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ABSTRACT

A substantial fraction of schools and childcare facilities in the United States closed their in-person operations during the COVID-19 pandemic. These closures may carry substantial costs to the families of affected children. In this paper, we examine the impact of school and childcare closures on parental labor market outcomes during the COVID-19 pandemic. In particular, we test whether COVID-19 school closures have a disproportionate impact on parents of school-age children (age 5-17 years old) and whether childcare closures affect parents of young children (age <5 years old) relative to others. Our results suggest that while closures have had little impact on whether parents work at all, they have had significant effects on whether parents work full time (at least 35 hours) and the number of hours worked per week. These effects are concentrated among low-educated parents, suggesting that such individuals had a more difficult time adjusting their work life to closures.

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1. Introduction

As part of their efforts to curb COVID-19, many state and local governments implemented lockdowns that resulted in the temporary closure of schools and childcare facilities. In the United States, shifts to distance learning began in March 2020 with 27 states recommending that schools temporarily cease in-person operations. By May 2020, all states except Wyoming and Montana recommended school building closures for the remainder of the academic year, affecting at least 50.8 million public school students ("The Coronavirus Spring", 2020). At the beginning of the next academic year in Fall 2020, school closures began to be distributed unevenly across the country due to varying decisions made at the state and local level (Parolin and Lee, 2021).[1]

School closures have been controversial: data on almost 200,000 children from 47 states revealed an infection rate of only 0.13 percent among students and 0.24 percent among staff in September 2020 (Oster, 2020). Bravata et al. (2021) use millions of household-week level mobile phone data over the first 46 weeks of 2020 to find that an increase from the 25th percentile to the 75th percentile of the frequency of school visits increases the risk of COVID-19 infection in a household with children by approximately four percent. At the same time, there is evidence that closures carry significant costs in terms of the health and learning outcomes of children (e.g. Azevedo et al., 2020; Kuhfeld et al., 2020; Bailey et al., 2021; Engzell, Frey and Verhagen, 2021; Larsen, Helland and Holt, 2021; Halloran et al., 2021; Fuchs-Schündeln et al., 2021). The costs of school closures are also borne by parents. With 40 percent (or 33 million families) of all families having children under 18 years old in 2020 (US Bureau of Labor Statistics, 2021), there is much anecdotal evidence that school closures have affected parental labor supply due to difficulties in balancing work and childcare responsibilities (e.g. Brodeur, 2020; Leonhardt, 2020; Tedeschi, 2020; see also Musaddiq et al., 2021).

Several recent studies have found that women's labor market outcomes were disproportionately harmed by the pandemic relative to men. On one hand, leisure/hospitality and other service industries, which disproportionately employ women, were initially more harmed by the pandemic (e.g. Lee, Park and Shin, 2021; Albanesi and Kim, 2021a). On the other, additional childcare responsibilities owing to closed schools or childcare facilities or parental concerns regarding COVID risk may have exacerbated the gender gap in employment outcomes (Alon et al., 2020; Alon et al., 2021; Heggeness, 2020; Russell and Sun, 2020; Fairlie, Couch and Xu, 2021; Furman, Kearney and Powell, 2021; and Amuedo-Dorantes et al., 2020). The relative importance of labor supply factors versus demand factors in determining COVID-19 employment outcomes by gender is still not clear.

School closures arguably represent a shock to parental labor supply. Though pandemic conditions obviously contribute to closures while having a direct effect on labor-market outcomes, we posit it that it is unlikely that such conditions on their own would disproportionately affect the outcomes of those with children of school age (ages 5-17, for school

[1] During this time, some parents transferred their children from public to private schools as the latter had more autonomy or flexibility to adhere to COVID-19 health protocols while maintaining in-person operations (Dickler, 2020; Reilly, 2020).

closures) or younger children (<5 years old, for childcare closures). Thus, by using individuals without children in these age ranges as a control group, we can tease out the effects of closures on labor-market outcomes.

To date, information on the impact of school closures on labor market outcomes has been fragmented, mostly covering the early months of the pandemic in spring 2020. Furthermore, no study to our knowledge has simultaneously examined how COVID-19 school and childcare facility closures have affected labor-market outcomes. We examine the period August 2020 to April 2021, as it both covers the height of the pandemic (November 2020 to January 2021), and the first full academic term in which many schools closed their in-person operations and switched to remote learning in the United States due to the COVID-19 pandemic.

The results suggest that the impact of school closures on labor market outcomes has mostly come in the form of a reduction in hours worked in the past week (1.3 hours for mothers; 1.5 hours for fathers) and a decline in full-time rates (3.8 percentage points for mothers and 2.5 percentage points for fathers), which is mostly explained by transitions to part-time work. Effects on whether parents work at all are generally small and statistically insignificant at conventional levels. Thus, in contrast to evidence from the early part of the pandemic, the burden of childcare appears to fall more equally on mothers and fathers and on the intensive rather than extensive margin later on in the pandemic. Effects of childcare closures on parents with young children are much larger in magnitude for women than men, though the effects for both are generally imprecisely estimated.

We examine heterogeneity in our results by marital status and educational attainment. Among married individuals, the reduction in full-time work and work hours due to school closures appears to be about equal among men and women. Among unmarried individuals, the effect on full-time work is larger for women than men, though the reduction in hours is similar by gender (though only the effect for women is statistically significant at conventional levels).

The most striking finding in our results is seen when we perform our analysis for less educated (less than a college degree) and more educated (college degree or more) individuals separately. In that case, the effects on labor supply are substantially larger for less educated parents. For example, effects on hours worked for the low education group range from 1.9-2.2 hours per week for women and men but are small and statistically insignificant for highly educated women and men. At least two factors may contribute to this difference: first, less educated individuals likely had a harder time arranging a flexible, at-home work schedule than those with more education. This is consistent with the findings of Mongey, Pilossoph, and Weinberg (2020) that 82 percent of individuals with less than college education are in occupations with low ability to work from home. Second, less educated parents may have not been able to secure options such as private schooling or alternative childcare arrangements to the degree that more educated parents did (Murnane et al., 2018; Musaddiq et al., 2021). We return to these ideas in the Conclusion.

2. Related Literature

Several studies have now analyzed how COVID-19 has affected employment outcomes across gender and parental status. Albanesi and Kim (2021a) use the Current Population Survey (CPS) and finds a disproportionate impact of the pandemic on women relative to men, with the largest difference recorded for married individuals with children: employment of married women with children fell by four percentage points more than men in the same category in spring and summer of 2020. Fairlie, Couch, and Xu (2021) uses CPS data from January 2017 to December 2020 and find that the largest declines in employment rates—ranging from 2.3 to 4.3 percentage points, with losses in work hours ranging from 8.3 to 26.7 percent—were among women with school-age children. Decomposition analysis in their paper suggests this gap is mostly due to childcare responsibilities rather than demand-side differences with comparable men.

Other studies come to different conclusions on which channels are most important in explaining labor-market gaps by gender and parental status due to COVID. Alon et al. (2021) find that through September 2020, among individuals with school-age children, the gap for women has widened by about 1.8 and 8.9 percentage points in employment and hours worked, respectively. Using their decomposition analysis, the authors find that the relative decline in employment and hours worked for women are explained by occupational characteristics and childcare responsibilities (presence of children) in roughly equal measure, though most of the change in the gap is left unexplained after accounting for these two channels.

