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Home Production and Leisure During the COVID-19 Recession*

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Abstract

Between the months of February and April of 2020, average weekly market hours dropped by 6.25, meanwhile 35% of commuting workers reported switching to remote work arrangements. In this paper, we examine implications of these changes for the time allocation of different households, and on aggregate. We estimate that home production activity increased by 2.1 hours a week, or 34% of lost market hours, whereas leisure activity increased by 3.8 hours a week. The monthly value of home production increased by $30.83 billion – that is 10.5% of the concurrent $292.61 billion drop in monthly GDP. Although market hours declined the most for single, less educated individuals, the lost market hours were absorbed into home production the most by married individuals with children.

JEL Codes: D13 (household production), E32 (business cycles), J22 (time allocation and labor supply)

Key words: Shutdown, COVID-19, pandemic, home production, remote work

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1 Introduction

The labor market effects of the strict economic shutdown implemented during the months of March, April, and May of 2020 have been widely discussed. Less is known about what type of families suffered the most and how they spent the extra time at home. If those extra hours were spent on home improvement projects, home schooling and cooking dinners, the loss in market output would be partly offset by the gain in home production. In this paper, we estimate the effects of the pandemic on time allocation of different types of households, and on aggregate.

The main source of time use data in the U.S. is the American Time Use Survey (ATUS). The ATUS is a monthly survey, but there is a significant time lag between data collection and its availability, which makes it less relevant for real-time policy making.[1] Most importantly, ATUS data collection was suspended altogether during the COVID-19 shutdown resuming in mid-May.[2] Therefore, one must rely on estimates to get a sense of time allocation patterns during the pandemic recession. We offer estimates based on combining real-time data on work hours and remote work with their effects on time allocation.[3]

Why are these estimates useful? They help assess the cost of a shutdown. They help paint a more accurate picture of the pandemic experience across household types and allow for a more accurate cross-household welfare assessment. They also provide useful calibration targets for researchers studying the pandemic recession and pandemic-related policies through models that explicitly feature home production, family-level decision making, and/or household heterogeneity.[4]

The effects of a job loss will likely depend on the type of household experiencing it. Single workers with less education may decide to spend the extra time taking an online training class, while married workers with children may spend the extra time turning their backyard into a vacation oasis. We therefore separately consider several types of households, differentiated by marital status, gender, partner's employment status, education and the presence of children in the household. We focus on individuals of age 18 to 65.

Although we report on both home production and leisure, we focus our discussion mainly on home production. We separately discuss changes due to lost market hours (Section 3) and changes due to the rise

[1] The 2019 data were released in June of 2020, indicating a 14 to 18 month delay in data availability for the first four months of 2019.

[2] See https://www.bls.gov/covid19/effects-of-covid-19-pandemic-on-employment-and-unemployment-statistics.htm#ATUS

[3] We chose to focus on the period from February to April which marked the largest decline in employment. Labor markets picked up in May.

[4] Explicit modeling of home production has long been recognized to help business cycle models fit the data and to matter for policy analysis (e.g. Greenwood and Hercowitz [1991], McGrattan et al. [1997]). Doepke and Tertilt [2016] effectively motivate the importance of incorporating family-level decision making into macroeconomic analysis.

in remote work (Section 4), combining the two effects in the latter section. This is done in order to facilitate comparison to previous studies such as Aguiar et al. [2013] for the effects of lost market hours and Pabilonia and Vernon [2020] for telecommuting effects.

We estimate changes in home production (and leisure) by combining losses of market hours experienced by each household type with our estimates of substitution rates across time use categories.

On average, market weekly hours were reduced by 6.25 hours between February and April. The less educated were affected the most. The least affected groups were the college educated married men. We estimate the substitution rates by applying the identification strategy used in Aguiar et al. [2013] separately to each type of household in 2003-2018 ATUS. This methodology assumes the same aggregate trend in time allocation patterns across the U.S. states, thereby allowing us to identify the causal effects from cross-state variation of changes in time allocation. Aggregate trends in time use are widely documented (e.g. Ramey [2009]). In addition, we allow for differential substitution rates and differential trends across household types, highlighted, for example, in Bar and Leukhina [2011]. Depending on the type of household considered, we find that home production activities absorb anywhere from 11% to 49% of lost market hours.[5]

Combining the magnitude of lost market hours with their substitution rates into home production, we find that the total impact on home production hours ranges from 1 hour per week to 4 hours per week.[6] Generally speaking, home production increased more for married individuals and households with children. We also decompose the total impact into the part implied by changes in employment (the extensive margin) and the part implied by hours reduction of the employed. Aggregating over household groups, we derive the total impact of reduced market work hours. Starting at about 20.7 weekly hours in January, home production hours remained unchanged in February, rose by 0.3 hours in March and by nearly 1.4 hours in April, totaling to the 1.7 hour increase between February and April.[7]

While the 1.7 weekly hour increase may not seem like a lot, it is 27% of the 6.25 hour decline in weekly market hours. Moreover, it places the estimated change in the value of monthly home production between February and April at $25.09 billion, or 8.6% of the $292.61 billion drop in the monthly GDP over the same time period. We estimate the home production value using a method similar to the "specialist cost method" described in Bridgman [2016].

In addition to the loss in market hours, the pandemic recession marked an unprecedented rise in work-

[5]Leisure absorption rates are much greater, ranging between 46% and 68%.

[6]The response in leisure is much greater, ranging between 1.8 hours to 7 hours a week.

[7]Starting at 110.4 weekly hours in January, leisure hours remained unchanged in February and increased by 3.75 by April.

from-home arrangements. Working from home allows for a more flexible schedule and therefore easier access to household and child-related chores throughout the day. We estimate its contribution to the rise in home production by combining the commute-to-remote switch rates for various households with the estimates of remote work effects on home production hours.

