

# Telework and the Employment Child Penalty by Education\*

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## Abstract

We document an increase of roughly five percentage points in the employment rate gap between women with a college degree and women without a college degree over the last two decades, mainly driven by a sustained increase in employment among college-educated women with young children. We argue that differential patterns in motherhood child penalties are partially behind these trends, with child penalties in employment decreasing faster for women with college degrees since the mid-2010s. Exploiting cross-state variation in the share of jobs with future telework potential in the early 2000s, we find that child penalties for college-educated women decreased more in states with more employment in teleworkable occupations. We confirm this finding by leveraging individual-level occupational data and calculating child penalties for mothers in teleworkable and non-teleworkable occupations within a given education level. Child penalties decreased by more for women in teleworkable occupations, which are disproportionately held by women with college degrees.

*JEL Codes: J13, J16, J21, J22, J24.*

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# 1 Introduction

Over the past two decades, the employment rate gap between prime-age women holding at least a bachelor’s degree and those with lower levels of educational attainment has widened by roughly five percentage points—from 11.5 percentage points in 2000–2002 to 16.4 percentage points in 2021–2023, a striking 43% increase.<sup>1</sup> The growing female educational employment gap reflects a sharp rise of 13.6 percentage points in the employment rate of college-educated women with children under age five, driven by this group’s increasing labor market attachment. During this period, the child penalty in annual employment—defined as the differential causal impact on employment of the first child between mothers and fathers—decreased by 9.6 percentage points (30.2%) for women with a bachelor’s degree or higher. In contrast, the decrease was much smaller for women without a college education, at only 1.2 percentage points (6.1%).<sup>2</sup> Given the significant role that children play in explaining the persistent labor market gaps between men and women (Cortés and Pan, 2023), examining these contrasting trends in child penalties is crucial for understanding the growing employment disparities among women by education level. Studying these disparities, in turn, is important because they can exacerbate existing socioeconomic inequalities between college graduates and those without college degrees and affect intergenerational mobility by influencing the economic opportunities available to children depending on their mothers’ educational attainment.

In this paper, we use publicly available microdata from the American Community Survey (ACS) between 2000 and 2023 and the pseudo-event study method introduced by Kleven (2022) to systematically document the recent evolution of child penalties in employment for women with different levels of educational attainment in the U.S. economy. We find that child penalties in employment have decreased faster for women with college degrees since the mid-2010s. Our back-of-the-envelope calculations suggest that the diverging child penalty trends by education level we report can statistically account for about half of the rise in the employment rate gap between college-educated and non-college-educated women during the last twenty years.

To understand the drivers behind the trends we document, we construct child penalty estimates at the state-by-education level for different subperiods and relate changes in these measures to (i) the availability of occupations with potential for telework or remote

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<sup>1</sup>Authors’ calculations based on American Community Survey (ACS) data. Although the employment gap among men grew from 8.6 to 10.5 percentage points, the increase—1.8 points, or 21.3%—was comparatively smaller.

<sup>2</sup>Authors’ estimates using ACS data and Kleven (2022)’s pseudo-event study method. See Section 3 for details.

work, (ii) changes in societal norms about working mothers, and (iii) changes in child-care costs in each state. We find that the reduction in employment child penalties among college-educated mothers is positively correlated with the initial share of employment working in occupations with teleworkability potential in the mothers' state of residence, calculated using the classification developed by [Dingel and Neiman \(2020\)](#). We estimate that moving from the 25th to the 75th percentile of the state distribution of total employment share in potentially teleworkable occupations in the early 2000s (an increase of 5 percentage points) is associated with a decrease in the state-level child penalty of 2.1 percentage points (9.3%) in annual employment, 2.9 percentage points (10.4%) in weekly employment, and 2.9 percentage points (8.7%) in usual hours worked per week for college-educated mothers between the periods 2005-2009 and 2019-2023. In contrast, we only find a statistically significant relationship between the state-level child penalties and the state teleworkable employment shares for non-college-educated mothers at the extensive margin, with a decrease in the annual employment penalty of 2.2 percentage points (10.5%) for a 5-percentage points increase in the teleworkable employment share.

In general, our state-level regressions show no statistically significant association between changes in child penalties and changes in gender norms or the cost of childcare during this period among college-educated mothers. However, we find that state-wide improvements in gender progressivity are associated with lower child penalties in annual employment for women without a college degree and that increased childcare costs affect this group's employment outcomes relatively more. Moving from the 25th to the 75th percentile of the state distribution of changes in childcare workers' relative wages (an increase of 12.5 percentage points) is associated with an increase in the state-level child penalty of 2.4 percentage points (11.4%) in annual employment for non-college-educated mothers.

Given the previous findings, we then focus on studying the role of occupational teleworkability on child penalties by leveraging individual-level information from the ACS on parents' primary occupation, which covers all individuals who have worked in the past five years, even if they are currently non-employed at the time of the survey. We augment [Kleven \(2022\)](#)'s pseudo-event study matching algorithm by adding a binary indicator for being employed in a potentially teleworkable occupation to the set of characteristics used to construct the pseudo-panel of individuals. After validating that this approach produces comparable child penalty trends among the population with valid occupation information (relative to the overall sample), we calculate changes in child penalties over the last two decades for women in teleworkable and non-teleworkable occupations. We find that within a given educational group, child penalties decreased by

more in teleworkable occupations. For instance, while the child penalty in weekly employment decreased by 11 percentage points (40.3%) among college-educated women in teleworkable occupations, it decreased by 5.3 percentage points (25%) for those in non-teleworkable occupations. This pattern is particularly pronounced among women who do not have a college degree, with child penalties for non-college-educated women in occupations with low teleworkability potential even slightly increasing over the analysis period. We also find that while occupation characteristics play a key role in explaining the decrease in child penalties, the declines observed among college-educated women in *non-teleworkable* occupations are comparable to or greater than those among non-college-educated women in *teleworkable* occupations, highlighting the independent role that education has in granting more flexible workforce arrangements (Cowan, 2024).

We add to the literature in two important ways. First, our work contributes to the literature studying the effects of expanding telework and work-from-home (WFH) possibilities on mothers' labor market outcomes (e.g., Dettling, 2017; Farooqi, 2023; Harrington and Kahn, 2023; Cowan, 2024). Second, we add to the broader literature studying the determinants of the evolution of child penalties in employment across space and over time (e.g., Kleven, 2022; Kleven, Landais, and Leite-Mariante, 2024).

Dettling (2017) shows that the expansion of high-speed Internet increased married women's labor force participation by approximately 4.1 percentage points during the 2000s, with the effect being most pronounced among college-educated mothers. The study provides suggestive evidence that this increase may have been driven, at least in part, by broadband Internet facilitating telework opportunities among highly educated women. Closer to our work on child penalties, relying on NLSY97 data, Farooqi (2023) documents that mothers in jobs allowing for remote work experience a smaller decline in employment post-childbirth compared to those in on-site jobs. These results are analyzed in the context of a dynamic life-cycle model that jointly examines women's employment and fertility choices, showing that greater access to remote work not only lowers the non-pecuniary costs for mothers of young children but also has the potential to increase both labor participation and fertility rates. Similarly, Harrington and Kahn (2023) demonstrate that rising remote work opportunities in the 2010s narrowed the motherhood employment gap among college-educated women—particularly in traditionally family-unfriendly fields—by reducing the challenges of balancing work and childcare responsibilities.

We extend this body of research by providing a more comprehensive analysis of the evolution of the child penalty in employment by education level and occupational teleworkability potential over time. Unlike Harrington and Kahn (2023), our work does not

exclusively focus on college-educated mothers; importantly, our results indicate that occupational teleworkability also contributes to reducing child penalties for mothers without a college degree. Moreover, in contrast to [Farooqi \(2023\)](#), enabled by [Kleven \(2022\)](#)'s pseudo-event study design, our study leverages a larger sample size, enhancing the statistical power to estimate child penalties by occupation type more precisely across different periods, and more clearly isolates the impact of teleworkability on post-birth labor market outcomes.

The remainder of this paper proceeds as follows. [Section 2](#) provides background on recent trends in women's employment. [Section 3](#) describes our data sources and key variables, detailing how we construct both the teleworkable occupation measure and the methodology used to estimate child penalties. [Section 4](#) outlines our empirical approach, leveraging cross-state variation in telework potential, childcare costs, and gender norms to identify the drivers behind shifting child penalties. [Section 5](#) discusses the main results, highlighting how these factors differentially affect college-educated and non-college-educated mothers. Finally, [Section 6](#) concludes by briefly summarizing the key findings and discussing potential avenues for future research.

## 2 Background

In May 2024, the prime age (25-54) women's employment rate in the U.S. reached a new all-time high of 75.7% ([Bureau of Labor Statistics, 2024](#)). Despite predictions that the COVID-19 pandemic would harm women's economic prospects disproportionately, they recovered faster than men and played a major role in the post-pandemic rebound in overall labor force participation ([Bauer and Yu Wang, 2023](#)).<sup>3</sup> Previous work shows that these gains are a product of two main factors since the turn of the century: 1) an increasing number of women obtaining college degrees, and 2) a decreasing child penalty for college-educated mothers, who are now more likely to stay in the workforce after having children ([Arnon, O'Connell, Villero, and Wu, 2023](#)).

Education and motherhood represent critical dimensions of women's labor market experience. Over the last two decades, the share of prime-age women with a college degree or higher has grown by almost 15% (as compared to under 10% for men). At the same time, the employment gap between college-educated women and women without a college degree has widened.

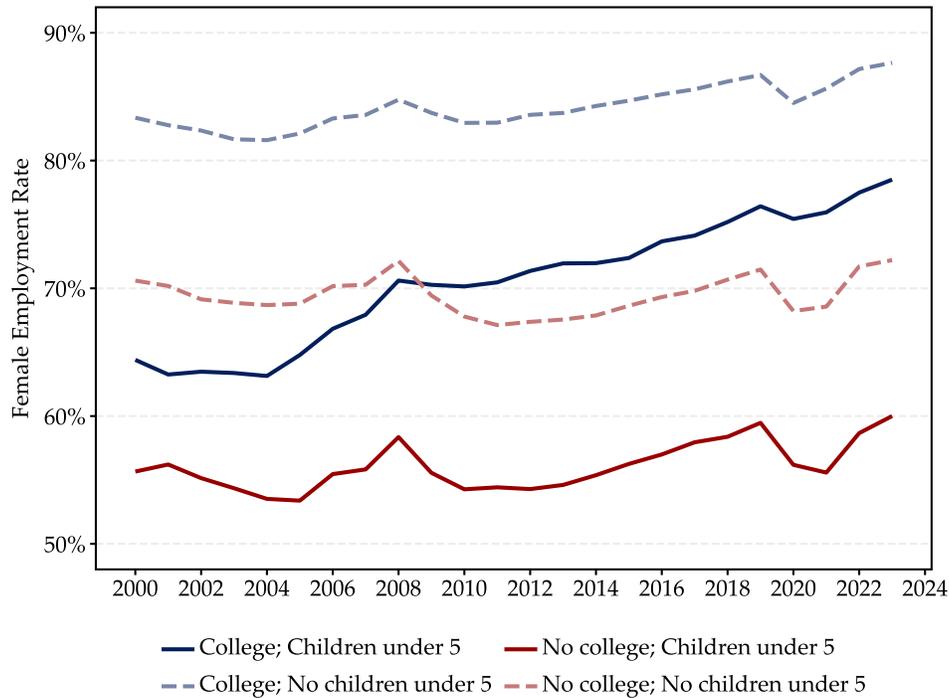
[Figure 1](#) shows that while another employment gap persists between mothers and non-mothers, regardless of education, college-educated mothers of young children, in

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<sup>3</sup>See, for example, [Cohen and Hsu \(2020\)](#) and [Taub \(2020\)](#).

particular, are approximately ten percentage points more likely to be employed today than in the early 2000s. Compared to other groups along the lines of education and motherhood, whose employment rates have tended to follow the business cycle, this group has weathered business cycles (and the 2007-2009 recession the most) and experienced the fastest pandemic recovery of any other group of women or men (Arnon et al., 2023).

**Figure 1.** Prime Age Women’s Employment Rate by Educational Attainment and Motherhood Group, 2000–2023



*Notes:* This figure plots the share of women ages 25 to 54 in each group that is employed between 2000 and 2023. The blue lines show the evolution of the employment rates for women with a college degree or more with children under age 5 (solid blue line) and without children under age 5 (dashed blue line). The red lines show the evolution of the employment rates for women without a college degree with children under age 5 (solid red line) and without children under age 5 (dashed red line).

*Source:* Authors’ calculations from ACS data. Data obtained via IPUMS.

In the context of these trends, this paper focuses on another critical metric of most women’s labor market experience: the child penalty for motherhood, defined as the difference in the employment effect of having a child between fathers and mothers. We will show that child penalties in employment decreased more among women with a bachelor’s degree or more. The rest of this paper explores these child penalty trends and the factors driving their dynamics by educational attainment, with a focus on the characteristics of the occupations held by women.