Furman, Kearney and Powell (2021) quantify the effect of parent-specific issues, such as childcare challenges, on the aggregate employment deficit in early 2021 relative to before the pandemic by constructing counterfactual employment and labor force participation rates that assign the mothers of young children the percentage change in employment and labor force participation rates of comparable mothers without young children. They find that the differential job loss among mothers is not a major driver of the overall decline in employment due to 1) demographically similar women without children also having declines in employment over the pandemic, and 2) the small fraction of mothers of young children in the US workforce. Nevertheless, Furman, Kearney and Powell (2021), Heggeness and Suri (2021), and Lofton, Petrosky-Nadeau, and Seitelman (2021) all find that over the pandemic, mothers' employment has declined at least modestly relative to those of women without children as well as fathers.

The literature on school/childcare availability and parental labor supply prior to COVID has generally found positive effects on mothers' employment and work hours (Gelbach, 2002; Baker, Gruber, and Milligan, 2008). Many recent papers have begun to analyze the impact of COVID-19 school and childcare closures on parental labor market outcomes. Several early papers rely on state-by-state variation in COVID restrictions related to childcare and school closures for identification. Russell and Sun (2020) assess the effects of childcare closures and class size restrictions on employment using a triple-differences approach in which being a mother of a child aged 0-5 is interacted with state-level mandates and time (only women are analyzed in their paper). They find that both restrictions increase the unemployment rate of mothers of young children in the short-run, and the impact persists even after states lift the restrictions (through September 2020, the end of their sample window), consistent with a permanent reduction in childcare centers stemming from initial closure mandates.

Heggeness (2020) uses state-level variation in the timing of shutdowns in the early part of the pandemic and CPS data from January to May of 2019 and 2020 to estimate the immediate impact of school closures on employment. She finds that working mothers of school-age children coped differently than working fathers: while mothers on average took a full week of leave from formal work in the initial phase of the pandemic, there was no corresponding effect for fathers (though full-time fathers did reduce their hours worked by 0.53 hours per week). Similarly, Collins et al. (2021) find that the gender gap in parental labor force participation grew five percentage points (relative to 2019) in states that offered primarily remote elementary instruction in September 2020 but only one percentage point in states that were primarily in-person or hybrid.

The paper that most closely resembles our study is that of Amuedo-Dorantes et al. (2020), which exploits *local* variation to identify the impact of school closures on employment outcomes in the early months of the pandemic. They calculate a daily school closure index (0 to 1) at the district level from *Education Week*. They do not, however, examine how school closures affect the outcomes of those who are not parents of young children (a control group in our analysis). Their findings suggest that school closures primarily affected the labor supply of mothers and fathers of younger school-age children in two-partnered households through the intensive margin (an 11 and 15 percent decline in the weekly hours worked conditional on working at all by men and women, respectively). The authors also only focus on the early months of the pandemic as their dataset runs from January 2019 through May 2020. Meanwhile, Koppa and West (2021) examine how the decision of whether to *start* the 2020-21 academic year with remote learning affects county-level employment, finding little evidence of a relationship. However, their analysis only considers aggregate employment—for example, neither hours worked nor outcomes of parents specifically are considered.

We contribute to this nascent literature in several ways. First, we use county-level school and childcare closure data from Parolin and Lee (2021) and Lee and Parolin (2021) respectively, that tracks in-person visits to schools and childcare facilities. This allows us to exploit variation in actual school and childcare closures at the sub-state level rather than the discrete treatment of the occurrence of state-level school closure mandates found in some of the existing literature. Second, we analyze the impact of school closures and childcare closures together on parents of children of various ages as well as non-parents unlike any previous studies. This allows for a stronger test of our identification assumptions regarding the causal impact of school and childcare closures on labor market outcomes because we expect each type of closure to affect parents of children of different age groups differently. Lastly, in contrast to the often-analyzed early months of the pandemic, our analysis covers a later and longer time frame, from August 2020 to April 2021, which includes the height of the pandemic (November 2020 to January 2020) in the United States, and the first full academic year (2020-2021) when schools were often closed at various points and for varying lengths of time. Extending the time frame offers a clearer picture of how COVID-19 school and childcare closures changed the working patterns of parents when it became clear that pandemic-related closures were the “new normal”: they could be implemented at any time and sometimes last for several months or more.

3. Data

Our sample includes all individuals age 21 years and over surveyed in the Basic Monthly Current Population Survey (CPS) from August 2020 to April 2021 (Flood et al., 2021). To match individuals to school/childcare closures in their area with as much precision as possible, we restrict our sample to the subset of individuals who have non-missing county identifiers (more sparsely populated counties are not identified due to concerns about respondent confidentiality). This is about 40 percent of the full CPS sample over this time period.

We consider various measures of employment in our analysis. First is the extensive margin of labor supply: whether an individual is "at work," defined as doing any work for pay or profit or working at least fifteen hours without pay in a family business or farm in the previous week. This excludes individuals who are employed but currently absent from work since some may respond to school closures by taking leave. We also consider various measures of labor supply on the intensive margin: whether an individual works "full-time," defined as working at least 35 hours in all jobs in the previous week, "part-time" work (more than zero hours but less than 35 hours in all jobs in the previous week), and "hours worked," defined as the total number of hours worked by the individual in the previous week.[2]

We utilize the school closures database from Parolin and Lee (2021), which tracks visits to K-12 public schools in 94 percent of school districts spanning 98 percent of counties in the country. We combine this with childcare closures from Lee and Parolin (2021) containing visits to about 78 percent of the total 109,414 licensed childcare institutions in the United States. These institutions are classified as North American Industry Classification System (NAICS) code 62441, which identifies all places that are primarily engaged in providing daycare of infants or preschool children. Both the school and childcare databases use aggregated and anonymized mobile phone data from *Safegraph*. The authors track year-over-year changes in the number of visitors to each individual school or childcare facility in each month relative to the same month in 2019 (the pre-pandemic baseline). Institutions are considered "closed" if there is at least a 50 percent year-over-year decline in the number of in-person visits; we use this same cutoff in our main analyses and use a more stringent cutoff (75 percent reduction) in robustness checks. We use the share of closed institutions in each county in each month to be our measure of the extent of school (childcare) closures in our analysis. Data on school and childcare closures by county are available for all CPS respondents for whom county of residence is identified.

As a robustness check, we use another dataset to measure public school closures based on administrative rather than phone traffic data. This is the *Burbio K-12 School Opening Tracker* that covers over 1,200 school districts representing 47 percent of U.S. K-12 student enrollment.[3] The *Burbio* data provides the percentage of public schools in each county fitting various modes of instruction: in-person, virtual (100% online), and hybrid (2-3 days per week in-person). As our measure of school closures with this data, we calculate the percentage of schools that were virtual and hybrid within each county in the second week of each month to match the CPS reference week. *Burbio* has complete information on school closures in all counties identified in the CPS. We use *Safegraph* data in our baseline analyses because of the consistency with which it is collected across location and time; the *Burbio* data is collected from various sources such as

[2] The definition of full-time and part-time work is based on the definition of "usual full-time" and "usual part-time" work in the CPS published by the Bureau of Labor Statistics : https://www.bls.gov/cps/definitions.htm#fullparttime.
[3] https://cai.burbio.com/school-opening-tracker/

school district websites, Facebook pages, local news articles and other publicly available sources that could introduce a higher degree of error in measuring school closures.

