Work from Home After the COVID-19 Outbreak*

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Abstract

Based on rich novel survey data, we document that 35.2 percent of the US workforce worked entirely from home in May 2020, up from 8.2 percent in February. Highly educated, high-income and white workers were more likely to shift to working from home and maintain employment following the pandemic. Individuals working from home daily before the pandemic lost employment at similar rates as daily commuters. This suggests that, apart from the potential for home-based work, demand conditions also mattered for job losses. We find that 71.7 percent of workers that could work from home effectively did so in May.

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1 Introduction

The global COVID-19 pandemic has led to widespread physical distancing to contain the spread of the virus. Many businesses scaled back or ceased operations in the regular workplace because of government-mandated closures and stay-at-home orders, concerns for the health of their employees, or a lack of customers. Some workers were able to transition to working from home relatively easily. In many jobs, however, performing regular work activities from home is impossible, forcing many workers to become inactive or look for a new job.

In this paper, we present novel facts on how many US workers shifted to home-based work in the months after the pandemic outbreak. This evidence is based on the Real-Time Population Survey (RPS), a bi-weekly online survey with the same core questions as the Current Population Survey (CPS). The results in this paper are based on supplemental questions about commuting behavior in recent months that are not available in the CPS.

Our first main finding is that 35.2 percent of workers in the RPS worked entirely from home in May, compared to 8.2 percent in February. The increase in work from home was mostly driven by the switching behavior of those who commuted to work every day in February (which constituted about 3/4 of workers in February). Among daily commuters in February who were still employed in May, 60 percent continued to commute daily, 12 percent commuted on some days, and 28 percent worked entirely from home.

While the proportion of home-based workers increased broadly, we document considerable heterogeneity across socioeconomic groups and industries. In particular, switching to working from home was more prevalent among workers who were highly educated, white, and high income prior to the pandemic. The difference is particularly stark between education groups: 50 percent of workers with a bachelor's degree or more worked entirely from home in May, compared to only 15 percent of workers with a high school degree or less. Overall, we find that data on actual substitution to home-based work are broadly in line with predictions based on measures of the potential for home-based work across workers and industries, e.g. Dingel and Neiman (2020) or Mongey et al. (2020).

At the same time, we find that workers who already worked from home before the pandemic lost employment at almost the same rate as those who commuted daily. Job losses were also greater among minorities and low-skilled workers even if they already worked from home before the pandemic. Home-based workers lost employment in a range of industries, to a greater extent in contact intensive sectors hard-hit by social distancing, but also in certain lower proximity industries. We view the similar rates of job loss for home-based workers as evidence that demand conditions also shaped employment losses in the pandemic, for instance via channels analyzed recently by Baqaee and Farhi (2020) and Guerrieri et al. (2020).

Our survey evidence provides key facts to help understand the nature and extent of the labor market disruptions caused by the pandemic. Assessments of the impact of social distancing have so far relied mostly on various proxies of potential work-from-home capacity (Adams-Prassl et al., 2020a,b; Dingel and Neiman, 2020; Gottlieb et al., 2020; Hensvik et al., 2020; Mongey et al., 2020; Papanikolaou and Schmidt, 2020; Su, 2020). We document the differences between estimates of the *potential* for home-based work in the literature, and *actual* home-based work in the RPS. Specifically, using estimates of the number of potential home-based workers by Dingel and Neiman (2020), we find that 71.7 percent of US workers that could work from home actually did so in May, and that this share varies by industry. These results can serve as a key input into quantitative models that currently rely exclusively on the measures of the potential for calibrating or validating economic shocks, see for instance Bonadio et al. (2020) or Gregory et al. (2020). Moreover, the comparisons between actual and potential home-based work are important for evaluations of virus containment policies and reopening strategies, see Aum et al. (2020), Baqaee et al. (2020), Jones et al. (2020), Kaplan et al. (2020), and Krueger et al. (2020), and others. Baqaee et al. (2020), for example, use our estimates to help quantify the contribution of reductions in workplace density to the containment of the virus.

Going forward, the RPS will provide a time series on home-based work that will be relevant for a host of questions related to the reopening of the economy as well as the possible longer term impacts of the pandemic, such as more permanent reallocations to home-based work (Barrero et al., 2020; Erol and Ordoñez, 2020; Mas and Pallais, 2020) or gender equality (Alon et al., 2020).

2 The Real-Time Population Survey and Work from Home Before COVID-19

The RPS is an online survey of around 2,000 respondents selected to be representative of the US population.[1] The survey is designed to correspond closely to the basic module of the Current Population Survey (CPS), which allows us to assign labor market status in a manner consistent with the Bureau of Labor Statistics (BLS). In this paper, we combine the data collected over two survey weeks in May (starting May 10 and May 26). Survey respondents are also asked about their spouse or partner if they live in the same household, which means we have information on nearly 5,000 working age adults. Crucially, the survey contains retrospective questions about February that allow us to analyze changes in home-based work since the start of the pandemic, as well as the relationship between pre-pandemic commuting behavior and post-pandemic employment outcomes. In addition to the real-time availability, the panel aspect is a core contribution relative to other sources of information on home-based work that will eventually become available, such as the American Time Use Survey. For more compre-

[1]The RPS was initially designed by Bick and Blandin (2020), and is presently conducted in collaboration with the Federal Reserve Bank of Dallas. Results are posted on https://sites.google.com/view/covid-rps/home and https://www.dallasfed.org/research/rps.

hensive information about the RPS, we refer to Appendix A as well as Bick and Blandin (2020).

