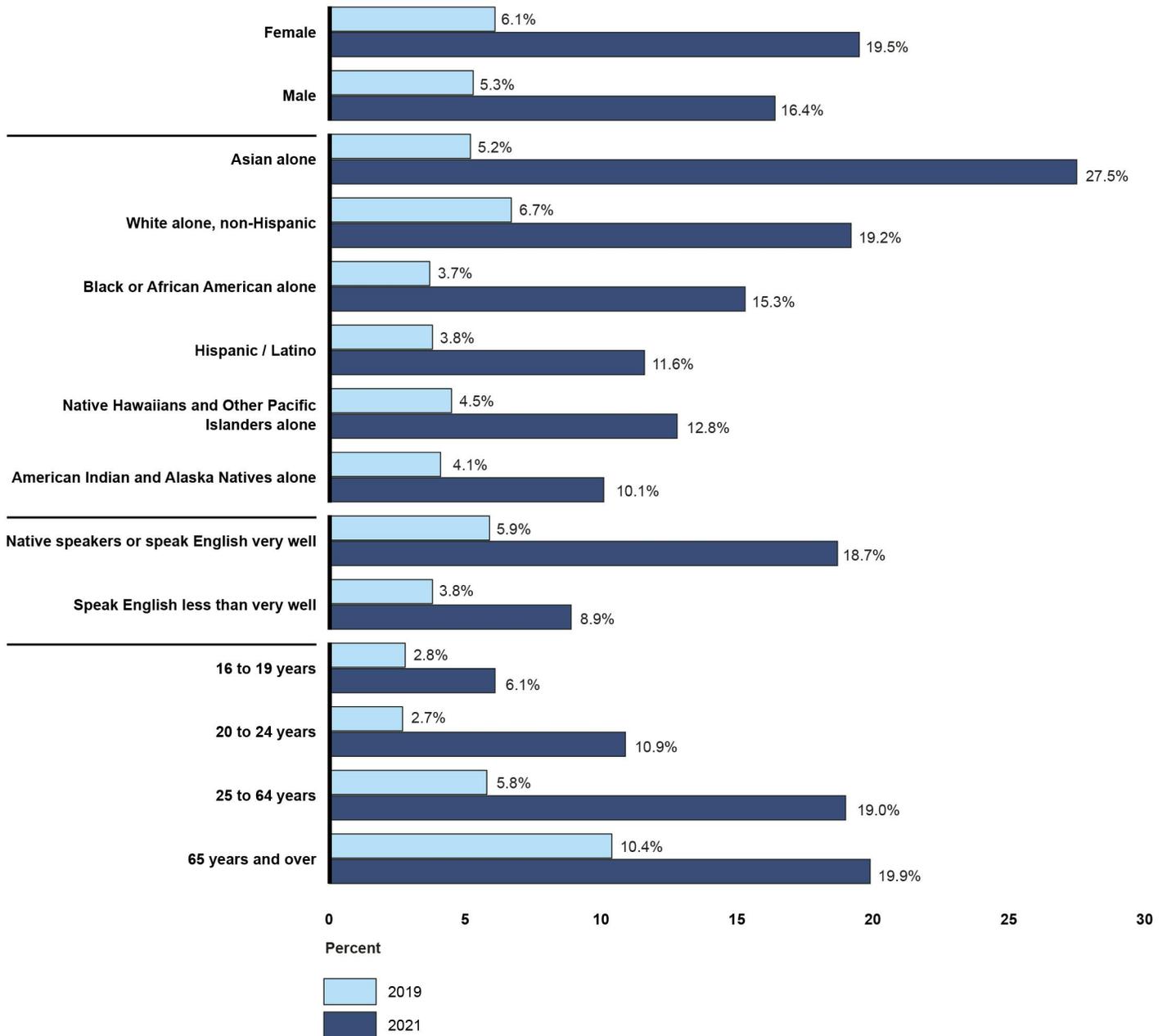
Note: Data for 2020 are not shown because, due to the impact of the COVID-19 pandemic on data collection, the American Community Survey (ACS) 2020 1-year data failed to meet Census Bureau's quality standards for publication. Respondents are identified as teleworking based on their response to a question about their primary means of transportation to work over the past week. Respondents who replied "worked from home" are classified as teleworkers. All changes from 2019 to 2021 are statistically significant. We excluded "military specific occupations" from this figure because the focus of this objective is the private sector civilian labor force. American Community Survey occupation categories are defined in this document on pages 78-92: https://www2.census.gov/programs-surveys/acs/tech_docs/code_lists/2021_ACS_Code_Lists.pdf. Margins of error for all estimates in this figure are within +/- 0.16 percentage points.

Prevalence of Telework Varied by Race, Ethnicity, and Other Demographic Characteristics

The onset of the pandemic created large gaps in the prevalence of telework across workers of different genders, races, ethnicities, ages, and other demographic characteristics that had not been present before the pandemic.¹⁸ For example, an estimated 20 percent of women and 16 percent of men primarily teleworked in 2021, compared to about 6 percent and 5 percent, respectively in 2019 (see fig. 6). By race and ethnicity, an estimated 28 percent of Asian workers primarily teleworked in 2021, compared to an estimated 19 percent of White workers (who are not Hispanic or Latino), and an estimated 15 percent of Black or African American workers; in all other groups 13 percent or less primarily teleworked. In contrast, prior to the pandemic in 2019, there was only about a 1 to 1.5 percent gap between the percent of Asian workers who primarily teleworked, and any other racial or ethnic group. Figure 6 provides further illustrations of differences in telework across other demographic characteristics.

¹⁸For our analyses of telework by demographic characteristics, we measured telework using the ACS, our more conservative measure of telework. Where possible, we used the ACS measure to analyze the variation in telework prevalence across groups because it does not include incidental telework. For more information, see appendix I. In this report, we use the terms “women” and “men” to describe female and male workers, and we use the term “gender” rather than “sex.” The ACS data we analyzed includes demographic information based on sex as defined by female and male and does not include additional information on gender identity.

Figure 6: Estimated Percentage of Workers Who Primarily Worked from Home during the Week, by Gender, Race, Ethnicity, Language at Home, and Age, 2019–2021



Source: GAO analysis of Census Bureau's American Community Survey data. | GAO-23-105999

Accessible Data for Figure 6: Estimated Percentage of Workers Who Primarily Worked from Home during the Week, by Gender, Race, Ethnicity, Language at Home, and Age, 2019–2021

| Category | 2019 (percent) | 2021 (percent) |
|--|----------------|----------------|
| Female | 6.1 | 19.5 |
| Male | 5.3 | 16.4 |
| Asian alone | 5.2 | 27.5 |
| White alone, non-Hispanic | 6.7 | 19.2 |
| Black or African American alone | 3.7 | 15.3 |
| Hispanic / Latino | 3.8 | 11.6 |
| Native Hawaiians and Other Pacific Islanders alone | 4.5 | 12.8 |
| American Indian and Alaska Natives alone | 4.1 | 10.1 |
| Native speakers or speak English "very well" | 5.9 | 18.7 |
| Speak English less than "very well" | 3.8 | 8.9 |
| 16 to 19 years | 2.8 | 6.1 |
| 20 to 24 years | 2.7 | 10.9 |
| 25 to 64 years | 5.8 | 19 |
| 65 years and over | 10.4 | 19.9 |

Source: GAO analysis of Census Bureau's American Community Survey data. | GAO-23-10

Note: Data for 2020 are not shown because, due to the impact of the COVID-19 pandemic on data collection, the American Community Survey (ACS) 2020 1-year data failed to meet Census Bureau's quality standards for publication. Respondents are identified as teleworking based on their response to a question about their primary means of transportation to work over the past week. Respondents who replied "worked from home" are classified as teleworkers. All changes from 2019 to 2021 are statistically significant. The "White" category in this figure refers specifically to people who are White alone (no other race), and non-Hispanic. The "African American", "Asian", "American Indians and Alaska Natives", and "Native Hawaiians and other Pacific Islanders" categories each refer to people who report that race group and no other. The "Hispanic/Latino" category includes people who may be of any race. These categories are not mutually exclusive, because each race group (except for White alone, non-Hispanic) may include Hispanic and non-Hispanic people. Respondents reporting "some other race" and respondents who reported two or more races are excluded from this figure due to significant changes in how the multi-racial population was surveyed between 2019 and 2021. Margins of error for all estimates in this figure are within +/- 0.6 percentage points, except for the estimate for Native Hawaiians and other Pacific Islanders, which has a maximum margin of error of +/-1.5 percentage points. See appendix I for more information.

Studies Found Telework Generally Had a Positive Impact on Worker Productivity and Firm Performance in Certain Settings, but Long-term Impacts Are Uncertain

Studies on Telework before the COVID-19 Pandemic Found a Modest Increase in Worker Productivity in Certain Industries

Eight studies we reviewed found a modest increase in worker productivity from telework in certain settings, primarily prior to the COVID-19 pandemic, using a number of different measurements.¹⁹ For example, a study that used objective measurements to assess the impact of telework on productivity of a Chinese call center found that productivity as measured by calls resolved increased by 13 percent.²⁰ In addition, a

¹⁹We found that these eight studies, from among the 44 we reviewed, had a strong research design that would allow the researchers to assess the causal impacts of telework on worker productivity. We also identified 19 other studies that examined the impacts of telework on worker productivity. However, we do not include the findings of those studies in this section because they lacked causal research design as described for the eight studies. We also do not include findings from the 17 remaining studies because they did not focus on the impacts of telework on worker productivity, and for other reasons. Appendix I provides more details on the methodology we used to review the studies we identified.