### 3 Data and Key Variables

This section describes our data sources and details the construction of the key variables used in our analyses. Our analysis of child penalties relies on individual-level data from the American Community Survey (ACS) spanning two decades from 2000 to 2023. We obtain these data via [IPUMS \(Ruggles et al., 2024\)](#). We also rely on ACS data to construct our measure of teleworkability potential, leveraging information from [Dingel and Neiman \(2020\)](#) on the feasibility of remote work by occupation. Additionally, we employ data from the General Social Survey (GSS) from 1972 to 2022 to monitor trends in societal attitudes toward working mothers, either directly or obtained from [Kleven \(2022\)](#). Our childcare cost measure is constructed using ACS data and closely follows the approach of [Bloodworth II and Gascon \(2022\)](#).

#### 3.1 Child Penalty Measures

To establish how the dynamics of labor market outcomes around childbirth have changed in recent decades, we examine what happens to women’s annual employment, weekly employment, and usual hours worked per week in the years immediately after they have a child for the first time. We use an event study approach that compares these outcomes in the years just before and just after the “event” of childbirth, adjusting for any other factors that might affect mothers’ labor market outcomes. While event study models typically require longitudinal data that track the same individuals over time, we instead leverage the pseudo-event study approach developed by [Kleven \(2022\)](#), which can be applied to our cross-sectional ACS data. This approach, combined with ACS sample sizes, allows us to estimate child penalties for different sub-periods and sub-groups.

To provide event studies around parents’ first childbirth, indexed as event time  $\tau = 0$ , we use a simple matching algorithm adapted from [Kleven \(2022\)](#) to create a pseudo-panel with our ACS data: each person observed at event time  $\tau = 0$  is matched to a childless person  $n$  years younger,  $n$  years before, and with the same demographic characteristics (year, gender, age, education, race, marital status, and state of residence) to obtain a synthetic observation for  $\tau = -n$ . We can then examine labor market outcomes for our pseudo-panel for the period  $n \in [-5, 4]$ , that is, five years before first birth up to four years after birth.<sup>4</sup> From here, and as in [Kleven \(2022\)](#), we follow the event study procedure of [Kleven, Landais, and Sogaard \(2019\)](#) to calculate child penalties.

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<sup>4</sup>Following [Kleven \(2022\)](#), this matching algorithm works slightly differently for weekly and annual outcomes, given the typical timing differences between survey response and outcomes for annual variables (e.g., reporting about income in year  $t$  in year  $t + 1$ ). See [Kleven \(2022\)](#) for details.

**Equation 1** defines the outcome of interest (annual employment, weekly employment, or usual weekly hours) for individual  $i$  of gender  $g$  in year  $t$ , denoted  $Y_{it}^g$ , as the dependent variable of the following regression:

$$Y_{it}^g = \sum_{\substack{\tau=-5 \\ \tau \neq -2}}^4 \alpha_{\tau}^g \cdot \mathbb{1}[t - B_i = \tau] + \theta_{a(i)}^g + \theta_t^g + \nu_{it}^g, \quad (1)$$

where  $B_i$  is the year of birth of the first child,  $\theta_{a(i)}$  represents age fixed effects,  $\theta_t$  represents year fixed effects, and  $\nu_{it}^g$  is an error term.<sup>5</sup> After conditioning on year and age effects, identification of the event-time coefficients  $\alpha_{\tau}^g$  in this equation comes from variation in parent's age at first birth (Kleven, 2022).

**Equation 1** is estimated separately for men ( $g = m$ ) and women ( $g = w$ ). Level effects for the estimated event coefficients,  $\hat{\alpha}_{\tau}^g$ , are then converted to percentages as follows:

$$P_{\tau}^g = \frac{\hat{\alpha}_{\tau}^g}{\mathbb{E}[\tilde{Y}_{it}^g | \tau]}, \quad (2)$$

where  $\tilde{Y}_{it}^g$  represents the predicted outcome exclusive of the event dummies, i.e.,  $\tilde{Y}_{it}^g = \hat{\theta}_{a(i)}^g + \hat{\theta}_t^g$ , and  $P_{\tau}^g$  can be interpreted as the relative-year- $\tau$  effect of children on the outcome of interest as a percentage of the counterfactual outcome without children.

Using these percentages, we define the short-run child penalty, *SRCP*, for each of our labor market outcomes as the difference in the average gender gap for the outcome variable,  $\mathbb{E}[P_{\tau}^m - P_{\tau}^w]$ , between the entire pre-birth period and the post-birth period (up to four years after birth):

$$SRCP \equiv \mathbb{E}[P_{\tau}^m - P_{\tau}^w | 0 \leq \tau \leq 4] - \mathbb{E}[P_{\tau}^m - P_{\tau}^w | -5 \leq \tau \leq -1]. \quad (3)$$

This exercise produces separate *SRCP* measures for annual employment, weekly employment, and usual weekly hours. These child penalties measure the average causal effect of motherhood on labor market outcomes during the first four years since the child's birth. As discussed by Kleven (2022), causal identification is based on the smoothness of the potential outcomes in parent's age at first birth and a parallel trends assumption in potential outcomes between men and women with respect to age at first birth.

We calculate *SRCP* measures for 3- or 5-year bins of our ACS data. We do this to guar-

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<sup>5</sup>Following Kleven (2022), annual employment is defined as having positive annual earnings in the previous year. We define weekly employment as being employed *and* "at work" during the last week. Usual weekly hours are defined as the number of hours per week that the person usually worked, conditional on having worked during the previous year (we code hours as 0 if the person did not work).

antee that the matching algorithm to construct the pseudo-panel works as intended and to achieve higher statistical precision. Generally, we use 3-year bins to analyze national trends and 5-year bins to construct state-level or more granular subgroup child penalties. The following subsections discuss the intuition and construction of each of our child penalty correlates.

### 3.2 Measure of Occupation Teleworkability

Occupational flexibility has been shown to have a meaningful effect on women’s labor market outcomes, particularly around childbirth (Chung and van der Horst, 2018; Goldin and Katz, 2011; Goldin, 2014). While definitions of flexibility range widely, ability to work from home (WFH) or telework is a commonly cited component, and increases in its prevalence have been linked to increases in eating at home, free time, and time spent with children (Cowan, 2024). Critically, increases in WFH have also been associated with increases in mothers’ employment relative to other women, though these gains have not been evenly distributed. Prior to the COVID-19 pandemic, improvements in technology increased working from home (WFH) for workers with particular college degrees, implying the conversion of a broader set of jobs to more family-friendly occupations (Harrington and Kahn, 2023).

We aim to examine the relationship between this conversion and the decline in child penalties. To do this, we leverage the teleworkable jobs classification developed by Dingel and Neiman (2020) to compute the share of jobs that can be performed at home by state using our ACS data.<sup>6</sup> The classification uses responses to two surveys from the U.S. Department of Labor’s Occupational Information Network (O\*NET) program: the [Work Context Questionnaire](#) and the [Generalized Work Activities Questionnaire](#). Specifically, each occupation is coded as *not* able to be performed at home if certain conditions hold, neglecting many characteristics that would merely make working from home *difficult*.<sup>7</sup> As such, they acknowledge that this definition likely overstates/upper bounds the share of jobs that have actually been performed entirely at home in recent years (Dingel and Neiman, 2020).

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<sup>6</sup>We exclude group quarters and subset the ACS data to those who report being employed last week and working for a wage/salary. Also, we note that compared to Harrington and Kahn (2023), we do not rely on college degree field information to proxy telework potential, and can therefore conduct our analysis for individuals without a bachelor’s degree.

<sup>7</sup>For example, if the average respondent to the Work Context survey say they use email less than once per month (Q4) or reports that Handling and Moving Objects is very important (Q17A) in the Generalized Work Activities survey, then the occupation is coded as non-teleworkable. See Dingel and Neiman (2020) for full details and specific survey questions used.

To apply the replicated teleworkable classification to ACS data, we must crosswalk occupation schemes. From the O\*NET data, the classification is computed for 2018 Standard Occupational Classification (SOC2018) codes. They must then be crosswalked to the 2010 Standard Occupational Classification (SOC2010) scheme and then to an IPUMS harmonized coding scheme (OCC2010) constructed on the basis of the Census Bureau’s 2010 Occupation Classification. We then collapse teleworkable scores to the OCC2010 occupation level, taking the weighted average for each occupation based on the number of O\*NET respondents and discretizing to 0 or 1 using a threshold of 0.5. This allows us to examine whether an ACS observation works in a teleworkable occupation or not.<sup>8</sup> We validate our crosswalking exercise by examining the correlation between the state-level average teleworkable scores reported by [Dingel and Neiman \(2020\)](#) for the year 2018 with our calculated OCC2010 state-level average teleworkable scores for the same year. We find a strong correlation coefficient of 0.97 between the two.

[Figure A1a](#) plots the state-level variation in the share of total employment in occupations with teleworkable potential derived from this exercise using pooled ACS data for 2000-2004, which is the measure we use in our empirical analysis. It is important to note that our replication of [Dingel and Neiman \(2020\)](#)’s scores is based on survey data from the O\*NET Release 24.2 (February 2020). Approximately 50% of responses were collected between 2015 and 2019, 40% between 2010 and 2014, 10% between 2005 and 2009, and only a negligible fraction between 2002 and 2004. Because the scores reflect more recent workplace contexts and activities, applying them to earlier periods (such as 2000-2004, as in our analysis)—when the technological infrastructure to support widespread teleworking was still limited—should be interpreted as an indicator of the potential for teleworkability rather than actual telework feasibility at that time.<sup>9</sup>

[Table 1](#) summarizes our teleworkable jobs classification, also using pooled ACS data for the same 2000-2004 period we use in our empirical analysis, by occupation group. There is a clear positive relationship between an occupation group’s potential for tele-

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<sup>8</sup>Note that we end up with 27 out of 458 unique IPUMS OCC2010 codes which do not have teleworkable classifications mapped to them; therefore, ACS observations reporting these codes (3.6 percent of our 2000-2023 sample) are excluded from our final calculation of teleworkable job shares. Although we use the same O\*NET questions/data as [Dingel and Neiman \(2020\)](#), our methods differ in that they refrain from crosswalking and simply report the teleworkable classification for SOC2018 occupations.

<sup>9</sup>See [Figure A2](#) for a comparison of actual telework/WFH rates in ACS by teleworkable occupation status. We take the patterns in the figure as illustrative evidence of the validity of our replicated [Dingel and Neiman \(2020\)](#) teleworkable classification: regardless of education, WFH rates are markedly higher for workers in occupations classified as teleworkable. This is especially apparent after the COVID-19 pandemic, when WFH rates skyrocketed. [Buckman et al. \(2025\)](#) note that the ACS question design captures the incidence of fully remote work (as opposed to hybrid work) and yields WFH rates that are commensurate with measures from other surveys.

**Table 1.** Summary of Teleworkable Jobs Classification for 2000-2004, by Occupation Group

OCC2010 Group	Teleworkable Score	Female Share (%)	College Share (%)
Education, Training, and Library	1.00	75.1	77.1
Computer and Mathematical	1.00	30.1	63.4
Legal	1.00	55.1	75.3
Financial Specialists	0.95	57.1	66.2
Business Operations Specialists	0.94	57.0	47.4
Arts, Design, Entertainment, Sports, and Media	0.81	47.5	57.3
Management, Business, Science, and Arts	0.81	39.0	51.0
Office and Administrative Support	0.71	76.2	16.3
Life, Physical, and Social Science	0.63	42.3	78.8
Community and Social Services	0.59	62.3	72.2
Architecture and Engineering	0.55	14.0	71.9
Personal Care and Service	0.48	79.5	15.0
Protective Service	0.29	19.6	21.4
Sales and Related	0.25	48.7	28.1
Healthcare Practitioners and Technicians	0.06	76.7	55.1
Transportation and Material Moving	0.04	18.8	7.3
Production	0.01	32.8	6.5
Extraction	0.00	2.6	4.1
Construction	0.00	3.3	5.3
Building and Grounds Cleaning and Maintenance	0.00	41.2	5.1
Food Preparation and Serving	0.00	59.8	8.4
Healthcare Support	0.00	88.6	8.5
Installation, Maintenance, and Repair	0.00	5.1	6.8
Farming, Fishing, and Forestry	0.00	27.0	6.0
Technicians	0.00	18.6	15.3

*Notes:* This table presents summary information for our teleworkable jobs classification adapted from [Dingel and Neiman \(2020\)](#). Calculations are done using ACS data restricted to prime age (25-54) employed people in the years 2000-2004, with weighted averages calculated using ACS person weights. Military specific occupations are excluded. All values are rounded to the hundredths place.

workability and its share made up of college graduates. Several of the occupation groups with the highest teleworkable scores are majority women as well. There are notable exceptions to these trends, however, such as Computer and Mathematical (heavily male-dominated, highly teleworkable) on one hand and Healthcare Support (heavily female-dominated, largely non-teleworkable) on the other hand. Occupation groups with tele-

workability scores near 0.50 contain occupations with greater variation in teleworkability; for example, a Personal Care and Service employee in 2000-2004 has nearly equal odds of working in a teleworkable job as a non-teleworkable job.<sup>10</sup>

### 3.3 Gender Norms Toward Working Mothers

Our main measure of gender attitudes toward working mothers comes from the state-level Gender Progressivity Index (GPI) constructed by [Kleven \(2022\)](#) using data from the General Social Survey (GSS) for the period 1972-2018. The GPI incorporates information about three GSS questions:

1. “It is much better for everyone involved if the man is the achiever outside the home and the woman takes care of the home and family.”
2. “A working mother can establish just as warm and secure a relationship with her children as a mother who does not work.”
3. “A pre-school child is likely to suffer if his or her mother works.”