We first document how many individuals in the RPS worked from home before the pandemic. The May 10-16 and May 24-30 waves of the RPS ask those that report working in February: "*How many days per week did you [your spouse/partner] usually work for this job?*" and "*How many days per week did you [your spouse/partner] usually commute to this job?*", where "*this job*" corresponds to the main job in the case of multiple jobholders. Of the 3587 respondents aged 18-64 who were employed and at work in February, 75.4 percent report commuting to work every workday, 16.4 percent report commuting on some days, and 8.2 percent report working exclusively from home.[2]

The RPS evidence on pre-COVID home-based work can be compared with evidence from a number of existing surveys. The regular time diary in the American Time Use Survey (ATUS) shows that respondents commuted to work on 84.2 percent of workdays in 2017-2018, which is close to the corresponding number (84.8 percent) for February 2020 in the RPS. Several other surveys instead provide estimates of the fraction of workers usually working exclusively from home. The lowest of these estimates is 2.8 percent in the ATUS Leave and Job Flexibilities Module; see a similar calculation by Pabilonia and Vernon (2020).[3] According to the Survey of Business Uncertainty, US firms report that 3.5 percent of full-time employees worked 5 full days per week at home in 2019 (Barrero et al., 2020). In the 2018 American Community Survey (ACS), 5.0 percent report usually working from home. In the Survey of Income and Program Participation (SIPP), Mateyka et al. (2012) calculate that 6.6 percent of all workers usually work exclusively from home in 2010, and in the 2017 National Household Travel Survey (NHTS) 11.9 percent report doing so. Finally, based on a Google Consumer Surveys question posted in April and May 2020, Brynjolfsson et al. (2020) find that 15.0 percent of workers say they were already working from home prior to the pandemic. The RPS estimate of 8.2 percent falls right in the middle of the range of estimates from these other surveys, and we therefore view it as broadly in line with the existing evidence on home-based work prior to the pandemic.

3 Commuting and Work from Home During COVID-19

In mid-March, the coronavirus outbreak triggered broad-based sheltering-in-place and the closures of many non-essential businesses. One of the consequences of social distancing was a sharp reduction in commuting to work. Google mobility metrics, for example, show a decrease of approximately 40 percent in workplace visits in May compared to the Feb 10 - Mar 8 baseline.[4] Mobility metrics derived from geolocation data, however, do not reveal to what extent

[2]We do not ask about commuting for workers who were employed but absent from work in February or in May. In both the February CPS and in the May RPS, only 1.8 percent of workers were absent from work.

[3]There appears to be some disagreement between the ATUS time diaries, in which respondents work from home on 15.8 percent of workdays, and the ATUS Leave and Job Flexibilities Module, in which only 13.0 percent of respondents say that they ever work from home (2.8 percent report always working from home and 10.2 percent report occasionally, i.e. at least once a month, working from home).

[4]See https://www.google.com/covid19/mobility/.

Table 1: Aggregate Changes in Commuting

	February	May	Change in Log Points
Employment Rate (%)	73.2	54.0	-30.4
Avg. Days Worked per Week	4.7	4.6	-2.1
Fraction of Workdays Commuting (%)	84.8	56.9	-39.9
Log Points Change in Weekly Commuting Trips:			-72.5

Notes: RPS results are for the May 10-16 and May 24-30 reference weeks and for adults aged 18-64.

commuting declined because people switched to working from home or because they stopped working.

Table 1 provides insights into the causes of the overall reduction in commuting based on evidence in the RPS. In each of the May surveys, respondents are asked: "*Last week, how many days did you [your spouse/partner] work for this job?*" and "*Last week, how many days you [your spouse/partner] commute to this job?*", where "*this job*" refers to the main job in the case of multiple jobholders. Based on the survey responses, we find that the total number of weekly commuting trips in May declined by 51.6 percent, or 72.5 log points, compared to February, which is a somewhat larger decline than suggested by the Google mobility metrics. The total number of weekly commuting trips is the product of the number of workers, the average number of days worked per worker, and the average fraction of workdays commuting. The rows in Table 1 show how each of these components changed between February and May, and the last column provides the log points contribution to the total decline in weekly commuting trips.

In the aggregate, employment for adults aged 18-64 in the RPS fell by 30.4 log points from February to May, from 73.2 percent of the population to 54.0 percent.[5] Those individuals that remained employed worked slightly fewer days per week in May than in February (4.6 days in May versus 4.7 in February), a reduction of 2.1 log points. Workers only commuted on 56.7 percent of workdays in May, compared with 84.8 percent in February, a decline of 27.9 log points. The increase in home-based work therefore accounts for slightly more than half ($39.9/72.5 = 55.0$ percent) of the overall decline in weekly commuting trips. The remainder is accounted for by reductions in hours worked, largely driven by lower employment.

Table 2 provides further information on the change in commuting patterns between February and May. Panel (a) shows that the share of workers commuting to work on a daily basis

[5]The retrospective RPS estimate of the February employment rate for adults aged 18-64 is close to the CPS estimate of 73.8 percent. The May estimate in the RPS is lower than the CPS estimate of 64.7 percent. The average number of workdays for February in the RPS is the same as in the 2017/18 ATUS time diary.

Table 2: Work from Home, February vs. May

a. Commuting Behavior	February	May
Commuting to Work Every Day	75.4	51.1
Commuting on Some Days	16.4	13.7
Working from Home Every Day	8.2	35.2

b. February-May Transition Rates	*In February:*		
In May:	Commuting Every Day	Commuting Some Days	Working from Home
Commuting to Work Every Day	43.7	14.9	2.4
Commuting on Some Days	8.8	31.1	5.7
Working from Home Every Day	19.8	25.2	65.4
No Longer Employed	27.7	28.8	26.5

Source: Real-Time Population Survey, adults aged 18-64, combined statistics for the May 10-16 and May 24-30 reference weeks. In panel (a), the total number of workers in the sample is 3,587 in Feb and 2,565 in May. In panel (b), the total number of workers in the sample is 3,587.

declined from 75.4 percent in February to 51.1 percent in May. At the same time, the share working entirely from home increased from 8.2 percent in February to 35.2 percent. Even with the partial economic reopening in several U.S. states, these figures are fairly stable across the two reference weeks in our sample: in the week of May 10-16, the share working entirely from home was 35.7 percent, while in the week of May 24-30 the share was 34.2 percent. This is consistent with Google's mobility metric for workplace visits, which remained flat throughout May.

The large increase in the share of individuals working from home is not necessarily entirely driven by workers switching to working from home. If workers who already worked from home in February were more likely to remain employed in May, then the increase could partly reflect a selection effect. We find, however, that pre-crisis commuting behavior is not strongly related to employment outcomes in May: the shares of daily commuters and entirely home-based workers were virtually the same among those who remained employed (75.4 percent and 8.5 percent, respectively) and those no longer employed in May (75.2 percent and 7.8 percent, respectively).