²⁰Nicholas Bloom, James Liang, John Roberts, and Zhichun Jenny Ying, "Does Working from Home Work? Evidence from a Chinese Experiment," *The Quarterly Journal of Economics* (2015): 165-218. A study of a U.S. call center released in 2021 also found that telework increased the productivity of call center employees. Natalia Emanuel and Emma Harrington, "Working remotely? Selection, Treatment and the Market Provision of Remote Work." Working Paper (April 2021): 1-83. The researchers issued a revised version of this paper in May 2023, using data from a different time period, and found in this case that telework decreased productivity. We did not include this new version in our report because the publication date of May 2023 fell outside our date range and because the updated version focused on telework during the COVID-19 business closures. We discuss specific challenges associated with estimating the impact of telework on worker productivity during the early months of COVID-19 later in this report.

survey fielded in Great Britain found a positive relationship between teleworking and manager-assessed productivity for workers.²¹

Also, some of the eight studies examined workers who teleworked some days and worked on-site other days, and found that this type of work arrangement slightly enhanced worker productivity. For example, a study of a large U.S. government agency used subjective self-reported productivity measures to compare the performance of hybrid workers on their at-home and in-office days. The study found that workers reported higher levels of job performance on telework days compared to the days when they were working in the office.²²

Another study examining telework in a large Chinese travel agency found that computer engineers who were randomly assigned the option to work from home up to 2 days a week wrote 8 percent more lines of code relative to those who were not provided this option. The study also found that there was no impact on the performance reviews for workers who were allowed to telework. Additionally, the study found that the engineers reported that their productivity rose by 1.8 percent on average compared to the peers who were not teleworking.²³

In addition, all eight of the studies analyzed the impact of a particular telework policy in a specific context, and findings may not generalize to

²¹Eleftherios Giovanis, "The Relationship Between Flexible Employment Arrangements and Workplace Performance in Great Britain," *International Journal of Manpower*, vol. 39, no. 1 (2018): 51-70.

²²Ronald P. Vega, Amanda Anderson, and Seth A. Kaplan, "A Within-Person Examination of the Effects of Telework," *Journal of Business Psychology*, 30 (2015): 313-323.

²³Nicholas Bloom, Ruobing Han, and James Liang, "How Hybrid Working from Home Works out" (NBER Working Paper 30292, National Bureau of Economic Research, Cambridge, Mass., July 2022), 1-47. Similarly, a study in a life sciences firm in the United Kingdom found that the option to work remotely increased self-reported productivity relative to when the same workers did not have that option. See Eliot L. Sherman, "Discretionary Remote Working Helps Mothers Without Harming Non-Mothers: Evidence from a Field Experiment," *Management Science*, vol. 66, no. 3 (March 2020): 1351-1374.

other occupations or settings.²⁴ For example, occupations may differ in how telework impacts essential job tasks. However, collectively these studies demonstrate the potential for a full-time or hybrid telework arrangement to enhance productivity in a number of specific settings. In the studies, productivity gains were attributed to factors such as quieter workspaces and fewer distractions, more flexibility in scheduling, or increased motivation and effort.

Studies Found That Firms with Greater Ability to Allow Workers to Telework Were More Resilient during the COVID-19 Pandemic

We identified seven studies examining the relationship of telework and firm performance during the COVID-19 pandemic.²⁵ All of these studies found that firms with greater ability to allow workers to telework were more resilient during the pandemic, and that telework mitigated the negative impact of the pandemic on firm performance.²⁶ We were unable to identify a sufficient number of studies that allowed us to report on the impacts of telework on firm performance before the COVID-19 pandemic (see appendix I for more details on our scope and methodology). Studies on the impact of telework on firm performance during the COVID-19 pandemic generally used firm or industry-level data on firm productivity or output to assess the extent to which telework mitigated losses that might have occurred due to the closure of non-essential businesses and stay-at-home orders.

While the overall U.S. economic output fell during the start of the pandemic, the ability for workers to telework buttressed certain industries and enabled output to be maintained at substantially higher levels than

²⁴For example, a study found a telework arrangement that allowed employees to fully telework, unconstrained by the geographic area of the employer, resulted in an increased work output by 4.4 percent for patent examiners in the U.S. when these examiners were given the option to telework from anywhere compared to those teleworking without permission to relocate. Prithwiraj (Raj) Choudhury, Cirrus Foroughi, and Barbara Larson, "Work from Anywhere: The Productivity Effects of Geographic Flexibility," *Strategic Management Journal*, 42 (2021): 655-683.

²⁵As noted earlier, the other 37 studies focused on the impacts of telework on worker productivity.

²⁶For the definition of resiliency and other details, see GAO, *Disaster Resilience Framework: Principles for Analyzing Federal Efforts to Facilitate and Promote Resilience to Natural Disasters*, [GAO-20-100SP](#) (Washington, D.C.: Oct. 23, 2019).

would have been possible without telework. In the U.S., gross domestic product declined by 9 percent in the second quarter of 2020.²⁷ In addition, total hours worked declined by 11.7 percent in the second quarter compared to the previous quarter.²⁸ One of the seven studies we reviewed estimated that telework mitigated decline in gross domestic product during the recession that occurred during the early months of the COVID-19 pandemic to half of what it would have been.²⁹ The greatest reductions in output and hours worked were among workers earning lower wages, where workers were not able to substitute telework for in-location hours.³⁰

In addition, several of these studies we reviewed found that firms and industries less able to use telework experienced greater declines in key economic indicators such as output, firm productivity, firm stock market performance, and increase in likelihood of firm default.³¹ These studies compared the performance of firms or industries in the U.S. with a greater ability to telework (for example, the information and technology industry) to those with less ability to telework (such as the hospitality industry).

One study found that firms with high pre-pandemic telework levels had higher resilience to the pandemic and fared significantly better than firms with lower pre-pandemic telework levels. Specifically, firms with high pre-

²⁷Gross domestic product is the total value of goods and services produced in the United States. The National Bureau of Economic Research (NBER) declared a recession from February 2020 to April 2020. The NBER traditionally defines a recession as a significant decline in economic activity that is spread across the economy and that lasts more than a few months.

²⁸Klaas de Vries, Abdul Erumban, and Bart van Ark, "Productivity and the Pandemic: Short-Term Disruptions and Long-Term Implications: The Impact of the COVID-19 Pandemic on Productivity Dynamics by Industry," *International Economics and Economic Policy*, 18 (2021): 541-570.

²⁹Janice C. Eberly, Jonathan Haskel, and Paul Mizen, "'Potential Capital', Working from Home, and Economic Resilience" (NBER Working Paper 29431, National Bureau of Economic Research, Cambridge, Mass., October 2021), 1-39.

³⁰Nicholas Bloom, Philip Bunn, Paul Mizen, Pawel Smietanka, and Gregory Thwaites, "The Impact of COVID-19 on Productivity." According to the Bureau of Labor Statistics, people employed in service occupations, particularly personal care and service occupations and food preparation and serving-related occupations, were among the most likely to have been unable to work due to the pandemic in July 2020. <https://www.bls.gov/cps/effects-of-the-coronavirus-covid-19-pandemic.htm>.

³¹Firm default risk refers to the risk that a borrower is unable to make required payments on debt obligations.

pandemic telework levels had roughly 15 percent higher net incomes, 4 percent higher sales, and better stock market performance—measured by stock returns and volatility.³²

Other studies found that firms with lower pre-pandemic telework levels had slight increases in default probability over the next 6 months, larger declines in operating revenue and stock market performance, and lower cash flow, among other outcomes.³³

In addition to the seven studies, we identified one study that conducted a large survey of managers and workers from 25 countries about their beliefs on how telework was impacting firm performance. This study found that both managers and workers had an overall positive view of the impact of telework on firm performance during the COVID-19 pandemic.³⁴

Methodological Challenges Complicate Efforts to Assess the Long-term Impacts of Telework on Worker Productivity and Firm Performance

Several methodological challenges make it difficult to assess the long-term impacts of telework on worker productivity and firm performance. These challenges include the ability to measure outputs from varying types of jobs, separating impacts of telework from those of other macroeconomic events on worker productivity and firm performance, and confounding factors associated with the rapid expansion of telework during the COVID-19 pandemic.

³²This study compared firms with high pre-pandemic telework levels to firms with low levels to see whether they performed differently from each other while accounting for other factors such as firm size. John (Jianqiu) Bai, Erik Brynjolfsson, Wang Jin, Sebastian Steffen, and Chi Wan, “Digital Resilience: How Work-from-Home Feasibility Affects Firm Performance” (NBER Working Paper 28588, National Bureau of Economic Research, Cambridge, Mass., March 2021), 1-37.

³³Dimitris Papanikolaou and Lawrence D.W. Schmit, “Working Remotely and the Supply-Side Impact of COVID-19” (NBER Working Paper 27330, National Bureau of Economic Research, Cambridge, Mass., June 2020), 1-41; Ting Zhang, Dan Gerlowski, and Zoltan Acs, “Working from Home: Small Business Performance and the COVID-19 Pandemic,” *Small Business Economics*, vol. 58 (2022): 611-636.

³⁴Chiara Criscuolo, Peter Gal, Timo Leidecker, Francesco Losma, and Giuseppe Nicoletti, “The Role of Telework for Productivity During and Post COVID-19: Results from an OECD Survey among Managers and Workers” (OECD Productivity Working Papers 31, OECD Publishing, Paris, France, December 2021), 1-64.

Job Type

Measuring productivity for certain jobs is inherently difficult, especially for jobs in the knowledge economy that do not have tangible or concrete outputs. Worker productivity is generally defined as output per worker per hour. While some jobs lend themselves to such a measurement, others do not. For example, when analyzing productivity within a call center, researchers have used the number of calls per hour. Similarly, when analyzing productivity for computer engineers, researchers have used lines of code written.

However, some jobs do not have clearly defined hourly output, such as a scientific researcher producing research that informs product development over years and decades, making measuring productivity for these jobs difficult. For jobs without clearly defined outputs, productivity could be assessed by a survey of workers, but self-reported productivity collected this way is subjective. In particular, workers may conflate working long hours with being highly productive, rather than assessing output on an hourly basis.

Separating Impacts of Telework from Other Macroeconomic Events

It has been difficult to disentangle the impact of telework from the impact of other macroeconomic events, such as the recession during the COVID-19 pandemic. For example, during the early months of the COVID-19 pandemic, the workforce composition changed because workers with the lowest productivity were more likely to be laid off or lose hours of work.³⁵ Measured labor productivity increased during the early months of the COVID-19 pandemic because the reduction in hours worked was larger than the reduction in economic output.³⁶ Moreover, some changes in measured worker productivity or firm performance during the COVID-19 pandemic could be attributed to changes in employment composition rather than telework. For this reason, studies of how telework impacted worker productivity or firm performance during the COVID-19 recession may not be generalizable to other time periods with different macroeconomic conditions.

³⁵Bloom, Bunn, Mizen, Smietanka, and Thwaites, "The Impact of COVID-19 on Productivity."