According to the representative survey conducted by Brynjolfsson et al. [2020], 35% of the employed workers surveyed in the beginning of April reported having switched from commuting to remote work, and no additional switches recorded in the beginning of May. Not everyone had equal opportunity to switch to remote work, with the less educated households more likely to hold service jobs that cannot be performed remotely. We proxy the type-specific switch rates by assuming they are proportional to the pre-pandemic prevalence of remote work. We then estimate the effects of remote work on home production hours for different types of employed workers on post-Great Recession ATUS data. Combining these two steps, we find that home production increased between 0.17 to 0.71 hours hours a week, as a direct result of the rise in telecommuting. The college-educated workers were affected the most.

Updated with remote work effects, average weekly home production hours among the employed increased by an additional 0.4 hours between March and April, bringing the cumulative increase between February and April to 2.1 hours. The increase in the value of monthly home production between February and April updates to $30.83 – a $5.74 billion gain in value and a 10.5% of the estimated $292.61 billion drop in the monthly GDP.

Our estimates of the impact on home production likely represent a lower bound of the actual changes that took place, while the opposite is true for leisure activities. This is because leisure options – such as going to the gym, watching baseball or basketball, and eating out – were severely limited during the pandemic recession. Of course, households were likely substituting other leisure activities for those they missed out on (e.g. watch a TV show instead of March Madness), but we expect some movement away from leisure and towards home production activities, and especially so for households with small children whose daycare/school closed down.

The rest of the paper proceeds as follows. In Section 2, we discuss our data sources. In Section 3, we explain our methodology and report the estimated changes in home production and leisure hours generated by lost work hours. We augment these estimates with remote work effects in Section 4. Conclusions are given in Section 5.

2 Data: CPS and ATUS

We obtain labor market and demographic characteristics from the monthly Current Population Surveys (CPS), which is conducted by the Census Bureau.[8] All questions refer to the week that includes the 12th day of each month. We measure average employment rates and overall market hours for twenty groups of working-age population (18 to 65) defined according to marital status,[9] gender, education (college/less than college), presence of own children in the household, and spousal employment.[10] We deem an individual to be employed only if they report to be at work last week. This approach treats furloughed workers and those on payroll but not at work as not employed and therefore better serves our purpose of identifying changes in time allocation patterns. We measure hours worked for working individuals using the reported number of hours worked last week. We also calculate the distribution of working-age individuals across groups (population shares). There are 326,169 observations in our CPS sample.

We obtain time allocation data from the 2003-2019 waves of the ATUS. This survey is conducted by the Census Bureau via telephone interviews, and individuals in the sample are drawn from the exiting sample of the CPS. Our sample includes all working age respondents with complete time use records and non-missing information on demographic characteristics. There are 138,351 observations in our ATUS sample.

ATUS respondents complete detailed time-use diaries over a 24-hour period, which allows them to distinguish between primary and secondary activities. All activities are classified into seventeen time-use categories. We segment individual time endowment into seven categories of primary time use defined in Aguiar et al. [2013]: market work, other income-generating activities, job search, child care, non-market work, leisure, and other time use. We adhere to the same definition of market work and leisure, but combine child care and non-market work into a single "home production" category. We use records of activity location to document the fraction of hours worked from respondents' homes.[11]

[8] In an earlier stage of this project, we used the real-time population survey data from Bick and Blandin [2020].

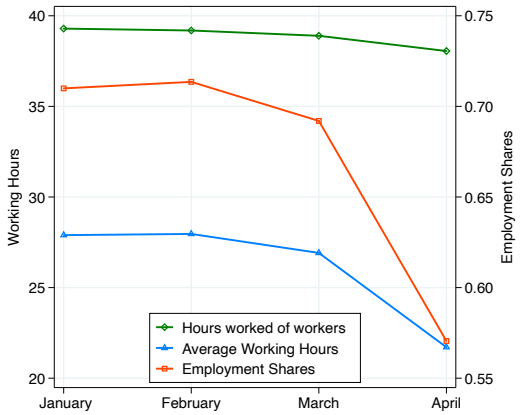
[9] Married individuals not living together are considered single.

[10] We use spousal employment to differentiate between married men only, as the sample of married women with nonworking spouses is insufficiently large.

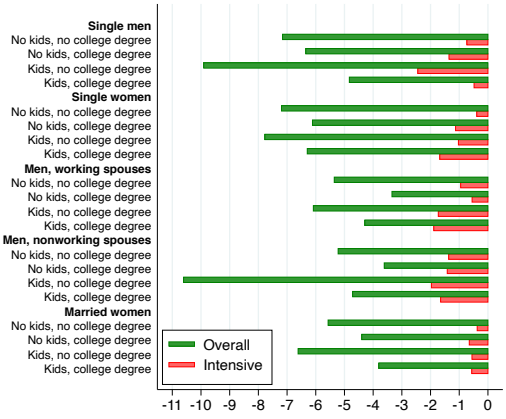
[11] Market hours are the total of hours worked on the main job, second job and in overtime, hours spent on work-related activities and travel related to work. Leisure hours are measured as time spent in activities for which time complements monetary expenditures (e.g. watching TV, sleeping, exercising). Non-market work encompasses housework (e.g. cooking, cleaning, lawn care), home ownership activities (e.g. home improvement and lawn care), care for other adults, and obtaining goods and services. See Aguiar et al. [2013] for more details.

Figure 1: Trends in Market Hours and Employment

(a) Aggregate Trends



(b) Loss by Household Type



Notes: Panel a shows the evolution of average market hours and employment between the months of January and April, 2020. Panel b illustrates changes in market hours for each type of household. The green bars, entitled "Overall," mark the total change in average hours. The red bars, entitled "Intensive," mark the change in average hours of the employed.
Source: Current Population Survey, authors' calculations.