Panel (b) in Table 2 provides additional details on the transitions in commuting behavior from February to May. Among workers who commuted daily in February, less than half (43.7 percent) commuted daily in May. A large fraction, 27.7 percent, were no longer employed. The remainder of daily commuters began to work from home, with most ($19.8/28.6 = 69.2$ percent) doing so on a daily basis. The bottom row of Panel (b) also confirms that commuting status before the pandemic is not strongly related to employment status in May. Specifically, individuals who already worked from home every day before the pandemic lost employment

at essentially the same rate (26.5 percent) as occasional and daily commuters (27.7 and 28.8 percent, respectively).

The fact that pre-COVID home-based workers were about as likely to lose employment as daily commuters suggests that the ability to work from home by itself was not sufficient to insulate workers from job loss during the pandemic. We see at least two possible explanations for this pattern. First, there is a distinction between the ability to work from home and the ability to avoid physical proximity to co-workers or customers. Some jobs—for example providing in-person services like fitness training, cooking lessons, or physical therapy—may be home-based but still require physical contact. Consistent with this notion, in the next section we find a clear positive relationship between the probability of job loss and individual characteristics that Mongey et al., 2020 show correlate with high-proximity work. The second explanation is that demand spill-overs and the associated reductions in labor demand affected workers regardless of their ability to work from home (Baqaee et al., 2020; Guerrieri et al., 2020). The latter is also in line with recent evidence by Kahn et al. (2020) on job postings, which dropped by a similar amount for jobs that can be done from home as for those that cannot.

We will now compare our results to the available evidence on how many workers switched to home-based work since the start of the health crisis. Estimates for the UK from a real-time survey of firms by The Decision Maker Panel are similar to ours, indicating that 37 percent of employees were working from home in May. Similarly, based on surveys of over 85,000 individuals in EU countries, Eurofund (2020) reports that on average 37 percent started working from home in April (on average 9 percent worked from home daily prior to the COVID-19 outbreak). Bartik et al. (2020) provide some recent evidence on work from home for the US from a survey of small business leaders and a survey of business economists. They find that 45 to 50 percent of firms report having any workers switch to working remotely during the COVID-19 pandemic. The only other US evidence from household surveys we are aware of is by Brynjolfsson et al. (2020) and Barrero et al. (2020). Based on a Google Consumer Surveys question in early April and May, Brynjolfsson et al. (2020) find that about half of the employed in May worked from home. Based on a survey question posed to 2,500 US residents, Barrero et al. (2020) conclude that 62 percent of labor services were supplied from home in late May. Each of these alternative US estimates is higher than in the RPS. A possible explanation is that these online surveys oversample home-based workers relative to RPS. One indication is that Brynjolfsson et al. (2020) find pre-pandemic rates of home-based work that are substantially above those of other surveys, including the RPS, see Section 2.[6] In addition, both estimates appear somewhat large given existing estimates of work-from-home capacity, see Section 5. A key contribution of our paper compared to Barrero et al. (2020) and Brynjolfsson et al. (2020) is that we document the heterogeneity in work from home and employment outcomes across a rich set of worker and industry characteristics.

[6]Barrero et al. (2020) report estimates of home-based work before the pandemic for their firm survey, but not for their household survey.

4 Heterogeneity in Switching to Home-Based Work

The RPS collects demographic information such as sex, race, education, family structure, and household income in 2019, as well as the industry in the worker's main job. Here we document the differences in the transitions to working from home along these dimensions.

4.1 Home-Based Work by Individual Characteristics

Recent jobs reports released by the BLS show larger increases in unemployment among minorities, women, and low-skill workers. Similarly, Cajner et al. (2020) document the disproportionate impact on workers at the bottom of the earnings distribution. One likely reason is that the feasibility of switching to work from home varies greatly across the occupations held by different demographic groups. Based on occupation-level measures of work-from-home capacity and physical proximity at work, Mongey et al. (2020) predict that relatively more low-education and low-income workers would become inactive as a result of social distancing. Similarly, Alon et al. (2020) predict relatively larger job losses among women because of the large impact on in-person service occupations with high female employment shares.

Based on the RPS, we find that actual transitions to home-based work indeed varied strongly across different socioeconomic groups, and were negatively related to the probability of job loss. Table 3 summarizes the main results by sex, race, education, income, and the presence of (young) children in the household.

The first column in Table 3 lists the fraction of workers working from home on a daily basis before the virus outbreak. Overall there is relatively little heterogeneity across the categories. The fraction of home-based workers was somewhat larger among white workers (9.7 percent versus 6.8 percent for Black and 5.2 percent for Hispanics), high-income workers (9.6 percent versus 7.6 percent for low-income and 6.8 percent for mid-income workers), and adults without children at home (9.7 percent versus 5.6 percent for adults with children and 5.2 percent for adults with young children). There was no meaningful difference in working from home by sex or education in February.

The second column in Table 3 shows that the fraction of entirely home-based workers rose substantially for every category in May. However, the increase was more pronounced for some groups than for others. While there was no notable difference in work from home by education in February, 50.2 percent of all workers with a college degree or more (high education) worked from home every workday in May; in contrast, only 14.6 percent of workers with a high school degree or less (low education) worked from home in May. Similarly, the share of high income home-based workers rose to 45.5 percent, whereas the share of low income workers rose only to 18.4 percent. The fraction of women working from home increased more than the fraction of men, to 38.6 percent versus 32.2 percent, respectively. Many more white workers switched

Table 3: Work from Home by Individual Characteristics

	% Working at Home Every Day		No Longer Employed in May, as % of Workers	
	February	May	Commuting Every Day in Feb	Working at Home Every Day in Feb
All	8.2	35.2	27.7	26.5
Male	7.8	32.2	25.6	20.5
Female	8.7	38.6	30.2	31.4
White	9.7	39.4	22.5	23.5
Black	6.8	24.5	33.9	31.7
Hispanic	5.2	23.4	34.0	26.5
Low Education	8.2	14.6	33.9	40.0
Mid Education	8.4	25.2	33.7	31.7
High Education	8.2	50.2	20.2	14.8
Low Income	7.6	18.4	39.9	41.5
Mid Income	6.8	30.7	28.1	28.2
High Income	9.6	45.5	19.4	17.9
Children	5.6	34.1	27.8	28.6
Youngest< 13y	5.2	33.2	27.9	31.3
No Children	9.7	35.7	27.7	25.8

