Child Penalty amid Declining Fertility: Evidence from Administrative Data in South Korea*

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Abstract

This paper studies the relationship between the child penalty and declining fertility, by investigating changes in mothers' behavioral responses to childbirth as well as their composition in the country with the world's lowest fertility rate, South Korea. We utilize administrative data covering the entire population to estimate the effect of first childbirth in an event study framework. Focusing on women born between 1976 and 1985, we find that the loss in women's earnings in the short-run *increased* across cohorts from 40% to 46%. We explore underlying mechanisms and find that changes in mothers' baseline characteristics do not seem to explain the increase in child penalties. Instead, we find that the cohort difference is partly attributable to the higher use of parental leave among the more recent cohort.

JEL Codes: J16, J13
Keywords: Child penalty, low fertility

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1 Introduction

Recent studies show the existence of significant "child penalty" as women's earnings fall sharply following first childbirth whereas men's remain largely unaffected (Angelov et al., 2016; Kleven et al., 2019a,b). With the gender gap in educational attainment narrowing, child penalty is considered the largest remaining obstacle in eliminating the gender pay gap in developed countries (Cortés and Pan, 2020; Goldin, 2021; Kleven et al., 2023). Various policies are thus being discussed and studied with the goal of reducing the child penalty (Andresen and Nix, 2022a; Kleven et al., 2020; Olivetti and Petrongolo, 2017).

However, from an individual woman's perspective, there is a sure way to avoid the child penalty—to not have any children. Among OECD countries, the fertility rate is indeed lower in places with characteristics associated with larger child penalties such as less generous family policy, more traditional social norms, and inflexible labor markets (Feyrer et al., 2008; Doepke et al., 2023). But cross-country correlations do not provide insight on how the child penalty would evolve as childlessness increases. Would the child penalty also decline in low-fertility regions, leading to convergence across both gender and countries? Or could the large child penalty affect the composition of mothers, so as to further increase the child penalty?

This paper studies the relationship between the child penalty and declining fertility, by investigating changes in the outcomes and characteristics of mothers in the country with the world's lowest fertility rate, South Korea.[1] Specifically, we focus on the labor market trajectories of recent cohorts of women, born between 1976 and 1985, for whom the cohort fertility rate by age 36 dropped from 1.5 to 1.07 child per woman.[2] We utilize exceptional administrative data from the National Health Insurance System (NHIS), which contains information on employment, earnings, healthcare utilization and household members of the entire population from 2002 to 2020.

[1] The total fertility rate (TFR) in South Korea is 0.78 as of 2022. The OECD average TFR is 1.58.
[2] Authors' calculations using data from the Vital Statistics and Population Projections. The 1985 cohort are not yet old enough to observe complete cohort fertility.

To estimate the impact of children, we adopt a quasi-experimental approach based on event studies around the birth of the first child as in Kleven et al. (2019a). We track mothers' labor market outcomes from three years prior to five years after first childbirth. We construct two separate comparison groups. The first group is the husbands. This approach has the advantage that we observe the gender gap in earnings profiles among parents who are affected by the same event. However, husbands may not be the best comparison group if we are interested in the counterfactual of remaining childless, which is especially relevant in a low-fertility country. Therefore, we also construct a control group of childless women by combining matching with the event study methodology.[3]

We find that mothers' earnings drop by more than 41% by the fifth year relative to the year before first childbirth, whereas men's earnings profiles are nearly unaffected. Most of the drop in women's earnings actually occurs months before first childbirth, during pregnancy. When we compare cohorts 1976–80 and 1981–85, we find that the child penalty in the short-run has *increased* from 40% to 46%. This is in sharp contrast to prior studies such as Andresen and Nix (2022a) and Kleven (2022) which find that child penalties have declined across years in Norway and the U.S., respectively.

