How Many Americans Work Remotely?

A Survey of Surveys and Their Measurement Issues

By

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Abstract

Remote work surged during the Covid pandemic but there is disagreement about the extent of the change. To address this question, we field a new, nationally-representative survey: the Remote Life Survey (RLS). We find that in October 2020, 31.6 percent of the continuously employed workforce always worked from home (WFH) and 21.9 percent sometimes or rarely WFH, totaling 53.5 percent. We compare our results with alternative measurement approaches, with a focus on government surveys and provide estimates on the impact of four factors: (a) differences among mail versus web-based survey respondents, (b) differences in the inclusion of self-employed workers, (c) the industry mix of the sample, and (d) the exclusion of people who were already remote pre-pandemic. We find that the last explanation (d) explains the bulk of the difference in estimates between the Current Population Survey (CPS) and other measures of remote work. Policymakers and researchers who turn to the BLS-CPS data series for an estimate of remote work prevalence in the American economy should note that it might be underestimating WFH levels by up to 25 percentage points. Under our preferred estimates, we find that about half of the U.S. workforce worked remotely at least one day each week as of December 2020.

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List of Figures

List of Tables

1. Introduction

The COVID-19 pandemic and the associated federal and state quarantine policies led to a surge in the share of remote workers (Brynjolfsson et al. 2020). While certain sectors were classified as essential, others were not. Combined with a supply-induced decline in demand (Guerrieri et al. 2020), these circumstances led to substantial declines in employment (Cajner et al. 2021).

Remote work provided a critical margin for managers to redesign jobs. Many anticipate that the shift to remote work, or at least hybrid work, is likely permanent (Barrero et al. 2021), with profound effects on individual productivity, mediated through employee engagement and intra-firm communication (Makridis and Schloetzer 2022; Choudhury et al. 2021b). However, there remains wide disagreement and resulting uncertainty about aggregate remote work numbers. Our primary contribution is to document the wide dispersion in remote work measures and to explain how various survey decisions affect aggregate measurement differences.

There is a large literature documenting the link between coordination and firm performance (Malone and Crowston 1994; Bresnahan et al. 2002), underscoring the importance of accurate measurement of remote work. The large, abrupt shift to remote work has had and will have wide-ranging economic and social consequences. Depending on how and which employees value remote work, the nature of the workplace and the supply chains of products and services may fundamentally change (Barrero et al. 2020; Harrington and Emanuel 2020; Bai et al. 2021). In particular, the shift to remote work is having large effects on migration and the composition, as well as the structure of cities (Coven et al. 2021; Delventhal et al. 2020; Althoff et al. 2020; Ramani and Bloom 2021). This widespread adoption of remote work means that a variety of spillovers beyond those anticipated today may occur throughout the economy. However, before these resulting effects can be quantified, we need proper measurement of remote workers and their intensity of remote work. There are several efforts to measure the prevalence of remote work (Barrero et al. 2021; Bick et al. 2021; Dey et al. 2021). We add results from a nationally representative sample survey and use our data to reconcile differences in measurements across other efforts.

We first introduce the "Remote Life Survey" (RLS), a new survey instrument that we implemented with Gallup between October and November 2020 with several novel features. We capture not only respondents who answer Web-only surveys, but also those who answer by physical mail. Our survey contains detailed geographic information on respondents and a wide array of demographic, work, and well-being characteristics. Although we present only cross-sectional estimates from the initial survey wave in this paper, a critical

advantage of our survey is that it allows us to follow the same workers over time and understand flows in and out of remote work. These flows play a major role in disciplining quantitative models of the labor market.[1]

Next, we compare our survey to six other measures of remote work. We find relatively low dispersion in remote work rates for similar periods of time among non-governmental series. However, the measure from the Current Population survey is an outlier compared to our new measure and four other measures, including: Barrero et al. (2021) and their Survey of Working Arrangements and Attitudes, Bick et al. (2021) and their Real-Time Population Survey, Brynjolfsson et al. (2020) and their Google Consumer Surveys; and Gallup's COVID Tracking Survey. We also find disagreement between our measure and the American Time Use Survey (ATUS) when with respect to pre-pandemic work from home incidence. As these measures of remote work remain highly visible and (some) are regularly updated, we compare our results to theirs.

After introducing our survey instrument and headline results, we assess potential explanations for the heterogeneity in estimates of the incidence of remote work. Differences in the incidence of remote work among respondents who participate in web-only versus mail surveys can contribute to an overestimate of 1.6 percentage points in the "always WFH" category and an overestimate of 0.9 percentage points in the "sometimes WFH" category. As such, this could serve as a starting point for researchers to adjust surveys that rely solely on online panels.

Another factor to consider is the self-employment angle and we conduct a comparison against the American Time Use Survey's 2017-18 Leave and Job Flexibilities Module (ATUS). This is another government source of WFH estimates that is used by the literature, often for benchmarking pre-pandemic remote work incidence (Bick et al. 2021; Barrero et al. 2021). We find that ATUS's exclusion of the self-employed can downward bias pre-pandemic remote work incidence estimates by around 3 percentage points. This is primarily driven by the positive relationship between self-employment status and pre-pandemic teleworking rates. Calculations involving the use of ATUS as the baseline for pre-Covid WFH levels should keep this in mind. Without correcting for this sample bias, there will be a risk of overestimating the magnitude remote work adoption since the start of Covid-19. Of note, the BLS-CPS includes those who are self-employed so this measurement issue mainly affects those who use ATUS for pre-pandemic benchmarking.

We examine whether industry composition can narrow the measurement gap between

[1]To narrow the scope of this paper, we focus on introducing the new data and answering a more urgent question: why do estimates of remote work vary so drastically across surveys? Future work will include panel data analyses of multiple waves of surveys.

the BLS-CPS and the RLS. After applying weights that match our occupational distribution to that used by the BLS-CPS, we see that our headline "always or sometimes WFH" rate drops from 51 to 43 percent. This is in comparison to the BLS-CPS rate of 22 percent, so occupational differences can explain over a quarter of the 29 percentage point gap if we assume a like-for-like comparison between two stock measurements. Alternatively, we can interpret the BLS-CPS as a measurement of remote work adoption (as argued by our fourth discrepancy factor, survey administration and design). Under this alternate interpretation and using the CPS occupation weights, our measurement of "sometimes WFH" adoption since the start of the pandemic drops from 26 percent to 20 percent, turning our "overestimate" into an "underestimate" when compared against the BLS-CPS's 22 percent. Therefore, we argue that the industry mix plays a large role in explaining the gap between our numbers and those of the BLS-CPS.

Finally, we show how survey administration and design can impact the measurement of remote work. If a survey primes its respondents to only report changes in remote work behavior due pandemic circumstances, then the outcome becomes a flow (change over time) and not a stock (level) measure. Excluding those previously working from home results in an estimate of 23.6 percent for the strictest definition of WFH ("I always worked from home"). This implies a reduction of 8 percentage points from our headline rate of 31.6 percent and it accounts for over 80 percent of the 9.6 percentage point gap between RLS and BLS-CPS. For a more flexible definition of WFH, one includes both the "sometimes" and "always" WFH population, we see an updated estimate of 28.2 percent. This implies a reduction of 25.3 percentage points from our headline rate and it accounts for 80 percent of the 31.5 percentage point gap between RLS and BLS-CPS. In addition to the RLS, we present evidence from Google Consumer Surveys designed for distinguishing the flow versus stock debate. We find that the definition of our object of measurement and survey design can explain most of the gap between the RLS and the BLS-CPS estimate.

In sum, our results underscore the importance of careful and precise survey design and execution. The most likely cause of the lower propensity of remote work observed in the CPS is exclusion of pre-pandemic remote work. When including those who are sometimes remote, this can reduce the estimated remote work share by up to 25.3 percentage points in our data. The consistency among other measures, including those longitudinal and non-web surveys, suggest that the CPS measure is indeed a substantial underestimate and has been for the duration of the pandemic. The bias appears to be 20 percentage points or more for several peer survey comparisons against the BLS-CPS, which is an approximate magnitude of the bias expected by excluding pre-pandemic work from home. As interest in tracking the incidence of remote work continues, researchers can use our estimates as

adjustment factors to ensure meaningful comparisons across surveys.

2. Data

2.1. Remote Life Survey

We launched the "Remote Life Survey (RLS)," consisting of 6,672 U.S. adults, ages 18 and older, and drawn from a nationally representative sample of Gallup's household panel. Of the 6,672 respondents, 6,049 completed the survey by web and 623 completed the survey by mail. Web interviews were completed between October 16-23, 2020; mail surveys were sent on October 16 and responses were accepted through November 30. Gallup panelists are recruited through random selection methods, including through random-digit dial (RDD) telephone recruiting and address-based sampling (ABS) mail recruiting.

One of the advantages of our survey instrument is that it also contains representation of adults without internet access, which could matter greatly for understanding the incidence of remote work and heterogeneity in its effects across the population – after all, the 7 percent of Americans without internet access may find it difficult to do many types of work from home. Among the mail respondents, we asked a subset of questions asked of the web respondents. All samples were drawn using a stratified sampling method to ensure our respondents are representative of the U.S. adult population.[2] The combined response rate for mail and web respondents was 28 percent, including 32 percent for web respondents and 26 percent for mail respondents.

To correct for non-response and ensure nationally representative samples according to gender, age, race, ethnicity, education, and census region, both the web-only and combined web/mail obtained samples were weighted. These weighting targets were computed using data from the most recent Current Population Survey. The margin of sampling error for the combined web and mail sample, and the web only sample of U.S. adults, is +/- 2 percentage points.

Online Appendix A.1 presents the full suite of questions asked in both Web and Mail surveys. We focus on the responses to the following question: "In the past month, about how often did you work from home as part of your job? (1) Never; (2) A few times a year; (3) About once a month; (4) About once a week; (5) 3-4 times a week; (6) I always worked from home." An advantage of our survey approach is that we provide respondents with the option of stating *how much* they work remotely, rather than a simple binary option, which is especially pertinent given recent evidence that varying interpretations of hybrid work will

[2] Furthermore, we included a small incentive of $2 to encourage participation in the study.

become the standard in the workplace (Barrero et al. 2021; Makridis and Schloetzer 2022; Choudhury et al. 2021b). For our measurement of remote work, we focus on respondents who are employed and working at home around once a week, i.e. "sometimes remote."