Source: Real-Time Population Survey, adults aged 18-64, combined statistics for the May 10-16 and May 24-30 reference weeks. Low education: high school or less; Mid Education: some college; High Education: college degree or higher. Low Income: household income last year less than $50k; Mid Income: household income last year between $50k and $100k; High income: household income last year higher than $100k.

to working from home (39.4 percent) than Black or Hispanic workers (24.5 and 23.5 percent, respectively). Finally, whereas individuals without children were more likely to work from home in February than those without children, the gap disappeared in May. It is clear that social distancing measures, in particular the widespread closure of daycares and schools, led many adults to balance home-based work and parenting.

The third column in Table 3 shows the fraction of workers that lost employment among daily commuters in February.[7] Transitions out of employment tend to be more common for groups with lower transitions to home-based work. Large gaps in transitions rates out of employment exist between: whites and minorities (22.5 percent, 33.9 percent, and 34.0 percent for whites, blacks, and Hispanics, respectively); high- and low-education workers (20.2 percent for workers with a college degree or more versus 33.9 percent for workers with a high school degree or less);

[7]The complete set of transition rates for all categories is provided in Table B.1 of the Appendix.

and high- and low-income workers (19.4 percent versus 39.9 percent). The transition rates by sex are an interesting counterexample; women transitioned at higher rates than men to both non-employment and home-based work. A potential explanation lies in the distinction between the ability to work from home and the ability to avoid physical proximity to others, as Mongey et al. (2020) find that women tend to work in occupations that score high in the former, but low in the latter.

Overall, our results are consistent with predictions of which categories of workers would have greater difficulty transitioning to home-based work. In particular, the findings that low-income, low-education, and minority workers transitioned to home-based work at lower rates is consistent with analyses by Mongey et al. (2020), Adams-Prassl et al. (2020a), and others. At the same time, the fourth column in Table 3 shows that, as in the aggregate, the rate of employment loss within a particular category is similar whether or not workers commuted in February, and is higher for women, minorities, and workers with less education even if they were already working from home. With the exception of the relatively greater job loss for women, the job loss patterns for pre-pandemic home-based workers resemble those of more typical economic downturns. This suggests that, besides social distancing, more typical recessionary dynamics are also at work.[8]

4.2 Home-Based Work by Industry

Employment losses following the pandemic were widespread across industries, but were much larger in some than in others.[9] While this variation is influenced by many factors, such as the extent to which a given industry includes services deemed essential by government-mandated restrictions, one possibly important source of variation is the potential for home-based work across industries (Dingel and Neiman, 2020).

Here we use the RPS to quantify the change in rates of home-based work across industries, and relate these to changes in employment. Figure 1 displays the relationship between three variables by industry: the percent change in employment from February to May, the share of home-based workers in February, and the share of home-based workers in May. To facilitate comparisons between February and May, as well as to better illustrate the role of home-based work in driving changes in industry employment, we express the May share of home-based workers as a fraction of February employment.

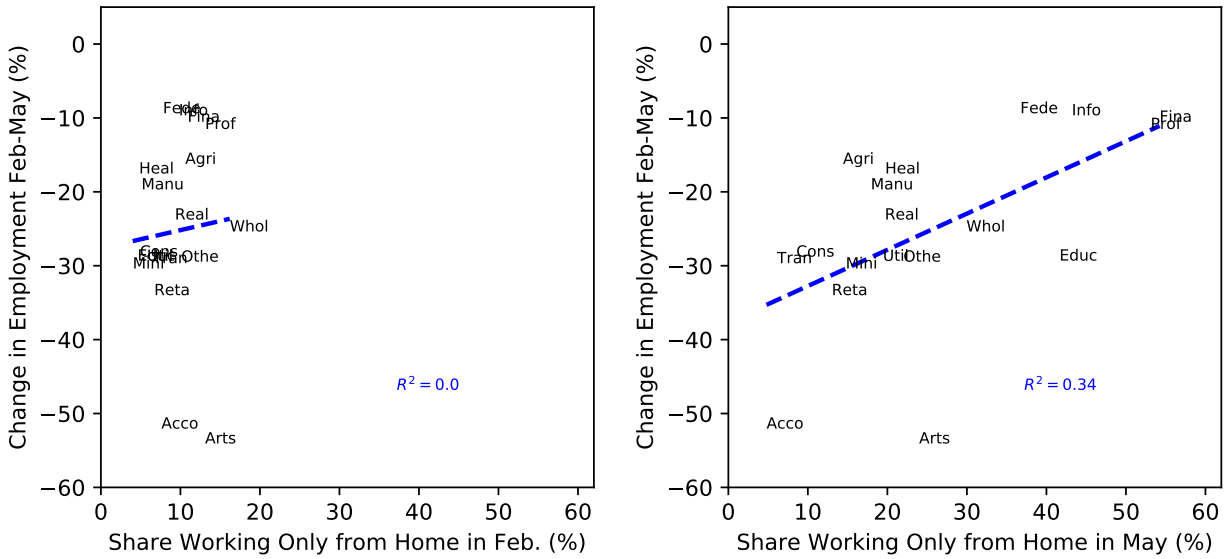
Figure 1a reveals that there was relatively little variation in rates of home-based work by industry just prior to the pandemic, and that the variation that did exist was not predictive of rates of employment loss in the first few months of the pandemic. In contrast, Figure 1b

[8] More typical recessionary dynamics do not involve any significant increase in working from home: prior to the great recession, the fraction of workdays commuting was 88 percent in the ATUS time diary for 2006/07. During the great recession in 2008/09, this fraction dropped just minimally to 87 percent.

[9] Appendix C provides a table with the employment changes by industry in the RPS.