Originally, answers to these three questions were recorded on a Likert-type scale, capturing the extent of the respondents’ agreement or disagreement with each statement.<sup>11</sup> To construct the GPI, [Kleven \(2022\)](#) first normalizes these answers using the question-specific mean and standard deviation for the overall period. Then, the GPI is formed by averaging the three normalized scores, creating an index for which higher values reflect “stronger gender progressivity.” We use [Kleven’s](#) state-by-decade index for 1990-99 and 2010-18 and calculate the change in the progressivity index between these two periods. When presenting national trends of the GPI by education level, we use publicly available GSS data and follow [Kleven \(2022\)](#)’s approach to form the index and then construct averages by education level for each survey year. [Figure A1b](#) plots the state-level variation in the change in gender progressivity between the 1990s and the 2010s. [Figure A3a](#) plots the evolution of the national-level GPI by educational attainment between 2000 and 2022. While there has been an overall increase in gender progressivity over time, there is significant variation across states. The GPI has also improved relatively faster among college-educated individuals with an average increase of 0.026 standard deviations per year versus 0.020 standard deviations for the non-college-educated group.

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<sup>10</sup>Recall that the teleworkable scores used in our analysis are calculated at the OCC2010 occupation level. [Table 1](#) is a summary of these scores abstracted to the occupation group for illustrative purposes.

<sup>11</sup>The scale is: 1 - Strongly agree, 2 - Agree, 3 - Disagree, 4 - Strongly disagree. The second question is recoded so that higher values signal more progressivity for all three questions.

### 3.4 Relative Wage of Childcare Workers to Private Sector Workers

Since the early 2000s, childcare costs have grown faster than real wages, leading some parents to pursue options like part-time care arrangements, home-based centers, supervision by relatives, or potentially leaving the workforce entirely (Schochet, 2019). Estimating childcare affordability is confounded by this “mix-and-match” care approach, which may lead to cost undercounting on surveys. Quality variation and selection bias may also distort these estimates (i.e., the price paid by families may not reflect the cost of care provision) (Bloodworth II and Gascon, 2022). Thus, we follow a method analogous to Bloodworth II and Gascon (2022), which relies on the fact that labor costs are the key cost driver for childcare centers. Specifically, we calculate the ratio of average hourly wages of childcare workers to all other private sector workers by state and year using ACS data.<sup>12</sup> This relative wage measure serves as a proxy for childcare affordability—when it increases (decreases), we infer that childcare has become less (more) affordable. Figure A3b plots the nationwide evolution of the relative wage by educational attainment between 2000 and 2022, calculated using ACS data. As measured by this indicator, nationally, relative childcare costs have increased by an average of 0.1% per year for college-educated workers and by 0.4% per year for workers without a college degree.

## 4 Empirical Analysis

Our empirical analysis focuses on two related exercises. First, we relate changes in state-level child penalties by educational attainment to three factors: (i) possibilities for remote work, (ii) changes in societal attitudes about working mothers, and (iii) changes in childcare affordability. Second, we use individual-level information on the person’s primary occupation, which is available in the ACS data for individuals who have worked within the previous five years, including those not employed at the moment of the interview. We augment Kleven (2022)’s matching algorithm by adding a binary indicator for being employed in a teleworkable occupation—classified following Dingel and Neiman (2020)—to the set of characteristics used to construct the pseudo-panel of individuals. This allows us to construct child penalties for motherhood for women employed (or for-

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<sup>12</sup>We exclude group quarters and subset the ACS data to those who report working for a wage/salary. Childcare workers are defined on the basis of occupation (OCC2010) and industry (IND1990) combinations—see Table A1 for the classification scheme, adapted from CSCCE (2024). Private sector workers are defined as all other non-government wage workers. Hourly wages are calculated by discretizing the ACS variable for weeks worked last year—specifically, assigning the median of the range of weeks respondents reported working—then dividing wage and salary income last year by weeks worked last year times usual weeks worked.

merly employed) in jobs with different remote work potentials and track their evolution over time.

For our state-level analysis, we use the following regression specification, run separately for women with a college degree or more and women without a college degree:

$$\begin{aligned}
 SRCP_{st} = & \varphi_0 \cdot d_{2019-2023} + \varphi_1 \cdot (d_{2019-2023} \times Telework_s) + \varphi_2 \cdot (d_{2019-2023} \times \Delta GPI_s) \\
 & + \varphi_3 \cdot (d_{2019-2023} \times \Delta ChildCareRW_s) + \lambda_s + \varepsilon_{st},
 \end{aligned} \tag{4}$$

where  $SRCP_{st}$  is the child penalty for years 0-4 after the birth of the first child in a given labor market outcome for state  $s$  in 5-year period  $t \in [2005-2009, 2019-2023]$ ,  $d_{2019-2023} = \mathbb{1}[t = 2019-2023]$ ,  $\lambda_s$  are state fixed effects, and  $\varepsilon_{st}$  is an error term. Our estimation sample is restricted to data for 2005-2009 and 2019-2023, the first and last year ranges for which we can calculate  $SRCP_{st}$  for annual employment, weekly employment, and usual weekly hours.<sup>13</sup>

In [Equation 4](#),  $Telework_s$  represents the average share of jobs classified as teleworkable by state over the years 2000-2004. In this way, we examine the influence of states' initial availability of teleworkable jobs on the child penalty over time (i.e., before our first child penalty measures are calculated for 2005-2009). Intuitively, we expect that states with greater shares of teleworkable jobs experienced greater declines in the child penalty, particularly for higher-educated women who are more likely to have access to these jobs ([Dingel and Neiman, 2020](#); [Cowan, 2024](#)).  $\Delta GPI_s$  represents the state-level change of the Gender Progressivity Index between 1990-1999 and 2010-2018.  $\Delta ChildCareRW_s$  denotes the state-level average percent change (growth) in relative wages of childcare workers to all other private sector workers between 2005-2009 and 2019-2023. To facilitate the interpretation of the coefficients, our regression analysis uses a standardized version of these three variables. We subtract the median value of the variable from each state observation and scale it by the interquartile range (IQR) using the state-level distribution. Thus, the  $\varphi_0$  coefficient in [Equation 4](#) describes the average child penalty change from the beginning (2005-2009) to the end (2019-2023) of our sample period for the state with the median share of total employment in teleworkable occupations and that experienced the median change in gender norms and childcare affordability. In turn,  $\varphi_1$ - $\varphi_3$  measure the additional change in child penalties associated with moving from the 25th to the 75th percentile in the state distribution of each of these three variables. Finally, we weight each cell in our regressions by the sum of the female population used to estimate the state-level

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<sup>13</sup>Although we use ACS data starting in 2000, 2005 is the first year for which we have a complete set of synthetic non-parents ( $\tau \in [-5, -1]$ ) to calculate child penalties as defined in [Equation 3](#).

child penalties in a given period (calculated using IPUMS-ACS weights) and cluster the standard errors at the state level.

Our second exercise focuses on studying more directly the differential impact of being in a teleworkable job on employment outcomes and how this differential effect has evolved over time for women with different education levels. We create a binary teleworkable indicator for all individuals with valid occupation information in the ACS population based on the 0-1 occupation-specific teleworkable score retrieved using the classification developed by [Dingel and Neiman \(2020\)](#) and the crosswalk method described in [Section 3](#). This indicator is then used as an additional dimension to match parents with childless individuals of the same demographic *and* occupational characteristics, allowing us to construct a pseudo-panel that accounts for potential teleworkable status. We separately calculate child penalties by education for women in these two occupational groups defined by remote work potential.

We also report results from the following regression on the individual-level pseudo-panel data, separately for each gender and education group, using the three labor market outcomes of interest:

$$\begin{aligned}
 Y_{it}^g = & \beta_0^g \cdot PostBirth_{it} + \beta_1^g \cdot \left( Telework_{o(i)} \times PostBirth_{it} \right) + \beta_2^g \cdot \left( d_{2019-2023} \times PostBirth_{it} \right) \\
 & + \beta_3^g \cdot \left( d_{2019-2023} \times Telework_{o(i)} \times PostBirth_{it} \right) + \gamma_{a(i)o(i)}^g + \gamma_{to(i)}^g + \epsilon_{it}^g.
 \end{aligned}
 \tag{5}$$

Building on [Equation 1](#) and [Equation 4](#), [Equation 5](#) collapses all pre/post indicators in a single post-birth indicator,  $PostBirth_{it} = \mathbb{1}[t - B_i \geq 0]$ , and adds an interaction term between a  $Telework_{o(i)}$  indicator—equal to one if an individual  $i$ 's occupation  $o$  is classified as teleworkable—and this post-birth indicator which allows us to estimate the differential effect of having a child on a given outcome for individuals in jobs with remote work potential with respect to individuals in the same demographic cell but in non-teleworkable occupations. We allow the age and year effects to vary by occupational teleworkability status. We estimate [Equation 5](#) using the first (2005-2009) and last (2019-2023) pseudo-panels of individuals and include an additional interaction term with a dummy for the end-of-period panel,  $d_{2019-2023}$ , to measure the change over time in the teleworkability effect.

## 5 Results

In this section, we present the evolution of motherhood child penalties in employment by educational attainment and the results of our two sets of empirical exercises.

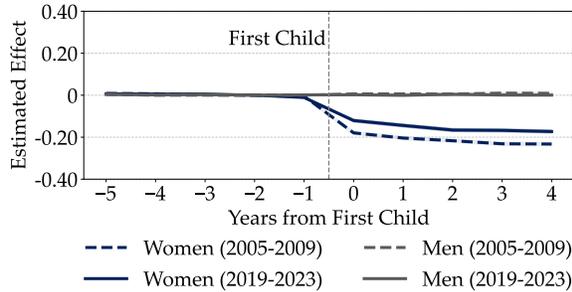
## 5.1 The Child Penalty Over Time by Educational Attainment

Figure 2 illustrates the impact of the first child on employment outcomes by gender and educational attainment, covering event times from five years before to four years after the child’s birth. Employment for women, both with and without a college degree, declines sharply during the year of childbirth and remains low throughout the observed period, as extensively documented in previous literature (see Cortés and Pan, 2023 for a review). This pattern is largely unique to women, as men’s employment outcomes remain steady both before and after their first child’s birth, highlighting a significant motherhood penalty. Pre-trends for both women and men are mostly flat in the years leading to the birth of the first child, evidencing that the Kleven (2022) pseudo-panel approach we follow works well in our setting, adding support to the causal interpretation of the child penalties we calculate later on.

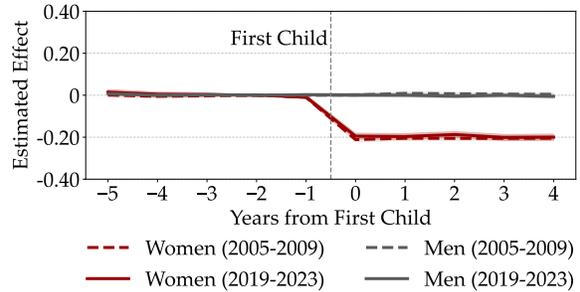
In each plot of Figure 2, we present event studies for 2005-2009 and 2019-2023, the first and last of the 5-year periods for which we have a complete pseudo-panel of individuals and can calculate child penalties. Notably, from 2005-2009 to 2019-2023, the negative impact of childbirth has lessened for college-educated mothers across all outcomes. In contrast, the improvement is relatively minimal for women without a college degree. When measured with employment (weekly or annual), there is almost no change and only modest gains if measured with usual weekly hours. For college-educated women, the reduction in the estimated effect of childbirth between these two periods seems uniform and persistent across the post-birth years, with the lines for the 2019-2023 period shifted up almost parallel to the 2005-2009 lines. The corresponding child penalties for motherhood derived from the event studies plotted in Figure 2—estimated using Equation 3—are shown in Panel A of Table 2.