³⁶De Vries, Erumban, and van Ark, "Productivity and the Pandemic: Short-Term Disruptions and Long-Term Implications."

Confounding Factors due to Rapid Expansion of Telework during COVID-19

We found that specific challenges related to telework during the pandemic influenced measures of worker productivity and may not apply to telework in a non-pandemic setting. The COVID-19 pandemic led to a rapid expansion of telework, during which many firms suddenly transitioned workers from office to telework. Surveys of worker productivity fielded during the pandemic primarily relied on measures of self-assessed or manager-assessed productivity, and these studies had inconsistent results.

Some studies found that teleworkers reported being more productive, while others found teleworkers reported being less productive. For example, a survey of U.S. workers found increases in telework frequency were associated with higher self-perceived productivity per hour.³⁷ Conversely, a survey of four manufacturing companies in Japan found that productivity declined on average for teleworkers in all four companies.³⁸

We identified many confounding factors from the pandemic that limit the generalizability of the results of these studies. Specific confounding factors we identified include:

- *Child care.* Some studies found that telework had a negative impact on parents relative to non-parents during the COVID-19 pandemic.³⁹ Respondents in one study specifically cited child care concerns as a challenge of working from home during the COVID-19 pandemic.⁴⁰

³⁷Jose Maria Barrero, Nicholas Bloom, and Steven J. Davis, "Why Working from Home Will Stick" (NBER Working Paper 28731, National Bureau of Economic Research, Cambridge, Mass., April 2021), 1-68.

³⁸Ritsu Kitagawa, Sachiko Kuroda, Hiroko Okudaira, and Hideo Owan, "Working from Home and Productivity under the COVID-19 Pandemic: Using Survey Data of Four Manufacturing Firms," *PLOS ONE*, vol. 16, no. 12 (2021).

³⁹Sumit S. Deole, Max Deter, and Yue Huang, "Home Sweet Home: Working from Home and Employee Performance during the COVID-19 Pandemic in the UK" (GLO Discussion Paper 791, Global Labor Organization (GLO), Essen, Germany, 2021).

⁴⁰Ben Etheridge, Li Tang, and Yikai Wang. "Worker Productivity during Lockdown and Working from Home: Evidence from Self Reports." ISER Working Paper Series 202-12. Institute for Social & Economic Research, University of Essex, October 2020, 1-31.

- *Mental health.* Some studies reported that mental health was another challenge for workers during the COVID-19 pandemic that may also impact worker productivity.⁴¹
- *Work equipment.* Inadequate home office equipment and information technology issues were commonly cited as productivity concerns during the COVID-19 pandemic among surveyed teleworkers in the studies we reviewed.⁴²
- *Change in work responsibilities.* Another study reported that a reason for lower productivity was that some workers were assigned less work during the COVID-19 pandemic.⁴³
- *Number of hours worked.* Hours worked is a key input for labor productivity statistics, but actual hours worked can be difficult to track since they may differ from contractual hours, particularly when working from home. A common theme among the COVID-19 studies is that many workers reported working more hours than when they were working from the office before the COVID-19 pandemic.⁴⁴ Thus some of the self-reported productivity gains may be attributable to longer work days, rather than true increases in per-hour productivity.

In light of these confounding factors, studies examining the impacts of telework on worker productivity during the COVID-19 pandemic should be interpreted with the understanding that their results could be affected by the pandemic. In fact, one study using survey data from the United

⁴¹Etheridge, Tang, and Wang, "Worker Productivity during Lockdown and Working from Home." See also Darja Smite, Anastasiia Tkalic, Nils Brede Moe, Efi Papatheocharous, Eriks Klotins, Marte Pettersen Buvik, "Changes in Perceived Productivity of Software Engineers during the COVID-19 Pandemic: The Voice of Evidence," *The Journal of Systems & Software*, vol. 186 (2022): 1-14.

⁴²Ritsu Kitagawa, Sachiko Kuroda, Hiroko Okudaira, and Hideo Owan, "Working from Home and Productivity under the COVID-19 Pandemic"; Smite, Tkalic, Moe, Papatheocharous, Klotins, and Buvik, "Changes in perceived productivity of software engineers during the COVID-19 Pandemic"; Masayuki Morikawa, "Work-from-Home Productivity during the COVID-19 Pandemic: Evidence from Japan," *Economic Inquiry*, vol. 60, no. 2 (2022): 508-527.

⁴³Etheridge, Tang, and Wang, "Worker Productivity during Lockdown and Working from Home."

⁴⁴Mohamad Awada, Gale Lucas, Burcin Becerik-Gerber, "Working from Home during the COVID-19 Pandemic: Impact on Office Worker Productivity and Work Experience," *Work*, vol. 69, no. 4 (2021): 1171-1180; Michael Gibbs, Friederike Mengel, and Cristoph Siemroth, "Work from Home & Productivity: Evidence from Personnel & Analytics Data on IT Professionals," *Journal of Political Economy Microeconomics*, Forthcoming (March 2022).

Kingdom found productivity decreases during the pandemic—even among those who teleworked both before and during the pandemic—suggesting that the COVID-19 pandemic caused a negative impact on worker productivity.⁴⁵

Current Research Highlights Important Uncertainties about the Impact of Telework on Worker Productivity and Firm Performance in the Long Run

The 44 studies we reviewed found that telework affected how employees work and how employers operate. However, whether and how many of these effects may impact worker productivity or firm performance would likely not yet be evident in more recent changes in the prevalence of telework.⁴⁶ For example, studies we reviewed found that telework might affect employee turnover and recruitment or firms' office needs. One of the studies found that telework reduced employee attrition and generated cost savings in floor space needs for a Chinese call center.⁴⁷

Several of the studies also found that telework may allow firms to recruit from greater geographic areas, thus drawing from a wider pool of talent and potentially improving the match between jobs and hires. Additionally, several of the studies also found that workers perceive telework as an employee benefit.⁴⁸ By helping firms recruit and retain workers best suited for the jobs, telework could improve productivity and firm performance.

However, some other studies have found that telework may result in less innovation or impede collaboration, which could result in reduced

⁴⁵Etheridge, Tang, and Wang, "Worker Productivity during Lockdown and Working from Home."

⁴⁶The impacts of factors on productivity may also change over time. Specifically, some studies found that workers reported increases in productivity for later time periods relative to earlier time periods, suggesting there may be a transition period after which some of these negative impacts may diminish. For example, see Smite, Tkalich, Moe, Papatheocharous, Klotins, and Buvik, "Changes in perceived productivity of software engineers during the COVID-19 Pandemic."

⁴⁷Bloom, Liang, Roberts, and Ying, "Does Working from Home Work?"

⁴⁸Michael Dalton and Jeffrey A Groen, "Telework during the COVID-19 Pandemic." Cevat Giray Aksoy, Jose Maria Barrero, Nicholas Bloom, Steven J. Davis, Mathias Dolls, and Pablo Zarate, "Working from Home Around the World" (NBER Working Paper 30446, National Bureau of Economic Research, Cambridge, Mass., September 2022).

productivity or firm performance over time. A field experiment found that workers generated fewer novel ideas when brainstorming over videoconference compared to workers who were brainstorming within the same room.⁴⁹ Another study found that professional chess players displayed reduced cognitive performance when competing from home as compared to tournaments on site.⁵⁰ In addition, two studies identified potential challenges with collaboration and teamwork for teleworking employees.⁵¹

A survey of managers across 25 countries reported manager concerns about training staff remotely and reduced on-the-job learning, and that the teleworking environment was less innovative and creative. The same study also found that a majority of managers surveyed believed that “excessive” levels of telework could decrease collaboration between team members, thereby hampering firm-level productivity growth in the long run.⁵²

The current state of research on the impact of telework on productivity and firm performance has important gaps across occupations, industries, and effects that may emerge only over the longer term. Current research suggests some promising opportunities for workers and firms in certain occupations and sectors to benefit from telework. Research also suggests additional economic and workforce impacts that are not yet well understood. Evolving remote work practices, new measures of productivity, and future research could illuminate key opportunities and challenges associated with telework, including how new technologies and business practices might best harness the benefits and manage challenges from the growth of telework across the economy.

⁴⁹Melanie S. Brucks and Jonathan Levav, “Virtual Communication Curbs Creative Idea Generation,” *Nature*, vol. 605 (April 2022): 108-112.

⁵⁰Steffen Kunn, Christian Seel, and Dainis Zegners, “Cognitive Performance in Remote Work Evidence from Professional Chess,” *The Economic Journal*, vol. 132 (April 2022): 1218-1232.

⁵¹Gibbs, Mengel, and Siemroth, “Work from Home & Productivity”; Smite, Tkalic, Moe, Papatheocharous, Klotins, and Buvik, “Changes in Perceived Productivity of Software Engineers during the COVID-19 Pandemic.”

⁵²Criscuolo, Gal, Leidecker, Losma, and Nicoletti, “The Role of Telework for Productivity during and Post COVID-19.”

Agency Comments and Our Evaluation

We provided a courtesy copy of our draft report to the Department of Labor, the Office of Management and Budget, and the Office of Personnel Management, and invited them to provide comments. All three agencies provided no comments.

As agreed with your offices, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the report date. At that time, we will send copies to the appropriate congressional committees and the Acting Secretary of Labor, Director of the Office of Management and Budget, and Director of the Office of Personnel Management. In addition, the report will be available at no charge on the GAO website at <https://www.gao.gov>.

If you or your staff have any questions about this report, please contact us at (202) 512-6445 or hoffmanme@gao.gov, or (202) 512-7215 or sawyerj@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are listed in appendix IV.



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Appendix I: Objectives, Scope, and Methodology

This report examines (1) changes in the extent of telework in the United States before and during the pandemic, and (2) reported impacts of teleworking on worker productivity and firm performance. For this report, the term telework refers to a flexible work arrangement under which employees perform their duties from a worksite—often at home—other than the location from which they would otherwise work.