In addition to these responses on remote work *during* the pandemic, we have information about remote work prior to the pandemic, which helps reconcile some of the disagreement in prior studies of remote work and allows us to provide an estimate about the increase in remote work relative to the pre-pandemic baseline. In particular, we ask: "Prior to February 1, how often did you work from home as part of your job? (1) Never; (2) A few times a year; (3) About once a month; (4) About once a week; (5) 3-4 times a week; (6) I always worked from home." Tables 1 and 2 show how the breakdown of remote work intensity impacts the headline WFH estimate that we report and how that changes before and after the onset of Covid-19.

TABLE 1. Pre-COVID onset WFH rates for varying definitions of WFH.

Answer	"WFH" definition includes...				Wgt. Fraction
I always worked from home	✓	✓	✓	✓	8.04%
3-4 times a week		✓	✓	✓	4.91%
About once a week			✓	✓	7.88%
About once a month				✓	4.50%
A few times a year					10.86%
Never					63.80%
Total WFH rate:	**8.04%**	**13.0%**	**20.8%**	**25.3%**	

[1] Weighted fraction = average response rates weighted by Gallup survey weights.
[2] The answer choices listed in the table define the full set of allowed responses to the following survey question (used to generate Table 1 data):

"Prior to Februrary 1, how often did you work from home as part of your job?"

2.2. Survey Modality

Many surveys on remote work are conducted through Web-only surveys, which could attract a systematically different type of individual—that is, individuals who are more likely to engage in remote work. One advantage of our approach is that we not only include respondents from the Web, but also those who respond through physical mail. We use these data to ascertain the incidence of remote work across different survey modalities, which can be used to adjust Web-only surveys to reflect the more population in ways that demographic weights cannot deliver.

TABLE 2. Post-COVID onset WFH rates for varying definitions of WFH.

Answer	"WFH" definition includes...				Wgt. Fraction
I always worked from home	✓	✓	✓	✓	31.6%
3-4 times a week		✓	✓	✓	9.56%
About once a week			✓	✓	5.69%
Once or twice				✓	6.69%
Never					46.4%
Total WFH rate:	**31.6%**	**41.2%**	**46.9%**	**53.5%**	

[1] Weighted fraction = average response rates weighted by Gallup survey weights.
[2] The answer choices listed in the table define the full set of allowed responses to the following survey question (used to generate Table 2 data):

"In the past **month**, about how often did you work from home as part of your job?"

To characterize possible survey response bias arising from web-only responses, we regress indicators for always and mostly WFH on an indicator for being a web-only respondent, controlling for demographics and state fixed effects. We also justify the inclusion of key controls in our main regression by showing that they are strongly predictive of the web-response indicator ("selection into web-response") and we want to disentangle the impact of demographics versus survey modality. Our controls include: indicators for race (baseline dummy is White/Caucasian), education (baseline dummy is college-educated), an indicator for full-time employment status before and after February 1, 2021, log download speeds for fixed and mobile internet, and state fixed effects.

Table 3 highlights the coefficients of interest in the regression, whereas Table A.2 in the Online Appendix presents the unabridged results. They show that Web-only respondents are much more likely to work remotely even after accounting for demographic differences. We also find that African Americans are less likely to respond via the web and that college-educated workers are drastically more likely to respond by web. Faster mobile speeds as measured at a county level are also positively associated with web-only responses.

TABLE 3. Mail vs. Web Respondent Characteristics (Selected Results)

	Always WFH		Mostly WFH		Web-based Respondent	
	(1)	(2)	(3)	(4)	(5)	(6)
Web-only Respondent	.225***	.158***	.143***	.091***		
	(.033)	(.033)	(.030)	(.030)		
Black		.006		-.021	-.132***	-.139***
		(.025)		(.023)	(.011)	(.011)
Some College		-.164***		-.052**	.091***	.092***
		(.025)		(.023)	(.011)	(.011)
log(Mobile Download Speed)		.113***		-.030*		.016*
		(.019)		(.018)		(.009)
			Regression included controls for...			
Race		✓		✓	✓	✓
Education level		✓		✓	✓	✓
FTE pre- and post-Feb. 1, 2021		✓		✓	✓	✓
Fixed, mobile download speeds		✓		✓		✓
R-squared	.055	.122	.033	.064	.126	.129
Sample size	3776	3763	3776	3763	6557	6554

Note: *p<0.1; **p<0.05; ***p<0.01
†All regressions include state-wise fixed effects.

What are the aggregate implications of differential selection into these two types of

survey instruments? Since Mail-only respondents are less likely to work from home, failing to include them will overestimate the share of remote workers in the economy. Restricting our sample to those who are employed in both periods, we find 31.4 percent of Web-only respondents who always WFH, whereas only 6.3 percent of Mail-only respondents always WFH. The differences are slightly smaller for mostly WFH: 22.4 percent for Web-only and 8.1 percent for Mail-only. Given that 93.5 percent of the employed respondents are Web-only in our sample (which broadly coincides with the internet penetration rate of 93 percent in the U.S.), an analysis without the Mail-only respondents would have likely overstated our headline WFH rate by $(0.314 - 0.063) \times 0.065 = 1.6$ percent for always WFH and $(0.224 - 0.081) \times 0.065 = 0.92$ percent for mostly WFH.[3]

2.3. Pandemic-Era Measures of Remote Work

There has been a flurry of interest in measuring the remote work economy since the onset of the pandemic. However, different surveys ask different questions to gauge the incidence of remote work at a given point of time, sometimes leading towards substantially different conclusions. Below, we consolidate several prominent examples of how remote work was measured during the pandemic (enumerated alphabetically as: [authors] - [any abbreviations]), highlighting differences in methodological approaches that may contribute to different aggregate statistics.

(a) Barrero et al. (2021)

- Survey name: Survey of Working Arrangements and Attitudes.
- Sample size: Each survey wave collects between 2,500 and 5,000 responses.
- Measurement time frame: 5/2020 - Present.
  - Most recent measurement: 38.6 percent WFH (legacy series), 29.3 percent WFH (new series) (both as of 12/2022).
- Question asked:
  - Phase 1: 5/2020 - 10/2020.
    - "Currently (this week) what is your working status?" $\rightarrow$ categorical responses: e.g. "Working on my business premises", "Working from home", "Still employed and paid, but not working."
  - Phase 2: 11/2020 - 10/2021.
    - "Currently (this week) what is your working status?"

[3] https://www.pewresearch.org/internet/fact-sheet/internet-broadband/

        - (If working) "How many full days are you working this week (whether at home or on business premises)?" → categorical numerical response for number of days between None, 1 to 5+ days
    - Phase 3: 11/2021 - Present.
        - "How many full paid working days are you working from home this week?" (improved version of Phase 2 Question)
        - Asks respondents to fill out a diary-style questionnaire for each day of last week.
        - Allows respondents to report working 6 or even 7 days in the reference week.
- Sample characteristics: U.S. residents, 20-64 years old.
    - Between 5/2020 and 3/2021 they used a $20,000 threshold for 2019 earnings.
    - Between 4/2021 and 9/2021 they transitioned to a threshold of $10,000 in 2019 earnings.
- Survey method: web surveys.

(b) Bick et al. (2021) - BBM.

- Survey name: Real-Time Population Survey.
- Sample size: 4,700 households per month.
- Measurement time frame: 2/2020 - 6/2021.
    - Most recent measurement: 37.7 percent WFH (6/2021).
- Question asked: "Last week, how many days did you [your spouse/partner] commute to this job?"
- Sample characteristics: all employed.

(c) Dey et al. (2021) - Bureau of Labor Statistics, CPS, Work from Home Supplement.

- Survey name: Current Population Survey.
- Sample size: 60,000 households.
- Measurement time frame: 5/2020 - Present.
    - Most recent measurement: 5.2 percent WFH (9/2022).
- Question asked: "At any time in the LAST 4 WEEKS, did (you/name) telework or work at home for pay because of the coronavirus pandemic?"
- Sample characteristics: all employed.

(d) Brynjolfsson et al. (2020) - BHORST, BHORST-GCS.

- Sample size: 80,555
- Measurement time frame: 4/2020 to 5/2020.

    - Most recent measurement: 35.2 percent of workers switching to WFH in the last 2 months, 15.0 percent of workers already WFH pre-pandemic (5/2020).
  - Question asked: "Have you started to work from home in the last 4 weeks / 2 months?"
  - Sample characteristics: U.S. adults 18-64.
  - Survey method: Google Consumer Surveys.

(e) Saad and Wigert (2021) for Gallup - Gallup COVID Panel, Gallup.

  - Survey name: Gallup COVID Tracking Survey, Gallup COVID Panel.
  - Sample size: over 54,000 adults.
  - Measurement time frame: 4/2020 - Present.
    - Most recent measurement: 49.2 percent WFH (11/2021).
  - Question asked: "In the past 24 hours have you visited your place of work?"
  - Sample characteristics: employed full-time or part-time.

Our paper is related to the emerging literature about the incidence of remote work. For example, earlier work done by the BLS measured remote work based on the ability to telework (Dey et al. 2020), which could produce an upwards biased estimate if the ability does not correspond with the actual implementation of it. Taking a similar approach with O*NET, Dingel and Neiman (2020) find that roughly 37 percent of jobs can be done remotely. Brynjolfsson et al. (2020) launched a survey of roughly 25,000 responses in April 2020, finding upwards of a third of workers shifting to remote work and providing one of the earliest empirical measures of remote work adoption immediately after the onset of Covid-19. Moreover, Barrero et al. (2021) surveyed over 30,000 between May 2020 and March 2020, and found that 20 percent believed that full workdays will be supplied from home after the pandemic ends. This is close to our survey responses: 9.5 percent expect that all of their work will be remote after the pandemic and 20.8 percent expect that most of their work will be.

Our paper builds on a larger literature about the effects of remote work on productivity and workers. While there is a lot of descriptive evidence, causal estimates have been more difficult to obtain. In a pioneering randomized controlled trial (RCT) on China's largest online travel agency, (Bloom et al. 2015) finds that WFH led to a 13 percent performance increase and an overall increase in employee satisfaction. Moreover, using a natural experiment in the U.S. Patent and Trademark Office, Choudhury et al. (2021a) find a 4.4 percent increase in output as a result of their adoption of remote work arrangements for patent examiners. Using a more recent RCT in Bangladesh, Choudhury et al. (2021b) vary the number of days that employees come into the office, finding that additional days in the

office are associated with more emails, particularly for hybrid work arrangements, and emails directed towards more diverse employees in the organization. Nonetheless, there has been much evidence of adverse and unintended effects, especially when remote work arrangements have been adopted poorly or in a rush (e.g., as in Gibbs et al. (2021)).