3 Analysis

Our objective is three-fold. We first document the loss of employment and reduction of total market hours for different types of households (Section 3.1). Second, we quantify the impact of lost market hours on home production and leisure for different types of households, and on aggregate (Sections 3.2-3.4). Third, we proxy the impact on home production implied by the rise in remote work and explain how this added effect changes our prior estimates (Section 4).

3.1 Trends in Market Hours and Employment

Figure 1 (panel a) reveals that average weekly market hours were reduced by 6.25 hours between February and April, i.e. by 22.35%. We also find that the drop in overall hours was mainly due to lost employment – which declined by about 14 percentage points (i.e. a 20% drop) – rather than reduced hours on the job. In fact, average weekly hours among the employed declined by only 1.13 hours.

In Figure 1 (panel b), the overall loss of hours is broken down by household type. The green bars depicting the overall change indicate that, among the groups affected the most, were the less educated married men with children and stay-at-home wives (almost 11 hours) and single households with kids and no college degree (10 hours for men and 8 for women). Among those least affected were college educated

men with no kids and a working spouse (3 hours).

We further decompose the overall average drop in hours into hours reduction of the employed (the intensive margin ΔI_t^j) and the drop in employment (the extensive margin ΔE_t^j) according to

$$\Delta h_t^j = p_t^j h_t^{emp,j} - p_{t-1}^j h_{t-1}^{emp,j} = \Delta I_t^j + \Delta E_t^j, \tag{1}$$

where $\Delta I_t^j = (h_t^{emp,j} - h_{t-1}^{emp,j})(\frac{p_t^j + p_{t-1}^j}{2})$, $\Delta E_t^j = (p_t^j - p_{t-1}^j)(\frac{h_t^{emp,j} + h_{t-1}^{emp,j}}{2})$, p_t^j and $h_t^{emp,j}$ denote the employment share and the average market hours of the employed type j households.

The red bars in Figure 1 (panel b) illustrate the change in hours along the intensive margin, while the extensive margin can be visualized as the difference between the two bars. It is clear that, for all household types, the drop in hours is mainly accounted for by lost employment. Indeed, average weekly hours among the employed declined by at most 2.4 among the household groups we considered, with most groups experiencing only a 1 hour decline.

In contrast to a typical recession that disproportionately affects the male-dominated sectors, this shutdown marked similar losses across genders—6.32 hours for men and 6.05 hours for women. This is because it featured a larger than typical negative impact on female-dominated service sectors and increased child care needs due to school and daycare closures. See Alon et al. [2020] for a thorough analysis of gender differences during the pandemic recession. Overall, less educated workers and households with children were hit the hardest.

3.2 Time Substitution Rates Across American Households

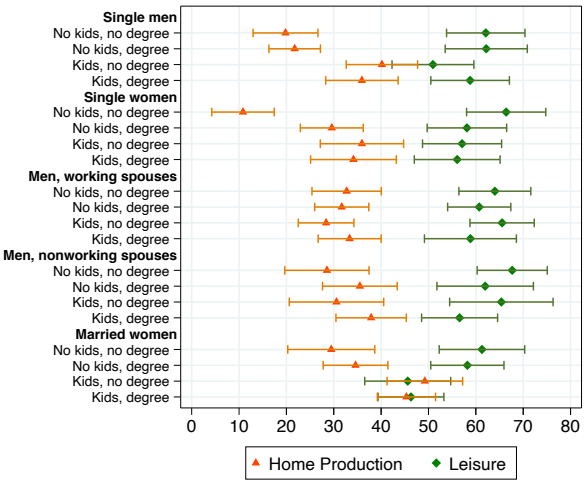
To estimate the extent with which foregone work hours are reallocated towards home production (hp) and leisure (l), we apply the identification strategy from Aguiar et al. [2013] to the 2003-2018 ATUS data. The strategy assumes the same time allocation trends across U.S. states and exploits the cross-state variation of changes in time use. Importantly, we also allow for differential trends and differential effects across household types.

For each time use category $k \in \{hp, l\}$ and each type of household j, we estimate

$$\Delta h_{st}^{k,j} = \alpha^{k,j} - \beta^{k,j} \Delta h_{st}^j + \varepsilon_{st}^{k,j}, \tag{2}$$

where $\Delta h_{st}^{k,j}$ is the change in average weekly hours spent on activity k by type j households in state s

Figure 2: Substitution Rates of Home Production/Leisure for Lost Market Hours, $\{\hat{\beta}^{k,j}\}$



Notes: The figure illustrates the estimated substitution rates of home production hours (in red) and leisure hours (in green) for lost market hours, along with 95% confidence interval bands.
Source: American Time Use Survey, authors' calculations.

between period $t-1$ and period t, and Δh_{st}^{j} is the change in average weekly hours spent on market work by type j households in state s between period $t-1$ and period t. $\beta^{k,j}$ measures the substitution rate of home production (or leisure) hours for lost market hours, for households of type j.[12] Our estimation sample includes 50 states and the District of Columbia ($s = 1,2,...,51$) and eight two-year time periods, 2003-2004, 2005-2006, ... , 2017-2018 ($t = 1,2,...,8$) which notably include the Great Recession.[13]

The estimated substitution rates $\{\hat{\beta}^{k,j}\}$ are illustrated in Figure 2 and also reported in Table 2 in the appendix. Depending on the type of household considered, we find that home production activities absorb anywhere from 11% to 49% of lost market hours. The smallest effect is experienced by single women without children and without a college degree (11%). The groups experiencing the highest absorption rates are married women with children without a college degree (49%), married women with children and a college degree (45%), single men with children and without a college degree (40%), and college-educated married men with children and a stay-at-home wife (38%).