Methodology to Examine the Extent of Telework in the United States

Telework is implemented through a variety of work arrangements, and is measured in a variety of ways. In this report we present data from two national datasets that allow us to describe trends in the use of telework from 2010 through 2021, the most recent data available at the time that we completed our analysis in May 2023, and the growth of telework by selected worker characteristics between 2019 and 2021, the time period in which the COVID-19 pandemic began: (1) Bureau of Labor Statistics' (BLS) *American Time Use Survey* (ATUS); and (2) *Bureau of Census' American Community Survey* (ACS).¹ We selected these datasets based

¹The annual American Time Use Survey (ATUS), sponsored by the Bureau of Labor Statistics and conducted by the Census Bureau, provides annual, nationally representative estimates of the amount of time people spend doing various activities such as paid work, child care, volunteering, and socializing. For this report, we use ATUS's measure of the percentage of respondents who worked from or near their home for any amount of time on the previous day. The Census Bureau's American Community Survey (ACS) is a national survey that annually collects population and housing information from a random sample of about 3.5 million households. For this report, we use ACS's measure of the percentage of workers who primarily worked from home over the past week.

on reviews of relevant literature and interviews with BLS subject matter experts.²

We limited our data sources to nationally representative datasets from federal statistical agencies because they are widely used by researchers, and we determined that they are sufficiently reliable for our reporting objective after we reviewed technical documents and assessed the reliability of the two databases according to GAO internal data guidance.³ Data from these surveys represented the most recent data available at the time of our review.⁴ Our analysis excluded ATUS and ACS data from 2020 because the ACS 2020 year data and ATUS 2020 annual estimates failed to meet Census Bureau’s quality standards for publication due to the impact of the COVID-19 pandemic on data collection. To assess the reliability of these datasets, we interviewed BLS subject matter experts. We also performed analyses using different measures of telework from ATUS, and compared our results with peer-reviewed studies and official reports such as those from BLS to ensure the robustness and consistency of our results.⁵

American Community Survey

The ACS is a national survey that annually collects population and housing information from a random sample of about 3.5 million

²We identified and interviewed three BLS researchers based on peer-reviewed studies we identified through our literature search: Matthew Dey, Harley Frazis, and Sabrina Pabilonia. For example, see Matthew Dey, Harley Frazis, Mark A. Loewenstein, and Hugette Sun, “Ability to work from home: evidence from two surveys and implications for the labor market in the COVID-19 pandemic,” *Monthly Labor Review* (Bureau of Labor Statistics, June 2020), <https://doi.org/10.21916/mlr.2020.14>; Matthew Dey, Harley Frazis, David S. Piccone Jr, and Mark A. Loewenstein, “Teleworking and lost work during the pandemic: new evidence from the CPS,” *Monthly Labor Review* (Bureau of Labor Statistics, July 2021), <https://doi.org/10.21916/mlr.2021.15>; S.W. Pabilonia and V. Vernon “Telework and Time Use” (Institute of Labor Economics Discussion paper No. 14827, November 2021).

³GAO, *Assessing Data Reliability*, [GAO-20-283G](#) (Washington, D.C.: December 2019).

⁴We initially also identified other data sources such as BLS’s Current Population Survey (CPS) supplemental monthly data measuring the effects of the COVID-19 pandemic on the labor market from May 2020 through June 2022. However, we decided not to use CPS because CPS is becoming less representative of our target population as increasingly fewer respondents telework due to the COVID-19 pandemic.

⁵See appendix II for more information about our analyses using alternative measures of telework.

households.⁶ From the ACS, we used the percentage of workers who primarily worked from home during the week as the measure of telework. We defined workers who primarily worked from home during the *week (or primarily teleworked)* as those who reported “work from home” in response to the question “how did you usually get to work in the last week?”⁷ The ACS measure provides a conservative estimate of the number of teleworkers because it only captures information about people who primarily work at home, not those who do so on an occasional basis.

The ACS also includes questions about the respondent’s employment and demographic characteristics, such as their employer’s type of business or industry, their main occupation, their race and ethnicity, their age, and how well they speak English. We used the ACS measure to analyze the variation in telework prevalence across groups because it does not include incidental telework—work performed at home that is not replacing work that would otherwise occur at a primary worksite, for example, a teacher who brings papers home to grade after school, or an office worker who checks email for half an hour in the evening.⁸ Moreover, incidental telework could obscure differences across groups.⁹ However, we were unable to use the ACS to report telework rates by education, as the published ACS tables did not contain educational attainment. In addition, we chose not to use the ACS to report telework rates by earnings because the ACS data captures annual earnings of full-

⁶The primary purpose of the ACS is to measure characteristics of the U.S. population. Some tables in the ACS cover the entire population, while some cover only a subset of the population (such as tables of employment status, which include data only for the population age 16 and older).

⁷The ACS question on the method of transportation usually used to get to work was asked of respondents ages 16 and over who were employed and at work in the previous week.

⁸Incidental telework may often be unpaid, which is another way that it differs from non-incidental telework. The BLS researchers we interviewed stressed the importance of understanding and assessing the extent of incidental telework in our measures of telework by, to the extent possible, reporting on the extent to which work at home replaces work that is otherwise done in the office.

⁹This is important in our analysis of cross-group variation, because certain groups are more likely to perform incidental telework than other groups. For example, if incidental telework is higher among groups that have higher rates of non-incidental telework, then the capture of incidental telework would exaggerate differences across groups at any point in time; it may also underestimate the impact of the pandemic on telework rates among groups with high levels of incidental telework, because pre-pandemic telework levels would be inflated.

time and part-time workers, as well as self-employed workers, which makes comparisons across earnings groups difficult to interpret.

To determine the growth of telework between 2019 and 2021 for different groups of workers, we developed estimates for the percentage of workers who primarily teleworked across the following groups:¹⁰

- **Industry.** Our analysis included 11 ACS industry categories, such as information, manufacturing, and retail trade, and the professional, scientific, and management services industries. We excluded the categories public administration and armed forces to focus this objective on the private sector civilian labor force.¹¹ We also excluded the category other services because it is a miscellaneous category that contains workers employed in widely varied industries.
- **Occupation.** Our analysis included five ACS occupational categories: management, business, science, and arts occupations; sales and office occupations; service occupations; natural resources, construction, and maintenance occupations; and production, transportation, and material moving occupations. We excluded military specific occupations because the focus of this objective is the private sector civilian labor force.¹²
- **Race and ethnicity.** Our analysis of race and ethnicity categories included the following categories: non-Hispanic White alone, Hispanic/Latino, Black or African American alone, Asian alone, American Indian or Alaska Natives alone, and Native Hawaiians or Other Pacific Islanders alone. The “alone” categories include those respondents who reported only a single race entry, and no other race.¹³ Our analysis of race by telework prevalence excluded respondents who reported Some Other Race and Two or More Races

¹⁰All changes from 2019 to 2021 are statistically significant at the 95 percent level for all categories of workers we report unless otherwise noted.

¹¹American Community Survey industry categories are defined in this document on pages 32-41: https://www2.census.gov/programs-surveys/acs/tech_docs/code_lists/2021_ACS_Code_Lists.pdf.

¹²American Community Survey occupation categories are defined in this document on pages 78-92: https://www2.census.gov/programs-surveys/acs/tech_docs/code_lists/2021_ACS_Code_Lists.pdf.

¹³These categories are not mutually exclusive, as Black alone and Asian alone include Hispanic and non-Hispanic people. The Hispanic category incorporated Hispanics of all races.

because of important changes to a survey question between 2019 and 2021; these respondents were not excluded from any other analyses in this report.¹⁴

- **Ability to speak English.** Our analysis of the ability to speak English is based on questions about languages spoken at home and how well someone speaks English. We include people who speak only English, or speak English very well, in addition to speaking some other language at home, into the category “Native speaker or speak English very well.” We include all other people who speak a language other than English at home in the category “Speak English less than very well.”
- **Sex.** The data include two sex categories: male and female.
- **Age.** Our analysis uses four age categories: (1) Age 16 to 19 years, (2) 20 to 24 years, (3) 25 to 64 years, and (4) 65 years and over.

American Time Use Survey

The American Time Use Survey (ATUS) provides continuous, nationally representative estimates of how, where, and with whom Americans spend their time. Individuals who are interviewed for the ATUS are randomly selected from a subset of households that have completed their eighth and final month of interviews for the Current Population Survey (CPS).¹⁵

¹⁴The Census Bureau changed the questions underlying their race and ethnicity measures in 2020 and changed the way it coded the results, and these changes had a substantial impact on certain estimates. Notably, there was a significant increase in the percentage of people coded as “two or more races” (from 2.7 percent in 2019 to 11.5 percent in 2021), and a substantial decrease in the percentage of people coded as “White alone” (from 73 percent to 63 percent). Changes to the underlying definition of a population group could make cross-year comparisons of telework rates invalid. Based on our assessment of the data, we determined that telework rates for the people coded as “two or more races” or “some other race” were not sufficiently reliable for our purpose. We also determined that telework rates for the White alone, non-Hispanic population were more reliable than telework rates for the White alone population. In our analysis of data from the ACS, the percentage of people coded as “White alone, non-Hispanic” only fell from 62 percent to 60 percent.

¹⁵The Current Population Survey is sponsored jointly by the Census Bureau and the Bureau of Labor Statistics and is the primary source of labor force statistics for the civilian non-institutional population of the United States. ATUS sample households are selected to ensure that estimates will be nationally representative. One individual age 15 or over is randomly chosen from each sampled household to be interviewed about his or her activities on the day before the interview. In 2021, the estimated annual sample size was 26,400 and the response rate was 39.4 percent, yielding approximately 10,400 completed interviews.

These individuals fill out a time use diary of their activities over a 24-hour period, which includes information about where and when people work—at their workplace, home, or another location.

From the ATUS, we use, as a measure of telework, the percentage of respondents who conducted work from their home for any amount of time on the previous day. We use this measure to present trends in telework over time, and we use this measure for our analyses of telework prevalence by education and earnings. This measure of telework likely overestimates the number of people who telework on an average day because it may include incidental telework and workers who spend any amount of time working at home, even if they spend only a few minutes a day, and even if the time spent working is unpaid.¹⁶ In effect, this measure of telework captures the extent to which telework has become a part of daily life for a large segment of the working population. Moreover, this estimate of the number of people engaged in telework during an average day is lower than the number of people engaged in telework during an average week.

Thus, even this less conservative measure does not necessarily capture the full extent of people engaged in some telework during a typical week. In appendix II we also present supplemental information on telework intensity (hours spent working at home).

The ATUS survey includes additional questions about worker characteristics, including earnings and level of educational attainment.¹⁷ We used data from these questions to determine the growth of telework between 2019 and 2021 across workers with different characteristics using the following data elements:

- **Earnings.** ATUS provides information on respondents' usual weekly earnings at their main job. Earnings data are restricted to full-time wage and salary workers with a single job. Estimates classify workers

¹⁶The ATUS diary data do not allow researchers to identify whether work is paid or unpaid.