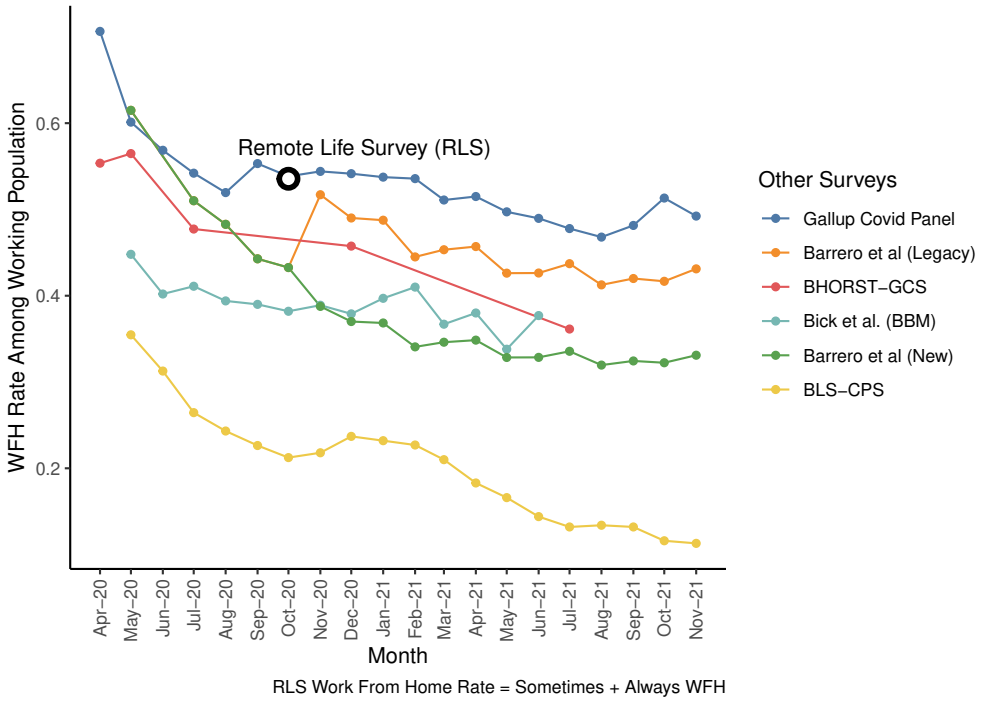

FIGURE 1. Comparing Remote Work Surveys

Figure 1 contrasts the BLS-CPS time series against academic and private sector alternatives, showing a clear and wide disagreement in the measured levels. If we focus on the average from December 2020 through June 2021, when we have estimates for all of the time series, we can see that the BLS-CPS measure is nearly half the next closest number – the average WFH rate as measured by the CPS is around 20 percent whereas Bick et al. (2021) measures 37.8 percent. Figure 2 illustrates how the BLS-CPS is different in not only levels, but also in terms of change over time. From May 2020 to November 2021, the CPS measure declines a cumulative 24 percentage points, while the Gallup COVID Panel measure only declines by 11 percentage points. The Gallup COVID Panel is used in the construction of Figure 2 because it provided the most overlap in survey frequency versus the BLS-CPS. RLS's WFH estimate in Figure 1 is seen as close to the Gallup COVID Panel series as well as the legacy series by Barrero et al. (2021). The RLS estimate consists of both sometimes or always WFH.

Figure 1 has multiple Barrero et al. (2021) series due to changes in methodology. Barrero et al. (2021) had three different survey phases for measuring WFH. In Phase 1 (May to

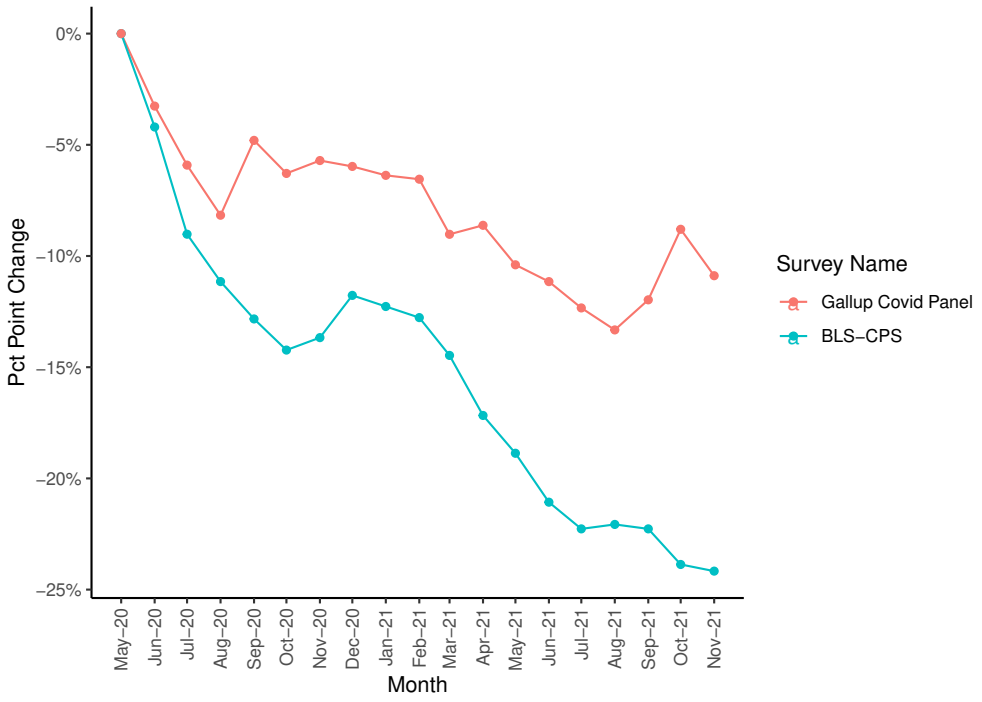

FIGURE 2. Cumulative percentage point change in share working from home at all

October 2020), their measurement of WFH rate was simply employees answering "working on my business premises" or "working from home" to the question: "Currently (this week) what is your working status?" In Phase 2 (November 2020 to October 2021), they wanted to measure the frequency of remote work and asked respondents to recall the number of working days and how many of those working days were at home during the past week. In Phase 3 (fielded from November 2021 onwards), they ask respondents their work and WFH status for each day of the past week. This latest iteration forces respondents to actively recall their behavior during the past week. Phases 1 and 2 are represented by the Barrero et al. (2021) legacy time series. The legacy time series from diverges from the new one starting in November 2020 because the new time series is imputed for Phase 2 data during a regression trained on the first six months (November 2021 to April 2022) where data exists for both old and new approaches. While the new series was designed to tackle the upward rounding bias from respondents, we still find comparisons to the Barrero et al. (2021) legacy series useful because it is constructed with minimal processing of the raw data.

We also include a comparison against the BLS's National Longitudinal Survey 1997 (NLSY97) data in Online Appendix A.2. There is a significant contrast as the NLSY97 reports that 46.7 percent of workers are engaging in remote work versus the CPS showing 23 percent. Even within government sources, the BLS-CPS results seem to stand out as underestimates.

3. Sources of Measurement Differences

3.1. Remote Work by Occupation Area: Comparing CPS to RLS

What is the role of industry composition in accounting for differences in remote work estimates? Based on the 95 percent confidence intervals presented in Figure 3, the distribution of occupations between Gallup and CPS is significantly different for several job areas. For example, while the CPS excludes military personnel from being interviewed for the main questionnaire our data contains respondents who self-classify as part of the "military", albeit a very small portion. More rigorously, running a χ^2 test of homogeneity allows us to test whether the distributions of counts differ significantly between Gallup and CPS. With a χ^2 statistic of 1531.5 and 16 degrees of freedom, we obtain a p-value of 2.2×10^{-16}. This means that the two distributions are different in a statistically significant way.

FIGURE 3. Occupation Distribution Across CPS and Gallup

In our sample, military jobs appear to have higher WFH adoption than average, which contributes to the headline average WFH gap between CPS and RLS. To illustrate this effect and to show the importance of each job category on WFH rates, we run the following

regression, where Y_i denotes the combined rate of sometimes and always WFH:

$$Y_i = \sum_{j:\forall j \neq \text{transportation}} \beta_j \cdot \mathbb{I}[\text{Job Area} = j]_i + \alpha_1 \cdot \mathbb{I}[\text{college}] + \alpha_2 \cdot \text{age} + \alpha_3 \cdot \mathbb{I}[\text{female}] + \alpha_4 \cdot \mathbb{I}[\text{caucasian}] + \sum_m \delta_m \cdot \mathbb{I}[\text{income} = \text{m}]_i + \sum_s \delta_s \cdot \mathbb{I}[\text{state} = \text{s}]_i + \epsilon_i$$

Figure 4 plots the coefficients β_j. The coefficients for each job title is benchmarked against "transportation workers", the omitted/reference dummy. A naïve regression is also included in Figure 4, and this specification contains no demographic nor income controls. We use the naïve point estimates to sort the coefficient plot. State dummy controls are used for the main regression given that many pandemic related policies were enforced at the state level. Demographic and income controls are added to show that "job category" is a statistically significant predictor of WFH rates in spite of key controls. By construction, the coefficient for the baseline dummy is set at 0.

We also conduct a rough approximation using the remotability scores provided by Dingel and Neiman (2020) and can report similar membership for the top and bottom 5 occupations. Dingel and Neiman also does not have the military in their dataset as they were referencing the CPS categories. We observe manufacturing, farming, service hospitality, transportation, healthcare, and construction at the bottom 6 of both rankings. We also see education, information technology, legal, life sciences, and finance in the top 5 of both. Biggest disagreements are in arts/media and architecture, where we rank arts/media at the top (and DN ranks it in the middle of the pack) and rank architecture in the middle (and DN ranks it at the top).

To aggregate the net effect that might be attributed to compositional differences we apply CPS industry weights to Gallup data to see how overall remote work intensities change. Table 4 shows that using the CPS industry weights reduces our WFH intensities across the board and narrows the gap between CPS and RLS across varying definitions of average remote work rates.

In Table 4, we refer to the behavior of switching from no remote work before Covid-19 to remote work after the emergence of Covid-19 as "adoption". "Participation" is measuring static WFH levels and not the changes between pre and post periods. "Post" prefix in variables refers to the period since the start of the pandemic in February 2020 – it should be considered a "during the pandemic" indicator. Since the CPS survey did not obtain WFH frequency information, we consider our "sometimes WFH" segment the most comparable sub-population to the CPS-defined remote working population. In particular, anyone who reported working from home at least once a week is considered as part of this classification.