For most groups, the majority of forgone market hours are reallocated towards sleep and leisure activities such as watching TV, socializing and exercising. Leisure absorption rates are high, ranging from 46% to 68%, and correlate negatively with home production absorption rates. For almost all households, about 90% of lost work hours are reallocated towards either home production or leisure activities. However, single

[12] We include controls for race and time period dummies in each estimation.
[13] Averaging over two years, as in Aguiar et al. [2013], increases the size of state-level samples.

men without children and less educated single women without children respond notably less in terms of home production, reallocating as much as 23% of their lost work hours to other time use categories, such as education and other income-generating activities.

3.3 Impact of Lost Work on Home Production and Leisure Across American Households

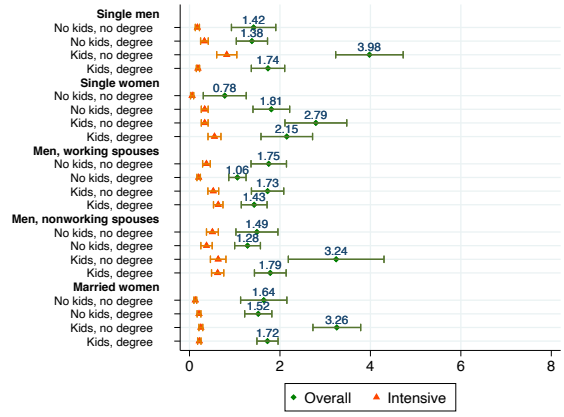
With the estimated substitution rates $\{\hat{\beta}^{k,j}\}$ and the monthly changes in market hours $\{\Delta h^j\}$ in hand, we compute the implied monthly changes in home production hours (and leisure) as the product $\{\hat{\beta}^{k,j}\Delta h^j\}$.

Figure 3 (panels a and c) reports the estimated cumulative changes in home production and leisure between February and April. Home production hours increased anywhere from 1 to 4 hours per week, with the largest impacts seen by married individuals and those with children. The two groups predicted to increase their home production hours the most—less-educated single men with children and less-educated married women with children—do so for very different reasons: the former because they lost more market hours than almost any other group (a 10 hour loss) and the latter because they substituted home production for lost work more than any other group (a 49% substitution rate). Meanwhile, while single individuals fared worse than married individuals in terms of employment, they exhibit a moderate change in home production hours due to their low substitution rates. Panel c reveals a larger response of leisure (due to greater substitution rates) across all household groups, especially single individuals.

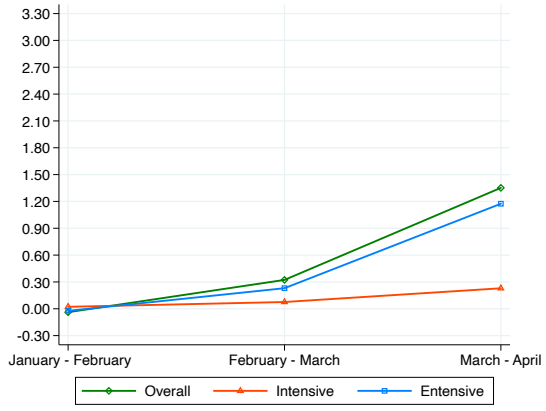
We also decomposed the predicted change in home production hours (and leisure) into the part due to individuals that stayed employed, i.e. the intensive margin $\hat{\beta}_I^{k,j}\Delta I_t^j$, and the part due to individuals who lost their employment, i.e. the extensive margin $\hat{\beta}_E^{k,j}\Delta E_t^j$. With ΔI_t^j and ΔE_t^j measured according to (1), it remains to find $\hat{\beta}_I^{k,j}$ and $\hat{\beta}_E^{k,j}$. We first compute the substitution rates for the employed households $\{\hat{\beta}_I^{k,j}\}$ by re-estimating the regression model in (2) on the sample of employed workers. The resulting estimates are included in Table 2 in the appendix. This allows us to predict time allocation shifts along the intensive margin. The extensive margin is computed as a residual satisfying the proposed identity: $\beta^{k,j}\Delta h_t^j = \beta_I^{k,j}\Delta I_t^j + \beta_E^{k,j}\Delta E_t^j$. Figure 3 reveals that the intensive margin accounts for a very small part of the total impact on home production and leisure hours, for nearly all household types, implying that it is the loss of employment that drives the total rise in home production and leisure. The intensive margin is relatively larger for college-educated married men. These groups fared better in terms of employment. For example, for the college educated married men with children and a working wife, we have $\Delta I \approx \Delta E$ and $\hat{\beta}_E^{hp} \approx \hat{\beta}_I^{hp}$, and so the two margins are equally important.

Figure 3: Estimated Impact of Lost Work on Time Use

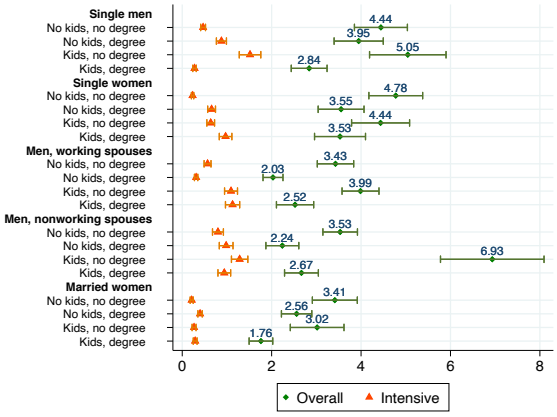
(a) Impact on Home Production, by Household, $\{\hat{\beta}^{hp,j}\Delta h^j\}$



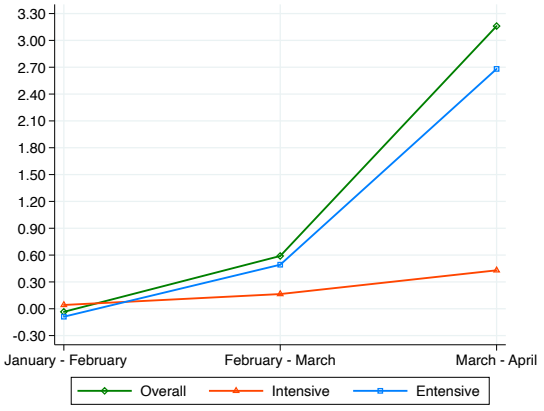
(b) Monthly Changes in Average Home Production Hours