We also include a set of COVID-19 related variables as controls in our analysis including the number of confirmed COVID-19 cases and deaths at the county level from the database maintained by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University (CSSE, 2020), and dummy indicators for state-level COVID-19 policies that include stay-at home orders, non-essential business closures, restaurant limitations, and bar closures from the Kaiser Family Foundation database.[4] [5]

4. Methodology

Our baseline model is shown in Equation (1):

$$Y_{ict} = X_{ict}\alpha + \beta_1(schoolagechild_{ict} \times schoolclosure_{ct}) + \omega_t + \theta_c + \varepsilon_{ict} \quad (1)$$

Y_{it} refers to the employment outcome for individual *i* in county *c* in month *t*. X_{ict} is a vector containing both individual and county characteristics including an indicator for whether the individual has at least one child ages 5 to 17 years old residing in their household (*schoolagechild*); the percentage of schools that are closed in the individual's county of residence (*schoolclosure*); individual demographics (age and its square, number of own children residing in the household, dummies for race and Hispanic ethnicity, foreign born, presence of a disability, marital status, and veteran status); individual industry and occupation dummies; county COVID-19-related variables including the cumulative number of confirmed COVID-19 cases and deaths per 100,000 in each county by the second week of the sample survey month (the reference week of CPS), the number of the additional confirmed cases and deaths per 100,000 in the past month, and state-level policy dummy indicators that include stay-at-home orders, non-essential business closures, restaurant limitations, and bar closures. ω_t represents a month fixed effect, with August 2020 as the baseline period, and θ_c represents a county fixed effect.

We exploit within-county variation of school closures for identification of the coefficient of interest, β_1, which tells us how school closures affect the employment outcomes of individuals who live with at least one school-age child relative to those who do not. We acknowledge that school closures may be endogenous with respect to COVID and economic conditions in a particular area. Our identifying assumption is that school closures alone should have a disproportionate effect on parents of school-age children relative to others. In this case, β_1 is the effect of school closures on parental labor-market outcomes.

If for some reason school closures were otherwise correlated with *parental* labor market outcomes specifically, that would jeopardize interpretation of our results. Though we cannot rule this out definitively, we can examine whether school closures affect the labor-market outcomes of parents of only very young children who are not yet old enough to attend public school (<5

[4] https://github.com/CSSEGISandData/COVID-19/tree/master/csse_covid_19_data/csse_covid_19_time_series
[5] https://github.com/KFFData/COVID-19-Data/tree/kff_master/State%20Policy%20Actions/State%20Social%20Distancing%20Actions

years old, which we label *youngchild* below). If school closures had no effect on the labor supply of these parents, it would provide more evidence that any measured effect of closures on parents of school-aged children is causal. We examine this possibility in Equation (2):

$$Y_{ict} = X_{ict}\alpha + \beta_1(schoolagechild_{ict} \times schoolclosure_{ct}) + \beta_2(youngchild_{ict} \times schoolclosure_{ct}) + \omega_t + \theta_c + \varepsilon_{ict} \quad (2)$$

In this equation, our hypothesis is that if the outcome variable is hours worked, for example, $\beta_1 < 0$ and $\beta_2 = 0$.

Lastly, we examine both school closures and childcare facility closures in the same regressions. School and childcare closures are highly correlated over our sample period (ρ = 0.82), not surprisingly, since many common factors including pandemic conditions and state and local mandates likely influenced decisions in both sectors. Thus, multicollinearity may make it difficult to tease out the separate effects of each kind of closure. Nevertheless, we proceed with this analysis to see if the effects of school closures load on outcomes for parents of school-age (ages 5-17) children while the effects of childcare closures (*careclosure*) load on parents of only very young children (<5 years old). Our previous specifications are modified as follows:

$$Y_{ict} = X_{ict}\alpha + \beta_1(schoolagechild_{ict} \times schoolclosure_{ct}) + \beta_2(youngchild_{ict} \times schoolclosure_{ct}) + \beta_3(schoolagechild_{ict} \times careclosure_{ct}) + \beta_4(youngchild_{ict} \times careclosure_{ct}) + \omega_t + \theta_c + \varepsilon_{ict} \quad (3)$$

In this equation, our hypothesis is that if the outcome variable is hours worked, for example, $\beta_1 < 0$, $\beta_2 = 0$; and $\beta_3 = 0$, $\beta_4 < 0$.

Because other papers in the literature have found different pandemic-related effects on labor-market outcomes for men and women, we estimate Equations (1)-(3) separately by gender. Later in the paper, we examine the effects by marital status and parental education as well. Standard errors are clustered at the county level throughout our analysis.

5. Main Results

The COVID-19 pandemic has caused job losses for both men and women. Figure 1 shows that the percentage of men and women who were "at work" dipped in the second quarter of 2020, the pandemic's initial peak. Meanwhile, by the first quarter of 2021, at-work rates of all women and women with at least one school-age child (5-17 years old) were still (respectively) 3 and 3.6 percentage points lower than just before the pandemic; at-work rates of all men and men with at least one school-age child were 3.2.and 2.9 percentage points lower, respectively. The larger decline observed in the at-work rates of women with school-age children relative to all women—which is not observed for their male counterparts—is consistent with the hypothesis that school and childcare center closures have affected the labor market status of working mothers more than fathers. However, this may also be due to other factors, such as the pre-pandemic distribution of occupations among these various groups. This leads us to consider the question of how

school/childcare closures affect the employment outcomes of women and men in the regression models outlined in Section 4.

Table 1 displays summary statistics for our sample in September 2020 and April 2021. The share of schools that were closed in a county declined from 56 percent in September 2020 to 42 percent in April 2021. This partial relaxation of school closures is illustrated in Figure 2 and is consistent with the decline in states' stay-at-home orders (from 37 percent in September 2020 to 5 percent in April 2021), non-essential business closures (from 99 percent to 71 percent), restaurant limitations (from 89 percent to 62 percent), and bar closures (from 76 percent to 62 percent) over the same time period. On the other hand, childcare facility closures barely changed over this period, as further illustrated in Figure 3. One can also observe in Figures 2 and 3 that counties with a higher proportion of school closures also have a higher proportion of childcare closures, on average.

I. Impact of School Closures on the Extensive Margin of Labor Supply

The first three columns in Table 2 (3) show the impact of school and childcare closures on whether women (men) are at work. Columns 1-3 display the results from Equations (1)-(3), respectively. In Table 2, though the effects of school closures for women with 5-17 year-old children are negative (ranging between 1.4 and 2.7 percentage points), none are significant at conventional levels. In columns 2 and 3, the presence of young (ages 0-4) children is, expectedly, correlated with lower at-work levels for women. The interaction between childcare closures and presence of young children is again negative but not statistically significant.

The interaction terms between school closures and school-age children are also negative for men (Table 3), but they are smaller than the ones for women and again insignificant. Thus, we fail to reject the hypothesis that school or childcare closures have no effect on whether parents are at work at all.

II. Impact of School Closures on the Intensive Margins of Labor Supply

Columns 4-6 in Tables 2 and 3 show effects on the probability of full-time work (at least 35 hours per week), while columns 7-9 pertain to part-time work (less than 35 hours per week) and columns 10-12 pertain to total weekly work hours. In Table 2, we see a fairly consistent effect of school closures on the full-time status of mothers with school-age children across specifications (these range from 3.7 to 4.3 percentage points). For example, our baseline specification in column 4 indicates that going from all schools in the county being open to all being closed (taking our closures measure from 0 to 1) would mean that the probability of full-time work would fall by 3.8 percentage points (8.4 percent of the mean) for mothers with school-age children. The corresponding effect for men in Table 3 is 2.5 percentage points (3.4 percent of the mean).