Consistent with the evidence in Kleven (2022), Panel A of Table 2 shows that child penalties tend to be smaller at the extensive margin—whether or not mothers remain employed—than at the intensive margin (the number of weeks and hours worked). For example, among college-educated mothers in 2005-2009, the annual employment child penalty was 22.2%, whereas the usual weekly hours penalty was 33%. For non-college mothers, these penalties were 20.7% versus 29%, respectively. By 2019-2023, the annual employment penalty declined to 15.5% (college) and 19.5% (non-college), while the hours penalties fell to 23.5% and 27.8%, respectively. These comparisons illustrate that while many mothers remain in the labor force after having children, they are more likely to reduce their working hours. However, the relative reduction in child penalties along the extensive and intensive margins between 2005–2009 and 2019–2023 is very similar, indicating comparable improvements on both fronts despite the baseline differences.

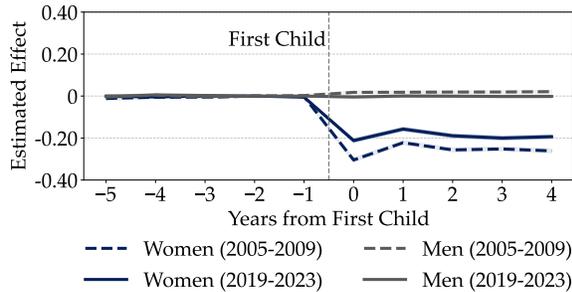
**Figure 2.** The Effect of the First Child on Employment by Gender and Educational Attainment



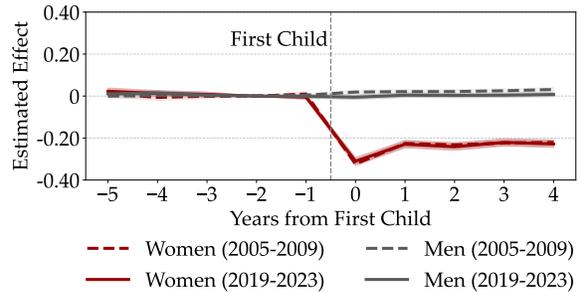
**(a) Annual Employment - College**



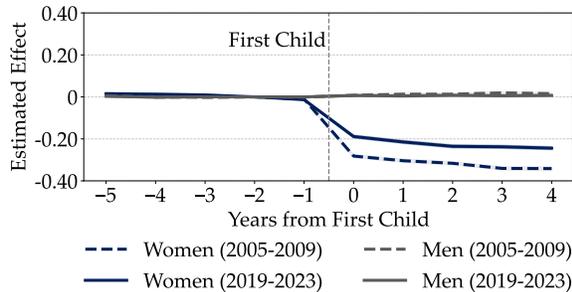
**(b) Annual Employment - No College**



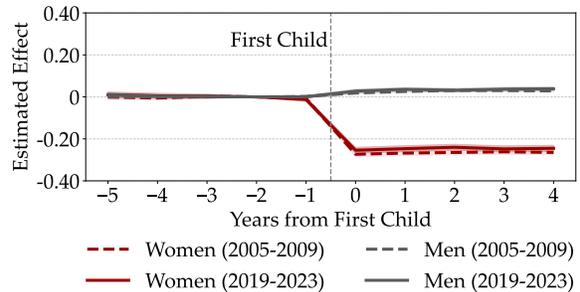
**(c) Weekly Employment - College**



**(d) Weekly Employment - No College**



**(e) Usual Weekly Hours - College**



**(f) Usual Weekly Hours - No College**

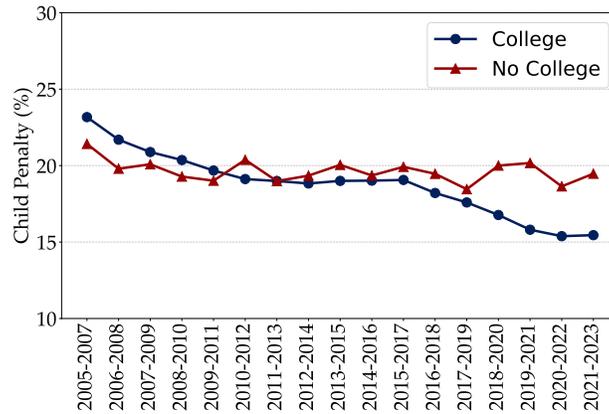
*Notes:* These figures plot the effect of the first child by educational attainment (college degree, no college degree) and gender (men, women) on annual employment (a, b), weekly employment (c, d), and usual hours worked per week (e, f). The effects are measured in percentage terms of the counterfactual outcome and are estimated using Equation 1 and Equation 2. For each figure, event-study plots using  $\tau = -2$  as the reference period are shown for two different periods: 2005-2009 (dashed line) and 2019-2023 (solid line). Shaded areas represent 95% confidence intervals based on robust standard errors.

**Table 2.** Summary of Changes in Nationwide Child Penalties

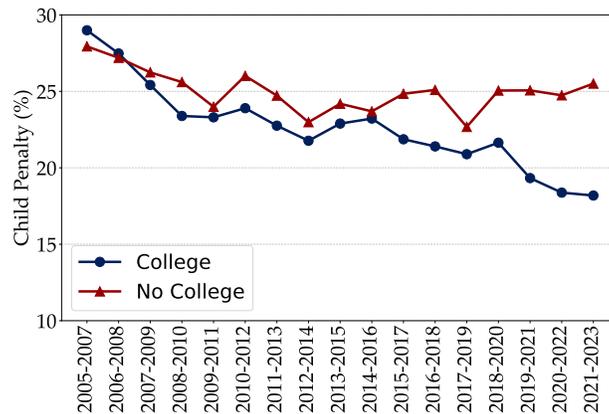
	Child Penalty					
	Annual Employment		Weekly Employment		Usual Weekly Hours	
	College	No College	College	No College	College	No College
<b>Panel A. All Sample</b>						
2005-2009	22.2	20.7	27.4	27.0	33.0	29.0
2019-2023	15.5	19.5	18.6	25.1	23.5	27.8
Change (p.p.)	-9.6	-1.2	-8.8	-2.0	-9.6	-1.2
Change (%)	-30.2	-6.1	-32.2	-7.3	-28.9	-4.0
<b>Panel B. Sample with Valid Occupation</b>						
2005-2009	17.0	15.2	25.4	22.7	29.0	24.0
2019-2023	11.0	14.1	16.0	22.1	19.7	22.8
Change (p.p.)	-6.0	-1.1	-9.3	-0.6	-9.4	-1.2
Change (%)	-35.0	-7.3	-36.8	-2.6	-32.3	-5.0
<b>Panel C. Non-Teleworkable Occupations</b>						
2005-2009	14.0	14.1	21.2	22.5	30.1	23.5
2019-2023	9.8	15.0	15.9	23.6	22.1	24.0
Change (p.p.)	-4.2	0.9	-5.3	1.1	-8.0	0.5
Change (%)	-30.1	6.4	-25.0	4.9	-26.7	2.3
<b>Panel D. Teleworkable Occupations</b>						
2005-2009	18.4	17.3	27.3	22.3	28.4	25.3
2019-2023	11.9	12.3	16.3	17.9	18.2	19.6
Change (p.p.)	-6.6	-5.0	-11.0	-4.4	-10.1	-5.7
Change (%)	-35.7	-29.0	-40.3	-19.7	-35.7	-22.7

*Notes:* This table presents child penalty changes between the initial (2005-2009) and final periods (2019-2023) of our ACS sample. Each panel reports the 2005-2009 and 2019-2023 child penalties as percentages and includes the changes over time in percentage points (p.p.) and percent change terms. These values are presented by child penalty outcome variable (annual employment, weekly employment, and usual hours worked per week) as well as education (college and no college) for the overall sample (Panel A), those with valid occupation data (Panel B), those reporting non-teleworkable jobs (Panel C), and those reporting teleworkable jobs (Panel D).

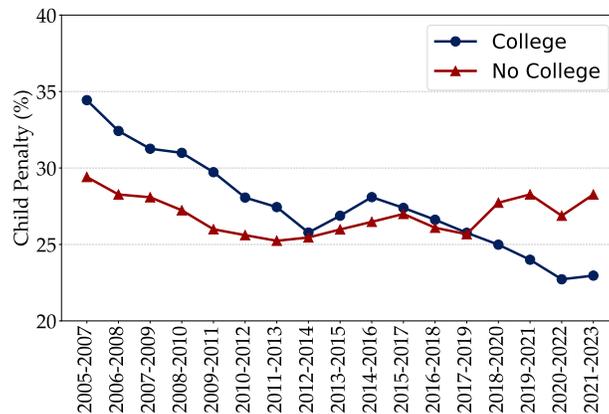
**Figure 3.** Evolution of the Motherhood Child Penalty in Employment by Educational Attainment



(a) Annual Employment



(b) Weekly Employment



(c) Usual Weekly Hours

*Notes:* These figures plot average motherhood child penalties for years 0-4 after the birth of the first child by educational attainment on annual employment (a), weekly employment (b), and usual hours worked per week (c). The effects are measured in percentage of the counterfactual outcome and estimated using Equation 3. Each figure shows time series plots for three-year rolling periods spanning 2005-2007 to 2021-2023. Blue solid lines with circles present the results for women with a college degree and more, while red solid lines with triangles do it for women without a college degree.

Notably, Panel A of [Table 2](#) shows that the child penalty fell substantially for college-educated mothers between 2005–2009 and 2019–2023 across all employment measures (annual employment, weekly employment, and usual weekly hours). For example, on the extensive margin, their annual employment penalty declined by 9.6 percentage points (a 30.2% drop), whereas non-college mothers saw only a 1.2 percentage-point improvement (6.1% drop). Similar patterns appear in weekly employment and hours, capturing disproportionate improvements among college-educated mothers on the intensive margin as well.

To better shed light on the dynamics of the child penalty over time for women with different education levels, [Figure 3](#) plots the evolution of the national-level motherhood child penalty by educational attainment using 3-year rolling windows starting with 2005–2007. Over the last two decades, the child penalty for college-educated and non-college-educated groups has decreased. However, [Figure 3](#) reveals again clear differences between these groups: the decrease is more sustained for the college-educated group, while for the non-college-educated group, the decline halts around the early 2010s, with no further improvement in the child penalty over the following decade. As a result, the college-educated group shows a much larger change from the first 3-year window (2005–2007) to the last (2021–2023): -7.7 percentage points (33.3%) if measured by annual employment, -10.8 percentage points (37.3%) by weekly employment, and -11.5 percentage points (33.3%) by usual weekly hours. In comparison, the numbers for non-college-educated women are -1.9 percentage points (9.1%), -2.4 percentage points (8.7%), and -1.1 percentage points (3.9%), respectively.

A more detailed version of the trends depicted in [Figure 3](#) is provided in [Figure A4](#), where we further disaggregate the college-educated group into those with and without an advanced degree (master’s degree, professional degree beyond a bachelor’s degree, or a doctoral degree). This breakdown reveals that mothers with an advanced degree experienced the most significant improvement among the three educational groups, regardless of the employment measurement used.

Over the past two decades, the employment rate gap between prime-age women with and without a college degree has widened from 11.5 to 16.4 percentage points (a 43% increase), largely driven by a sharp rise in employment among college-educated mothers as shown in [Figure 1](#). This increase parallels the contrasting declines in the employment child penalties for college-educated women compared to those without a college degree we documented above. Because childbearing significantly influences male–female labor market differences ([Cortés and Pan, 2023](#)), these contrasting declines in child penalties might help explain the expanding educational employment gap among women. Indeed,

using within-state variation in changes over 2005–2009 and 2019–2023, we find that shifts in annual employment child penalties can account for nearly half (44%) of the growth in this gap during that period.

## 5.2 Explaining the Changes in Child Penalties by Education

We use cross-state variation in child penalties over time to study the relationship between changes in employment child penalties by education and teleworkability opportunities, gender norms toward working mothers, and childcare costs during our period of analysis. [Table 3](#) present the regression results from estimating [Equation 4](#). The college-educated group is shown in the upper panel (Panel A), and the non-college-educated group is shown in the lower panel (Panel B).

As expected, the estimated coefficient for the later period dummy is significantly negative across all metrics for both the college- and non-college-educated groups, indicating a general reduction in the employment child penalties from 2005-2009 to 2019-2023 as shown in [Table 2](#) and [Figure 3](#) earlier.

Regarding the interaction terms, for the college-educated group, the interaction between the 2019-2023 period dummy and the state-level telework share yields negative and statistically significant estimates across all three labor market outcomes. This suggests that the initial availability of teleworkable jobs in a state strongly correlates with child penalty improvements over time for this group; states with higher teleworkability potential see greater reductions in employment penalties. More specifically, the results suggest that moving from the 25th to the 75th percentile of the state distribution of total employment share in potentially teleworkable occupations in 2000-2004, an increase of 5 percentage points, is associated with a decrease in the state-level child penalty of 2.1 percentage points (9.3%) in annual employment, 2.9 percentage points (10.4%) in weekly employment, and 2.9 percentage points (8.7%) in usual weekly hours worked for college-educated mothers between the periods 2005-2009 and 2019-2023. In contrast, interactions with the change in the Gender Progressivity Index (GPI) or the relative wage of childcare workers are all comparatively smaller and statistically insignificant.