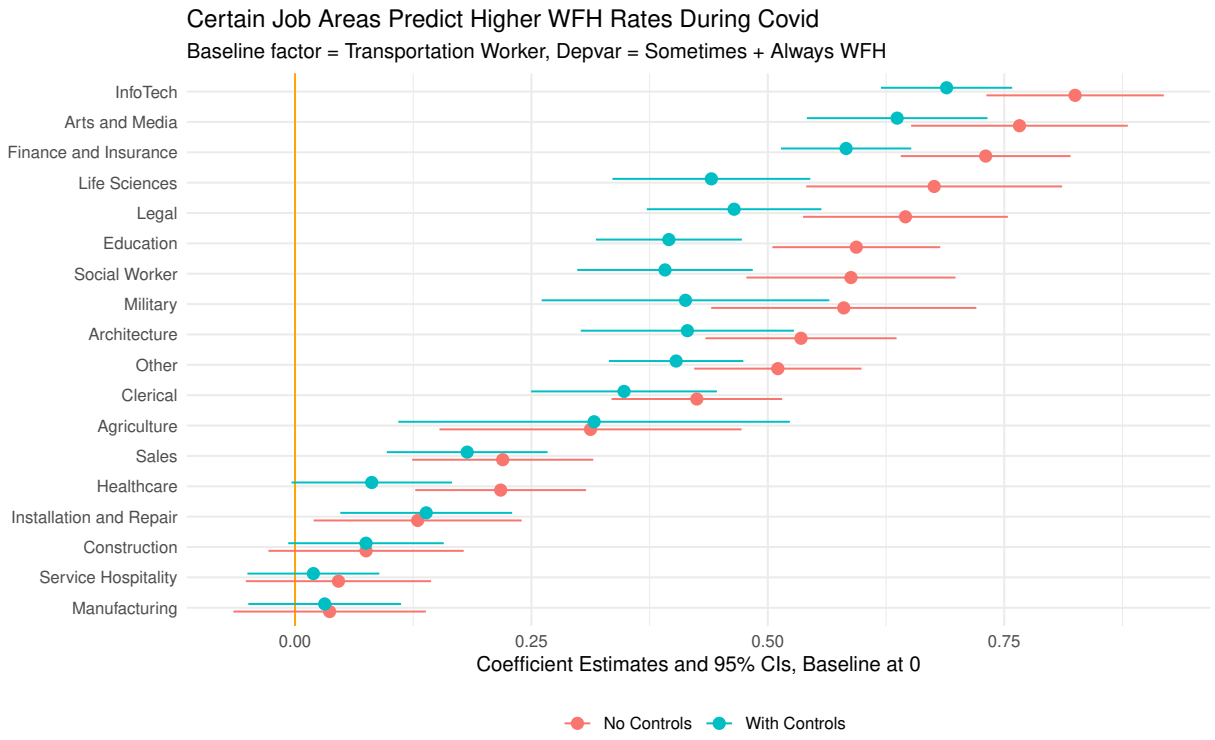

FIGURE 4. Coefficient Plot for WFH Rates vs. Job Area Regression

TABLE 4. Weighted mean rates (WMR) of varying WFH regimes.

Rate variable	Rate value	
Definition	Raw	CPS re-weighted
Always WFH adoption after COVID onset.	0.24	0.19
Sometimes WFH adoption after COVID onset.[2]	0.26	0.20
Always WFH participation after COVID onset.[3]	0.34	0.29
Sometimes WFH participation after COVID onset.[4]	0.51	0.43

[1] All rates computed over respondents working both before and since the onset of COVID-19, at the time of survey administration.
[2] Superset of always WFH respondents.
[3, 4] Includes WFH switchers due to pandemic and non-switchers (i.e., continuing always/sometimes WFH from pre-pandemic).

This excludes those who responded "About once a month", "Once or twice", or "A few times a year". We strip out employment effects by filtering for working respondents who remained employed in both the pre and post periods.

Comparing our "sometimes WFH" metrics to the CPS under different industry composition weights we see that our adoption of "sometimes WFH" measure drops from 26 to 20 percent among the working respondents population with matched occupations. This means that going from before to after the start of the Covid-19 pandemic in February 2020, around a quarter of our respondents have switched from not working from home to "sometimes WFH" using Gallup's industry composition. If we apply the CPS' industry mix, that number drops to 20 percent. Our measure of "sometimes WFH" stock levels during the pandemic (pre-pandemic stock + adoption) stands at 51 percent but drops to 43 percent with the application of CPS industry mix.

As a sanity check, we compare actual WFH rates against the Dingel-Neiman (DN) O*NET Remotability Scores, which is a measure of WFH potential based on job and task descriptions Dingel and Neiman (2020). We get an average of 0.534 remotability score for the RLS sample and 0.3761 remotability score for the CPS sample. To get these values, we replace the WFH rates from RLS and CPS with DN Remotability Scores at the job category level and take a weighted average in accordance to the occuational distriobution of each sample.

With the CPS overall WFH rate at 22 percent at the time of our survey, matching industry weights can play an important role in explaining the gap between our numbers and those of the CPS. If we assume that CPS is capturing sometimes WFH participation, our headline rate gap is reduced by 8 percentage points (51 to 43 vs. 22). If we assume that CPS is capturing sometimes WFH adoption, our headline rate gap is reduced by 6 percentage points (26 to 20 vs. 22). This conclusion is further validated by the comparison of DN Remotability Scores across the two samples, which show a lower remotability for the CPS sample than the RLS sample.

3.2. Measuring Remote Work Adoption Through Commute Behavior

According to Bick et al. (2021), henceforth referred to as BBM, approximately 19 to 21 percent of the workforce was fully remote in the October-December 2020 period. As a reminder, RLS measured 31.6 percent for the always work from home group during the same period, which implies a measurement gap of 10 to 12 percentage points (see Table 2). To address this gap, we decided to use the survey's collected responses on commuting habits to create our own commute-based WFH estimate and make it more comparable to BBM.

BBM ask two questions in their survey that help construct their WFH-Only measure: the number of days one worked during the last week and the number of days one commuted during the last week. If respondents reporting at least one commuting day but strictly fewer commuting days than workdays for the previous week then they were classified as "WFH Some Days". For full-time WFH worker classification, they need to report nonzero work days and zero commuting days for the previous week. If these two conditions are fulfilled, then they are classified as "WFH-Only".

In comparison, we asked the following related to commuting in the web portion of the RLS:

- Question 32: Prior to February 1, approximately how much total time in minutes per day did you spend commuting to and from work?
- Question 33: Approximately how much total time in minutes per day do you spend commuting to and from work now?

To approximate BBM's WFH-Only measure, we define an indicator variable that flags individuals who reported zero minutes of commute time with either a full time or part time employment status. We constructed this variable for both the pre-Covid period (based on Q32) and after the start of the pandemic (Q33). Finally, since BBM tries to match CPS sample weights, we approximate this by using CPS average occupational weights from October-November 2020, an exercise that's carried over from the occupation-based breakdown of WFH rates in section 3.1.

The results in Table 5 suggests that there is a gap between our measure of WFH-only rates when compared to those of BBM. This gap is relatively small before the pandemic (ours is nearly 11 percent and theirs is around 7.5 percent) but this gap increases after the onset of the pandemic (ours is around 38 percent and theirs is around 21 percent). Adding CPS weights does help reduce gap (after reweighting, our WFH-only share declines from 38 percent to around 32 percent) and it highlights the importance of standardizing survey weights when attempting to compare results across surveys. A final source of disagreement is due to framing. We ask respondents to think back to their commuting habits February 2020 and then compare to commuting habits at the point of survey (in this case Oct-Nov 2020). In contrast, BBM asks respondents to report the commuting behavior of the most recent week. Our framing might bias respondents towards more salient reporting of work from home habits because it is preceded by the pre-pandemic question.

TABLE 5. Comparing Effects of CPS Weighting on Pre and Post WFH Rates as Share of Working Population

BBM	RLS unweighted	RLS with CPS reweighting [1]	Variable
7.6%	10.7%	10.8%	pre-Covid, No Commute [2]
20.8%	37.7%	31.9%	post-Covid, No Commute

[1] Weights derived from CPS Oct-Dec 2020 surveys' average occupation distributions.
[2] `WFH_noCommute` is defined by respondents answering zero minutes of commute time.

3.3. Self-Employment

Our survey also reveals the need to caveat government sources that provide pre-pandemic measurements of remote work. In particular, we observe a gap between the pre-pandemic WFH level measured through the Bureau of Labor Statistics' American Time Use Survey (BLS-ATUS) survey data and those measured by Brynjolfsson et al. (2020) and the RLS, which is detailed in the Table 3 of the BLS-ATUS 2017-18 Leave and Job Flexibilities Module BLS (2019).[4] BLS-ATUS describes its sample as "collected directly from wage and salary workers, excluding the self-employed," which allows us to investigate the importance of self-employment in sample selection [5]. According to BLS-ATUS, around 14.7 percent of respondents reported engaging in exclusive work from home behavior at varying levels of frequency. Of the 14.7 percent sub-population, around 54.9 percent reported that engaged in exclusive work from home behavior at least once a week, which yields a rate of around 8.1 percent. Under Figure 1, we remind the reader that the RLS measured a pre-pandemic rate of 20.8 percent for workers who engaged in WFH at least once a week.

Figure 5 below illustrates the response rate differences across all WFH frequencies between ATUS and RLS. The aforementioned ATUS at-least-once-a-week WFH rate of 8.1 percent is derived from aggregating "Always work from home", "3-4 times a week", and "About once a week" categories. The implied "never WFH" category for ATUS is 85.3 percent and for Gallup is 64.5 percent, which results in an almost 20 percentage point difference between RLS and ATUS in terms of the most generous definition of pre-pandemic WFH adoption.

We believe that ATUS's exclusion of self-employed workers contributes to this measurement gap of over 12 percentage points and dedicate this section to explaining the links between remote work and self-employment. This gap is important to keep in mind because both Barrero et al. (2021) and Bick et al. (2021) use ATUS as a source of WFH estimates before the pandemic — for example, figure 1 from Barrero et al. (2021) sets the pre-pandemic level at around 5 percent.