Importantly, there is no evidence of an effect of school closures on whether women work full time if they do not have school-age children (see the coefficients on "school closure," which are positive but statistically insignificant). This suggest that given our controls, school closures are not associated with other factors that affect labor-market outcomes more generally. In fact,

across all of our measures of labor supply for both men and women, we do not find any evidence of significant deleterious effects of school or childcare closures on those without children in the age range affected by such closures.

Examining columns 7-9 in Tables 2 and 3 (for part-time work), we see that shifts into part-time work typically explain most of the reductions in full-time work for parents with school-age children when schools are closed. This is especially true for men and is consistent with relatively small and statistically insignificant effects observed on whether parents are at work at all (columns 1-3). Turning our attention to hours worked (columns 10-12), we consistently see effects of school closures on hours worked for both genders with school-age children of roughly 1.5 hours per week. On average, this translates to a 6.5 (4.3) percent reduction in hours worked for mothers (fathers) with school-age children.[6]

We now turn attention to examining the effects of school and childcare closures on outcomes for parents with school-age children vs. parents with only young children (see the second and third columns in each triplet in Tables 2 and 3). In columns 2, 5, 8, and 11 of each table, which correspond to Equation (2) in the previous section, we see that the effects of school closures on outcomes for parents of young children only are uniformly small and statistically insignificant. This gives us more confidence that the effects discussed above for parents of school-age children are not illusory, since for a similar demographic group (parents of younger children) but no direct reason to be affected by school closures, there is indeed little evidence of an effect.

In columns 3, 6, 9, and 12, which correspond to Equation (3), we add our childcare closure measure to the regression and interact it with presence of both age groups of children. We find no evidence that childcare closures negatively affect the employment outcomes of parents with school-age children (if anything, the effects are positive). As expected, childcare closures do reduce the probability of being at work and full-time work (this effect is particularly large at 12.3 percentage points) as well as hours worked for women with young children. However, none of these effects are statistically significant at conventional levels (standard errors may be elevated somewhat in part due to multicollinearity issues we discussed in the last section). In contrast, childcare closures appear to have no effect on the outcomes of men with young children, which is consistent with a gender gap in childcare responsibilities for pre-school children. This is only speculative, however, given the lack of precision in these estimates.

6. Extensions

We now move to examining how our results vary across two dimensions that might affect how school closures affect parental labor supply. First is marital status: married parents with a present spouse may respond differently to school closures by dividing responsibilities differently between labor-market and household production relative to single or cohabitating individuals. It is possible that, for example, married couples are better able to share the time burden of additional childcare when schools close. Conversely, married couples may specialize more

[6] We also tried using the inverse hyperbolic sine transformation of hours as a dependent variable, which approximates the logarithmic function but does not omit zeros. These results are largely similar to the ones in the text for hours in levels and are available on request.

across paid work/home production relative to cohabitating couples when schools close.[7] Single mothers are also much more common than single fathers: 21 percent of children under 18 live only with their mother versus four percent who live only with their fathers (Alon et al., 2020). Thus, the burden of school closures on unmarried women may be especially large.

Second, we examine how parental education mediates our results. Other studies have found a strong relationship between education and labor-market outcomes during the COVID pandemic owing to such differences as the ability to perform work responsibilities from home (e.g. Mongey, Pilossoph, and Weinberg, 2020), propensity to be in occupations designated as "essential," and industry-specific shocks associated with the pandemic and the public health response (e.g. Montenovo et al., 2020). These factors could certainly play a role in how parents respond to school closures specifically. On the one hand, a flexible, at-home work arrangement may allow better educated individuals to maintain their work hours even with children at home since they can adjust their work hours throughout the day (implying that the response in hours worked would be larger for low-educated parents; see Lofton, Petrosky-Nadeau, and Seitelman, 2021). On the other hand, if there is little flexibility in schedule or location in the work arrangements of less-educated individuals, their supply response to school closures might be smaller than that of the high education group.

It has also been shown that shifting children into private schooling during COVID rises with family income (e.g. Musaddiq et al., 2021), which is of course correlated with parental educational attainment. This would imply seeing a more muted response in labor supply to school closures among college graduates, since they would be better able to afford to send kids to private schools during public school closures.

In these exercises, we restrict our analysis to estimation of Equation (1) given that our analysis of all individuals revealed insignificant effects associated with young children (ages 0-4) and childcare closures (possibly owing in part to their correlation with school closures). At the same time, interactions between school closures and the presence of school-age children are quite robust to the inclusion of these additional covariates in Tables 2 and 3.

I. By Marital Status

Table 4 displays the results for the same set of dependent variables analyzed in Tables 2 and 3 but for individuals who are married with a present spouse specifically. The first four columns in Table 4 show the effects for women, while the second set display the effects for men. Table 5 does the same for unmarried individuals or those without a spouse present.

The effects of school closures on married parents of school-age children are very similar across gender and largely consistent with—though slightly larger than—effect sizes seen in Tables 2 and 3. This suggests that, on average, married parents largely shared the burden of additional childcare related to school closures in the second phase of the pandemic (fall 2020 to spring 2021), though this doesn't imply that the burden was shared equally *within* couples.

[7] See Albanesi and Kim (2021b) and Shore (2010) for evidence on risk-sharing in the labor-market behavior of married couples.

The largest effect on full-time work among the four groups with school-age children under consideration (married/unmarried by female/male) is for unmarried mothers (6 percentage points or about 12.4 percent of the mean). The decrease in hours (about 1.7 per week), however, is similar to what we observe for married women and men. On the other hand, there are no statistically significant effects of school closures on the labor-market outcomes for unmarried men living with school-age children (and the point estimate on full-time work is small and positive). The point estimate on hours worked is large (almost 2 hours per week), however, which means that we cannot reject the hypothesis that the effect on hours is the same for unmarried women and men.

II. By College Attainment

Tables 6 and 7 show how school closures affect the employment outcomes of parents with school-age children by college degree status (Table 6 contains results for those with at least a college degree; Table 7 pertains to those with less than a college degree). Considering differences for women first, mothers without a college degree experience a much larger reduction in full-time status (and corresponding increase in part-time status) than do mothers with a degree. Similarly, the decrease in hours for less educated women (1.9 hours) is substantially larger than the one for more educated women (a statistically insignificant 0.6 hours). For men, the reduction in full-time work likelihood is actually slightly larger for those with a college degree, but the difference in hours worked mirrors the one for women (a reduction of 2.2 hours for the less educated but a statistically insignificant 0.2 hours for the more educated). For both genders, the difference in coefficients on work hours for the low- and high-educated groups are statistically significant at the 10 percent level or better.

These results are consistent with the notion that individuals with less formal schooling had a more difficult time adjusting their work life to school closures either because of a less flexible schedule, less substitution to private schools, or other factors. Whatever the reason, this is evidence that school closures have disproportionately affected workers with relatively low education levels.

7. Sensitivity Analyses

Our analyses thus far have relied on measuring a school closure as a 50 percent year-over-year reduction in phone traffic at that institution using Safegraph data, as recommended in Parolin and Lee (2021). There are two potential issues with this. The first is that the 50 percent cutoff is arbitrary and schools may erroneously appear to be closed by this measure if significant numbers of parents *chose* to remove their children from a particular public school at some point during the pandemic. The second issue is the extent to which such removals are *endogenous* because parents who reduced their time at work also chose to remove their children from school. We view these possibilities as unlikely given that a 50 percent reduction in visits at a school would require an enormous response from many parents simultaneously. Nevertheless, we think it is worthwhile to explore how sensitive our results are to other measures of school closures. We first use the same Safegraph data but with a more stringent 75% cutoff; next, we employ an entirely

different dataset that documents school closures from administrative sources as collected by *Burbio*.