Figure 1: Work from Home and Employment Changes By Industry

(a) Work from Home Before the Pandemic (b) Work from Home During the Pandemic



Source: Real-Time Population Survey. Share working only from home in February and May are both expressed as a share of February employment. Blue dashed lines are regression lines. Black line in 2 is the 45 degree line. Appendix Table C.1 reports the numbers shown in the Figure.

displays much more variation in work from home across industries, and shows that the fraction of home-based workers in May is strongly negatively correlated with the change in industry employment. Contact intensive sectors such as arts, entertainment and recreation, accommodation and food, and retail trade all experienced greater reductions in employment and lower rates of work from home in May. Other sectors, such as finance and insurance, information, or professional and business services experienced a relatively small drop in employment, and higher rates of work from home.

That industry job losses are related to differences in the ability to switch to home-based work is especially clear in the transitions for those that were commuting daily in February.[10] We find that many more daily commuters transitioned out of employment in non-essential contact intensive service sectors, such as arts, entertainment and recreation (64.9 percent of daily commuters in February), accommodation and food (52.6 percent), and retail trade (37.8 recent). Sectors that experienced high rates of transition from commuting to working from home include information (37.3 percent of daily commuters in February), finance/insurance (45.2 percent), and professional and business services (44.8 percent).

At the same time, and consistent with our earlier findings, many completely home-based workers lost employment, particularly in sectors that were hard-hit by social distancing such as accommodation and food or retail trade. These likely include many low-proximity occupations

[10]The complete set of transition rates for all industries is provided in Table C.2 of the Appendix.

providing indirect labor services, e.g. a customer service representative for an apparels retailer or a travel planner for a cruise line. In sectors relying less on direct physical contact with customers, such as the information or finance/insurance sectors, generally very few home-based workers experienced job losses. A substantial number of home-based workers also lost employment in some sectors without particularly high direct exposure to customers, such as manufacturing or utilities. The losses of home-based jobs across a range of industries again points to factors other than work-from-home capacity shaping employment losses, including demand spillovers such as those described in Baqaee and Farhi (2020) and Guerrieri et al. (2020).

5 Did Everyone Who Could Work from Home Do So?

Expanding the number of workers that work from home potentially reduces the number infections at an economic cost that is lower than other containment policies. In this section, we assess the extent to which all workers who had the potential to work from home actually did so in May.

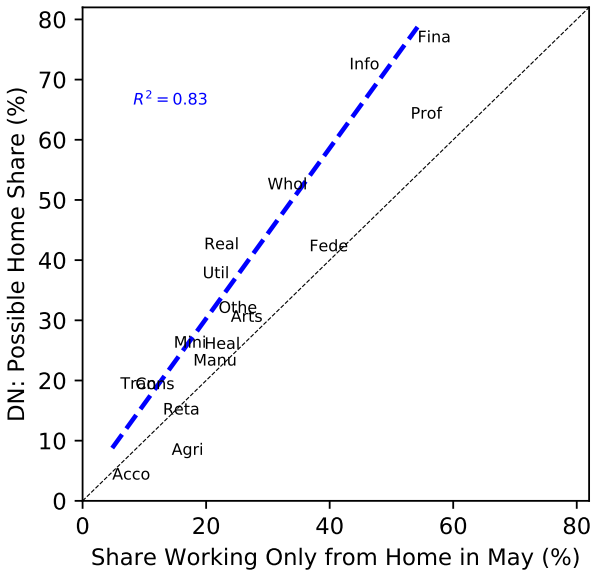
A number of recent papers have developed measures of the scope for working from home across different occupations and industries. Dingel and Neiman (2020) use O*NET data to classify the feasibility of working at home for all major occupations. Based on this classification, they conclude that 37 percent of jobs in the United States could be performed entirely at home.[11] Using a similar strategy, Su (2020) calculates that 39 percent of jobs can be done from home, at least in the short term.

Earlier in Table 2, we documented that 35.2 percent of all workers report working from home every day in May in the RPS. This is very close to the upper bound of 37 percent calculated by Dingel and Neiman (2020) – or the upper bound of 39 percent in Su (2020) – on the basis of O*NET data. Taking the 37 percent number of Dingel and Neiman (2020), this suggests that about 90.2 percent of workers that could work from home were doing so in May.

However, the 90.2 percent estimate is an upper bound for the ratio of effective to potential home workers in May because the potential for home-based work calculated by Dingel and Neiman (2020) is based on the composition of the workforce before the pandemic. The changes in employment caused by the pandemic are large, and as a result the composition of the workforce has changed markedly between May and February of 2020. A more accurate calculation for the ratio of effective to potential home workers is the ratio of May home workers to February employment. In addition, as documented earlier in Table 2, 26.5 percent of all those who worked from home in February were no longer employed in May. Our preferred estimate of the ratio of effective to potential home workers also subtracts these from the number of potential home workers. Taking the Dingel and Neiman (2020) estimates of the potential for home-based work,

[11] Gottlieb et al. (2020) use the measures in Dingel and Neiman (2020) to quantify the feasibility of working from home across countries.

Figure 2: Actual vs. Potential Work from Home



Source: Real-Time Population Survey, Dingel and Neiman (2020). Share working only from home in May is expressed as a share of February employment. Blue dashed lines are regression lines. Black line in 2 is the 45 degree line. Appendix Table C.1 reports the numbers shown in the Figure.

this suggests that 71.7 percent $(35.2 \times 54.0/(73.2 \times (100 - 8.2 \times 26.5/100)$ of the pre-COVID workforce who could work entirely from home did so in May.

It is also possible to compare the actual-to-potential work-from-home rates by industry. Figure 2 plots the share of home-based workers in May (as a fraction of February employment) against the potential industry-specific shares calculated by Dingel and Neiman (2020). The associated R squared is very high (0.83), indicating that the actual shares of home-based workers in May align closely with the Dingel and Neiman (2020) estimates of the share of potential home-based workers.[12] The regression line (as well as every industry except accommodation and food services and agriculture) lies above the 45 degree line, which means that the ratio of actual-to-potential home based workers is generally below one across industries.