(c) Impact on Leisure, by Household Type, $\{\hat{\beta}^{l,j}\Delta h^j\}$



(d) Monthly Changes in Average Leisure Hours



Notes: Panels a and c illustrate the predicted change in home production and leisure hours for each household type between February and April, 2020. Panels b and d illustrate the estimated monthly changes in average home production and leisure hours. "Overall" labels refer to the total change. "Intensive" labels refer to the change implied by reduced hours of the employed. "Extensive" labels refer to the change implied by job losses. The brackets mark 95% confidence intervals.
Sources: American Time Use Survey, Current Population Survey, authors' calculations.

The response in leisure is much greater, ranging between 1.8 hours to 7 hours a week. The high point estimate is for the less educated married men with children and nonworking spouses. These men exhibit one of the largest substitution rates between market work and leisure (65.4%) and they lost the most market hours (a 10.6 hour loss).

To impute the monthly level of home production (and leisure) for each household type, we first proxy its January time allocation based on the 2018-2019 ATUS data. We then impute the February home production hours by adding on the estimated increase $\hat{\beta}^{k,j}\Delta h_t^j$ where Δh_t^j measures the January-February change in market hours, and so on. Figure 5 in the appendix helps visualize the actual hours spent on home production

(and leisure) in February and April of 2020. It is clear that larger impacts were seen by groups that were already highly vested in that activity.

3.4 Implied Aggregate Impact of Lost Work on Home Production and Leisure

We impute the aggregate time allocation trends by aggregating over the monthly levels of home production (and leisure) for each household type, using appropriate population shares. The implied aggregate monthly changes are shown in Figure 3 (panels b and d). Starting at 20.7 hours a week in January,[14] home production hours remained approximately unchanged between January and February, rose by 0.3 between February and March and by nearly 1.4 between March and April, totaling a 1.7 hour increase between February and April. Only about 18 minutes of the 1.7 hours increase is accounted for by workers who maintained their employment, implying the bulk of the increase is driven by the loss of employment. Starting at 110.4 hours a week in January, leisure hours increased by 3.75 hours, also mostly along the extensive margin.

While the 1.7 hour increase in home production hours may not seem like a lot, it comprises about 27% of the 6.25 hour decline in weekly market hours. This estimate certainly represents a lower bound for the actual change, due to increased child care needs, severely limited options for leisure activities, and increased prevalence of telecommuting. We estimate the additional contribution of telecommuting in Section 4.

To put the increase in home production hours in perspective, it is useful to estimate the actual gain in the value of home production. Following a methodology similar to the one described in Bridgman [2016], we estimate the value of an hour of home production as the average wage (w) among private workers employed in sectors that Mazzolari and Ragusa [2013] identify as substitutes for home production (e.g., cooks, cleaners, child care workers). Using CPS data for January, we find that such workers made $17.35 an hour on average. We then calculate the value of total home production in a given month as the product $(30/7)wh_t^{hp}N_t$, where h_t^{hp} measures weekly time in home production, and N_t is the working age U.S. population in month t. We find that the value of monthly home production increased by $25.09 billion between February and April. This gain is equivalent to about 8.6% of the estimated $292.61 billion concurrent drop in monthly GDP.[15]

[14] These include 4.1 hours spent on child care.

[15] Official GDP numbers are only given at annual and quarterly rates; here, we rely on seasonally adjusted monthly GDP estimates from Macroeconomic Advisers.

4 Contribution of Remote Work to Home Production Hours

The pandemic recession also witnessed a remarkable increase in telecommuting. Working from home saves time and allows for a more flexible schedule and makes it easier to engage in household-related tasks throughout the day. In this section, we estimate the additional contribution of the rise in remote work to the rise in home production. We do so by combining the commute-to-remote switch rates for various households with the estimates of remote work effects on home production hours.

The first step is to proxy commute-to-remote switch rates. According to the representative survey conducted by Brynjolfsson et al. [2020], 35% of the employed workers surveyed in the beginning of April reported having switched from commuting to remote work, and no additional switches recorded in the beginning of May. Thus, $(1-0.35)(1-fr^{remote})h^{emp}_{March}$ represents the average hours of the employed worked away from home during the months of April and May, where fr^{remote} denotes the pre-pandemic fraction of total hours worked from home, and h^{emp}_{March} denotes the March market hours of the employed.

Not everyone had equal opportunity to switch to remote work, with the less educated households more likely to hold service jobs tied to specific locations. Dingel and Neiman [2020] estimate 37% of American jobs can be performed entirely at home. We proxy the type-specific switch rates $\{s_j\}_{j=1}^{20}$ by assuming they are proportional to the pre-pandemic remote work rates, while imposing the aggregate switch rate of 35%.[16] The pre-pandemic rates of remote work $\{fr^{remote,j}\}$ and our proxies for commute-to-remote switch rates are summarized in Table 1.

The second step is to estimate the effect of remote work on home production hours. We use the 2010-2019 ATUS waves to estimate the following model on the sample of employed respondents:

$$h^{hp}_i = \rho(1-fr^{remote}_i)h_i + \phi h_i + \sum_{j=1}^{20}\gamma^j \mathbb{I}_{type^i=j} + \varepsilon_i, \tag{3}$$

where i is the respondent's index and $\mathbb{I}_{type^i=j}$ indicates the respondent is of type j. In addition to the standard (negative) impact of market work on home production hours, this formulation allows for a separate effect of those hours that are worked away from home. This additional term captures all the time costs that increase

[16] Precisely, we proxy $\{s_j\}_{j=1}^{20}$ by solving $\frac{s_i}{s_j} = \frac{fr^{remote,i}}{fr^{remote,j}}, i,j \in \{1,2,...,20\}$ while imposing

$$(1-0.35)(1-fr^{remote})h^{emp}_{March} = \sum_{j=1}^{20}\left[\frac{\mu^j}{\sum_{j=1}^{20}\mu^j}(1-s^j)(1-fr^{remote,j})h^{emp,j}_{March}\right],$$

where μ^j is the March population share of the employed group j households.