Table 8 contains the results using the alternative 75% cutoff for school closure. These are largely consistent with our baseline results, though effects on full-time work and work hours are somewhat larger than they are in our baseline specifications. A greater percentage of the full-time effect also appears to be explained by reductions in any work than before (especially for women), though these effects for both women and men remain statistically insignificant.

Table 9 displays the results using *Burbio* closures. Here the results are smaller than they are in our baseline analysis, especially for men, where statistical significance largely disappears. The effects for women, though smaller in absolute value, are qualitatively consistent with the results using Safegraph data. Though it is difficult to know why using the *Burbio* data generates a larger gender gap in the results than we saw earlier, one possible reason we see a universal reduction in the coefficients with the *Burbio* data is that it measures school closures with a greater degree of error—indeed, the correlation between our primary (Safegraph) school closures measure and the *Burbio* measure is only 0.55.

8. Conclusion

We find that school closures over the course of the 2020-21 academic year had a significant effect on the labor-market outcomes of parents with school-age children. Though we do not find significant effects on whether parents work at all, we find that they are less likely to work full-time and reduce their hours worked per week in response to these closures. Our confidence that these findings are due to school closures rather than some other factor, such as local COVID cases or policies, is bolstered by the observation that school closures do not adversely affect the labor supply of individuals without school-age children, including those with children too young for public school (ages 0-4) specifically. We do find some evidence that childcare closures, which do affect these parents of young children directly, lead to less work among these parents, but the coefficients are imprecisely estimated, perhaps due in part to the correlation between school and childcare closures in a county.

These findings contribute to our understanding of several aspects of how COVID-19 and its fallout have disrupted the lives of working parents. First, the literature on how school and childcare closures has affected economy-wide changes in labor supply have focused on the extensive margin, that is, whether individuals work or are in the labor force (e.g. Albanesi and Kim, 2021a; Furman, Kearney and Powell, 2021). These papers suggest that closures had at most a modest impact on these measures. Our results are in alignment with these findings in that parents do not respond to school closures by being less likely to work at all. However, when we examine the intensive margin of labor supply (e.g., hours worked), we find significant effects of school closures (on the order of 1.5-2 hours per week for both mothers and fathers).

Another of our findings that adds to the existing literature on the labor-market effects of COVID is that over our sample period, reductions in work hours in response to school closures are generally similar for women and men. This is in contrast to evidence from the early part of the

pandemic that the effects were very different across gender (e.g., Heggeness, 2020). With little anticipation of school closures in spring 2020, it appears that women were more likely to take time out of work to care for children who had to stay home. This is consistent with evidence that other kinds of family shocks affect women's labor supply more than men's (e.g., Van Houtven, Coe, and Skira, 2013; Jeon and Pohl, 2017; Saad-Lessler, 2020). With more time to adjust schedules and anticipate closures starting in fall 2020, we find that the additional childcare burden brought on by school closures was more balanced across gender.

When we examine our results by education level, we find that parents without a college degree were significantly more affected in terms of work hours than college graduates. We speculate that this may be related to more flexible work schedules and/or more substitution toward private school or childcare among college graduates. Unpacking this difference is a topic for future research. The fact that we find a stronger effect of school closures on the labor supply of the less educated, who on average have lower earnings, adds to the evidence on how COVID has exacerbated health and other forms of inequality (e.g., Adams-Prassl et al., 2020; Bonacini, Gallo and Scicchitano, 2020; Andrasfay and Goldman, 2021; Alsan, Chandra and Simon, 2021).

Early in the pandemic, policymakers did not have the luxury of many credible estimates of the benefits and costs of closing schools. Several recent papers suggest that the health and human capital of children are harmed by school closures and that these effects are largest for disadvantaged kids (e.g., Kuhfeld et al., 2020; Engzell, Frey and Verhagen, 2021; Larsen, Helland and Holt, 2021; Halloran et al., 2021; Fuchs-Schündeln et al., 2021). Our results suggest that closures carry costs to families in the form of reduced parental work hours, particularly among less-educated mothers and fathers. These factors should be taken into account as policymakers continue to grapple with reducing disease during new waves of COVID or future pandemics in ways that are least costly to their constituents.