One possible conclusion from comparing the RPS evidence to the calculations by Dingel and Neiman (2020) is that 28.3 percent (100-71.7) more US workers could have switched to working from home in May to help contain the virus. Taking the measures of work-from-home capacity at face value, Figure 2 also implies that the education, information, and finance sectors are among the industries with the greatest scope for additional work from home.

An alternative interpretation, however, is that there are additional constraints to home-

[12]The close relationship across industries is also consistent with the recent evidence from firm surveys by Bartik et al. (2020).

based work that are not fully captured by the Dingel and Neiman (2020) estimates. A range of recent papers have proposed refinements or alternative measures (Adams-Prassl et al., 2020a,b; Alon et al., 2020; Gottlieb et al., 2020; Hensvik et al., 2020; Leibovici et al., 2020; Mongey et al., 2020; Papanikolaou and Schmidt, 2020; Su, 2020). While all of these could be confronted with the RPS evidence, we leave this for future work.

6 Concluding Remarks

The outbreak of the COVID-19 pandemic and associated social distancing measures have led to unprecedented employment losses, as well as severe disruptions to work and commuting habits. This paper provides extensive empirical evidence on home-based work and employment loss since the start of the crisis, both on the aggregate level as well as by individual characteristics and industry.

Overall, we find that the predictions based on work-from-home capacity regarding which workers would be able to switch to working from home, and which workers would lose employment, are broadly borne out by the evidence. According to our estimates, 71.7 percent of workers that could work from home effectively did so in May. One of our more surprising findings is that work from home prior to the virus outbreak shows little relationship with post-crisis employment outcomes, which we view as evidence for demand-side effects.

Our objective going forward is to produce time-series of the measures presented in this paper to continue to track patterns in home-based work as the crisis evolves. Such time series are relevant for the continued evaluation of containment policies to mitigate the current pandemic, and possibly also future ones. Such time series will also be useful to inform quantitative models of the economic impact of the pandemic. Finally, our results will provide real-time insights on the extent to which the spike in work from home during the initial months of the pandemic will affect long run patterns in work from home.

References

Adams-Prassl, A., T. Boneva, M. Golin, and C. Rauh (2020a). *Inequality in the impact of the coronavirus shock: Evidence from real time surveys*. CEPR Discussion Paper 14665.

Adams-Prassl, A., T. Boneva, M. Golin, and C. Rauh (2020b). *Work tasks that can be done from home: Evidence on the variation within and across occupations and industries*. IZA Discussion Paper 13374.

Alon, T. M., M. Doepke, J. Olmstead-Rumsey, and M. Tertilt (Apr. 2020). *The Impact of Covid-19 on Gender Inequality*. Working Paper 26947. National Bureau of Economic Research. DOI: 10.3386/w26947.

Aum, S., S. Y. (Lee, and Y. Shin (May 2020). *Inequality of Fear and Self-Quarantine: Is There a Trade-off between GDP and Public Health?* Working Paper 27100. National Bureau of Economic Research. DOI: 10.3386/w27100.

Baqaee, D. and E. Farhi (2020). *Supply and Demand in Disaggregated Keynesian Economies with an Application to the Covid-19 Crisis*. Working Paper.

Baqaee, D., E. Farhi, M. J. Mina, and J. H. Stock (2020). *Reopening Scenarios*. Tech. rep. National Bureau of Economic Research.

Barrero, J. M., N. Bloom, and S. J. Davis (2020). "COVID-19 Is Also a Reallocation Shock". In: *Brookings Papers on Economic Activity* June.

Bartik, A. W., Z. B. Cullen, E. L. Glaeser, M. Luca, and C. T. Stanton (June 2020). *What Jobs are Being Done at Home During the Covid-19 Crisis? Evidence from Firm-Level Surveys*. Working Paper 27422. National Bureau of Economic Research. DOI: 10.3386/w27422.

Bick, A. and A. Blandin (June 2020). *Real-Time Labor Market Estimates During the 2020 Coronavirus Outbreak*. Working Paper. Arizona State University.

Bonadio, B., Z. Huo, A. A. Levchenko, and N. Pandalai-Nayar (May 2020). *Global Supply Chains in the Pandemic*. Working Paper 27224. National Bureau of Economic Research. DOI: 10.3386/w27224.

Brynjolfsson, E., J. Horton, A. Ozimek, D. Rock, G. Sharma, and H. Y. T. Ye (2020). *Covid-19 and remote work: An early look at U.S. data*. Working Paper. Massachussets Institute of Technology.

Cajner, T., L. D. Crane, R. A. Decker, J. Grigsby, A. Hamins-Puertolas, E. Hurst, C. Kurz, and A. Yildirmaz (May 2020). *The U.S. Labor Market during the Beginning of the Pandemic Recession*. Working Paper 27159. National Bureau of Economic Research. DOI: 10.3386/w27159.

Dingel, J. I. and B. Neiman (Apr. 2020). *How Many Jobs Can be Done at Home?* Working Paper 26948. National Bureau of Economic Research. DOI: 10.3386/w26948.

Erol, S. and G. Ordoñez (2020). *Social and Economic Distancing*. Working Paper.

Eurofund (2020). *Living, working and COVID-19 dataset*. Tech. rep.

Gottlieb, C., J. Grobovšek, M. Poschke, and F. Saltiel (2020). "Lockdown Accounting". In: *Covid Economics* 71.

Gregory, V., G. Menzio, and D. G. Wiczer (May 2020). *Pandemic Recession: L or V-Shaped?* Working Paper 27105. National Bureau of Economic Research. DOI: 10.3386/w27105.

Guerrieri, V., G. Lorenzoni, L. Straub, and I. Werning (2020). *Macroeconomic Implications of COVID-19: Can Negative Supply Shocks Cause Demand Shortages*. Working Paper.

Hensvik, L., T. Le Barbanchon, and R. Rathelot (Apr. 2020). *Which Jobs Are Done from Home? Evidence from the American Time Use Survey*. IZA Discussion Papers 13138. Institute of Labor Economics (IZA).

Jones, C. J., T. Philippon, and V. Venkateswaran (Apr. 2020). *Optimal Mitigation Policies in a Pandemic: Social Distancing and Working from Home*. Working Paper 26984. National Bureau of Economic Research. DOI: 10.3386/w26984.