This measurement caveat might also have an effect on the literature documenting time use reallocations due to WFH adoption. For example, Pabilonia and Vernon (2022) use ATUS to conclude that teleworking enables families to better balance work and family responsibilities. Restrepo and Zeballos (2020) find that prime-age white-collar employees who worked remotely shifted their time allocation from work and personal care to leisure activities, sleeping, and food-related tasks compared to those who worked outside of their homes. Frazis (2020) find a similar pattern of reallocation, with emphasis on increased

[4] https://www.bls.gov/news.release/flex2.t03.htm
[5] https://www.bls.gov/news.release/flex2.nr0.htm

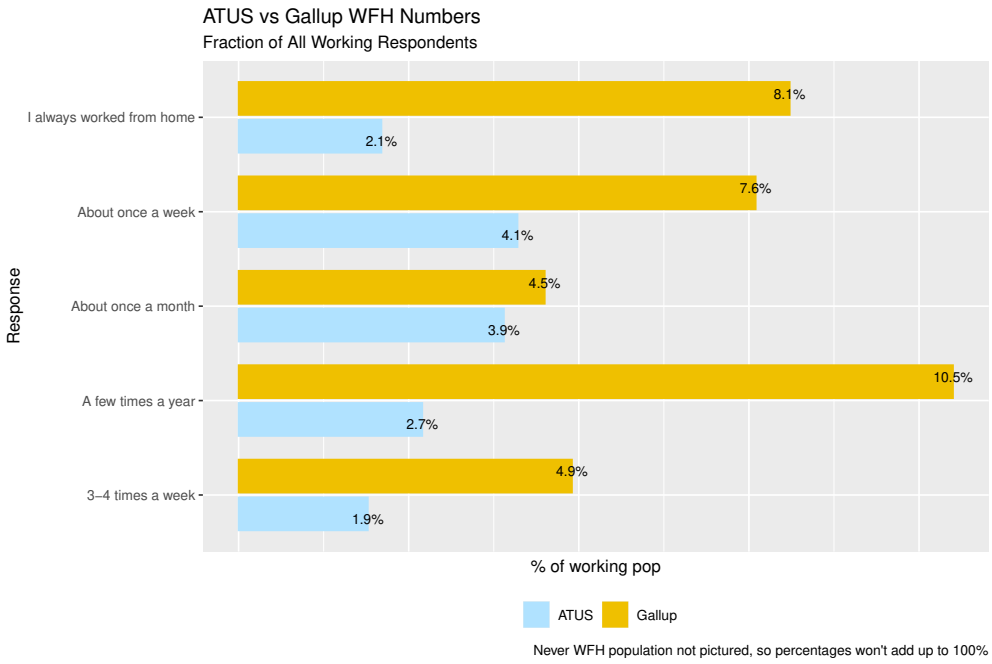

FIGURE 5. ATUS vs Gallup Response Rates Excluding "Never WFH"

secondary childcare [6].

To understand the link between self-employment and remote work, we begin by defining two key measures of self-employment, constructed using questions from the RLS.

- **"Sole proprietorship"**: the population of **currently employed** workers who report "None/I am the sole proprietor" to Q25 in our survey.[7] **Currently employed** is defined as those who answered either "employed full time" or "employed part time" in the current employment status question.

- **"Home based business"**: the population of workers who, in the **pre-pandemic period**, worked from home and justified their WFH choice by answering "I had a home-based business" to Q4.[8]

We also combine the two to create the intersection and union of these measures. Table 6 summarizes respondent frequencies in each of these categories. One reason for using the union of sole proprietorship and home-based business is that it captures all individuals with work environments that approach self-employment both before the onset of the pandemic and during the pandemic. This is considered the most generous definition of self-employment in our survey and we use it as the main self-employment variable since it provides an upper bound on the population of self-employed workers. Ideally we would have direct questions about self-employment in both periods, so what we have is a second best approximation of self-employment. Finally, Gallup uses demographic panel variables to keep track of the demographics underlying its panels. One of these variables measures the state of self-employment before the pandemic and was collected between 2017 and 2019. While we use this as a way to sanity check our results, we avoid using it as the primary measure of self-employment because 2017 is too distant from our period of interest.

Figure 6 shows how the combined variable using the intersection of "sole proprietorship" and "home-based business" relates to teleworking intensity before, during, and after the pandemic. "After the pandemic" is measured by asking respondents about their WFH expectations if the pandemic were to end within a year due to vaccines. Conditional on being part of the current or pre-Covid-19 self-employed population, we see that these respondents were more likely to engage in WFH. The pandemic prompted a larger increase in WFH among workers who were not self-employed relative to the self-employed. Finally,

[6] Secondary childcare is time spent doing childcare as a secondary activity, e.g. talking to a child while primarily working

[7] Q25: "Approximately how many people, other than yourself, work at your company or organization? If you have more than one job, answer in terms of your primary job."

[8] Q4: "Thinking about the times you worked from home prior to February 1, which of the following best describes your remote work situation?"

Variable	Levels	n	%	∑ %
WFH Due to	No	1155	87.1	87.1
Home-Based Business	Yes	171	12.9	100.0
	all:	**(1326)**	**(100.0)**	
Firm Size	1-5 other people	270	8.8	8.8
	101-500 other people	538	17.4	26.2
	21-100 other people	511	16.6	42.8
	6-20 other people	396	12.8	55.6
	No answer	8	0.3	55.9
	None/I am the sole proprietor	180	5.8	61.7
	Over 500 other people	1180	38.3	100.0
	all:	**(3083)**	**(100.0)**	
HomeBased OR	No	2823	91.6	91.6
Sole Proprietor	Yes	260	8.4	100.0
	all:	**(3083)**	**(100.0)**	
HomeBased AND	No	2992	97.0	97.0
Sole Proprietor	Yes	91	3.0	100.0
	all:	**(3083)**	**(100.0)**	
Gallup Demographic	No	2461	79.8	79.8
Panel Self-Employment	Yes	622	20.2	100.0
	all:	**(3083)**	**(100.0)**	

TABLE 6. Summary Table of Self-Employment Variables

those who are self-employed expect an increase in future WFH adoption whereas those who were not self-employed expect reversion to the mean with a future WFH rate that is somewhere in between the pre-pandemic world and during Covid-19.

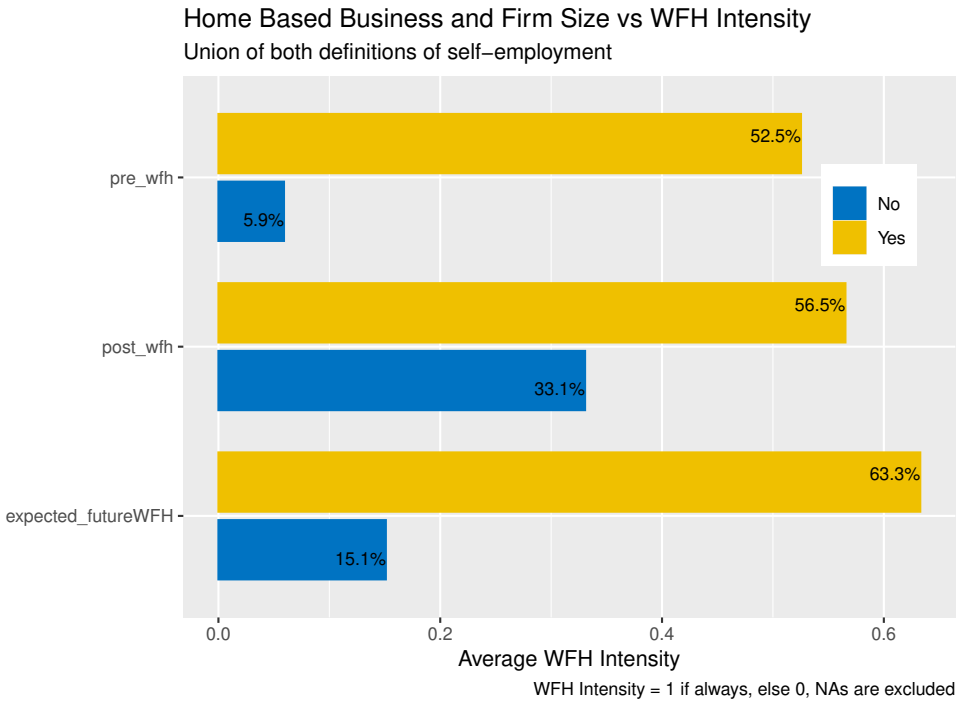

FIGURE 6. Combined Measure of Self-Employment vs. WFH

3.3.1. Estimating Self-Employment Impact

To quantify self-employment's impact on average WFH rates we run the following probit regression:

$$\mathbb{P}[\text{Always + Sometimes WFH Status}]_i = \Phi(Y_i) \tag{1}$$

$$Y_i = \beta_{SE} \cdot \mathbb{I}[\text{Self-Emp}]_i + \alpha_1 \cdot \mathbb{I}[\text{college}]_i + \alpha_2 \cdot \text{age}_i + \alpha_3 \cdot \mathbb{I}[\text{female}]_i + \alpha_4 \cdot \mathbb{I}[\text{caucasian}_i] + \epsilon_i \tag{2}$$

Tables 7 (pre-Covid) and 8 (during Covid) contain the results of estimating equations (1) ("Probit" column) and (2) ("LPM" column). As a reminder, the self-employment flag is defined by the intersection of the home-based business and sole proprietorship flags. "Any WFH" includes "sometimes" and "always" WFH, with the former defined as those who responded with "3-4 times a week" or "About once a week". Since our outcome variable is binary and the goal is to model changes in probability of an event, we prefer using probit.

However, we include the LPM as a sanity check on the direction of the probit coefficients. For interpretation purposes, we also include the average marginal effects of the probit model, shown under "Probit-MFX" in each table

The "Probit-MFX" column in Table 7 suggests that a change in self-employed status from 0 to 1 increases the likelihood of "any WFH" status in the pre-Covid-19 period by 38.4 percent. The same model in Table 8 suggests that a change in self-employed status from 0 to 1 increases the likelihood of "any WFH" status in the period after the start of Covid-19 by 27.6 percent. These effects are calculated by averaging across the marginal effects of self-employed on WFH conditioned on various combinations of the demographic controls we included in the model.