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Figures and Tables

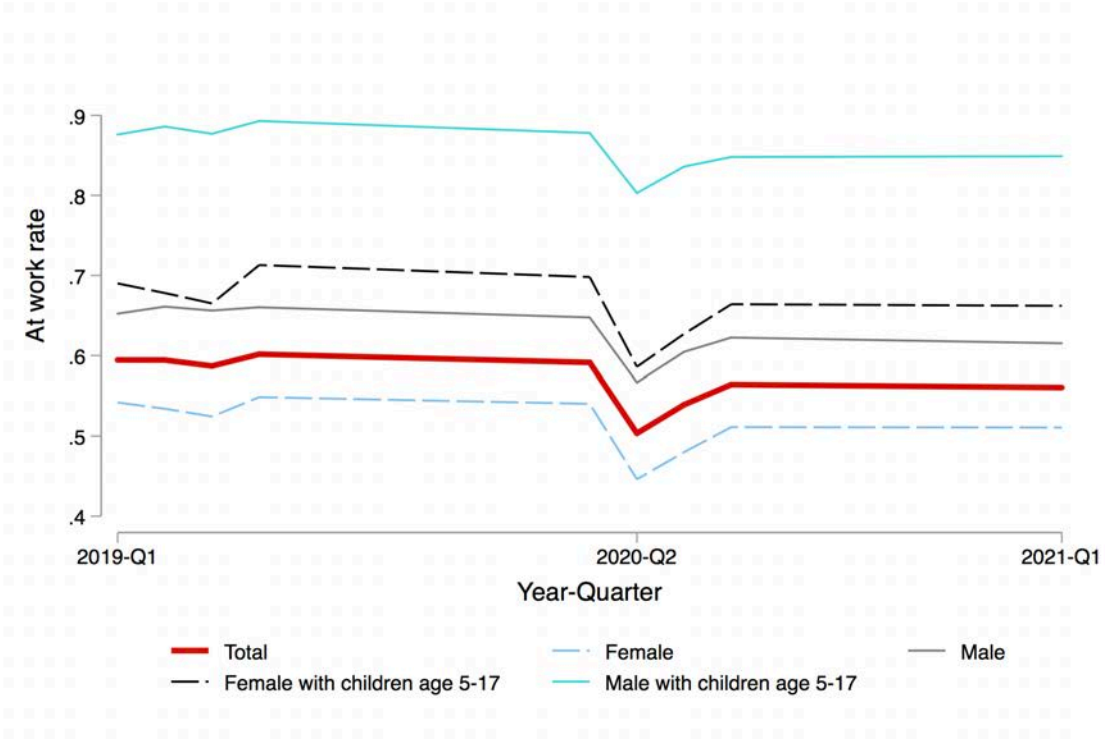

Figure 1. Percentage of individuals “at work,” 2019-Q1 – 2021-Q1

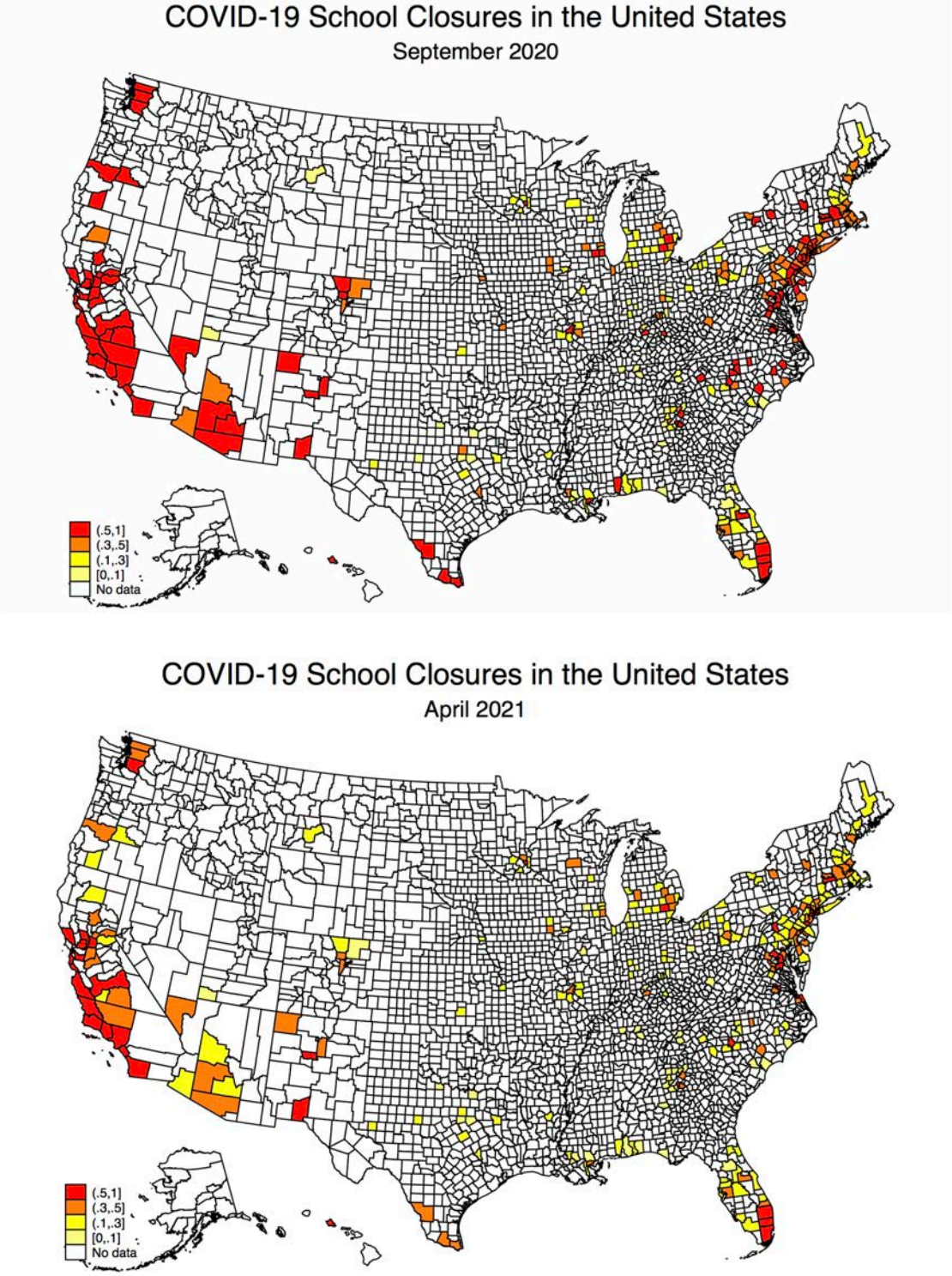

Figure 2. Percentage of school closures in CPS sample with county identifiers according to Parolin and Lee (2021) database, September 2020 & April 2021

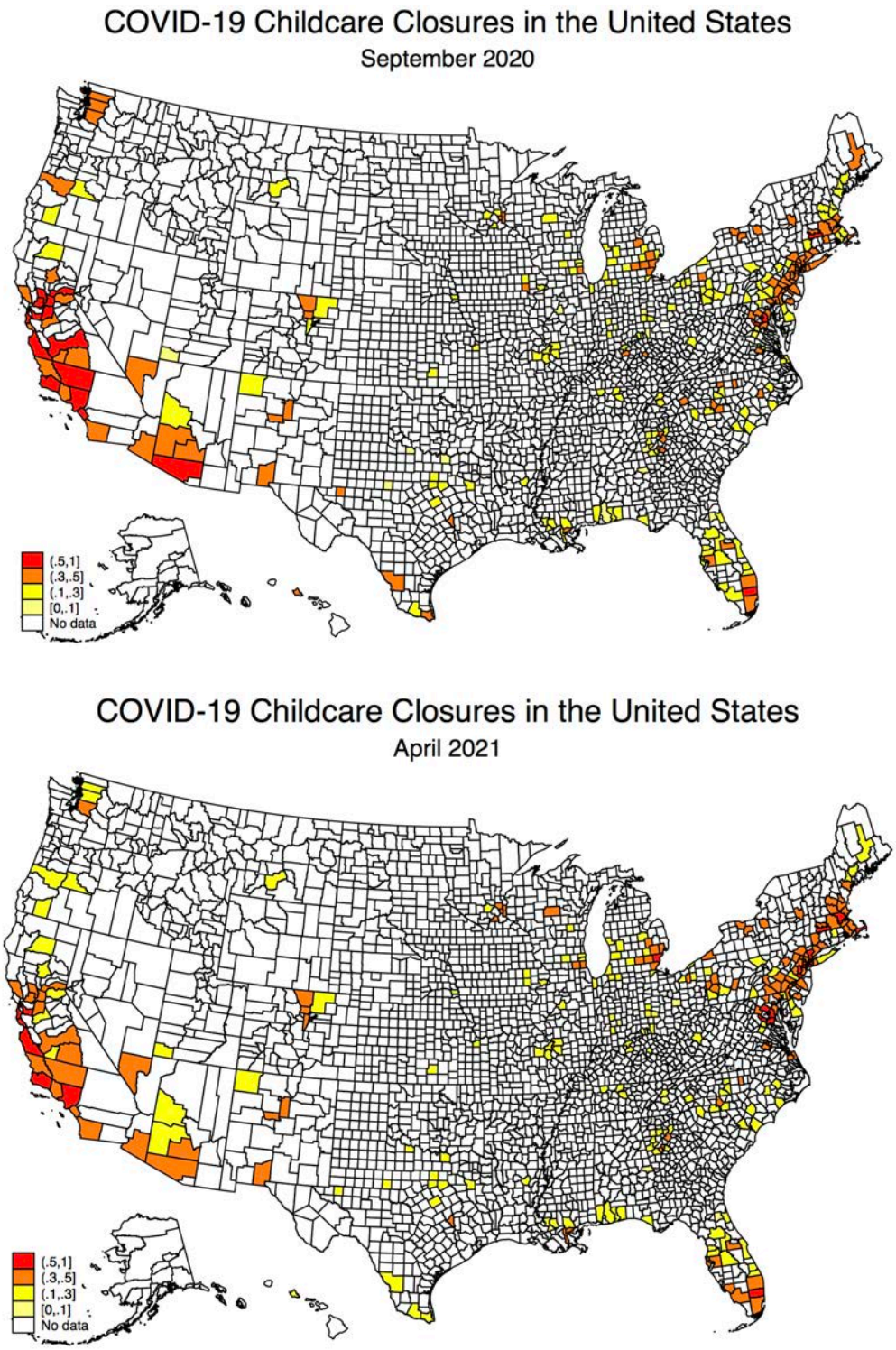

Figure 3. Percentage of childcare closures in CPS sample with county identifiers according to Lee and Parolin (2021) database, September 2020 & April 2021