For the non-college-educated group, telework potential is only strongly associated with the child penalty in annual employment. A similar 5-percentage points increase in the state share of teleworkable employment is associated with a reduction of 2.2 percentage points (10.5%) in the annual employment child penalty. The annual employment penalty captures a reduction in labor force participation at the extensive margin, while the weekly employment and usual hours penalties capture effects in both the extensive and

**Table 3.** Correlates of Changes in State-Level Child Penalties

	Child Penalty		
	Annual Employment	Weekly Employment	Usual Weekly Hours
	(1)	(2)	(3)
<b>Panel A: College</b>			
$d_{2019-2023}$	-6.238*** (0.634)	-8.332*** (0.640)	-8.730*** (0.655)
$d_{2019-2023} \times Telework$	-2.062*** (0.707)	-2.914*** (0.643)	-2.911*** (0.693)
$d_{2019-2023} \times \Delta GPI$	-0.127 (0.791)	-1.838 (1.149)	-0.013 (0.987)
$d_{2019-2023} \times \Delta ChildCareRW$	-1.011 (0.938)	0.416 (0.983)	-1.408 (1.087)
Observations	102	102	102
Mean 2005-2009	22.5	28.0	33.3
Mean 2019-2023	15.7	19.0	23.6
<b>Panel B: No College</b>			
$d_{2019-2023}$	-1.480** (0.679)	-2.433** (1.096)	-1.566* (0.801)
$d_{2019-2023} \times Telework$	-2.185*** (0.780)	-2.610* (1.525)	-1.325 (1.026)
$d_{2019-2023} \times \Delta GPI$	-1.983** (0.908)	0.274 (1.708)	-1.389 (1.119)
$d_{2019-2023} \times \Delta ChildCareRW$	2.354* (1.358)	0.330 (1.715)	2.938 (1.931)
Observations	102	102	102
Mean 2005-2009	21.0	27.8	29.3
Mean 2019-2023	19.5	24.8	27.7

*Notes:* This table presents results from estimating Equation 4. Each observation in the estimation sample is a state-level estimate of the average motherhood child penalty in employment (columns 1 and 2) or hours worked (column 3) during years 0-4 after the first child's birth for periods 2005-2009 or 2019-2023. Child penalties have been multiplied by 100, so the coefficients can be directly interpreted in percentage points. Panel A uses the child penalties for college-educated mothers. Panel B uses the child penalties for non-college-educated mothers.  $d_{2019-23}$  is a dummy variable equal to one if the period is 2019-2023. *Telework* represents the state share of total employment in teleworkable occupations in 2000-2004.  $\Delta GPI$  and  $\Delta ChildCareRW$  denote the changes in the state-level gender norms and childcare cost measures, respectively. These last three variables are standardized by subtracting their median and dividing by the IQR. All regressions weigh observations by the sum of the female population used to estimate the state-level child penalties. All regressions include state fixed effects. Standard errors are clustered at the state level and presented in parentheses (\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ ).

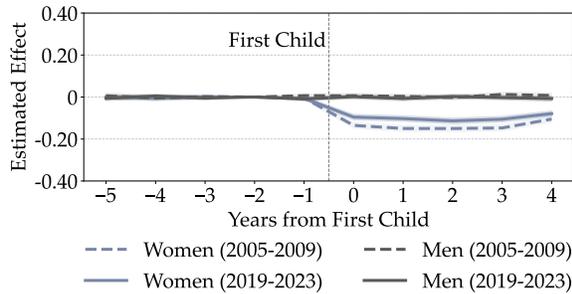
intensive margins. At the state level, telework potential correlates with reduced penalties at both margins for college-educated women but mainly at the extensive margin for women without a college degree. Additionally, improvements in gender progressivity are associated with lower child penalties in annual employment for women without a college degree. Moving from the 25th to the 75th percentile in the state distribution of GPI changes from the 1990s to the 2010s is correlated with a decrease of 2 percentage points (9.5%) in the annual employment child penalty for non-college women. Lastly, increased childcare costs seem to affect this group's employment outcomes relatively more. Moving from the 25th to the 75th percentile of the state distribution of changes in childcare workers' relative wages (an increase of 12.5 percentage points) is associated with an increase in the state-level child penalty of 2.4 percentage points (11.4%) in annual employment for non-college-educated mothers (significant at the 10% level).

To further understand how teleworkability affects the evolution of the child penalty over time within each educational group, we return to the individual-level data and estimate the impact of the first child on employment outcomes separately for individuals in teleworkable and non-teleworkable occupations. Only individuals who have worked in the last five years have a valid occupation code in the ACS data corresponding to their primary occupation (or the one at which they spent the most time). For non-employed individuals, the occupation reported corresponds to the most recent one.

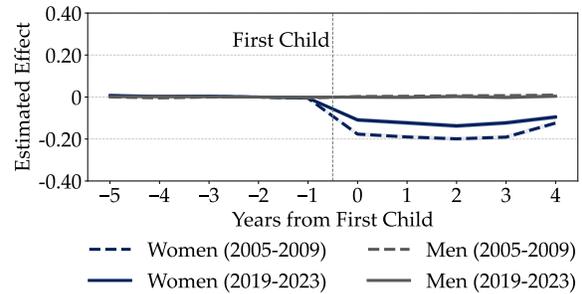
Since limiting the sample in this way affects the composition of our pseudo-panels, we first re-estimate the event studies and the overall child penalties by education within the sample of individuals with valid occupation information. [Figure A5](#) reports the equivalent of [Figure 2](#) using this restricted estimation sample. We also present the corresponding child penalties in Panel B of [Table 2](#). While the child penalties tend to be smaller among women in this group for all education groups, the event studies in [Figure A5](#) exhibit the same general patterns described before. In fact, Panel B of [Table 2](#) shows that, for the most part, the relative reductions in child penalties across all outcomes are comparable to the ones observed in the main sample.

Having corroborated that our general findings also hold in the sample with available occupational information, we plot in [Figure 4](#) the effect of the first child for the college-educated group separately by remote work feasibility of the individual's occupation. Panels on the left show the event studies for employment and usual weekly hours among men and women in non-teleworkable occupations, while panels on the right do it for those in teleworkable occupations. Importantly, our augmented matching algorithm produces flat pre-trends that are similar between men and women. While the negative effect of the first child on employment and hours tended to be greater for women in tele-

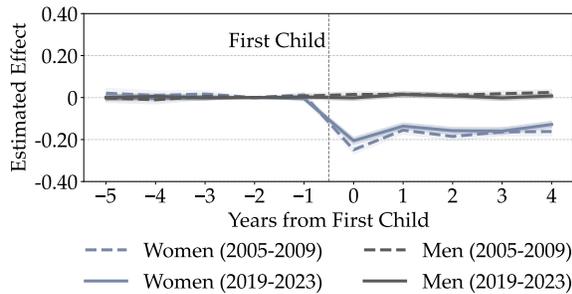
**Figure 4.** The Effect of the First Child on Employment by Gender and Occupation Teleworkability Potential: College-Educated Individuals



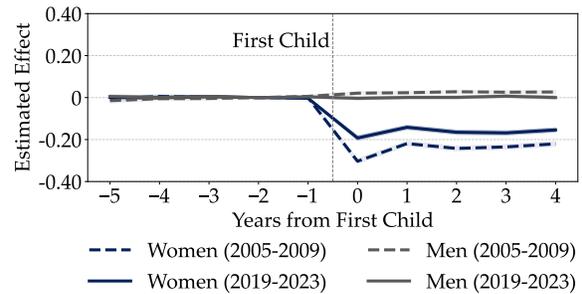
**(a) Annual Employment - Non-Teleworkable**



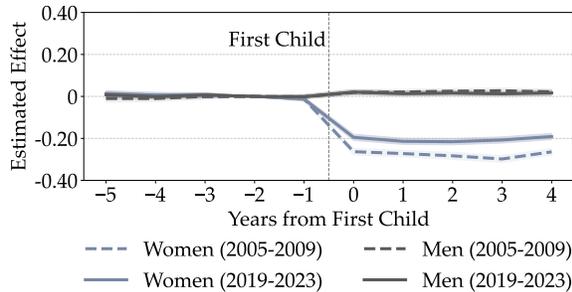
**(b) Annual Employment - Teleworkable**



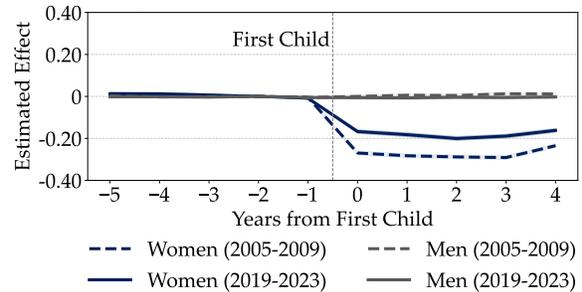
**(c) Weekly Employment - Non-Teleworkable**



**(d) Weekly Employment - Teleworkable**



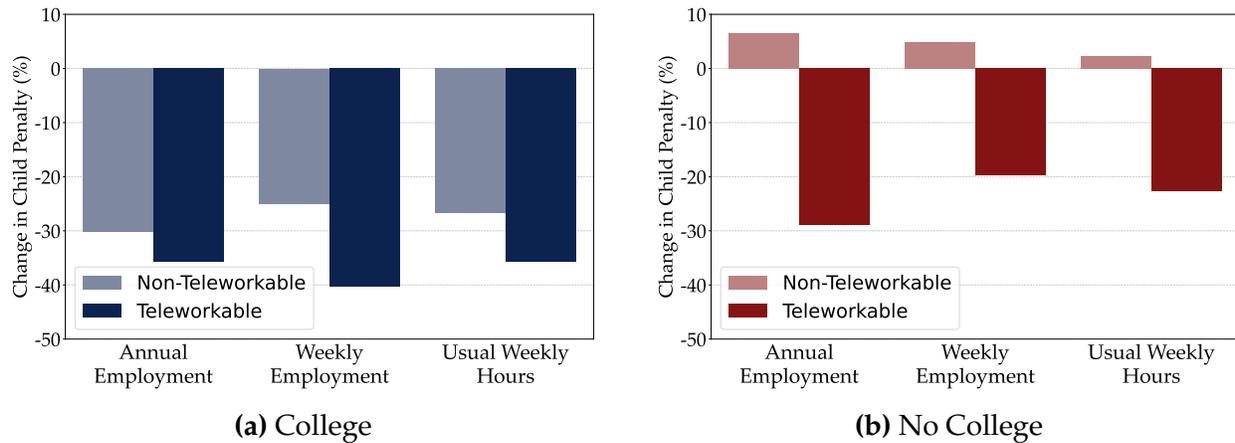
**(e) Usual Weekly Hours - Non-Teleworkable**



**(f) Usual Weekly Hours - Teleworkable**

*Notes:* These figures plot the effect of the first child on people with a college degree or more by teleworkability potential of occupations (non-teleworkable, teleworkable) and gender (men, women). Effects are measured in terms of annual employment (a, b), weekly employment (c, d), and usual hours worked per week (e, f). The effects are measured in percentage terms of the counterfactual outcome and are estimated using Equation 1 and Equation 2. For each figure, event-study plots using  $\tau = -2$  as the reference period are shown for two different periods: 2005-2009 (dashed line) and 2019-2023 (solid line). Shaded areas represent 95% confidence intervals based on robust standard errors.

**Figure 5.** Percent Change in Child Penalty by Occupational Teleworkability Potential and Educational Attainment



*Notes:* These figures plot percent changes between 2005-2009 and 2019-2023 in the motherhood child penalty for years 0-4 after the birth of the first child by occupational teleworkability potential separately for college-educated mothers (a) and non-college-educated mothers (b).

workable occupations at the beginning of the period, the effects in the teleworkable group and the non-teleworkable group became comparable by 2019-2023. This is because there was a more significant reduction in penalties for individuals in teleworkable occupations among those with a college education. The corresponding results for the non-college-educated group can be found in [Figure A6](#). We summarize the child penalties for this analysis in Panel C and Panel D of [Table 2](#) and plot the percentage change in these penalties over the past two decades in [Figure 5](#). Using a 5-year rolling window, we also present a time series of these child penalties on [Figure A7](#).

The findings in [Figure 5](#) indicate that child penalties decreased relatively more in teleworkable occupations than in non-teleworkable occupations, regardless of the mother’s educational level. Specifically, among college-educated women in teleworkable jobs, the child penalty in annual employment dropped by 35.7% (equivalent to 6.6 percentage points), while it decreased by 30.1% (or 4.2 percentage points) for those in non-teleworkable positions. When looking at weekly employment, the reduction gaps were even more pronounced, with a decline of 40.3% (11 percentage points) in teleworkable roles and 25% (5.3 percentage points) for non-teleworkable ones. Regarding usual hours worked per week, the child penalty decreased by 35.7% (10.1 percentage points) in teleworkable occupations and 26.7% (8 percentage points) in non-teleworkable jobs.