For a back of the envelope estimate on the impact ATUS's exclusion of self-employed workers we can simply use the following definitions:

$$\overline{WFH}(p^{\text{pre}}) \coloneqq \left(p^{\text{pre}} \times q^{\text{pre}}_{\text{self-employed}} + (1 - p^{\text{pre}}) \times q^{\text{pre}}_{\text{not-self-employed}} \right)$$

$$\implies \left(p^{\text{pre}} \times (q^{\text{pre}}_{\text{not-self-employed}} + \hat{\delta}^{\text{pre}}) + (1 - p^{\text{pre}}) \times q^{\text{pre}}_{\text{not-self-employed}} \right) \tag{3}$$

$$\overline{WFH}(p^{\text{pre}}) - \overline{WFH}(p^{\text{pre}} = 0) = p^{\text{pre}} \cdot \hat{\delta}^{\text{pre}} \tag{4}$$

Equation (3) is simply the pre-Covid-19 weighted average WFH rate ($\overline{WFH}(p^{\text{pre}})$) across a worker population that contains p^{pre} portion of self-employed workers engaging in work from home with a probability of $q^{\text{pre}}_{\text{self-employed}}$. The average marginal effect that we estimate in the probit regressions is captured by $\hat{\delta}^{\text{pre}}$. Equation (4) is just the difference in $\overline{WFH}(p^{\text{pre}})$ when toggling between the RLS estimated p^{pre} and the ATUS $p^{\text{pre}} = 0$ condition. According to the RLS data, there were $p^{\text{pre}} = 0.084$ (or 8.4 percent) of workers declared as self-employed (for the most generous definition of self-employment) before the start of the pandemic. Given the average marginal effect of 38.4 percent, this implies a difference of around 3.2 percentage points between RLS and ATUS in the pre period, which would explain about a quarter of the 12 percentage point gap between RLS and ATUS's estimates of pre-Covid remote work rates.

To summarize, ignoring the self-employed population will downward bias remote work estimates for the pre-pandemic era. Calculations involving the use of ATUS as the baseline for pre-Covid WFH levels should keep this in mind. Without correcting for this sample bias, there will be a risk of overestimating the magnitude remote work adoption since the start of Covid-19.

TABLE 7. Self-Employment Link to Pre-Covid Any WFH Status

	Probit	Probit-MFX	LPM
I(Self-Employed)	1.298***	0.384***	0.466***
	(0.085)	(0.022)	(0.026)
I(College)	0.378***	0.112***	0.106***
	(0.053)	(0.016)	(0.015)
Age	0.008***	0.002***	0.002***
	(0.002)	(0.001)	(0.001)
I(Female)	0.112*	0.033*	0.032*
	(0.050)	(0.015)	(0.014)
I(Caucasian)	–0.018	–0.005	–0.007
	(0.055)	(0.016)	(0.016)
Constant	–1.415***		0.045
	(0.110)		(0.031)
Num.Obs.	3233	3233	3233
R2			0.109
R2 Adj.			0.107
F	59.302	59.302	78.594

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Dependent Variable: I(Any WFH in Pre-Covid Period)

Regressions weighted by sampling weights provided by Gallup.

Self-employment defined as either home-based business or sole proprietorship.

TABLE 8. Self-Employment Link to Any WFH Status After Start of Covid (Post)

	Probit	Probit-MFX	LPM
I(Self-Employed)	0.796***	0.276***	0.279***
	(0.089)	(0.030)	(0.030)
I(College)	0.893***	0.309***	0.335***
	(0.049)	(0.014)	(0.017)
Age	–0.006***	–0.002***	–0.002***
	(0.002)	(0.001)	(0.001)
I(Female)	0.252***	0.087***	0.088***
	(0.046)	(0.016)	(0.016)
I(Caucasian)	–0.052	–0.018	–0.018
	(0.051)	(0.018)	(0.018)
Constant	–0.211*		0.415***
	(0.098)		(0.035)
Num.Obs.	3233	3233	3233
R2			0.158
R2 Adj.			0.156
F	102.829	102.829	120.663

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Dependent Variable: I(Any WFH in Post-Covid Period)

Regressions weighted by sampling weights provided by Gallup.

Self-employment defined as either home-based business or sole proprietorship.

3.4. Inclusion or Exclusion of Pre-Pandemic WFH

We now examine a final factor behind the discrepancy. The CPS remote work question explicitly refers to working at home "because of the coronavirus pandemic." The exclusion of people working remotely to various degrees because of the pandemic raises potential measurement issues with other surveys by excluding two potential groups of people.[9]

Fortunately, because of our RLS survey design, we can measure the effect of excluding pre-pandemic workers two ways. As a reminder, in our RLS wording for measuring remote work (either pre or during the pandemic), we asked: "In the past month, about how often did you work from home as part of your job?". In this question format there is no explicit qualifier that ties remote work to the pandemic. First, the RLS survey allows us to see the effect of focusing only on "new" working from home. Excluding those who were working from home sometimes before the pandemic reduces the share working from home sometimes during the pandemic by 25.3 percentage points, from 53.5 to 28.2 percent (see Tables 1 and 2 under section 2.2 for "sometimes WFH" definition and rates). If we are interested in the effects on those always working from home, excluding those doing so pre-pandemic reduces measured always working from home by 8 percentage points, from 31.6 to 23.6 percent. This re-definition results in the RLS estimating a post-pandemic remote work adoption of 23 percentage points in the "I always worked from home" category and 28 percentage points in the "sometimes" or "always" WFH category. With the BLS-CPS estimating a 22 percent WFH post-pandemic adoption rate at the time of our survey, we can see how comparable definition of our object of measurement and survey design can explain most of the gap between the headline RLS and the BLS-CPS estimates.

To fully understand the importance of word choice in the survey, we ran a wave of Google Consumer Surveys (GCS) between July 8, 2021 and July 13, 2021, similar to Brynjolfsson et al. (2020) (the first wave is discussed in Section 3.6). This online panel (termed "PrePost-GCS" to distinguish from BHORST-GCS) captured a sample of 3,500 respondents and explicitly asked whether someone was working from home now or before the pandemic. Table 9 summarizes response rates and shows that excluding those remote before the pandemic reduces the share remote from 46.3 percent to 35.8 percent, a decline of 10.5 percentage points.

In short, the exclusion of those working remotely pre-pandemic can generate double-digit changes in the percent working remotely. Both RLS and PrePost-GCS demonstrate a

[9]The CPS survey excludes those who worked entirely remotely pre-pandemic. In the instructions provided to surveyors, it states "Enter No if person worked entirely from home before the Coronavirus pandemic." There is also some ambiguity in measurement of remote work prevalence for those who are now permanently working remotely, but are no longer doing so as a temporary pandemic adaptation.

noticeable impact in average work from home estimates due to how BLS-CPS surveyors decide to frame the question. If they exclude those who were always remote workers pre-pandemic, then it will result in smaller changes before vs. during the Covid-19 era. Excluding those who were sometimes remote can cut measured teleworking rates in half.

TABLE 9. PrePost-GCS: Including vs. excluding pre-pandemic WFH

Adoption group	Remote work status	Fraction
Newly remote	"Yes, I'm now permanently remote."	12.7%
	"Yes, I'm now temporarily remote."	13.4%
	"Yes, but unsure whether permanent or not."	9.7%
	Remote post-pandemic only:	**(35.8%)**
Continuing remote	"Yes, but I was remote before the pandemic."	10.5%
	Remote at all:	**(46.3%)**
Not remote	"No, I am back at my workplace (in-person)."	53.8%

4. Conclusion

Remote work represents a massive, fast-moving shift in how we work. But how massive and how fast? The timing and incidence of remote work is a crucial issue for economists and policymakers. In this paper we have documented a variety of measurement issues that practitioners should consider and we recap some of the key takeaways below.

While representation of web versus mail-in respondents can affect results, the effects appear modest. Under a counterfactual exercise in which we convert our mail-in respondents to online respondents, we would overestimate the always WFH rate by 1.6 percentage points and our sometimes WFH rate by 0.9 percentage points. These estimates can be used as adjustments for surveys that rely solely on online panels.

We also found that survey inclusion of self-employed workers can have a substantial impact, as self-employed workers are significantly more likely to be remote and were already a non-trivial share of the workforce before the pandemic. One of the most-cited official pre-pandemic WFH rates came from the BLS's ATUS 2017-18 Leave and Job Flexibilities Module and it explicitly states that it excludes self-employed workers. As such, comparing the RLS against ATUS, we estimate that the exclusion of self-employed workers contributes to a 3.2 percentage point understatement of the economy's WFH rate during the pre-pandemic period. These estimates can be used as adjustments for surveys that exclude self-employed workers.

Another key source of measurement disagreement was attributed to differences in occupational distributions undergirding the survey samples. After applying weights that match our occupational distribution to that used by the BLS-CPS, we see that our headline "always or sometimes WFH" rate drops from 51 to 43 percent. This is in comparison to the BLS-CPS rate of 22 percent, so occupational differences can explain over a quarter of the 29 percentage point gap if we assume that we are comparing like for like. This caveat will be critical as seen in our fourth factor because we believe that the BLS-CPS headline number is measuring WFH adoption and not levels. As such, if we look at the same exercise but for "always or sometimes WFH" adoption due to Covid-19, we see a change from 26 percent to 20 percent, turning our "overestimate" into an "underestimate" when compared against the BLS-CPS's 22 percent.

By the same token, the discrepancy between our survey and Bick et al. (2021) highlighted the importance of standardizing survey weights. Using our commuting habits question, we were able to approximate BBM's commute-based WFH measure and found the gap between the two measures increase from around 3 percentage points to 17 percentage points, from pre to post periods. Just over a third of the 17 percentage point gap was

accounted for by using CPS occupational weights, since BBM mentions using CPS weights in their methodology. The recommendation here is to always run robustness checks with alternate survey weights and to understand the source of disagreements between sets of weights.

Finally and most importantly, we estimate the impact of a survey design that might exclude workers who engaged in remote work before the pandemic. A disagreement over the fundamental object that we are trying to measure will make like-for-like comparisons impossible and it is of first order importance to resolve these disagreements. Excluding those previously working from home reduces the RLS estimate of pandemic WFH rates by either 8.04 percent, for the strictest definition of WFH ("I always worked from home"), or 25.3 percent, for a more flexible definition of WFH ("sometimes" or "always" WFH). This re-definition results in the RLS estimating a post-pandemic remote work adoption of 23 percentage points in the "I always worked from home" category and 28 percentage points in the "sometimes" or "always" WFH category. With the BLS-CPS estimating a 22 percent WFH post-pandemic adoption rate at the time of our survey, we can see how comparable definition of our object of measurement and survey design can explain most of the gap between the headline RLS and the BLS-CPS estimates. By comparing a variety of remote work surveys and looking closely at the methodology, we believe that this last issue is a substantial one for the CPS measure of remote work, and a similar re-definition should be taken into account for other peer surveys wishing to compare against the BLS-CPS. The BLS-CPS measure is consistently lower than the other measures, as seen in Figure 1.