¹⁷The CPS survey obtains information about educational attainment through a question asking about the highest grade or degree completed. BLS links responses from the CPS to responses from the ATUS.

into earnings quartiles based on the distribution of weekly earnings among survey respondents (see table 1).¹⁸

Table 1: Earnings Quartiles for Usual Weekly Earnings of Full-time and Salaried Workers at Their Primary Job, 2019–2021

| Earning quartiles | 2019 | 2021 |
|-------------------|-------------------|-------------------|
| First quartile | \$0–\$650 | \$0–\$690 |
| Second quartile | \$651–\$1,000 | \$691–\$1,080 |
| Third quartile | \$1,001–\$1,620 | \$1,081–\$1,730 |
| Fourth quartile | \$1,621 and above | \$1,731 and above |

Source: Department of Labor, Bureau of Labor Statistics News Release: American Time Use Survey (ATUS)–2021 Results, USDL-22-1261 (released on June 23, 2022) and Department of Labor, Bureau of Labor Statistics News Release: American Time Use Survey (ATUS)–2019 Results, USDL-20-1275 (released on June 25, 2020). | GAO-23-105999

- Education.** The CPS survey obtains information about educational attainment for survey respondents 25 years or older through a question asking about the highest grade or degree completed. Our analysis includes four categories of educational attainment: less than high school diploma, high school graduates, some college or associate degree, and bachelor’s degree or higher. All percentage estimates we report are statistically significant at the 95 percent confidence level unless otherwise indicated.

Methodology to Examine the Impacts of Telework on Worker Productivity and Firm Performance

To better understand the impact of telework on worker productivity and firm performance, we conducted a review of relevant empirical research published between 2015 and 2022 that examined telework in the United States and abroad. We chose this time period to ensure an appropriate number of recent and relevant studies for further review. We conducted a total of four rounds of searches of various databases such as EconLit, Business Source Corporate Plus, and ProQuest Dialog using keywords such as “telework,” “remote work,” “work from home,” “productivity,” or

¹⁸The ATUS earnings data are limited to wage and salary workers (both incorporated and unincorporated self-employed workers are excluded). Each earnings range represents approximately 25 percent of full-time wage and salary workers who held only one job. BLS links responses from the CPS to responses from the ATUS, which is usually administered 2 to 5 months after the CPS; therefore, earnings data may be out of date for some respondents.

“firm performance.”¹⁹ We also identified studies through other sources, such as those cited within the studies we reviewed. To ensure that we identified an appropriate number of relevant studies with strong causal research design, we included studies from the United States and other countries, with both public and private sector workers. We identified a total of 181 studies from these searches.

To assess the relevance of these 181 studies and reports, we reviewed their abstracts to determine whether they addressed the impacts of telework on measures of worker productivity such as hourly output or self-assessed work efficiency or firm performance such as firm sales, firm productivity, stock prices, or profitability. Furthermore, because we identified relatively fewer studies related to the impacts of telework on firm performance in the first three rounds of our literature search, we conducted a fourth round focusing on studies related to the impacts of telework on firm performance. However, we were unable to identify many additional studies related to the impacts of telework on firm performance. We determined 71 out of 181 studies to be relevant to our objective for further review.

The 71 shortlisted studies were then independently reviewed by two GAO economists to evaluate the quality and robustness of the methodology. We compared the economists’ assessments and discussed and reconciled differences. For example, GAO examined the sample size and validity of the key outcome indicators, the rigor of the methodology, and the robustness of findings in the presence of any data or methodological limitations. We prioritized studies with a strong causal research design that would allow the researchers to assess the causal impacts of telework on productivity or firm performance—for example, a research design that included an appropriate control group.

In our review, we found that some of these studies used experimental methods to assess the impacts of telework on productivity by randomly assigning workers to telework (treatment group) or work from the office (control group). Other studies estimated the impacts of telework on worker productivity by tracking a group of workers at multiple points in time and comparing their productivity when they were teleworking to when the same workers were working from their traditional worksite.

¹⁹EconLit, Business Source Corporate Plus, and ProQuest Dialog are library databases that contain scholarly economic, business, and other more general trade literature.

We excluded 27 of the 71 studies because we determined that their methodology was not sufficiently rigorous or because of other reasons, such as the studies were outside the scope of our review. For example, we excluded studies that used insufficient sample sizes, or studies that did not use valid measures of labor productivity in their analyses. We included the remaining 44 studies as supporting evidence for our findings in this report (see the list of studies in app. III). Out of the 44 studies, we identified seven studies examining the relationship of telework and firm performance during the COVID-19 pandemic, but we did not have a sufficient number of studies that met our criteria to allow us to report on the impacts of telework on firm performance before the COVID-19 pandemic.²⁰ This is because, as noted earlier, we were unable to identify additional studies in our fourth search round focusing on the impacts of telework on firm performance.

We used 31 of these 44 studies to provide primary supporting evidence for our findings of the impacts of telework on worker productivity and firm performance. We prioritized eight of 31 studies with the strongest research designs, and these eight studies focused on the impacts of telework on worker productivity. We also broadly summarized the findings of another 16 (out of 31) studies on the impacts of telework on worker productivity while noting potential limitations to their methodologies. For example, we found that some survey studies conducted during the COVID-19 pandemic had research design limitations and did not isolate the impacts of telework on worker productivity from the impact of the COVID-19 pandemic itself. Lastly, we corroborated the contextual information provided by the 31 studies with another 13 studies to synthesize the potential long-term impacts of telework and the methodological challenges of assessing these long-term impacts. For example, these 13 studies provided examples of the challenges of measuring productivity or assessing impacts of telework in the longer run.

We conducted this performance audit from April 2022 to July 2023 in accordance with generally accepted government auditing standards.

²⁰We identified two studies that examined firm performance before the COVID-19 pandemic: one study, while primarily focused on estimating the impacts of telework on productivity of workers of a call center in China, also examined the productivity of the firm. See Nicholas Bloom, James Liang, John Roberts, and Zhichun Jenny Ying, "Does working from home work? Evidence from a Chinese Experiment," *The Quarterly Journal of Economics* (2015): 165-218. Another study examined managers' self-reported assessment of the financial performance of companies. See Eleftherios Giovanis, "The Relationship Between Flexible Employment Arrangements and Workplace Performance in Great Britain," *International Journal of Manpower*, vol. 39, no. 1 (2018): 51-70.

Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Appendix II: Overview of Selected Alternative Measures of Telework

In this report, we present two primary measures of telework, selected based on reviews of relevant literature and interviews with subject matter experts at the Bureau of Labor Statistics (BLS).¹ We limited our data selection to nationally representative datasets from federal statistical agencies that provide consistent information about telework before and after the onset of the COVID-19 pandemic. The primary measures we selected are from the BLS's American Time Use Survey (ATUS)² and the Census Bureau's American Community Survey (ACS).³ This appendix presents an overview of some of the alternative measures of telework that we examined and other researchers have developed using ATUS. It also describes analyses we have performed to ensure the consistency of the ACS and ATUS as sources of telework information, and provides

¹We identified and interviewed three BLS researchers based on peer-reviewed studies we identified through our literature search: Matthew Dey, Harley Frazis, and Sabrina Pabilonia. For example, see Matthew Dey, Harley Frazis, Mark A. Loewenstein, and Hugette Sun, "Ability to work from home: evidence from two surveys and implications for the labor market in the COVID-19 pandemic," *Monthly Labor Review* (Bureau of Labor Statistics, June 2020), <https://doi.org/10.21916/mlr.2020.14>; Matthew Dey, Harley Frazis, David S. Piccone Jr, and Mark A. Loewenstein, "Teleworking and lost work during the pandemic: new evidence from the CPS," *Monthly Labor Review* (Bureau of Labor Statistics, July 2021), <https://doi.org/10.21916/mlr.2021.15>; S.W. Pabilonia and V. Vernon "Telework, wages, and time use in the united states," *Review of Economics of the Household* (2022); S.W. Pabilonia and V. Vernon, "Telework and Time Use" in *Handbook of Labor, Human Resources and Population Economics*, eds. K.F. Zimmermann and Cham Springer, https://doi.org/10.1007/978-3-319-57365-6_274-2.

²ATUS, sponsored by the Bureau of Labor Statistics and conducted by the Census Bureau, provides estimates of the amount of time people spend doing various activities, such as paid work, child care, volunteering and socializing. For this report, we use ATUS's measure of the percentage of respondents who worked from or near their home for any amount of time on the previous day.

³ACS provides demographics data about all communities to help local officials, community leaders, and businesses understand the changes taking place in their communities. For this report, we use ACS's measure of the percentage of workers who primarily worked from home over the past week.

supplemental information on an additional measure of telework—hours worked at home—from 2010 to 2021.

While we used the percentage of teleworkers to examine the extent of telework, there are other measures that may examine other aspects of telework. For example:

- estimates of the intensity of telework, as measured by the number or percentage of hours worked at home;⁴
- estimates that classify different types of hybrid workers, based on the duration and regularity of telework;⁵ and
- estimates that identify the extent of “incidental” and “non-incidental” telework in the workforce, where non-incidental telework can be defined as work at home that is replacing work that would otherwise be done in the office or worksite.⁶

In this appendix, we present time trends using several different measures. Using ATUS, we constructed various measures of telework by limiting the time of day and days of the week when work at home is observed. We assumed that these alternate ATUS measures restrict incidental telework to different degrees. This allows us to examine the consistency of the ACS measure (which does not capture any incidental telework) with measures obtainable from ATUS (which capture incidental telework to different degrees). We also present a time trend of average hours worked at home, using ATUS.

⁴Examples include the percentage of paid working hours that are worked at home; the percentage of days that are worked at home; or the average number of hours worked at home. See figure 9 in this appendix for information on average hours worked at home.

⁵For example, Harley Frazis has classified different types of hybrid teleworkers based on criteria such as the number of “long workdays” that are worked (in this case, long days are defined as four or more hours), which helps identify workers who are conducting the majority of their work at home on certain days. (Harley Frazis, “Who Telecommutes? Where is the Time Saved Spent?” (Bureau of Labor Statistics Working Papers, Working Paper 523, April 2020). In related work, researchers have classified workers into occasional teleworkers and home-based teleworkers, based on the frequency with which people work at home over a 2-week period.