Table 1: Remote Work, Commute-to-Remote Switches and the Implied Rise in Home Production

Household Type	Pre-pandemic fraction working remotely (1)	Fraction switching to remote work (2)	Effect of remote work on home production hours (3)
Single men			
No kids, no college degree	0.059	0.168	0.183
No kids, college degree	0.153	0.435	0.472
Kids, no college degree	0.050	0.142	0.171
Kids, college degree	0.237	0.675	0.711
Single women			
No kids, no college degree	0.075	0.215	0.215
No kids, college degree	0.159	0.452	0.470
Kids, no college degree	0.061	0.175	0.183
Kids, college degree	0.190	0.542	0.550
Married men with working spouse			
No kids, no college degree	0.101	0.287	0.341
No kids, college degree	0.209	0.595	0.633
Kids, no college degree	0.076	0.216	0.265
Kids, college degree	0.199	0.568	0.612
Married men with non-working spouse			
No kids, no college degree	0.084	0.239	0.283
No kids, college degree	0.200	0.571	0.613
Kids, no college degree	0.064	0.184	0.226
Kids, college degree	0.201	0.574	0.623
Married women			
No kids, no college degree	0.124	0.355	0.359
No kids, college degree	0.230	0.655	0.618
Kids, no college degree	0.109	0.310	0.305
Kids, college degree	0.248	0.706	0.615

Notes: Column 1 presents the pre-pandemic prevalence of remote work, for each household type. These rates are computed as fractions of hours of the employed worked remotely, and based on 2010-2019 waves of ATUS. Column 2 reports our estimates of commute-to-remote switch rates between March and April of 2020, for each household type. Column 3 reports our estimates of the remote work effects on home production hours.
Source: American Time Use Survey, Current Population Survey, authors' calculations.

only with hours worked away from home thereby taking away from the time available for home production, such as excessive grooming, socializing with coworkers over drinks after work, going out for lunch and commute-related costs.[17] It is also meant to capture lower schedule flexibility typically associated with office jobs and therefore missed opportunities for school pickups and cooked dinners. Importantly, the effect of changing intensity of remote work is measured by ρh_i, and therefore average effects differ across household types due to differences in average market hours. The estimation results are given in Table 3.[18]

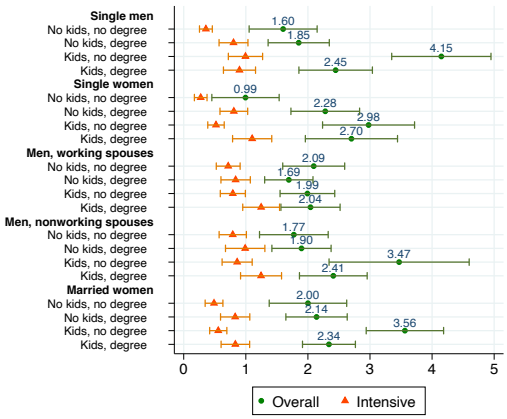
We proxy the added contribution of the rise in remote work to home production hours of the employed

[17] These categories are classified as leisure activities.

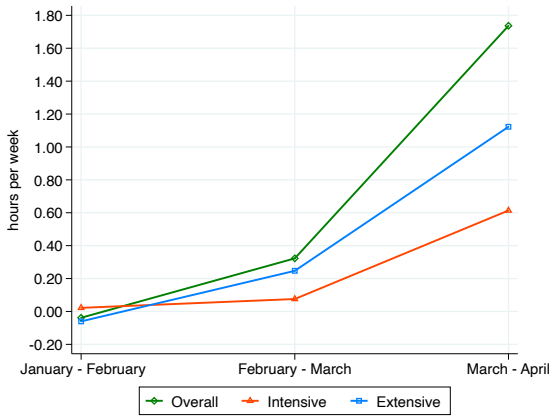
[18] We estimate this model on post-Great Recession data in order to avoid recession-related trends. Our results are largely unaffected if we include year dummies in our specification: $\hat{\rho}$ changes from -0.0313 to -0.0316 (see Table 3). It is also possible to estimate this formulation using the cross-state variation of changes in time use, as in Section 3.2. However, information on remote work is not as readily available as information on market hours. Slicing the sample by state, year, and household type introduces sample size issues. Although our results remain largely unaffected if pursuing this alternative identification ($\hat{\rho} = -0.0302$), we chose to present the more straightforward household-level regression.

Figure 4: Estimated Impact on Home Production Augmented with Remote Work Effects

(a) Augmented Impact on Home Production, by Household



(b) Augmented Changes in Average Home Production Hours



Notes: This figure summarizes our home production estimates augmented with remote work effects. Panel a reports predicted changes in home production hours for each type of household between February and April, 2020. Panel b illustrates the estimated monthly aggregate changes in home production hours augmented with remote work effects. The remote work effect augments the intensive margin between March and April 2020. The green marks entitled "Overall" refer to the total predicted change. The "Intensive" labels refer to the change implied by reduced hours of the employed and the rise in work-from-home arrangements. The "Extensive" labels refer to the change implied by the loss of jobs. The brackets mark 95% confidence intervals.
Sources: American Time Use Survey, Current Population Survey, authors' calculations.

type j households as

$$\Delta h^{hp,j} = -\hat{\rho} s^j (1 - fr^{remote,j}) h^{emp,j}_{March}. \tag{4}$$

This effect is due to the rise in remote work alone. Indeed, the product $-s^j(1-fr^{remote,j})h^{emp,j}_{March}$ represents the reduction in market hours worked away from home due to the rise in remote work alone as the average hours are kept at their March level. It is evaluated at $\hat{\rho}$. The added effects of remote work on home production are listed in the last column of Table 1. They range from 0.17 to 0.71 hours, with college-educated workers affected the most as they switched to remote work in greater numbers.