Having one outlier measure (in this case, the CPS) among an otherwise consistent field would normally not be a serious issues given the variety of measures available. However, the disparity is potentially consequential because the CPS measure is influential as an official government measure of remote work. For example, in September 2021, Elaine Godfrey wrote in the Atlantic that media perceptions of remote work were biased upward [10]. She guessed that in March, 2021 40 percent of workers were remote, but argues the CPS shows the real number was half that. In contrast, Figure 1 shows that most estimates were around 50 percent, meaning her estimate was underestimating if the consensus is correct. *The Atlantic* also surveyed the public about remote work perceptions in August, 2021 and the median respondent believed between 40 percent and 50 percent were working remotely. Barrero et al. (2021) and Saad and Wigert (2021) estimate between 46 percent and 49 percent working remotely in August 2021, making the public perception a good estimate. However, the author argued "In reality, only 13.4 percent worked from home in the final month of summer.", citing the CPS.

[10] https://www.theatlantic.com/politics/archive/2021/09/work-from-home-numbers/620107/

We cannot manage what we can't measure. And we cannot understand how much remote work will affect the economy and society if we do not know how many people are working remotely. Studying and addressing measurement issues carefully will help researchers, policymakers, workers, and employers correctly appraise the state of the labor market with respect to remote work. This will enable better decision-making broadly as the labor market re-configures the design of employment contracts to facilitate a much higher prevalence remote arrangements.

A. Appendix

A.1. Gallup Questionnaire for Remote Life Survey

GALLUP Panel™
be heard

WORK AND LIFESTYLE SURVEY

##ADDRESS##
##CITY##, ##STATE## ##ZIP_CODE##

Dear ##LAST_NAME## Household,

Gallup is conducting a short survey to understand more about Americans' work experiences during the coronavirus (COVID-19) pandemic and we need your help.

Because you were randomly selected to participate in our poll, your responses are important, and we cannot replace you with someone else. Your responses will represent thousands of people just like you who were not selected to participate. Read each question carefully and answer each one honestly - there are no right or wrong answers. It is your opinion that counts. Your individual responses will remain completely confidential and Gallup will never release any of your personal information. We have enclosed **$2.00** as a token of our appreciation.

We have included a paper survey in this booklet. Please complete the survey and mail it back (postage pre-paid).

In order to ensure that the research represents a random sample of all U.S. adults, please ask the person **age 18 or older in your household who will have the next birthday** to fill out this survey.

If you need assistance, contact Gallup Support at galluppoll@gallupmail.com or 1-888-297-8999. Thank you in advance for helping Gallup achieve our mission of "Helping People Be Heard."

Sincerely,
Gallup, Inc.

For the following questions, when we ask about your work situation PRIOR to February 1, we mean PRIOR to the coronavirus (COVID-19) pandemic.

When we ask about your current work situation, we are referring to your work situation today.

PRE-COVID EMPLOYMENT

1 Which of the following best describes your employment status on February 1?

- ☐ Employed full-time (e.g. worked at least 35 hours per week for pay)
- ☐ Employed part-time (e.g. worked less than 35 hours per week for pay)
- ☐ Unemployed and not looking for work
- ☐ Unemployed but looking for work
- ☐ Retired
- ☐ A homemaker
- ☐ A full-time student

→ *Skip to Question 8*

2 Prior to February 1, approximately how many total hours per week did you spend working?

☐☐ hours per week

3 Prior to February 1, how often did you work from home as part of your job?

- ☐ Never → *Skip to Question 6*
- ☐ A few times a year
- ☐ About once a month
- ☐ About once a week
- ☐ 3-4 times a week
- ☐ I always work from home

→ *Continue with Question 4*

Continue ⇨

4 **Thinking about the times you worked from home prior to February 1, which of the following best describes your remote work situation?**

- ☐ I worked from home instead of at my primary work location
- ☐ I took work home to catch up
- ☐ I had a home-based business
- ☐ Other *(specify)*

5 **Prior to February 1, approximately how many total hours per week did you spend working from home as part of your job?**

☐☐ hours per week

6 **Regardless of how much you actually worked from home, what percentage of your job on February 1 could you have done working from home full-time?**

☐☐☐ % of my job

7 **In the job you were working on February 1, did you:**

- ☐ Normally work as part of a team
- ☐ Mostly work on your own

8 **Have you experienced any of the following changes to your employment situation since February 1 as the result of the coronavirus (COVID-19)?**

	Yes ▼	No ▼
a. Been temporarily laid-off or furloughed.....	☐	☐
b. Been permanently let go from a job	☐	☐
c. Had your hours reduced.....	☐	☐
d. Seen a loss of income	☐	☐
e. Seen an increase in income.....	☐	☐

9 **Have you returned to work after being temporarily laid-off or furloughed?**

- ☐ Yes, same job
- ☐ Yes, different job
- ☐ No
- ☐ Does not apply

CURRENT EMPLOYMENT

10 **Which of the following best describes your current employment status during the past 7 days?**

- ☐ Employed full-time (e.g. worked at least 35 hours for pay)
- ☐ Employed part-time (e.g. worked less than 35 hours for pay)
- ☐ Furloughed from a full-time job
- ☐ Furloughed from a part-time job
- ☐ Unemployed and not looking for work
- ☐ Unemployed but looking for work
- ☐ Retired
- ☐ A homemaker
- ☐ A full-time student

→ ***Skip to Question 20***

11 **Do you have the same job now as you did on February 1?**

If you had more than one job on February 1, consider your primary job when answering this question.

- ☐ Yes
- ☐ No

12 **Thinking about your current work situation, approximately how many total hours do you currently spend working in a typical week?**

☐☐ hours per week

13 **In the past <u>month</u>, about how often did you work from home as part of your job?**

- ☐ Never → ***Skip to Note before Question 15***
- ☐ Once or twice
- ☐ About once a week
- ☐ 3-4 times a week
- ☐ I always worked from home

IF YOU ARE WORKING FROM HOME MORE NOW THAN YOU WERE ON FEBRUARY 1, CONTINUE; OTHERWISE SKIP TO THE NOTE BEFORE QUESTION 15.

14 **For what reasons are you working more hours from home now than you were on February 1?** ***Mark all that apply***

- ☐ Employer requiring remote work/worksite closed
- ☐ Employer encouraging remote work
- ☐ Different job
- ☐ More distractions at home during the workday
- ☐ Always available
- ☐ Less productive at home during the workday
- ☐ I'm concerned about being exposed to coronavirus at work
- ☐ Some other reason *(specify)*

IF YOU ARE WORKING A DIFFERENT JOB NOW THAN YOU WERE ON FEBRUARY 1, CONTINUE; OTHERWISE, SKIP TO QUESTION 16.

15 **Regardless of how much you actually work from home, what percentage of your current job could you do working from home full-time?**

☐☐☐ % of my job

16 **In your current job, how often do you interact <u>face-to-face</u> with people who work for other companies or organizations (this could include customers as well as colleagues in the same industry or field as you)?**

- ☐ Frequently
- ☐ Occasionally
- ☐ Rarely
- ☐ Never

17 **Suppose within the next year a coronavirus (COVID-19) vaccine or cure has been developed and schools and businesses across the country are fully re-opened. How often would you expect to be working from home if that happens?** ***Please use your best estimate.***

- ☐ Never
- ☐ A few times a year
- ☐ About once a month
- ☐ About once a week
- ☐ 3-4 times a week
- ☐ I plan to always work from home

18 **What is your current occupation?** ***Please be as specific as possible, including your title/position and the industry you work in.***

19 **Approximately how many people, other than yourself, work at your company or organization?**

If you have more than one job, answer in terms of your primary job.

- ☐ None/I am the sole proprietor
- ☐ 1-5 other people
- ☐ 6-20 other people
- ☐ 21-100 other people
- ☐ 101-500 other people
- ☐ Over 500 other people

LIKELIHOOD TO MOVE

20 **How likely are you to move to a new home in the next year?**

- ☐ Not at all likely ➔ ***Skip to Question 22***
- ☐ Not too likely ➔ ***Skip to Question 22***
- ☐ Somewhat likely
- ☐ Very likely

21 **For what reasons are you likely to move to a new home?** ***Please mark all that apply.***

- ☐ Shorter work commute
- ☐ More affordable area to live
- ☐ Change in employment
- ☐ Family reasons
- ☐ Change of scenery/lifestyle/climate
- ☐ Need larger/smaller home
- ☐ Other *(specify)*

CHILDCARE

22 **How many children currently living in your home full or part-time are in each of the following age ranges?** ***If you do not have any children living in your home, please enter 0 for each age range.***

- ☐☐ Newborn to age 5
- ☐☐ Ages 6 to 12
- ☐☐ Ages 13 to 17

IF YOU HAVE CHILDREN LIVING IN YOUR HOME, PLEASE CONTINUE; OTHERWISE SKIP TO THE NOTE BEFORE QUESTION 25.

23 **Prior to February 1, approximately how many hours per week did you spend directly supervising the children in your household between 9 am and 5 pm on weekdays?**

☐☐ hours per week

24 **Currently, approximately how many hours per week do you spend directly supervising the children in your household between 9 am and 5 pm on weekdays?**

☐☐ hours per week

IF YOU CURRENTLY WORK FROM HOME MORE THAN YOU DID PRIOR TO FEBRUARY 1, PLEASE CONTINUE; OTHERWISE SKIP TO THE NOTE BEFORE QUESTION 26.

PRODUCTIVITY AT HOME

25 **Think about how much work you can usually accomplish in 60 minutes at your workplace. How much time does it take you to complete the same amount of work when working at home?**

☐☐☐ minutes

IF YOU DO NOT WORK FROM HOME, PLEASE CONTINUE; OTHERWISE, SKIP TO QUESTION 27.

26 **What prevents you from working from home?** ***Please mark all that apply.***

- ☐ I need to use equipment or tools located outside my home (e.g. safety equipment).
- ☐ I need to physically handle materials (e.g. supplies).
- ☐ I need to interact with coworkers at my workplace.
- ☐ I need to interact with customers at my workplace.
- ☐ Other *(specify)*

Continue ⇨

ONLINE COURSEWORK

27 **Have you started taking any post-secondary or career development courses online since February 1?**

- ☐ Yes, paid for by my employer, for career reasons
- ☐ Yes, paid for by me, for career reasons
- ☐ Yes, paid for by me, for non-career reasons
- ☐ No, have not taken any online courses → ***Skip to Question 29***

28 **If you have taken any classes online since February 1, did you receive a certificate to confirm your successful completion?**

- ☐ Yes, have received or will receive a certificate
- ☐ No, will not receive a certificate

ONLINE ACTIVITIES

29 **Prior to February 1, how many hours a day did you spend online for work and for pleasure, on a computer, cell phone, or tablet?**

☐☐ hours

30 **How many hours a day do you spend online now for work and for pleasure, on a computer, cell phone, or tablet?**

☐☐ hours

31 **Did you order products in any of the following categories online for the first time since February 1?**

This can include items you ordered online and picked up or items you had delivered to your home. Please mark all that apply.