⁶Examples of incidental telework could include a teacher who brings papers home to grade after school, or an office worker who checks email for half an hour in the evening. Such incidental telework may often be unpaid, which is another way that it differs from non-incidental telework. The BLS researchers we interviewed stressed the importance of understanding and assessing the extent of incidental telework in our measures of telework. This can be done by reporting on the extent to which work at home replaces work that is otherwise done in the office.

Comparison of Telework Prevalence Measures Used in This Report

From the ACS, we used the percentage of workers who primarily worked from home during the week as the measure of telework. This measure was constructed as an annual average based on responses to the survey question “how did you usually get to work last week?” We classified respondents who selected “worked from home” as teleworkers. This measure likely underestimates the number of people who could be considered teleworkers, because it excludes many hybrid workers. For example, workers who work 3 days per week in the office and 2 days at home would likely not be captured as teleworkers using this measure.

From the ATUS, we used the percentage of respondents who did any work from their home or yard for any amount of time on the previous day. This measure likely overestimates the number of people who would be considered teleworkers because it captures incidental telework—work performed at home that is not replacing work that would otherwise be performed in the office.⁷ This measure includes work at home reported by employed people who report any amount of time working at home.⁸ They are included in this measure even if they report working from home for only a few minutes a day and the time spent working is unpaid. In effect, this measure of telework captures the extent to which telework has become a part of daily life for a large segment of the population.

Consistency between ACS and ATUS Measures of Telework

As part of our assessment of the reliability of the data, we sought to determine whether the measures of telework constructed using the two data sources presented a consistent time trend of telework prevalence despite being based on two different samples of workers. To do this, we first examined multiple measures of telework that are available in ATUS, to see whether we could obtain telework prevalence similar to that found in ACS. We determined that if we used an ATUS measure that likely

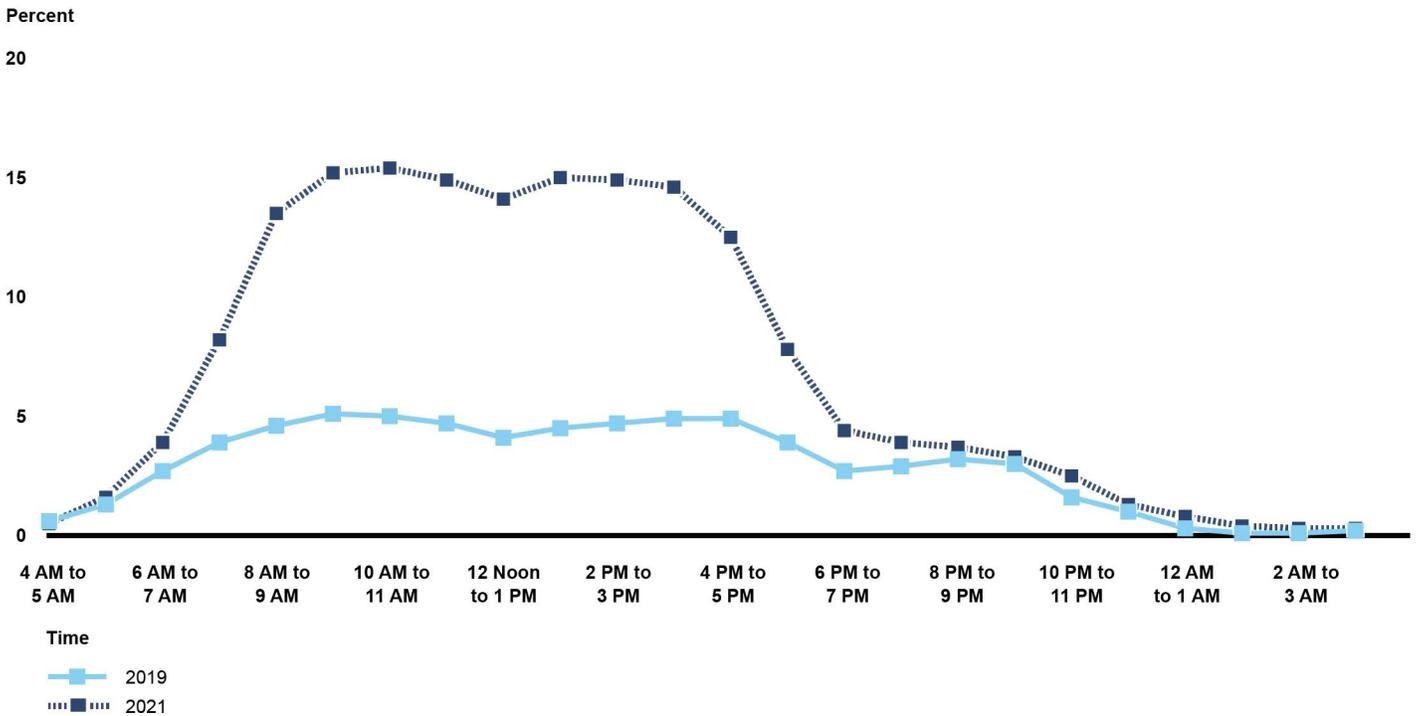
⁷At the same time, this estimate of the number of people engaged in telework during an average day is lower than the number of people engaged in telework during an average week; so even this less conservative measure does not necessarily capture the full number of people engaged in some telework during a typical week.

⁸The ATUS diary data do not permit researchers to identify whether work is paid or unpaid.

captures less incidental telework, it was possible to obtain a very similar estimate of telework prevalence using ATUS data.

One way to reduce the amount of incidental telework captured in the ATUS time use data is to take into account the time of day in which work at home is performed. We constructed histograms for 2019 and 2021 that examine the amount of work that is performed at home by time of day. Figure 7 shows that in both 2019 and 2021 a very small percentage of people worked at home early in the morning (before 7 a.m.) and late at night (after 9 p.m.). We expect that work during these atypical hours are more likely to be incidental work (work that is not replacing work that would otherwise be done in an office or worksite). In contrast, work from home that is done during standard work hours (for example, from 1 p.m. to 2 p.m.) is more likely to be replacing work that would otherwise be done in an office or worksite.

Figure 7: Percentage of Workers Who Did Any Work from Home during Each Hour of the Day, 2019 and 2021



Source: GAO analysis of data from the Bureau of Labor Statistics American Time Use Survey. | GAO-23-105999

Appendix II: Overview of Selected Alternative Measures of Telework

Accessible Data for Figure 7: Percentage of Workers Who Did Any Work from Home during Each Hour of the Day, 2019 and 2021

| Time | 2019 (percent) | 2021 (percent) |
|-----------------|----------------|----------------|
| 4 AM to 5 AM | 0.6 | 0.5 |
| 6 AM to 7 AM | 1.3 | 1.6 |
| 8 AM to 9 AM | 2.7 | 3.9 |
| 10 AM to 11 AM | 3.9 | 8.2 |
| 12 Noon to 1 PM | 4.6 | 13.5 |
| 2 PM to 3 PM | 5.1 | 15.2 |
| 4 PM to 5 PM | 5 | 15.4 |
| 6 PM to 7 PM | 4.7 | 14.9 |
| 8 PM to 9 PM | 4.1 | 14.1 |
| 10 PM to 11 PM | 4.5 | 15 |
| 12 AM to 1 AM | 4.7 | 14.9 |
| 2 AM to 3 AM | 4.9 | 14.6 |
| 4 AM to 5 AM | 4.9 | 12.5 |
| 6 AM to 7 AM | 3.9 | 7.8 |
| 8 AM to 9 AM | 2.7 | 4.4 |
| 10 AM to 11 AM | 2.9 | 3.9 |
| 12 Noon to 1 PM | 3.2 | 3.7 |
| 2 PM to 3 PM | 3 | 3.3 |
| 4 PM to 5 PM | 1.6 | 2.5 |
| 6 PM to 7 PM | 1 | 1.3 |
| 8 PM to 9 PM | 0.3 | 0.8 |
| 10 PM to 11 PM | 0.1 | 0.4 |
| 12 AM to 1 AM | 0.1 | 0.3 |
| 2 AM to 3 AM | 0.2 | 0.3 |

Source: GAO analysis of data from the Bureau of Labor Statistics American Time Use Survey. | GAO-23-105999

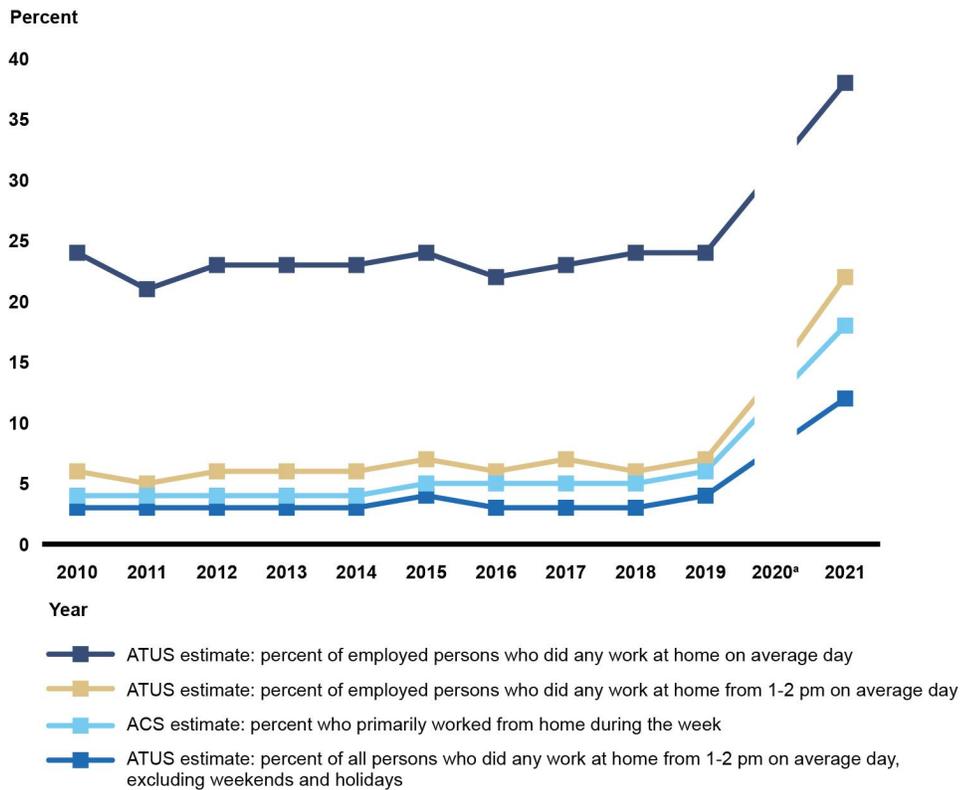
Note: Data shown is the percentage of the employed population who reported doing work at home, for any number of minutes, during each hour of the data. The population is restricted to employed workers reporting on survey days when they did any work at home. All estimates in this figure have margins of error less than or equal to 1.2 percentage points, and all estimates are statistically different from zero at the 95 percent confidence level.