Kahn, L. B., F. Lange, and D. G. Wiczer (Apr. 2020). *Labor Demand in the Time of COVID-19: Evidence from Vacancy Postings and UI Claims*. Working Paper 27061. National Bureau of Economic Research. DOI: 10.3386/w27061.

Kaplan, G., B. Moll, and G. Violante (May 2020). *Pandemics According to HANK*. presentation slides. London School of Economics.

Krueger, D., H. Uhlig, and T. Xie (Apr. 2020). *Macroeconomic Dynamics and Reallocation in an Epidemic*. Working Paper 27047. National Bureau of Economic Research. DOI: 10.3386/w27047.

Leibovici, F., A. M. Santacreu, and M. Famiglietti (2020). *Social Distancing and Contact-Intensive Occupations*. URL: https://www.stlouisfed.org/on-the-economy/2020/march/social-distancing-contact-intensive-occupations.

Mas, A. and A. Pallais (2020). "Alternative Work Arrangements". In: *Annual Review of Economics* forthcoming.

Mateyka, P. J., M. A. Rapino, and L. C. Landivar (Oct. 2012). *Home-Based Workers in the United States: 2010*. Current Population Reports.

Mongey, S., L. Pilossoph, and A. Weinberg (May 2020). *Which Workers Bear the Burden of Social Distancing Policies?* Working Paper 27085. National Bureau of Economic Research. DOI: 10.3386/w27085.

Pabilonia, S. W. and V. Vernon (2020). *Telework and Time Use in the United States*. GLO Discussion Paper Series 546. Global Labor Organization (GLO).

Papanikolaou, D. and L. D. Schmidt (June 2020). *Working Remotely and the Supply-side Impact of Covid-19*. Working Paper 27330. National Bureau of Economic Research. DOI: 10.3386/w27330.

Su, Y. (Apr. 2020). *Working from Home During a Pandemic: It's Not for Everyone*. URL: https://www.dallasfed.org/research/economics/2020/0407.

APPENDIX FOR ONLINE PUBLICATION ONLY

A Real-Time Population Survey Background Information

The RPS is administered online to respondents of the Qualtrics panel. The first survey wave was collected in the week of April 6, and a new wave has been collected every other week since then. Wave one consisted of 1,118 respondents; beginning in the second wave the sample size increased to about 2,000 respondents. The questions about commuting behavior appear first in the survey for the week of May 10. The sample of respondents was selected to be representative of the US population (ages 18-64 in wave 1, ages 18+ from wave 2-on) along several characteristics (age, gender, race/ethnicity, education, marital status, presence of children, geographic region, and household income in 2019).

The RPS asks respondents a host of questions related to demographic background and labor market outcomes. The labor market questions closely follow the basic module of the Consumer Population Survey (CPS) in asking about work experiences last week. This allows us to assign individuals to one of four basic labor force categories: employed and at work, employed and absent from work, unemployed, and not in the labor force. Employed respondents are asked about type of employer, employer tenure, industry, hours of work, commuting behavior, hourly or salaried pay status, and earnings. Non-employed respondents are asked about layoff status, availability for work, and search behavior. In addition to asking about work experiences last week, we ask individuals about work experiences in February, which provides a retrospective panel component to the survey. Since the full CPS sequence of questions for labor market status can be time consuming, the RPS only ask a subset of questions for February.

If the respondent cohabits with a spouse or partner, the RPS asks most of these questions of the spouse/partner as well. When respondents cohabit with a spouse/partner we assign each of them a weight of 0.5; respondents not living with a spouse/partner receive a weight of 1. We also assign weights based on age, relationship status and household income last year to match the joint distribution of these variables in the February CPS.

For additional details on the survey design and sample, see Bick and Blandin (2020).

B Work from Home and Commuting Transitions by Individual Characteristics

Table B.1 provides the full set of transitions in commuting status by individual characteristics, as estimated from the RPS data. The first three columns contain the outcomes in May for workers that were commuting on some workdays in February. The next three columns show the outcomes in May for workers that were commuting every workday in February. The last

three columns show the outcomes in May for workers that worked from home every workday in February.

Table B.1: Commuting Transitions by Individual Characteristics

	% of Daily Commuters to Work in February that are, in May,			% of Commuters on Some Days in February that are, in May,		
	Commuting Some Days	Working Home Every Day	No Longer Employed	Commuting Some Days	Working Home Every Day	No Longer Employed
All	8.8	19.8	27.7	31.1	25.2	28.8
Male	8.6	18.1	25.6	33.0	26.3	25.1
Female	29.1	24.1	32.6	8.9	21.5	30.2
White	8.9	22.9	22.5	25.7	39.4	21.8
Black	8.3	13.6	33.9	42.9	6.4	32.9
Hispanic	8.7	12.3	34.0	32.5	9.3	41.3
Low Education	6.6	4.9	33.9	37.0	8.0	42.1
Mid Education	8.9	10.7	33.7	31.2	14.5	36.5
High Education	10.2	34.8	20.2	27.9	41.3	16.7
Low Income	7.6	7.5	39.9	29.9	4.8	48.5
Mid Income	7.4	18.1	28.1	34.2	20.2	30.4
High Income	10.6	29.2	19.4	29.8	42.6	14.2
Children	9.4	21.2	27.8	35.0	22.5	24.6
Youngest< 13y	11.0	20.6	27.9	34.2	21.4	25.0
No Children	8.5	19.0	27.7	28.5	26.8	31.7

Source: Real-Time Population Survey, adults aged 18-64, combined statistics for the May 10-16 and May 24-30 reference weeks. Low education: high school or less; Mid Education: some college; High Education:college degree or higher. Low Income: household income last year less than $50k; Mid Income: household income last year between $50k and $100k; High income: household income last year higher than $100k.