- ☐ Prescriptions/Medicine
- ☐ Music, including streaming music
- ☐ Video, including streaming video
- ☐ Groceries
- ☐ Educational resources
- ☐ Electronics
- ☐ Activewear
- ☐ Other general apparel/footwear
- ☐ Home improvement goods
- ☐ Beauty care
- ☐ Office supplies
- ☐ Alcohol
- ☐ Games/Puzzles/Hobby supplies
- ☐ Take-out/Restaurant food
- ☐ Other *(specify)*

  ☐ _____

- ☐ None

WELLBEING

32 **Please imagine a ladder with steps numbered from zero at the bottom to 10 at the top. The top of the ladder represents the best possible life for you and the bottom of the ladder represents the worst possible life for you. On which step of the ladder would you say you personally feel you stand at this time?**

- ☐ 10 Best possible life
- ☐ 9
- ☐ 8
- ☐ 7
- ☐ 6
- ☐ 5
- ☐ 4
- ☐ 3
- ☐ 2
- ☐ 1
- ☐ 0 Worst possible life

DEMOGRAPHICS

33 **In politics, as of today, do you consider yourself a Republican, a Democrat, or an Independent?**

- ☐ Republican
- ☐ Democrat
- ☐ Independent
- ☐ Other party
- ☐ Don't know

IF YOU ARE CURRENTLY EMPLOYED, CONTINUE; OTHERWISE, PLEASE PLACE YOUR QUESTIONNAIRE IN THE POSTAGE-PAID ENVELOPE AND RETURN IT TO GALLUP.

34 **How concerned are you about getting coronavirus (COVID-19) at your workplace?**

- ☐ Not at all concerned
- ☐ Not too concerned
- ☐ Somewhat concerned
- ☐ Very concerned

Thank you for completing the survey. Please place your questionnaire in the postage-paid envelope provided and return it to Gallup.

A.2. NLSY Sanity Check

An additional measure of remote working is available from the BLS using the National Longitudinal Survey 1997 (NLSY97). This measure is useful for additional comparison to the CPS because it is a longitudinal dataset that has tracked individuals over time since 1997. The sample includes 8,984 individuals born between 1980 and 1984, who were interviewed in a supplement from Feb 2021 to May 2021 about the effects of the COVID-19 pandemic on work and life Auginbaugh and Rothstein (2022). To create a demographically similar comparison group, we utilized CPS microdata from IPUMS over these months focusing on individuals born in the same time-period as the NSLY sample.

The results show a significant discrepancy, with the CPS showing 23 percent of workers remote at all, compared to 46.7 percent in the NLSY97. These results are consistent with the time-series evidence, with the CPS generally being half the level of other surveys. In this case, compared to a representative and long-standing survey produced by the BLS itself.

TABLE A.1. CPS vs. NLSY WFH rates.

Remote work category	Survey	
	CPS	NLSY97
None	77.0%	53.3%
Some remote	.	21.3%
All remote	.	25.4%
All + some remote	23.0%	46.7%

A.3. Mail v. Web Regressions

TABLE A.2. Mail vs. Web Respondent Characteristics

	Always WFH		Mostly WFH		Web-based Respondent	
	(1)	(2)	(3)	(4)	(5)	(6)
Web-only Respondent	.225***	.158***	.143***	.091***		
	(.033)	(.033)	(.030)	(.030)		
Black		.006		-.021	-.132***	-.139***
		(.025)		(.023)	(.011)	(.011)
Hispanic		.0005		-.030	-.047***	-.050***
		(.020)		(.019)	(.010)	(.010)
High School		-.187***		-.120***	-.051***	-.045***
		(.021)		(.019)	(.010)	(.010)
Technical/Associates		-.119***		-.053**	.095***	.098***
		(.025)		(.023)	(.012)	(.012)
Some College		-.164***		-.052**	.091***	.092***
		(.025)		(.023)	(.011)	(.011)
Some Post-graduate		-.062		.095***	.101***	.100***
		(.039)		(.036)	(.019)	(.019)
Post-graduate		.083***		.090***	.105***	.103***
		(.024)		(.022)	(.012)	(.012)
Employed before and after Feb 1		-.086**		.052	.055***	.054***
		(.041)		(.037)	(.007)	(.007)
log(Fixed Download Speed)		.024		-.008		.038***
		(.026)		(.024)		(.011)
log(Mobile Download Speed)		.113***		-.030*		.016*
		(.019)		(.018)		(.009)
R-squared	.055	.122	.033	.064	.126	.129
Sample size	3776	3763	3776	3763	6557	6554

Notes: *p<0.1; **p<0.05; ***p<0.01

†All regressions include state-wise fixed effects.

References

Althoff, Lukas, Fabian Eckert, Sharat Ganapati, and Conor Walsh. 2020. "The City Paradox: Skilled Services and Remote Work." *CESifo Working Paper No. 8734*.

Auginbaugh, Alison, and Donna S. Rothstein. 2022. "How did employment change during the COVID-19 pandemic? Evidence from a new BLS survey supplement." Jan, https://www.bls.gov/opub/btn/volume-11/how-did-employment-change-during-the-covid-19-pandemic.htm.

Bai, John (Jianqiu), Erik Brynjolfsson, Wang Jin, Sebastian Steffen, and Chi Wan. 2021. "Digital Resilience: How Work-From-Home Feasibility Affects Firm Performance." *NBER Working Paper*.

Barrero, Jose Maria, Nicholas Bloom, and Steven J. Davis. 2020. "COVID-19 is also a Reallocation Shock." *NBER Working Paper*.

Barrero, Jose Maria, Nicholas Bloom, and Steven J. Davis. 2021. "Why Working from Home Will Stick." *NBER Working Paper*.

Bick, Alexander, Adam Blandin, and Karel Mertens. 2021. "Work from home before and after the Covid-19 outbreak." *Available at SSRN 3786142*.

Bloom, Nicholas, James Liang, John Roberts, and Zhichun (Jenny) Ying. 2015. "Does Working from Home Work? Evidence from a Chinese Experiment." *Quarterly Journal of Economics* 130 (1): 168–218.

BLS. 2019. "BLS ATUS Table 3. workers who worked at home and how often they worked exclusively at home by selected characteristics, averages for the period 2017-2018." Sep, https://www.bls.gov/news.release/flex2.t03.htm, BLS Dataset.

Bresnahan, Timothy F., Erik Brynjolfsson, and Lorin M. Hitt. 2002. "Information Technology, Workplace Organization, and the Demand for Skilled Labor: Firm-Level Evidence." *Quarterly Journal of Economics* 117 (1): 339–376.

Brynjolfsson, Erik, John J. Horton, Adam Ozimek, Daniel Rock, Garima Sharma, and Hong-Yi TuYe. 2020. "COVID-19 and Remote Work: An Early Look at US Data." *NBER working paper*.

Cajner, Tomaz, Leland Crane, Ryan A. Decker, John Grigsby, Adrian Hamins-Puertolas, Erik Hurst, Christopher Kurz, and Ahu Yildirmaz. 2021. "The U.S. labor market during the beginning of the pandemic recession." *Brookings Papers on Economic Activity* forthcoming.

Choudhury, Prithwiraj (Raj), Cirrus Foroughi, and Barbara Larson. 2021a. "Work-from-anywhere: The productivity effects of geographic flexibility." *Strategic Management Journal* 42 (4): 655–683.

Choudhury, Prithwiraj (Raj), Tarun Khanna, Christos A. Makridis, and Kyle Schirmann. 2021b. "Employee Performance and Communication in a Hybrid Remote Workplace: Evidence from a Field Experiment." *Mimeo*.

Coven, Joshua, Arpit Gupta, and Iris Yao. 2021. "Urban Flight Seeded the COVID-19 Pandemic Across the United States." *Journal of Urban Economics: Insights, R&R*.

Delventhal, Matt, Eunjee Kwon, and Andrii Parkhomenko. 2020. "How Do Cities Change When We Work from Home?." *SSRN Working Paper*.

Dey, Matthew, Harley Frazis, Mark A. Loewenstein, and Hugette Sun. 2020. "Ability to work from home: evidence from two surveys and implications for the labor market in the COVID-19 pandemic." *Bureau of Labor Statistics*.

Dey, Matthew S., Harley Frazis, Mark Loewenstein, and Piccone Ds. 2021. "Teleworking and Lost Work During the Pandemic: New Evidence from the CPS." *SSRN Electronic Journal*.

Dingel, Jonathan, and Brent Neiman. 2020. "How Many Jobs Can Be Done at Home?." *Journal of Public Economics* 189.

Frazis, Harley. 2020. "Who telecommutes? Where is the time saved spent?" Apr, https://www.bls.gov/osmr/research-papers/2020/ec200050.htm, accessed on 15th February, 2023, BLS WORKING

PAPERS.

Gibbs, Michael, Friederike Mengel, and Christoph Siemroth. 2021. "Work from Home & Productivity: Evidence from Personnel & Analytics Data on IT Professionals." *BFI Working Paper*.

Guerrieri, Veronica, Guido Lorenzoni, Ludwig Straub, and Ivan Werning. 2020. "Macroeconomic Implications of COVID-19: Can Negative Supply Shocks Cause Demand Shortages?." *American Economic Review, R&R*.

Harrington, Emma, and Natalia Emanuel. 2020. "Working remotely? Selection, treatment, and market provision of remote work." *Unpublished Manuscript. Harvard University. doi* 10.

Makridis, Christos A., and Jason Schloetzer. 2022. "Does Working from Home Increase Job Satisfaction and Retention? Evidence from the COVID-19 Pandemic." *SSRN working paper*.

Malone, Thomas W, and Kevin Crowston. 1994. "The interdisciplinary study of coordination." *ACM Computing Surveys (CSUR)* 26 (1): 87–119.

Pabilonia, Sabrina Wulff, and Victoria Vernon. 2022. "Telework, wages, and time use in the United States." *Review of Economics of the Household* 20 (3): 687–734. 10.1007/s11150-022-09601-1.

Ramani, Arjun, and Nicholas Bloom. 2021. "The Donut Effect of COVID-19 on Cities." *NBER Working Paper*.

Restrepo, Brandon J., and Eliana Zeballos. 2020. "The effect of working from home on major time allocations with a focus on food-related activities." *Review of Economics of the Household* 18 (4): 1165–1187. 10.1007/s11150-020-09497-9.

Saad, Lydia, and Ben Wigert. 2021. "Remote work persisting and trending permanent." Oct, https://news.gallup.com/poll/355907/remote-work-persisting-trending-permanent.aspx.