We used this information to construct additional telework measures from the ATUS diary data that are likely to reduce the inclusion of incidental telework:

- The first additional measure we examined may reduce the impact of incidental telework by focusing on work reported during a core work

hour. Like our primary measure, this measure also is restricted to employed people. The measure is the percentage of employed people who reported doing any work at home between 1p.m. and 2 p.m., limited to those who worked on the diary day. This ATUS measure yields a telework prevalence that is close to the telework prevalence estimated by the ACS. In 2021, 22 percent of workers were teleworking under this definition, compared to 18 percent under the ACS definition (see fig. 8).

Figure 8: Alternative Measures of Telework Prevalence, 2010–2021



Source: GAO analysis of data from the Bureau of Labor Statistics American Time Use Survey and the Census Bureau's American Community Survey. | GAO-23-105999

Accessible Data for Figure 8: Alternative Measures of Telework Prevalence, 2010–2021

| Year | ATUS estimate: percent of employed persons who did any work at home on average day | ATUS estimate: percent of employed persons who did any work at home from 1-2 pm on average day | ACS estimate: percent who primarily worked from home during the week | ATUS estimate: percent of all persons who did any work at home from 1-2 pm on average day, excluding weekends and holidays |
|-------------------|--|--|--|--|
| 2010 | 24 | 4 | 6 | 3 |
| 2011 | 21 | 4 | 5 | 3 |
| 2012 | 23 | 4 | 6 | 3 |
| 2013 | 23 | 4 | 6 | 3 |
| 2014 | 23 | 4 | 6 | 3 |
| 2015 | 24 | 5 | 7 | 4 |
| 2016 | 22 | 5 | 6 | 3 |
| 2017 | 23 | 5 | 7 | 3 |
| 2018 | 24 | 5 | 6 | 3 |
| 2019 | 24 | 6 | 7 | 4 |
| 2020 ^a | 31 | 12 | 14 | 8 |
| 2021 | 38 | 18 | 22 | 12 |

Source: GAO analysis of data from the Bureau of Labor Statistics American Time Use Survey and the Census Bureau's American Community Survey. | GAO-23-105999

Note: The upper line (an American Time Use Survey (ATUS) measure) shows the annual average estimated percentage of respondents who participated in work at home, on an average day, among those who were employed, on days they worked. Respondents who indicated that they performed work at their home for any amount of time on a diary report of the previous 24 hour day were classified as teleworkers. The second line (an ATUS measure) shows the annual average estimated percent of employed people who did any work at home during the hour of 1 p.m. to 2 p.m. during the diary survey day, on any day of the week. The third line (the ACS measure) shows the percentage of respondents who are identified as teleworking based on their response to a question about their primary means of transportation to work over the past week. We classified respondents who replied "worked from home" as teleworkers. The bottom line (an ATUS measure) shows the annual average estimated percentage of people who did any work at home during the hour of 1 p.m. to 2 p.m. during the diary survey day, excluding diaries collected on weekdays and holidays; this line was not restricted to people who were employed. Margins of error for all estimates in this figure are within +/- 1.96 percentage points.

^aData for 2020 are not shown because, due to the impact of the COVID-19 pandemic on data collection, the ACS 2020 1-year data and the 2020 annual ATUS estimates failed to meet Census Bureau's quality standards for publication.

- A second additional measure we examined may reduce the impact of incidental telework by excluding weekends and holidays; however, it

is not restricted to people who are employed.⁹ This measure is the percentage of people who reported doing any work at home between 1 p.m. and 2 p.m., limited to those who participated in some work at home on the day they filled out their diary reports of activities, excluding weekends and holidays. Using this ATUS measure yields a telework prevalence that is slightly lower than the telework prevalence estimated by the ACS—in 2021, 12 percent of workers were teleworking under this definition, compared to 18 percent under the ACS definition.

The similarity between these alternate ATUS measures and the ACS measure demonstrates that the ACS and ATUS surveys can produce telework measures that are highly consistent with each other. The difference in the telework prevalence across ATUS measures is explainable, and in part reflects the extent to which incidental telework is captured in each of the measures. We chose to focus on the broadest ATUS measure in this report because it is most useful in presenting a more expansive and narrowly defined measure of telework, reflecting the various forms of work arrangements that telework can take.

Hours Worked at Home

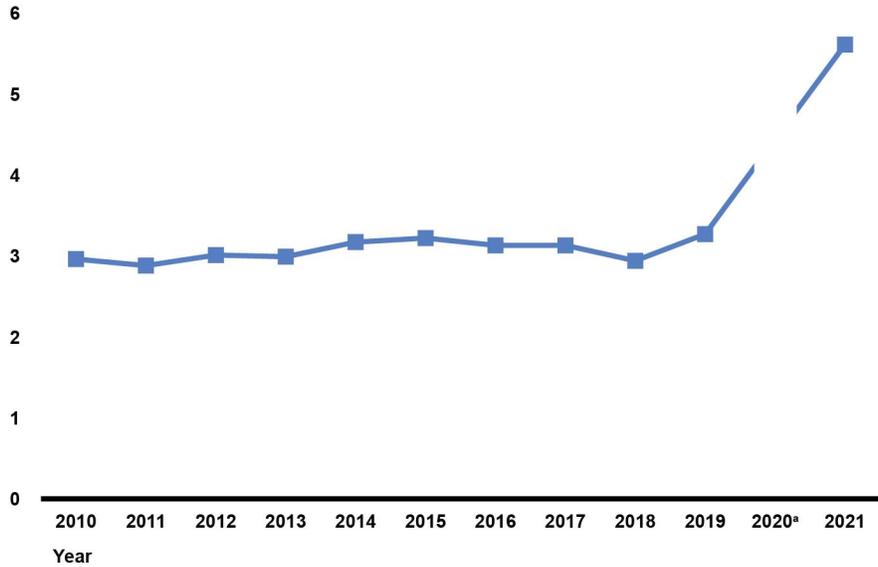
In order to provide additional context to our analysis of telework prevalence, we also used ATUS data to present a measure of telework intensity: the average number of hours worked at home over time, and by various characteristics. Figure 9 shows the average number of hours that employed workers spent working at home, on days that they worked at home. As shown in figure 9, the average number of hours spent working at home did not change much from 2010 (3.0 hours) to 2019 (3.3 hours), and increased significantly in 2021, rising to 5.6 hours per day.¹⁰ Overall, figure 9 demonstrates the substantial shift in work location among those able to telework. The trend in telework intensity shown in figure 9 is consistent with the trends in telework prevalence shown in figure 8.

⁹This estimate may include a small number of people who do not meet the ATUS definition of employed, but spent time working.

¹⁰This measure of telework intensity may overestimate telework to an extent because it captures incidental telework, in part because the average hours of telework shown in figure 9 include both paid and unpaid work. On the other hand, because this measure of telework intensity includes people who reported very low amounts of telework in a day, this measure could also be biased downwards relative to a measure that is more restrictive about who is counted as a teleworker.

Figure 9: Average Hours Worked at Home, among Those Who Worked at Home on Previous Day, 2010–2021

Average number of hours worked at home



Source: GAO analysis of data from the Bureau of Labor Statistics American Time Use Survey. | GAO-23-105999

Accessible Data for Figure 9: Average Hours Worked at Home, among Those Who Worked at Home on Previous Day, 2010–2021

| Year | Average number of hours worked at home (percent) |
|-------------------|--|
| 2010 | 2.96 |
| 2011 | 2.88 |
| 2012 | 3.01 |
| 2013 | 2.99 |
| 2014 | 3.17 |
| 2015 | 3.22 |
| 2016 | 3.13 |
| 2017 | 3.13 |
| 2018 | 2.94 |
| 2019 | 3.27 |
| 2020 ^a | 4.44 |
| 2021 | 5.61 |

Source: GAO analysis of data from the Bureau of Labor Statistics American Time Use Survey. | GAO-23-105999

Note: Data shows the estimated annual average number of hours worked per day at home, among employed persons age 15 or over, on days that they worked at home. Workers may report working in

**Appendix II: Overview of Selected Alternative
Measures of Telework**

both home and office on the same day. Margins of error for all estimates in this figure are within +/- 0.32 percentage points.

^aData for 2020 are not shown because data collection issues prevented the Bureau of Labor Statistics from publishing 2020 annual ATUS estimates.

Appendix III: List of 44 Studies Included in Our Literature Review of the Impact of Telework on Worker Productivity and Firm Performance

Aksoy, Cevat Giray, Jose Maria Barrero, Nicholas Bloom, Steven J. Davis, Mathias Dolls, and Pablo Zarate. "Working from Home Around the World." NBER Working Paper 30446, National Bureau of Economic Research, Cambridge, Mass., September 2022.

Angelici, Marta, and Paola Profeta. "Smart-Working: Work Flexibility without Constraints." CESifo Working Paper 8165, Munich Society for the Promotion of Economic Research, Munich, Germany, March 2020.

Awada, Mohamad, Gale Lucas, and Burcin Becerik-Gerber. "Working from Home during the COVID-19 Pandemic: Impact on Office Worker Productivity and Work Experience." *Work*, vol. 69 (2021): 1171-1189.

Bai, John (Jianqiu), Erik Brynjolfsson, Wang Jin, Sebastian Steffen, and Chi Wan. "Digital Resilience: How Work-from-Home Feasibility Affects Firm Performance." NBER Working Paper 28588, National Bureau of Economic Research, Cambridge, Mass., March 2021, 1-37.