Table 1. Summary Statistics by survey month

VARIABLES	(1) September 2020	(2) April 2021
In labor force	0.64	0.64
At work	0.57	0.58
Absent from work	0.02	0.02
Unemployed	0.05	0.04
Work hours last week	21.30	22.79
New deaths by 2nd week of the month per 100,000	7.60	8.91
Cumulative deaths by 2nd week of the month per 100,000	78.59	184.77
New cases by 2nd week of the month per 100,000	313.30	713.14
Cumulative cases by 2nd week of the month per 100,000	2,126.76	9,513.71
Stay-at-home order	0.37	0.05
Non-essential business closure	0.99	0.71
Restaurant limit	0.89	0.62
Bar Closure	0.76	0.62
Female (dummy)	0.52	0.52
Age	49.21	49.19
Number of children in household	0.69	0.71
Presence of young children (age <5) only	0.05	0.05
Presence of school-age children (ages 5-17)	0.21	0.21
White race	0.75	0.75
Black race	0.13	0.14
Asian race	0.09	0.09
Other race	0.03	0.03
Married	0.52	0.51
Veteran	0.06	0.06
U.S. born	0.76	0.76
Hispanic ethnicity	0.21	0.20
Presence of disability	0.11	0.11
Less than high school diploma	0.09	0.09
High school diploma	0.27	0.26
Some college	0.25	0.25
College degree	0.25	0.25
Advanced degree	0.15	0.15
Percentage of childcare facilities closed in county	0.38	0.39
Percentage of school facilities closed in county	0.56	0.42
Observations	33,668	33,841

(1) All numbers displayed are means weighted with final basic CPS person weights.

(2) The values for new deaths and new cases by the second week of the month is the month-over-month difference with the 14th day of each month as the reference date.

Table 2. OLS Regressions on "At Work", "Full-time", "Part-time", and "Hours Worked", Female

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
VARIABLES	At work	At work	At work	Full-time	Full-time	Full-time	Part-time	Part-time	Part-time	Hours worked	Hours worked	Hours worked
School closure	-0.002	0.000	-0.001	0.017	0.017	0.016	-0.018*	-0.017*	-0.017	0.146	0.185	0.300
	(0.009)	(0.009)	(0.009)	(0.013)	(0.013)	(0.015)	(0.010)	(0.010)	(0.013)	(0.446)	(0.445)	(0.469)
Presence of school-age children (5-17)	0.014*	0.001	-0.002	0.015*	-0.000	-0.002	-0.002	0.001	-0.000	0.725**	0.009	-0.132
	(0.007)	(0.007)	(0.007)	(0.009)	(0.009)	(0.011)	(0.008)	(0.008)	(0.009)	(0.334)	(0.338)	(0.386)
School closure x presence of school-age children	-0.014	-0.015	-0.027	-0.038**	-0.037**	-0.043*	0.024*	0.022*	0.017	-1.317**	-1.271**	-1.815**
	(0.010)	(0.011)	(0.017)	(0.015)	(0.015)	(0.024)	(0.012)	(0.012)	(0.022)	(0.536)	(0.550)	(0.874)
Presence of young children only (0-4)		-0.033***	-0.028*		-0.051***	-0.034*		0.018	0.007		-2.311***	-1.991***
		(0.012)	(0.014)		(0.015)	(0.018)		(0.015)	(0.017)		(0.539)	(0.631)
School closure x presence of young children only		-0.034	-0.014		-0.014	0.048		-0.020	-0.062*		-0.638	0.567
		(0.021)	(0.037)		(0.026)	(0.049)		(0.024)	(0.035)		(0.929)	(1.800)
Childcare closure			0.006			0.002			0.004			-0.318
			(0.018)			(0.026)			(0.022)			(0.917)
Childcare closure x presence of school-age children			0.023			0.012			0.011			1.075
			(0.026)			(0.040)			(0.035)			(1.424)
Childcare closure x presence of young children only			-0.039			-0.123			0.084			-2.414
			(0.060)			(0.078)			(0.058)			(2.807)
R-squared	0.767	0.767	0.767	0.502	0.502	0.502	0.193	0.193	0.193	0.668	0.669	0.669

*** p<0.01, ** p<0.05, * p<0.1. Standard errors in parentheses. N=157,993. School (childcare) closures refer to the share of all schools (childcare centers) in each county that had at least 50 percent year-on-year decline in in-person visits.

Table 3. OLS Regressions on "At Work", "Full-time", "Part-time", and "Hours Worked", Male

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
VARIABLES	At work	At work	At work	Full-time	Full-time	Full-time	Part-time	Part-time	Part-time	Hours worked	Hours worked	Hours worked
School closure	0.006	0.007	-0.006	0.021	0.022	0.015	-0.015	-0.016	-0.021*	0.453	0.511	-0.282
	(0.009)	(0.009)	(0.011)	(0.014)	(0.014)	(0.015)	(0.011)	(0.011)	(0.012)	(0.524)	(0.532)	(0.600)
Presence of school-age children (5-17)	0.008	0.008	0.006	0.026***	0.025**	0.016	-0.017**	-0.017**	-0.010	1.422***	1.503***	1.440**
	(0.007)	(0.007)	(0.008)	(0.010)	(0.010)	(0.011)	(0.007)	(0.007)	(0.008)	(0.385)	(0.404)	(0.460)
School closure x presence of school-age children	-0.004	-0.005	-0.011	-0.025*	-0.027*	-0.060***	0.021**	0.022**	0.048**	-1.470**	-1.530**	-1.746*
	(0.010)	(0.010)	(0.018)	(0.014)	(0.014)	(0.023)	(0.010)	(0.010)	(0.019)	(0.584)	(0.594)	(0.981)
Presence of young children only (0-4)		0.004	0.005		0.008	0.004		-0.004	0.001		0.698	0.612
		(0.011)	(0.012)		(0.017)	(0.020)		(0.014)	(0.016)		(0.677)	(0.788)
School closure x presence of young children only		-0.010	-0.010		-0.021	-0.036		0.011	0.031		-0.979	-1.274
		(0.019)	(0.058)		(0.028)	(0.056)		(0.021)	(0.041)		(1.184)	(2.190)
Childcare closure			0.047**			0.038			0.009			2.836**
			(0.018)			(0.027)			(0.022)			(1.069)
Childcare closure x presence of school-age children			0.014			0.067*			-0.053*			0.450
			(0.029)			(0.036)			(0.029)			(1.592)
Childcare closure x presence of young children only			-0.010			0.030			-0.039			0.610
			(0.058)			(0.091)			(0.066)			(3.493)
R-squared	0.723	0.723	0.723	0.513	0.513	0.513	0.121	0.121	0.121	0.622	0.622	0.622

*** p<0.01, ** p<0.05, * p<0.1. Standard errors in parentheses. N=141,683. School (childcare) closures refer to the share of all schools (childcare centers) in each county that had at least 50 percent year-on-year decline in in-person visits.