Table B.1 (Continued): Commuting Transitions by Individual Characteristics

	% of Those Working From Home Every Day in February that are, in May,		
	Commuting Some Days	Working Home Every Day	No Longer Employed
All	5.7	65.4	26.5
Male	5.6	69.9	20.5
Female	5.8	61.8	31.4
White	4.4	68.8	23.5
Black	11.0	55.3	31.7
Hispanic	12.6	61.0	26.5
Low Education	8.5	47.5	40.0
Mid Education	2.5	61.8	31.7
High Education	5.9	78.8	14.8
Low Income	11.1	45.2	41.5
Mid Income	2.6	65.6	28.2
High Income	4.4	75.9	17.9
Children	7.8	62.6	28.6
Youngest< 13y	6.9	60.5	31.3
No Children	5.0	66.3	25.8

Source: Real-Time Population Survey, adults aged 18-64, combined statistics for the May 10-16 and May 24-30 reference weeks. Low education: high school or less; Mid Education: some college; High Education:college degree or higher. Low Income: household income last year less than $50k; Mid Income: household income last year between $50k and $100k; High income: household income last year higher than $100k.

C Work from Home by Industry

Table C.1 reports results from the RPS for 18 major industries. The first column provides employment shares across the industries in February. The distribution of employment across industries in February is very similar to the February and May CPS, see Bick and Blandin (2020). The second column lists the percent change in employment from February to May in the RPS. Consistent with the CPS, the job losses were widespread across sectors, and they were particularly large in contact intensive service sectors such as arts, entertainment and recreation, accommodation and food, and retail trade. The last three columns show the share of workers working completely from home in February and May by industry, both as a fraction of the number of workers in May and as a fraction of the number of workers in February. The industries with the largest increase in home-based work are information, finance/insurance, and professional and business services.

Table C.1: Work from Home, by Industry

			% Working At Home Every Day in		
	% of Feb Employment	Feb-May % Change in Employment	February	May (as % of Workers in May)	May (as % of Workers in Feb)
Agriculture	2.2	-16.2	10.6	17.2	14.4
Mining	1.4	-30.4	4.0	21.2	14.8
Utilities	1.7	-29.3	5.8	27.5	19.4
Construction	6.9	-28.8	4.9	12.0	8.5
Manufacturing	7.5	-19.7	5.1	22.3	17.9
Wholesale Trade	2.0	-25.4	16.2	40.1	29.9
Retail Trade	8.9	-34.0	6.7	19.7	13.0
Transp/Warehousing	4.3	-29.7	6.5	8.7	6.1
Information	3.2	-9.6	9.8	47.8	43.2
Finance/Insurance	5.9	-10.5	10.9	60.6	54.2
Real Estate/Rental	1.5	-23.8	9.3	25.8	19.7
Prof/Bus. Services	10.1	-11.5	13.1	60.0	53.1
Education	10.2	-29.3	4.6	58.9	41.6
Health Care	9.8	-17.5	4.8	23.9	19.7
Arts/Entert/Recr	3.2	-54.1	13.1	52.2	24.0
Accom/Food	4.5	-52.0	7.6	10.0	4.8
Other Services	13.1	-29.4	10.1	31.2	22.0
Public Sector	3.8	-9.4	7.8	40.5	36.7

Source: Real-Time Population Survey, adults aged 18-64, combined statistics for the May 10-16 and May 24-30 reference weeks.

Table C.2 provides the transitions in commuting status by industry, as estimated from the RPS data. The first three columns contain the outcomes in May for workers that were commuting on some workdays in February. The next three columns show the outcomes in May

for workers that were commuting every workday in February. The last three columns show the outcomes in May for workers that worked from home every workday in February.

Table C.2: Commuting Transitions by Industry

	% of Daily Commuters to Work in February that are, in May,			% of Commuters on Some Days in February that are, in May,		
	Commuting Some Days	Working Home Every Day	No Longer Employed	Commuting Some Days	Working Home Every Day	No Longer Employed
Agriculture	12.5	5.5	14.1	61.0	4.3	22.8
Mining	11.2	2.6	18.3	40.0	19.1	11.6
Utilities	5.3	22.2	24.3	36.6	9.9	41.8
Construction	12.4	4.4	29.8	28.9	5.5	30.2
Manufacturing	6.3	12.9	21.0	40.6	20.8	33.9
Wholesale Trade	15.8	21.1	30.1	48.0	4.8	32.8
Retail Trade	6.1	9.2	37.8	37.8	1.8	47.4
Transp/Warehousing	3.7	2.8	26.8	27.4	7.7	37.9
Information	20.5	37.3	15.5	35.6	34.5	12.8
Finance/Insurance	9.8	45.2	16.2	13.1	61.2	7.7
Real Estate/Rental	14.4	7.3	24.4	38.0	45.0	5.4
Prof/Bus. Services	7.1	44.8	15.6	24.9	53.6	13.8
Education	13.9	42.8	24.9	25.7	33.6	23.8
Health Care	7.1	15.2	16.7	35.2	22.3	17.4
Arts/Entert/Recr	6.2	8.7	64.9	17.0	28.0	47.4
Accom/Food	3.8	1.6	52.6	17.3	0	60.7
Other Services	7.0	15.0	28.7	40.5	24.5	30.0
Public Sector	15.0	34.3	3.1	22.1	60.3	5.1

Source: Real-Time Population Survey, adults aged 18-64, combined statistics for the May 10-16 and May 24-30 reference weeks.

Table C.2 (Continued): Commuting Transitions by Industry

	% of Those Working From Home Every Day in February that are, in May,		
	Commuting Some Days	Working Home Every Day	No Longer Employed
Agriculture	9.7	83.0	7.3
Mining	0	54.1	45.9
Utilities	26.4	39.3	34.3
Construction	5.0	70.9	11.4
Manufacturing	0	82.5	17.5
Wholesale Trade	0	76.8	5.7
Retail Trade	0	64.6	31.9
Transp/Warehousing	6.7	52.6	40.7
Information	20.9	79.1	0
Finance/Insurance	6.4	90.4	3.1
Real Estate/Rental	44.8	55.2	0
Prof/Bus. Services	0	84.3	14.3
Education	18.2	56.5	25.3
Health Care	0	91.4	4.1
Arts/Entert/Recr	0	76.5	23.5
Accom/Food	0	46.4	38.7
Other Services	8.4	60.1	31.4
Public Sector	0	41.3	58.7

Source: Real-Time Population Survey, adults aged 18-64, combined statistics for the May 10-16 and May 24-30 reference weeks.