Barrero, Jose Maria, Nicholas Bloom, and Steven J. Davis. "Why Working from Home Will Stick." NBER Working Paper 28731, National Bureau of Economic Research, Cambridge, Mass., April 2021, 1-68.

Bao, Lingfeng, Tao Li, Xin Xia, Kaiyu Zhu, Hui Li, and Xiaohu Yang. "How Does Working from Home Affect Developer Productivity? A Case Study of Baidu during the COVID-19 Pandemic." *Science China Information Sciences*, vol. 65. (April 2022).

Battiston, Diego, Jordi Blanes I Vidal, and Tom Kirchmaier. "Is Distance Dead? Face-to-Face Communication and Productivity in Teams." CEP Discussion Paper 1473, Centre for Economic Performance, London, England, March 2017.

Blit, Joel, Mikal Skuterud, and Michael R. Veall. "The Pandemic and Short-Run Changes in Output, Hours Worked and Labour Productivity: Canadian Evidence by Industry." *International Productivity Monitor*, no. 39 (2020): 16-32.

Bloom, Nicholas, James Liang, John Roberts, and Zhichun Jenny Ying. "Does Working from Home Work? Evidence from a Chinese Experiment." *The Quarterly Journal of Economics* (2015): 165-218.

Bloom, Nicholas, Philip Bunn, Paul Mizen, Pawel Smietanka, and Gregory Thwaites. "The Impact of Covid-19 on Productivity." NBER Working Paper 28233, National Bureau of Economic Research, Cambridge, Mass., December 2020.

Bloom, Nicholas, Ruobing Han, and James Liang. "How Hybrid Working from Home Works out." NBER Working Paper 30292, National Bureau of Economic Research, Cambridge, Mass., July 2022.

Bolisani, Ettore, Enrico Scarso, Christine Ipsen, Kathrin Kirchner, and John Paulin Hansen. "Working from Home during COVID-19 Pandemic: Lessons Learned and Issues." *Management & Marketing. Challenges for the Knowledge Society*, vol.15, Special Issue (2020): 458-476.

Brucks, Melanie S. and Jonathan Levav. "Virtual Communication Curbs Creative Idea Generation." *Nature*, vol. 605 (2022): 108-112.

Chouldhury, Prithwiraj (Raj), Tarun Khanna, Cristos. A. Makridis, Kyle Schirmann. "Is Hybrid Work the Best of Both Worlds? Evidence from a Field Experiment." Working Paper 22-063, Harvard Business School, 2022.

Choudhury, Prithwiraj (Raj), Cirrus Foroughi, and Barbara Larson. "Work from Anywhere: The Productivity Effects of Geographic Flexibility." *Strategic Management Journal*, 42 (2021): 655-683.

Criscuolo, Chiara, Peter Gal, Timo Leidecker, Francesco Losma, and Giuseppe Nicoletti. "The Role of Telework for Productivity during and Post COVID-19: Results from an OECD Survey among Managers and Workers." OECD Productivity Working Papers 31, OECD Publishing, Paris, France, December 2021, 1-64.

Dalton, Michael and Jeffrey A. Groen. "Telework during the COVID-19 Pandemic: Estimates using the 2021 Business Response Survey." *Monthly Labor Review*. U.S. Bureau of Labor Statistics, March 2022.

Deole, Sumit S., Max Deter and Yue Huang. "Home Sweet Home: Working from Home and Employee Performance during the Covid-19 Pandemic in the UK." GLO Discussion Paper 791, Global Labor Organization (GLO), Essen, Germany, 2021.

De Vries, Klaas, Abdul Erumban, and Bart van Ark. "Productivity and the Pandemic: Short- Term Disruptions and Long-Term Implications. The Impact of the COVID-19 Pandemic on Productivity Dynamics by Industry." *International Economics and Economic Policy*, vol. 18 (2021): 541-570.

Eberly, Janice C., Jonathan Haskel, and Paul Mizen. "'Potential Capital', Working from Home, and Economic Resilience." NBER Working Paper 29431, National Bureau of Economic Research, Cambridge, Mass., October 2021, 1-38.

Emanuel, Natalia and Emma Harrington. "Working Remotely? Selection, Treatment and the Market Provision of Remote Work." Working Paper (April 2021): 1-83.

Etheridge, Ben, Li Tang, and Yikai Wang. "Worker Productivity during Lockdown and Working from Home: Evidence from Self Reports." ISER Working Paper Series 2020-12, Institute for Social & Economic Research, University of Essex, October 2020, 1-31.

Gibbs, Michael, Friederike Mengel, and Christoph Siemroth. "Work from Home & Productivity: Evidence from Personnel & Analytics Data on IT Professionals." *Journal of Political Economy Microeconomics*, Forthcoming (2022).

Giovanis, Eleftherios. "The Relationship Between Flexible Employment Arrangements and Workplace Performance in Great Britain." *International Journal of Manpower*, vol. 39, no. 1 (2018): 51-70.

Hackney, Amy, Marcus Yung, Kumara G. Somasundram, Behdin Nowrouzi-Kia, Jodi Oakman, and Amin Yazdani. "Working in the Digital Economy: A Systematic Review of the Impact of Work from Home Arrangements on Personal and Organizational Performance and Productivity." *PLOS ONE*, vol. 17, no. 10 (2022).

Kitagawa, Ritsu, Sachiko Kuroda, Hiroko Okudaira, and Hideo Owan. "Working from Home and Productivity under the COVID-19 Pandemic: Using Survey Data of Four Manufacturing Firm." *PLOS ONE*, vol. 16, no. 12 (2021).

Künn, Steffen, Christian Seel, and Dainis Zegners. "Cognitive Performance in Remote Work Evidence from Professional Chess." *The Economic Journal*, vol. 132 (April 2022): 1218-1232.

Maghlaperidze, Eka, Natalia Kharadze, and Halyna Kuspliak. "Development of Remote Jobs as a Factor to Increase Labor Efficiency." *Journal of Eastern European and Central Asian Research*, vol. 8, no. 3 (2021).

Mihalca, Loredana, Tudor Irimias, and Gabriela Brenea. "Teleworking during the COVID-19 Pandemic: Determining Factors of Perceived Work Productivity, Job Performance, and Satisfaction." *Amfiteatru Economic*, vol. 23 (2021): 620-636.

Moens, Eline, Louis Lippens, Philippe Sterkens, Johannes Weytjens, and Stijn Baert. "The COVID-19 Crisis and Telework: a Research Survey on Experiences, Expectations and Hopes." *The European Journal of Health Economics*, vol. 23 (2022): 729-753.

Morikawa, Masayuki. "Work-from-Home Productivity during the COVID-19 Pandemic: Evidence from Japan." *Economic Inquiry*, vol. 60, no. 2 (2022): 508-527.

OECD. "Productivity Gains from Teleworking in the Post COVID-19 Era: How Can Public Policies Make it Happen?" *OECD Policy Responses to Coronavirus (COVID-19)*, OECD Publishing, Paris, France, 2020.

Okubo, Toshihiro, Atsushi Inoue, and Kozue Sekijima. "Telework Performance in the COVID-19 era in Japan." *Asian Economic Papers*, vol. 20, no. 2 (2020).

Papanikolaou, Dimitris and Lawrence D.W. Schmidt. "Working Remotely and the Supply-Side Impact of Covid-19." NBER Working Paper 27330, National Bureau of Economic Research, Cambridge, Mass., June 2020: 1-49.

Rietveld, Jacqueline R., Djoerd Hiemstra, Aleid E. Brouwer, and Jan Waalkens. "Motivation and Productivity of Employees in Higher Education during the First Lockdown." *Administrative Sciences*, vol. 12, no. 1 (2022).

Rupietta, Kira and Michael Beckmann. "Working from Home – What is the Effect on Employees' Effort?" WWZ Working Paper 2016/07, Center of Business and Economics, University of Basel, Basel, Switzerland, December 2016, 1-40.

Sherman, Eliot L. "Discretionary Remote Working Helps Mothers Without Harming Non-Mothers: Evidence from a Field Experiment." *Management Science*, vol. 66, no. 3 (2020): 1351-1374.

Smite, Darja, Anastasiia Tklich, Nils Brede Moe, Efi Papatheocharous, Eriks Klotins, and Marte Pettersen Buvik. "Changes in Perceived Productivity of Software Engineers during the COVID-19 Pandemic: The Voice of Evidence." *The Journal of Systems & Software*, vol. 186 (2022): 1-14.

Stoker, Janka I., Harry Garretsen, and Joris Lammers. "Leading and Working From Home in Times of COVID-19: On the Perceived Changes in Leadership Behaviors." *Journal of Leadership and Organizational Studies*, vol. 29, no. 2 (2022): 208-218.

Tejero, Lourdes Marie S., Rosemary R. Seva, and Vivien Fe F. Fadrilan-Camacho. "Factors Associated with Work-Life Balance and Productivity before and during Work from Home." *Journal of Occupational and Environmental Medicine*, vol. 63, no. 12 (December 2021): 1065-1072.

Van der Lippe, Tanja and Zoltán Lippényi. "Co-workers Working from Home and Individual and Team Performance." *New Technology, Work and Employment*, vol. 35, no. 1 (2019): 60-79.

Varotsis, Nikolaos. "Exploring the Influence of Telework on Work Performance in Public Services: Experiences during the COVID-19 Pandemic." *Digital Policy, Regulation and Governance*, vol. 24, no. 5 (2022): 401-417.

Vega, Ronald P., Amanda Anderson, and Seth A. Kaplan. "A Within-Person Examination of the Effects of Telework." *Journal of Business Psychology*, vol. 30 (2015): 313-323.

**Appendix III: List of 44 Studies Included in Our
Literature Review of the Impact of Telework on
Worker Productivity and Firm Performance**

Zhang, Ting, Dan Gerlowski, and Zoltan Acs. "Working from Home: Small Business Performance and the COVID-19 Pandemic." *Small Business Economics*, vol. 58 (2022): 611-636.

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In addition to the contacts named above, Mary Crenshaw (Assistant Director), Terence Lam and Elaine Vaurio (Analysts-in-Charge), Amy Abramowitz, Colleen Candrl, Kirsten Lauber, Abigail Loxton, Joseph Maher, Alec McQuilkin, Abinash Mohanty, Jessica Orr, Dae Park, Rhiannon Patterson, Curtia Taylor, Meg Tulloch, and Brennan Williams, made key contributions to this report.

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