We augment our earlier estimates of home production changes along the intensive margin, given in Figure 3 panel a, with $\{\Delta h^{hp,j}\}$ given in equation (4). The updated estimates are reported in Figure 4 panel a. The overall change is updated by the same amount, as it sums over the intensive and the extensive margins, the latter not affected by telecommuting. The updated predicted changes in home production hours now range from 1 to 4.15.

The aggregate impact on home production hours, updated with remote work effects, is reported in Figure 4 panel b. Compared to our earlier estimates illustrated in Figure 3 panel b, weekly home production hours among the employed (the intensive margin) increased by an additional 0.4 hours between March and April,

bringing the cumulative increase between February and April to 2.1 hours. Because the remote work effect applies to the employed only, the intensive margin becomes more prevalent, now accounting for a third of the total predicted rise in home production hours.

The increase in the value of monthly home production between February and April updates to $30.83 – a $5.74 billion gain in value and a 10.5% of the estimated $292.61 billion drop in the monthly GDP.

5 Conclusions

We documented the loss of employment and reduction of total market hours for different types of households between the months of February and April. Hardest hit were the less educated workers and households with children. In contrast to other recessions, men and women experienced similar drops in hours. We estimated that home production activity increased by 1.7 hours a week (or 27% of the 6.25 hour drop in market hours), as a direct result of lost market hours. Although market hours declined the most for single, less educated individuals, the lost market hours were absorbed into home production the most by married individuals with children. With remote work effects added on, which mainly impacted college-educated households, our estimate for the increase in home production activity rose to 2.1 hours a week, or 34% of lost market hours. Evaluating this change at wage rates paid in sectors that substitute for home production, we estimated that the monthly value of home production increased by $30.83 billion – that is 10.5% of the concurrent $292.61 billion drop in monthly GDP.

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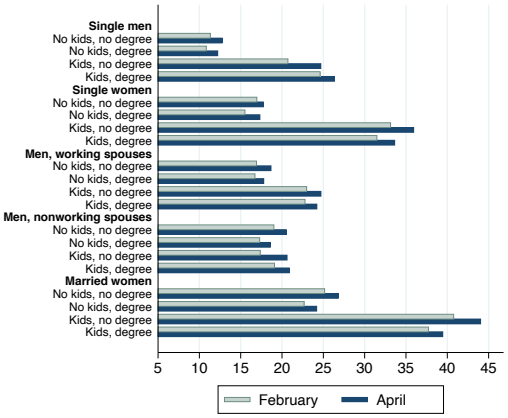
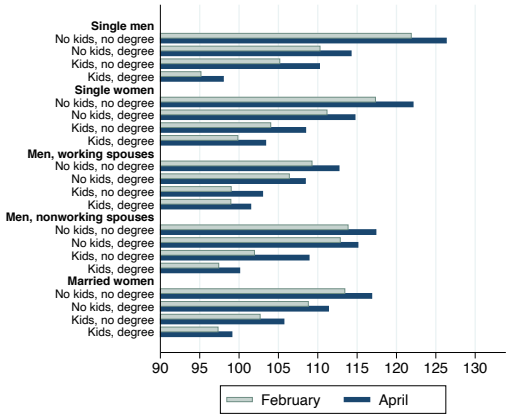
A Supplementary Exhibits

Figure 5: Time Use Estimates Based on Lost Market Hours, $\{\hat{h}_t^{k,j}\}$

(a) Home Production Hours, February and April

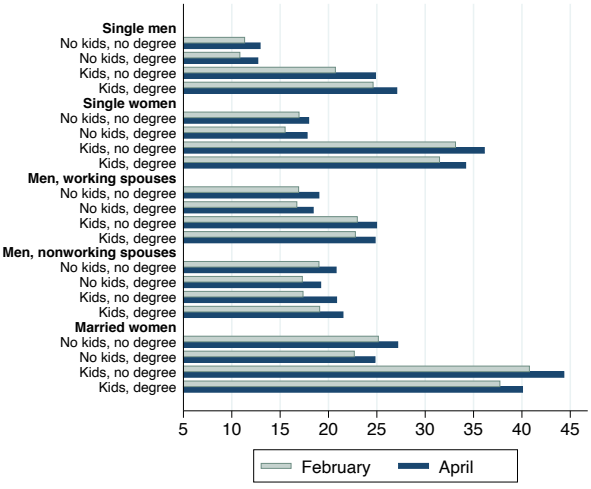


(b) Leisure Hours, February and April



Notes: This figure illustrates predicted weekly home production hours (panel a) and leisure hours (panel b), for each type of household. The "February" bars refer to predicted weekly hours in February 2020. The "April" bars refer to predicted weekly hours in April 2020.
Sources: American Time Use Survey, Current Population Survey, authors' calculations.

Figure 6: Home Production Estimates with Added Remote Work Effects, February and April



Notes: This figure illustrates predicted weekly home production hours, updated with remote work effects. The "February" bars refer to predicted weekly hours in February 2020. The "April" bars refer to predicted weekly hours in April 2020.
Source: American Time Use Survey, Current Population Survey, authors' calculations.