To better understand initial level differences and the distinct evolution of the employment child penalties by education and potential teleworkability groups, we use the job flexibility index introduced by [Goldin \(2014\)](#) to calculate flexibility scores for all occu-

pations in our ACS sample using data from 2000-2004 (see [Figure A8](#)).<sup>14</sup> This exercise suggests that occupations with high teleworkability potential—measured by [Dingel and Neiman \(2020\)](#)’s classification—tended to be less flexible and exhibited a higher elasticity of annual earnings to weekly hours. Across education levels, child penalties tended to be greater at the beginning of our sample period for college-educated women partly because they disproportionately held occupations with less flexibility and with higher returns to working long hours (but with high telework potential). Within educational groups, women in potentially teleworkable occupations tended to have bigger child penalties (particularly at the extensive margin), and those occupations tended to be less flexible in the [Goldin \(2014\)](#) sense. This was no longer the case in later periods, perhaps because of the materialization of the telework potential of these originally “inflexible” occupations. Short-run child penalties in employment converged, and they are now smaller for college-educated women than for women without a college degree; within a given education group, women in teleworkable occupations generally experience similar or lower child penalties. This point is similar to the one made by [Harrington and Kahn \(2023\)](#), who point out that among college-educated women, the motherhood penalty shrank more in traditionally family-unfriendly fields like finance and marketing.

We highlight two additional facts. First, in non-teleworkable occupations, the reductions in child penalties are exclusively concentrated in women with college degrees. The motherhood penalty for non-college-educated women in these occupations increased slightly relative to the initial period. This result is consistent with the findings in [Cowan \(2024\)](#), who shows that in occupations with low telework potential, in the [Dingel and Neiman \(2020\)](#) sense, holding a college degree appears to confer a bigger advantage in enabling *actual* remote work. Second, the decrease in child penalties for the non-teleworkable, college-educated group is comparable to, if not greater than, the reduction observed in the teleworkable, non-college-educated group: 30.1% compared to 29% in annual employment, 25% compared to 19.7% in weekly employment, and 26.7% compared to 22.7% in usual weekly hours. These findings suggest that occupational teleworkability and educational attainment play important but distinct roles in shaping child penalties in

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<sup>14</sup>[Goldin \(2014\)](#)’s original index comprises five characteristics that “reflect time pressure, the need for workers to be around at particular times, the flexibility of the occupation with regard to scheduling, the groups and workers the employee must regularly keep in touch with, and the degree to which the worker has close substitutes” ([Goldin, 2014](#), p. 1107). Although the specific O\*NET release version used for the scores was not explicitly stated, a possibility suggested by the publication timing is Release 18.0 (July 2013), for which nearly 50% of responses were collected between 2010 and 2013, another 50% between 2005 and 2009, and a very small fraction between 2002 and 2004. The selection of these characteristics, along with the distribution of data collection timing, suggests that [Goldin \(2014\)](#)’s flexibility scores capture a broader concept of workplace flexibility reflective of an earlier period, not directly aligning with the more recent, telework-specific focus of [Dingel and Neiman \(2020\)](#).

**Table 4.** The Effect of the First Child on Employment by Gender and Occupation Teleworkability Potential

	Annual Employment		Weekly Employment		Usual Weekly Hours	
	Female (1)	Male (2)	Female (3)	Male (4)	Female (5)	Male (6)
<b>Panel A: College</b>						
<i>PostBirth</i>	-0.135*** (0.003)	0.002 (0.003)	-0.177*** (0.005)	0.015*** (0.004)	-11.349*** (0.167)	1.245*** (0.144)
<i>Telework</i> × <i>PostBirth</i>	-0.042*** (0.004)	0.004 (0.003)	-0.052*** (0.006)	0.007* (0.004)	-0.335* (0.193)	-0.655*** (0.163)
<i>d</i> <sub>2019-2023</sub> × <i>PostBirth</i>	0.048*** (0.004)	0.003 (0.004)	0.038*** (0.006)	-0.011** (0.005)	3.617*** (0.207)	-0.636*** (0.190)
<i>d</i> <sub>2019-2023</sub> × <i>Telework</i> × <i>PostBirth</i>	0.023*** (0.005)	-0.006 (0.004)	0.037*** (0.007)	-0.010* (0.005)	0.956*** (0.242)	-0.103 (0.214)
Observations	2,038,394	1,444,843	1,876,513	1,346,073	2,038,394	1,444,843
Base Mean	0.936	0.933	0.852	0.884	38.184	43.928
<b>Panel B: No College</b>						
<i>PostBirth</i>	-0.128*** (0.003)	-0.001 (0.002)	-0.180*** (0.005)	0.014*** (0.002)	-7.740*** (0.136)	0.881*** (0.079)
<i>Telework</i> × <i>PostBirth</i>	-0.030*** (0.005)	0.001 (0.004)	-0.022*** (0.007)	-0.006 (0.005)	-0.743*** (0.204)	0.385** (0.177)
<i>d</i> <sub>2019-2023</sub> × <i>PostBirth</i>	-0.014*** (0.005)	-0.007*** (0.003)	-0.023*** (0.006)	-0.012*** (0.004)	0.194 (0.186)	0.051 (0.118)
<i>d</i> <sub>2019-2023</sub> × <i>Telework</i> × <i>PostBirth</i>	0.052*** (0.007)	-0.002 (0.006)	0.040*** (0.010)	-0.017** (0.008)	1.583*** (0.294)	-0.706** (0.274)
Observations	976,522	1,355,909	827,318	1,192,528	976,522	1,355,909
Base Mean	0.909	0.925	0.78	0.855	33.454	41.734

Notes: This table presents results from estimating Equation 5. It shows the average level effect of the first child's birth (years 0-4) on employment by gender (men, women) and education level (college or more, no college). The table shows the differential effect of being on an occupation with teleworkability potential. The sample includes individuals in pseudo-panels from 2005-2009 and 2019-2023. Robust standard errors are presented in parentheses (\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ ).

employment.

Finally, we test for the statistical significance of the role that teleworkability has on the employment effect of having the first child by pooling all individuals in our first and last pseudo-panels and running a single regression on the combined sample using the specification in Equation 5. Table 4 displays the results by gender estimated using the college-educated population (Panel A) and the non-college-educated population (Panel B). The first row in both panels presents the average level effect of the first child on annual employment, weekly employment, and usual hours worked per week four years after birth (relative to the previous five years) for individuals in our first pseudo-panel in non-teleworkable occupations. As expected, all the estimated coefficients for women are negative and statistically significant, while for men, they are comparatively small and

close to zero. These numbers are behind the child penalties reported earlier in [Table 2](#). The interaction between the post-birth and the telework indicators are all statistically significant and negative for women, indicating again that at the beginning of the period, women in these occupations tended to experience a more significant motherhood penalty. For instance, women with a college degree in teleworkable occupations used to experience an additional 4.2 percentage points reduction in annual employment. In turn, the interaction between the post-birth and the later-period indicators are all positive and significant for college-educated women. This indicates decreased child penalties for women with college degrees in non-teleworkable occupations in the last period. However, the positive and significant coefficient for the triple interaction that adds the telework indicator implies that the reduction in employment penalties is higher among women in occupations with teleworkable potential. In contrast, the improvements for women without college degrees are exclusively driven by mothers in potentially teleworkable occupations.

## 6 Conclusion

In this paper, we documented that over the past two decades in the U.S., college-educated mothers have experienced a significant decrease in short-run child penalties in employment both at the extensive margin and at the intensive margin, particularly in occupations with strong potential for remote work, but not exclusively. By contrast, non-college-educated mothers have seen only modest reductions in child penalties, all concentrated in occupations with telework potential. These contrasting paths have, in turn, widened overall disparities in labor force participation by education. Indeed, our estimates suggest that changes in annual employment child penalties alone can explain almost half of the five-percentage-point increase in the female educational employment gap over this period. Our results also suggest that telework potential and education independently shape motherhood penalties. Further research is essential to explore additional factors contributing to these trends and their implications for socioeconomic inequality and intergenerational mobility.

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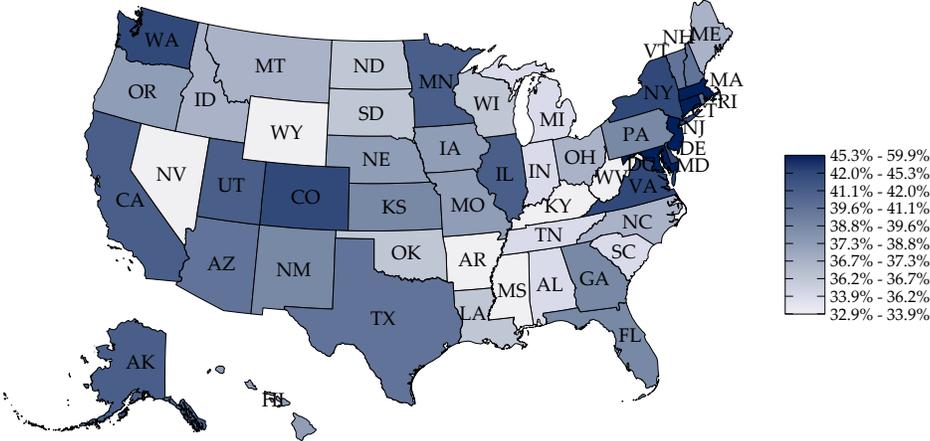
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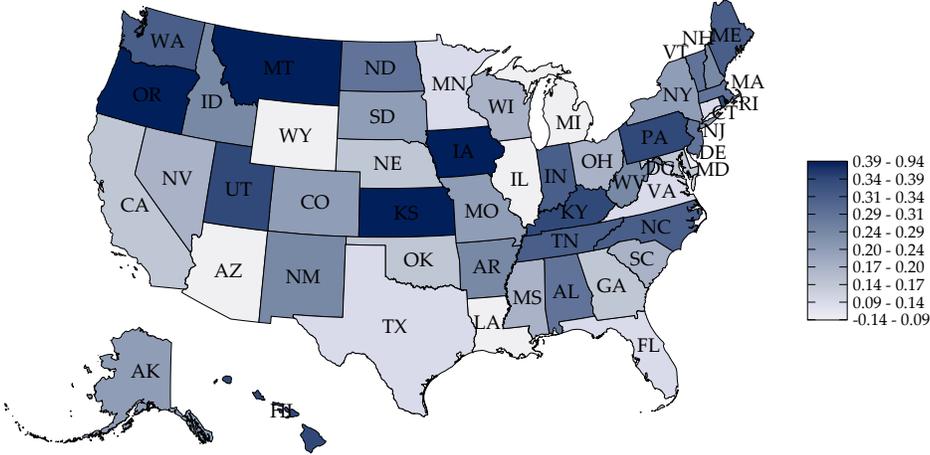
# Appendices

## A Appendix tables and figures

**Figure A1. Telework Potential and Gender Norms Changes Across States**



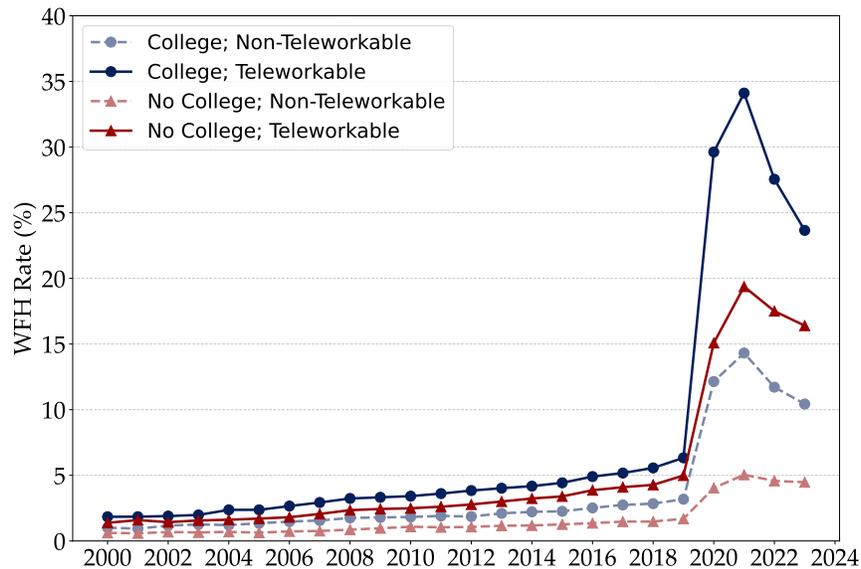
**(a) Share of State Employment in Teleworkable Occupations: Average 2000-2004**