Table 4. OLS Regressions on "At Work", "Full-time", "Part-time", and "Hours Worked," Married

	Female				Male			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	At work	Full-time	Part-time	Hours Worked	At work	Full-time	Part-time	Hours Worked
School closure	0.002	0.041**	-0.038**	0.688	0.011	0.043**	-0.032**	1.043*
	(0.013)	(0.017)	(0.014)	(0.624)	(0.010)	(0.017)	(0.013)	(0.627)
Presence of school-age children (5-17)	0.024***	0.031**	-0.007	1.220***	0.012*	0.036***	-0.025***	1.710***
	(0.006)	(0.012)	(0.011)	(0.407)	(0.007)	(0.010)	(0.009)	(0.433)
School closure x presence of school-age children	-0.015	-0.046**	0.031*	-1.470**	-0.009	-0.043***	0.034***	-1.830***
	(0.010)	(0.020)	(0.018)	(0.638)	(0.010)	(0.016)	(0.012)	(0.664)
R-squared	0.795	0.520	0.221	0.690	0.774	0.554	0.121	0.658

*** p<0.01, ** p<0.05, * p<0.1. Standard errors in parentheses. Columns 1-4 are for females, and columns 5-8 are for males. N=79,020 for females and N=78,051 for males. School closures refer to the share of all schools in each county that had at least 50 percent year-on-year decline in in-person visits.

Table 5. OLS Regressions on "At work", "Full-time", "Part-time" and "Hours worked", Unmarried

	Female				Male			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	At work	Full-time	Part-time	Hours Worked	At work	Full-time	Part-time	Hours Worked
School closure	-0.001	0.003	-0.003	0.082	0.004	0.004	0.001	0.088
	(0.012)	(0.016)	(0.014)	(0.536)	(0.016)	(0.022)	(0.017)	(0.798)
Presence of school-age children (5-17)	-0.001	0.005	-0.006	0.214	0.014	-0.008	0.022	0.689
	(0.014)	(0.015)	(0.014)	(0.543)	(0.018)	(0.022)	(0.016)	(0.864)
School closure x presence of school-age children	-0.019	-0.060***	0.041*	-1.742**	-0.032	0.008	-0.040	-1.964
	(0.022)	(0.022)	(0.023)	(0.860)	(0.029)	(0.036)	(0.027)	(1.514)
R-squared	0.749	0.508	0.203	0.662	0.680	0.486	0.156	0.595

*** p<0.01, ** p<0.05, * p<0.1. Standard errors in parentheses. Columns 1-4 are for females, and columns 5-8 are for males. N=78,973 for females and N=63,632 for males. School closures refer to the share of all schools in each county that had at least 50 percent year-on-year decline in in-person visits.

Table 6. OLS Regressions on "At work", "Full-time", "Part-time" and "Hours worked", college degree or more

	Female				Male			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	At work	Full-time	Part-time	Hours Worked	At work	Full-time	Part-time	Hours Worked
School closure	-0.015	0.026	-0.041**	0.083	0.006	0.025	-0.019	0.109
	(0.013)	(0.022)	(0.018)	(0.733)	(0.013)	(0.023)	(0.018)	(0.771)
Presence of school-age children (5-17)	0.022**	0.024	-0.002	0.942*	0.006	0.041***	-0.035***	1.397***
	(0.008)	(0.015)	(0.014)	(0.487)	(0.008)	(0.013)	(0.012)	(0.527)
School closure x presence of school-age children	-0.012	-0.017	0.004	-0.560	0.016	-0.034*	0.050***	-0.244
	(0.012)	(0.027)	(0.024)	(0.780)	(0.012)	(0.019)	(0.018)	(0.786)
R-squared	0.764	0.499	0.181	0.647	0.756	0.530	0.142	0.627

*** p<0.01, ** p<0.05, * p<0.1. Standard errors in parentheses. Columns 1-4 are for females, and columns 5-8 are for males. N=65,446 for females and N=56,863 for males. School closures refer to the share of all schools in each county that had at least 50 percent year-on-year decline in in-person visits.

Table 7. OLS Regressions on "At work", "Full-time", "Part-time" and "Hours worked", less than college degree

	Female				Male			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(9)
VARIABLES	At work	Full-time	Part-time	Hours Worked	At work	Full-time	Part-time	Hours Worked
School closure	0.009	0.012	-0.003	0.405	0.005	0.014	-0.009	0.350
	(0.012)	(0.016)	(0.012)	(0.565)	(0.012)	(0.017)	(0.013)	(0.680)
Presence of school-age children (5-17)	0.011	0.017	-0.006	0.785*	0.012	0.018	-0.006	1.363***
	(0.009)	(0.011)	(0.010)	(0.408)	(0.009)	(0.012)	(0.009)	(0.499)
School closure x presence of school-age children (5-17)	-0.019	-0.059***	0.040***	-1.898***	-0.019	-0.023	0.004	-2.176***
	(0.014)	(0.015)	(0.015)	(0.593)	(0.015)	(0.019)	(0.014)	(0.786)
R-squared	0.763	0.495	0.233	0.675	0.708	0.509	0.137	0.622

*** p<0.01, ** p<0.05, * p<0.1. Standard errors in parentheses. Columns 1-4 are for females, and columns 5-8 are for males. N=92,547 for females and N=84,820 for males. School closures refer to the share of all schools in each county that had at least 50 percent year-on-year decline in in-person visits.

Table 8. OLS Regressions on Female "At work", "Full-time", "Part-time" and "Hours worked" using 75% closure cutoff

	Female				Male			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	At work	Full-time	Part-time	Hours Worked	At work	Full-time	Part-time	Hours Worked
School closure	-0.002	0.021	-0.023*	0.222	0.002	0.035*	-0.033**	1.145
	(0.012)	(0.017)	(0.014)	(0.630)	(0.016)	(0.019)	(0.015)	(0.841)
Presence of school-age children (5-17)	0.012**	0.004	0.008	0.432*	0.009*	0.020***	-0.011**	1.134***
	(0.005)	(0.007)	(0.006)	(0.249)	(0.005)	(0.007)	(0.006)	(0.274)
School closure x presence of school-age children (5-17)	-0.027	-0.042*	0.015	-2.017**	-0.015	-0.041*	0.026*	-2.458***
	(0.016)	(0.022)	(0.018)	(0.842)	(0.014)	(0.022)	(0.015)	(0.821)
R-squared	0.767	0.502	0.193	0.668	0.723	0.513	0.121	0.622

*** p<0.01, ** p<0.05, * p<0.1. Standard errors in parentheses. Columns 1-4 are for females, and columns 5-8 are for males. N=157,993 for females and N=141,683 for males. School closures refer to the share of all schools in each county that had at least 75 percent year-on-year decline in in-person visits.

Table 9. OLS Regressions on Female "At work", "Full-time", "Part-time" and "Hours worked" using *Burbio* School Closures

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	At work	Full-time	Part-time	Hours Worked	At work	Full-time	Part-time	Hours Worked
School closure	0.001	0.015**	-0.014**	0.399**	-0.005	0.001	-0.006	-0.286
	(0.005)	(0.006)	(0.006)	(0.201)	(0.005)	(0.007)	(0.005)	(0.266)
Presence of school-age children (5-17)	0.010*	0.013	-0.003	0.492	0.003	0.019**	-0.016**	0.776**
	(0.006)	(0.008)	(0.007)	(0.308)	(0.006)	(0.008)	(0.006)	(0.321)
School closure x presence of school-age children	-0.006	-0.026***	0.020***	-0.681**	0.004	-0.010	0.014**	-0.208
	(0.006)	(0.009)	(0.008)	(0.324)	(0.005)	(0.008)	(0.006)	(0.351)
R-squared	0.767	0.502	0.193	0.668	0.723	0.513	0.121	0.622

*** p<0.01, ** p<0.05, * p<0.1. Standard errors in parentheses. Columns 1-4 are for females, and columns 5-8 are for males. N=157,993 for females and N=141,683 for males. School closures refer to the percentage of schools that were reportedly virtual or hybrid (not in-person) in each county.