Table 2: Estimated Time Substitution Rates

Household Type	Home Production				Leisure			
	$\hat{\beta}$	S.E.	$\hat{\beta}_I$	S.E.	$\hat{\beta}$	S.E.	$\hat{\beta}_I$	S.E.
	(1)		(2)		(3)		(4)	
Single men								
No kids, no college degree	19.81	(3.49)	23.77	(3.20)	62.10	(4.22)	63.77	(3.75)
No kids, college degree	21.75	(2.77)	24.31	(3.20)	62.20	(4.42)	64.59	(4.22)
Kids, no college degree	40.17	(3.84)	33.73	(4.65)	50.94	(4.41)	62.10	(5.03)
Kids, college degree	35.94	(3.90)	38.70	(3.80)	58.79	(4.23)	56.93	(4.05)
Single women								
No kids, no college degree	10.84	(3.37)	15.02	(4.54)	66.41	(4.27)	59.74	(3.50)
No kids, college degree	29.59	(3.39)	29.86	(3.44)	58.12	(4.28)	58.26	(3.95)
Kids, no college degree	35.95	(4.49)	32.71	(3.72)	57.09	(4.26)	61.93	(4.26)
Kids, college degree	34.16	(4.62)	32.92	(4.36)	56.06	(4.62)	57.81	(4.28)
Married men with working spouse								
No kids, no college degree	32.72	(3.73)	39.49	(4.58)	64.01	(3.88)	59.70	(4.16)
No kids, college degree	31.69	(2.91)	36.76	(3.55)	60.72	(3.40)	56.36	(3.48)
Kids, no college degree	28.38	(3.00)	30.39	(3.52)	65.54	(3.46)	63.11	(4.27)
Kids, college degree	33.35	(3.39)	33.68	(2.84)	58.85	(4.95)	59.71	(4.30)
Married men with non-working spouse								
No kids, no college degree	28.56	(4.54)	37.06	(4.89)	67.68	(3.78)	58.47	(4.55)
No kids, college degree	35.52	(4.02)	26.56	(4.50)	61.97	(5.20)	69.32	(5.51)
Kids, no college degree	30.58	(5.09)	32.22	(4.45)	65.39	(5.57)	65.26	(4.75)
Kids, college degree	37.89	(3.79)	37.77	(4.18)	56.57	(4.10)	57.09	(4.40)
Married women								
No kids, no college degree	29.47	(4.69)	34.36	(4.16)	61.29	(4.61)	56.70	(4.61)
No kids, college degree	34.60	(3.49)	32.34	(3.30)	58.21	(3.94)	61.39	(3.81)
Kids, no college degree	49.23	(4.07)	45.13	(3.92)	45.62	(4.63)	47.54	(4.06)
Kids, college degree	45.34	(3.14)	38.60	(3.40)	46.30	(3.55)	51.51	(3.86)

Notes: Columns 1 and 3 report weighted least squares estimates of the regression model (2) for time use category $k \in \{hp, l\}$. All coefficients are multiplied by 100. Standard errors, clustered at the state level, are in parentheses. Each specification includes controls for race and time dummies, omitted from the table. Each observation is weighted by the state's population. Columns 2, 4 report weighted least squares estimates of the same model, reestimated on the sample of the employed.
Sources: American Time Use Survey, authors' calculations.

Table 3: Estimated Effects of Remote Work

	Home production hours (1)		Home production hours (2)	
$(1-fr^{remote})h^{market}$	-0.0313***	(0.005)	-0.0316***	(0.005)
h^{market}	-0.263***	(0.007)	-0.262***	(0.007)
Group Dummies				
Single men				
No kids, no college degree	0	(.)	0	(.)
No kids, college degree	0.971**	(0.352)	0.973**	(0.353)
Kids, no college degree	7.857***	(0.637)	7.860***	(0.638)
Kids, college degree	9.533***	(1.312)	9.569***	(1.315)
Single women				
No kids, no college degree	1.422***	(0.348)	1.438***	(0.348)
No kids, college degree	2.231***	(0.359)	2.221***	(0.359)
Kids, no college degree	13.22***	(0.504)	13.22***	(0.504)
Kids, college degree	14.19***	(0.673)	14.20***	(0.673)
Married men with working spouse				
No kids, no college degree	3.041***	(0.407)	3.062***	(0.407)
No kids, college degree	3.169***	(0.435)	3.178***	(0.435)
Kids, no college degree	8.075***	(0.400)	8.065***	(0.400)
Kids, college degree	10.09***	(0.362)	10.11***	(0.362)
Married men with non-working spouse				
No kids, no college degree	1.858***	(0.540)	1.859***	(0.539)
No kids, college degree	1.690**	(0.653)	1.670*	(0.653)
Kids, no college degree	5.922***	(0.448)	5.925***	(0.448)
Kids, college degree	7.339***	(0.461)	7.338***	(0.460)
Married women				
No kids, no college degree	5.999***	(0.409)	5.992***	(0.409)
No kids, college degree	5.033***	(0.441)	5.041***	(0.442)
Kids, no college degree	15.35***	(0.478)	15.34***	(0.479)
Kids, college degree	16.92***	(0.382)	16.93***	(0.382)
Year Dummies				
2010			0.725	(0.381)
2011			0.689	(0.379)
2012			0.205	(0.369)
2013			0.284	(0.383)
2014			-0.209	(0.365)
2015			0.134	(0.374)
2016			0.435	(0.385)
2017			0.129	(0.387)
2018			0.308	(0.396)
2019			0	(.)
Constant	25.27***	(0.383)	24.99***	(0.477)
Observations	31303		31303	
R^2	0.3484		0.3487	

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: Column 1 presents weighted least squares estimates of the regression model (3), estimated on the sample of the employed in 2010-2019 ATUS data. Regressors include weekly market hours worked from home, weekly market hours, and household type dummies. Each observation is weighted with the sampling weight. Columns 2 presents the estimates for the specification that also includes the year dummies. Robust standard errors associated with the estimated coefficients are in parentheses.
Sources: American Time Use Survey, authors' calculations.