**(b) Change in Gender Progressivity Index from 1990s to 2010s**

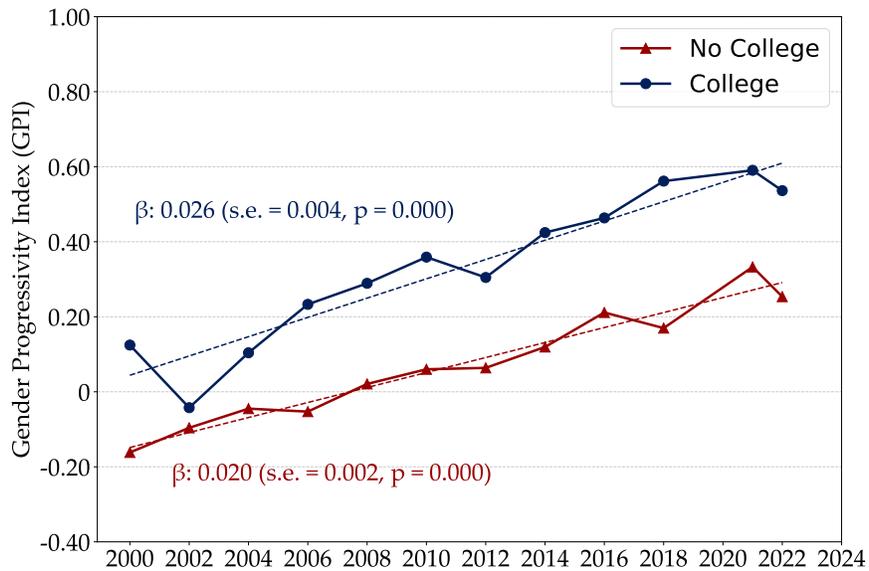
*Notes:* Panel (a) plots the state-level variation in the share of total employment in occupations with teleworkable potential as categorized by [Dingel and Neiman \(2020\)](#). State shares are estimated using pooled ACS data for 2000-2004. Panel (b) plots the state-level variation in changes in the Gender Progressivity Index (GPI) measuring attitudes towards working mothers (higher values imply more progressive attitudes) between the decades of the 1990s and 2010s. Information for the state-by-decade level GPIs comes from [Kleven \(2022\)](#).

**Figure A2.** Work from Home (WFH) Rates by Education and Teleworkable Occupation Status

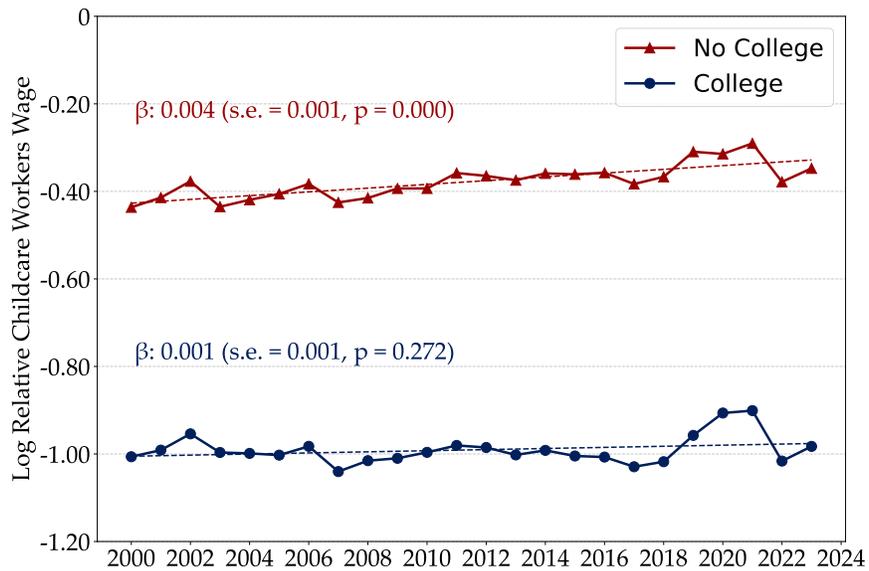


*Notes:* This figure plots national average work from home (WFH) rates between 2000 and 2023, separated by education level and teleworkable occupation status, using ACS data and person-level weights. The WFH rate is defined as the share of the employed (positive usual weekly work hours and wage income last year), prime age (25-54) wage and salary worker population that reported working from home last week (TRANWORK = 80). Teleworkable occupation status is based on the classification developed by [Dingel and Neiman \(2020\)](#). Blue solid lines with circles represent workers with a college degree and more, while red solid lines with triangles represent workers without a college degree. Lighter lines represent non-teleworkable occupations, while darker lines represent teleworkable occupations.

**Figure A3.** Gender Norms and Relative Childcare Workers Wages by Educational Attainment



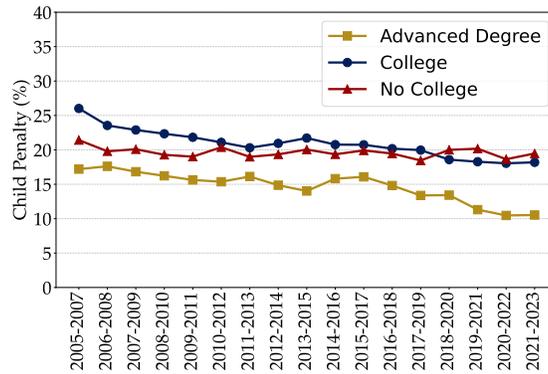
**(a)** Gender Progressivity Index (2000-2022)



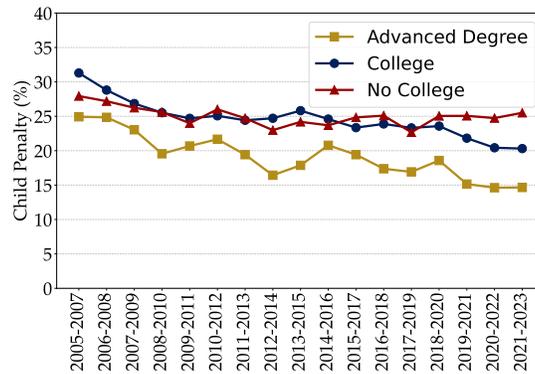
**(b)** Relative Wage of Childcare Workers to Private Sector Workers (2000-2023)

*Notes:* Panel (a) plots the evolution of the Gender Progressivity Index (GPI) measuring attitudes toward working mothers (higher values imply more progressive attitudes) by educational attainment between 2000 and 2022. We construct the GPI using data from the General Social Survey (GSS) following [Kleven \(2022\)](#) and then separate respondents by their education level. Panel (b) plots the evolution of the (log) relative wage of childcare workers to private sector workers between 2000 and 2023, estimated using ACS data. For both plots, numbers correspond to national averages. Solid blue lines with circles show information for individuals with a college degree or more, and solid red lines with triangles do it for individuals without a college degree. Dashed lines represent linear trends. We report the slope of those lines ( $\beta$ s) with their corresponding (robust) standard errors and the  $p$ -value of a statistical significance test.

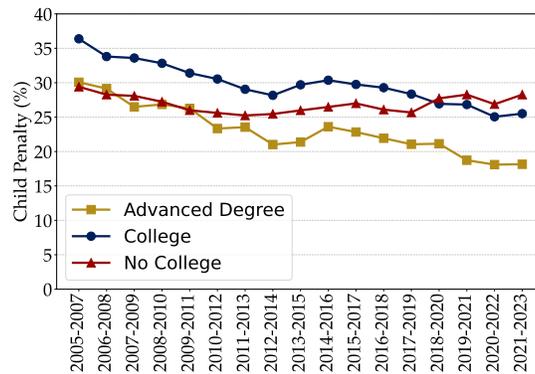
**Figure A4.** Evolution of Child Penalty by Educational Attainment (Advanced Degree)



**(a) Annual Employment**



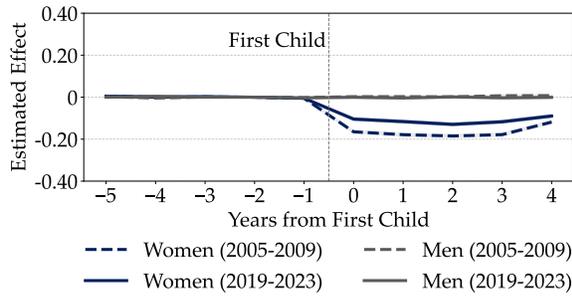
**(b) Weekly Employment**



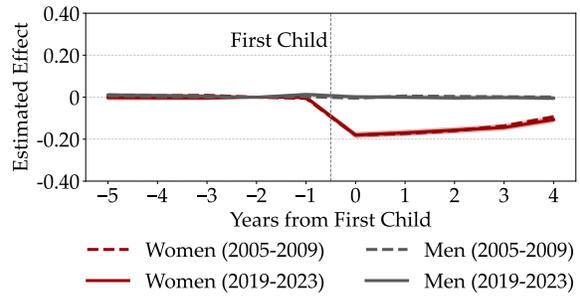
**(c) Usual Weekly Hours**

*Notes:* These figures plot average motherhood child penalties for years 0-4 after the birth of the first child by educational attainment on annual employment (a), weekly employment (b), and usual hours worked per week (c). The effects are measured in percentage of the counterfactual outcome and estimated using Equation 3. Each figure shows time series plots for three-year rolling periods spanning 2005-2007 to 2021-2023. Yellow solid lines with squares present the results for women with advanced degrees; blue solid lines with circles present the results for women with a college degree; and red solid lines with triangles do it for women with less than a college degree.

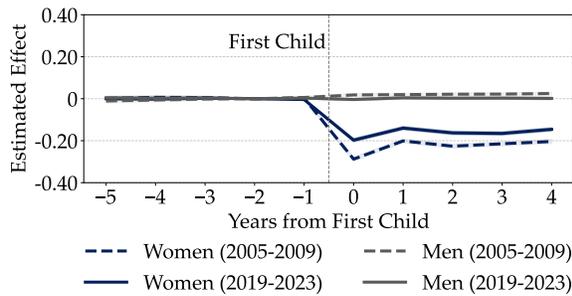
**Figure A5.** The Effect of the First Child on Employment by Gender and Educational Attainment: Individuals with Valid Occupation Information



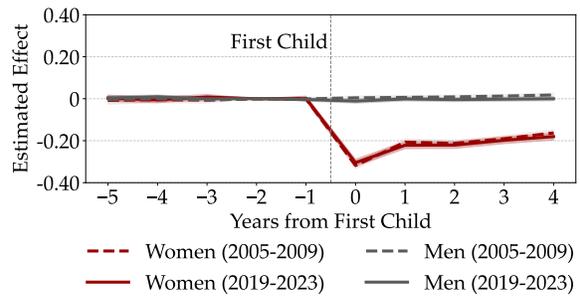
**(a)** Annual Employment - College



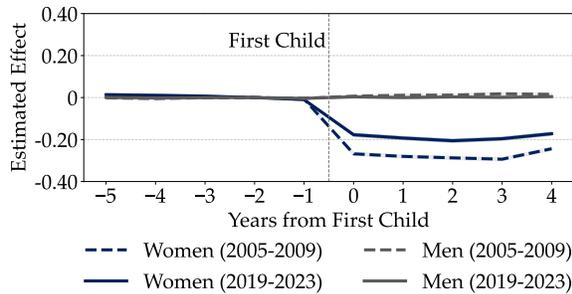
**(b)** Annual Employment - No College



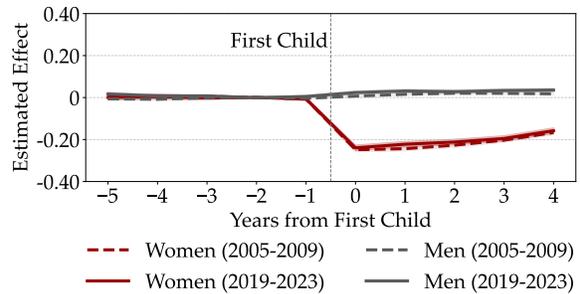
**(c)** Weekly Employment - College



**(d)** Weekly Employment - No College



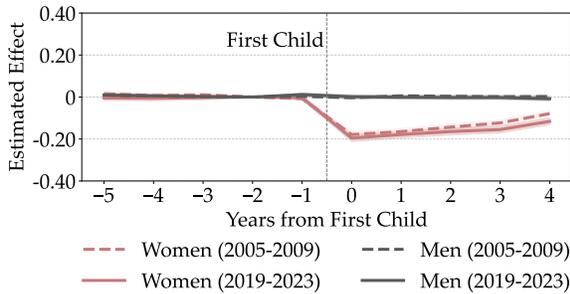
**(e)** Usual Weekly Hours - College



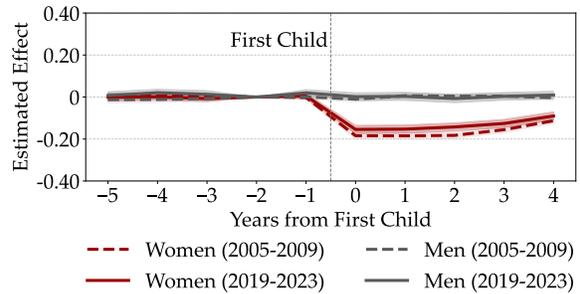
**(f)** Usual Weekly Hours - No College

*Notes:* These figures plot the effect of the first child by educational attainment (college degree, no college degree) and gender (men, women) on annual employment (a, b), weekly employment (c, d), and usual hours worked per week (e, f) for observations reporting valid occupation information (i.e., for individuals who had worked within the previous five years and are not new workers). The effects are measured in percentage terms of the counterfactual outcome and are estimated using Equation 1 and Equation 2. For each figure, event-study plots using  $\tau = -2$  as the reference period are shown for two different periods: 2005-2009 (dashed line) and 2019-2023 (solid line). Shaded areas represent 95% confidence intervals based on robust standard errors.

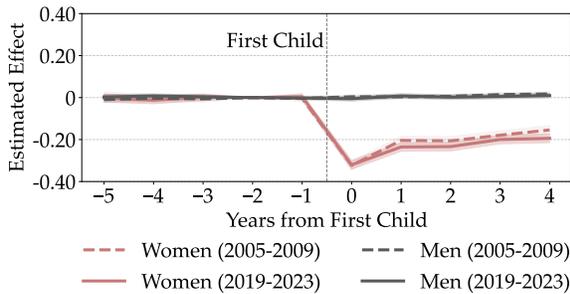
**Figure A6.** The Effect of the First Child on Employment Gender and Occupation Teleworkability Potential: Non-College-Educated Individuals



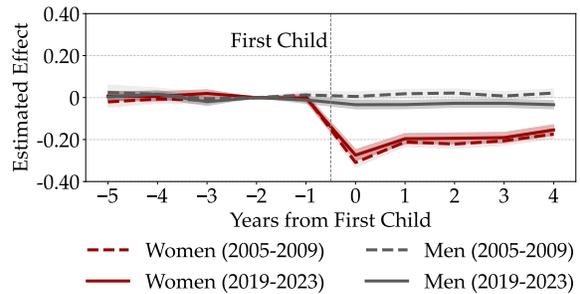
**(a)** Annual Employment - Non-Teleworkable



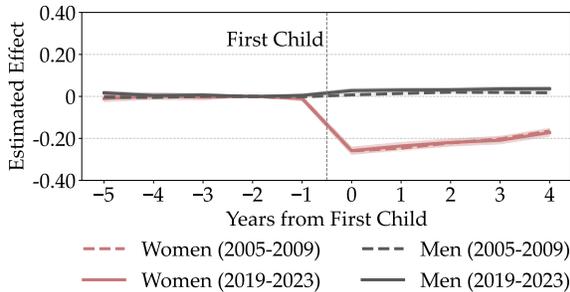
**(b)** Annual Employment - Teleworkable



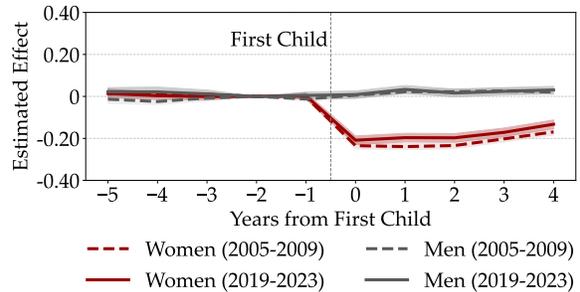
**(c)** Weekly Employment - Non-Teleworkable



**(d)** Weekly Employment - Teleworkable



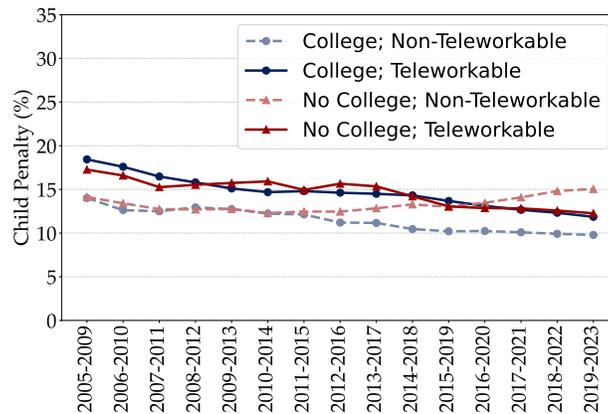
**(e)** Usual Weekly Hours - Non-Teleworkable



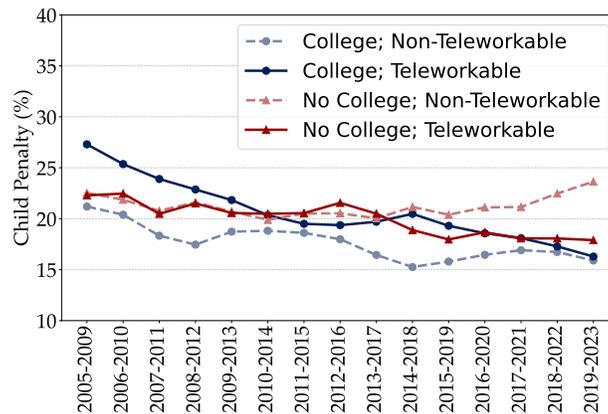
**(f)** Usual Weekly Hours - Teleworkable

*Notes:* These figures plot the effect of the first child on people without a college degree by teleworkability potential of occupations (non-teleworkable, teleworkable) and gender (men, women). Effects are measured in terms of annual employment (a, b), weekly employment (c, d), and usual hours worked per week (e, f). The effects are measured in percentage terms of the counterfactual outcome and are estimated using Equation 1 and Equation 2. For each figure, event-study plots using  $\tau = -2$  as the reference period are shown for two different periods: 2005-2009 (dashed line) and 2019-2023 (solid line). Shaded areas represent 95% confidence intervals based on robust standard errors.

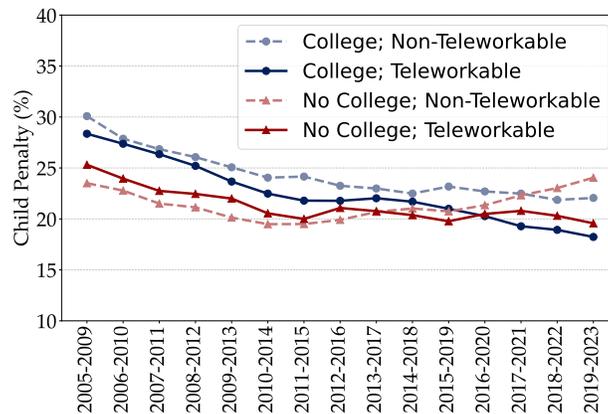
**Figure A7.** Evolution of the Motherhood Child Penalty in Employment by Educational Attainment and Occupational Teleworkability Potential



**(a) Annual Employment**



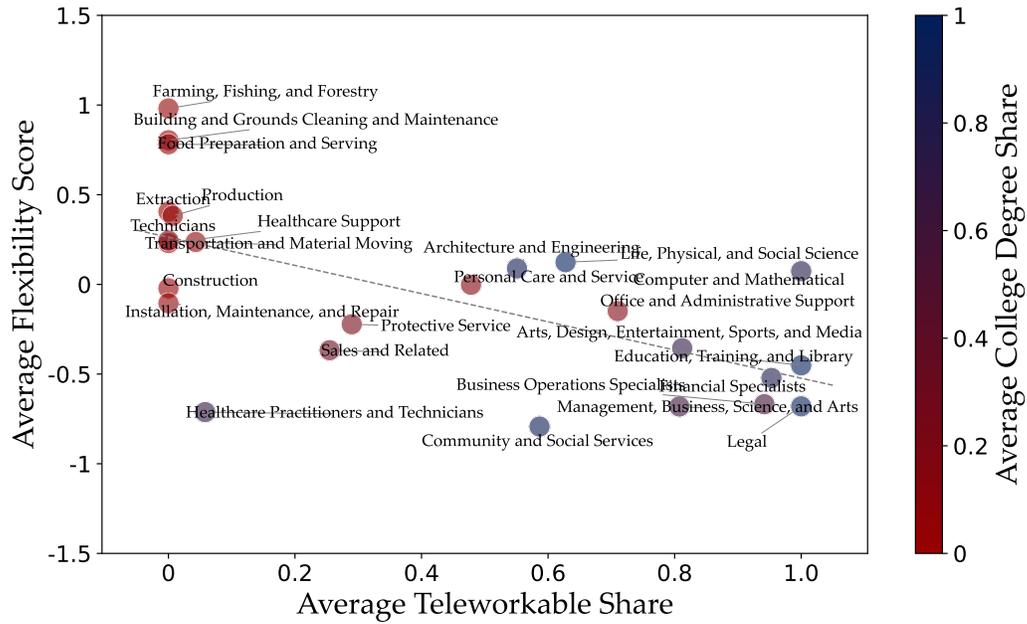
**(b) Weekly Employment**



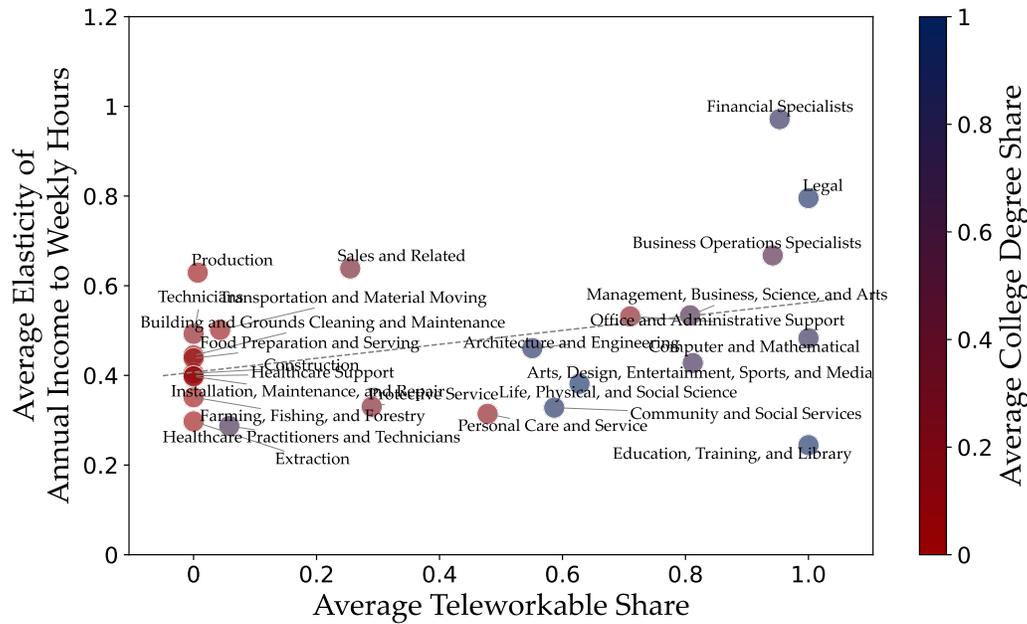
**(c) Usual Weekly Hours**

*Notes:* These figures plot average motherhood child penalties for years 0-4 after the birth of the first child by educational attainment and occupational teleworkability potential on annual employment (a), weekly employment (b), and usual hours worked per week (c). The effects are measured in percentage of the counterfactual outcome and estimated using Equation 3. Each figure shows time series plots for five-year rolling periods spanning 2005-2009 to 2019-2023. Blue solid lines with circles present the results for women with a college degree and more, while red solid lines with triangles do it for women without a college degree.

**Figure A8. Telework Potential and Flexibility by Occupational Group**



**(a) Telework and Job Flexibility**



**(b) Telework and Elasticity of Annual Income to Weekly Hours**

*Notes:* This figure presents the relationship between job flexibility and telework potential by occupational group. Panel (a) presents a job flexibility index defined following Goldin (2014). In our application, higher values indicate more flexibility. Panel (b) presents the elasticity of annual earnings to weekly hours worked estimated using the same specification in Goldin (2014). Telework potential is given by the classification developed by Dingel and Neiman (2020). We report the average for each occupational group as defined by the IPUMS 2010 harmonized occupation coding scheme. We use pooled 2000-2004 ACS data.

**Table A1.** American Community Survey Occupation-Industry Pairings Defining Child-care Workers

<b>ACS Occupation (OCC2010)</b>	<b>ACS Industry (IND1990)</b>
4600 Childcare Workers	862 Child day care services
4600 Childcare Workers	761 Private households
4600 Childcare Workers	842 Elementary and secondary schools
4600 Childcare Workers	880 Religious organizations
2300 Preschool and Kindergarten Teachers	862 Child day care services
2540 Teaching Assistants	862 Child day care services
0230 Education Administrators	862 Child day care services

*Notes:* This table describes the ACS occupation-industry pairings used to define childcare workers for the purpose of calculating the relative wages of childcare workers to private sector workers. Each row represents a unique combination of OCC2010 and IND1990 codes which define a childcare worker. This classification scheme was adapted from [CSCCE \(2024\)](#).