To explain the large child penalty and its increase across cohorts, we explore potential changes in the composition of mothers as well as their behavioral responses to childbirth. First, we apply inverse probability weighting to test whether the cohort difference in child penalty diminishes when we take into account various observable characteristics. We find that the result remains largely unaffected when we align baseline characteristics across cohorts. However, we find that there is a significant cohort difference in whether mothers take leave. Women in the 1981–85 cohort are twice as likely to take leave than the 1976–80 cohort within 18 months since first childbirth. In fact, the gap in child penalties across cohorts reverses if we replace zero earnings of workers on leave with their earnings preceding leave. The recent cohort of women are also slightly more likely

[3]The results using the second control group are not yet included in this version of the paper.

to have subsequent children, conditional on having the first child.

The paper contributes to the growing literature on child penalty. To study the effect of children on women's earnings, earlier research used instrument variables such as sibling sex mix and twin births to account for the endogeneity of having children (e.g., Angrist and Evans, 1998). This method comes with the limitation of being unable to examine the effect of *first* childbirth, which is known to have a greater impact than subsequent births. Recent studies, following the work of Kleven et al. (2019a), exploit panel data to estimate the effect of first childbirth using an event study framework (see Cortés and Pan (2020) for a review of this literature). All studies report signficant child penalties for women, although the magnitude differs by country (Kleven et al., 2023).

To our knowledge, we are the first to empirically investigate the child penalty in light of declining fertility within a country. Most prior studies on the child penalty focus on its contribution to the gender pay gap, and thus compare the outcomes of wife and husband (or women and men in general). However, in countries with rising childlessness, the child penalty can be affected not only by intra-household allocation but also by who chooses to become parents in the first place. If women anticipating relatively small child penalties become mothers, the average child penalty would decrease. Conversely, if women willing and able to take leave become mothers, the average child penalty would increase. We explicitly consider these possibilities, and thereby provide new insight on the source of child penalty. Our findings will also shed light on other countries in Asia experiencing similar demographic trends.

The remainder of the paper is organized as follows. Section 2 provides background on South Korea's low fertility. Section 3 describes the NHIS data and our estimation framework. Section 4 presents the results on child penalties across cohorts, and Section 5 explores underlying mechanisms. Finally, Section 6 concludes.

2 Background

South Korea experienced one of the fastest economic growth in the world, transforming from a developing to a developed county within a few generations. Educational attainment expanded remarkably, with the share of population holding tertiary education increasing from 27% among 55–64 year olds to 70% among 25–34 year olds (OECD, 2023d). The gender gap in educational attainment also disappeared; college entrance rates for women have in fact surpassed that of men since 2009.

Cultural and institutional features do not change as quickly, however. As a legacy from the labor-intensive high-growth era, South Korea has the fourth longest working hours among OECD countries (OECD, 2023c). Traditional gender norms also persist. For instance, more than half of Koreans agree to the statements "Men should have more right to a job than women" and "Pre-school child suffers with working mother" (53 and 65 percent, respectively) in the 2017–2018 World Value Survey, in contrast to the U.S. where only a small minority agree to these statements (5 and 21 percent, respectively). Housework and childcare responsibilities continue to disproportionately fall on the wife. Among dual-earner couples with young child, the gender gap in housework and childcare time in South Korea is three times the gender gap in the U.S. (Bureau of Labor Statistics, 2020; Choi, 2018)

Therefore, working mothers face a challenging trade-off between the demand from "greedy work" and from traditional gender roles in the household (Goldin, 2021). The gender wage gap among full-time employees is 31%, the largest among OECD countries (OECD average is 12%; OECD, 2022). Meanwhile, the total fertility rate (TFR) has been below 1.3 children per woman ("lowest-low" fertility rate; Kohler et al., 2002) for more than twenty years, and has currently reached the world's lowest level at 0.78. With many women exiting the labor market upon childbirth, South Korea's large gender pay gap and low fertility rate may be two sides of the same coin.[4]

[4]Other factors contributing to the declining fertility rate include the rise in housing prices, childcare costs,

To address these issues, the South Korean government increased public spending on families by more than tenfold since the early 2000s. Paid parental leave has expanded in both eligibility and allowance amount. From 2002 to 2020 (the first and last years of our study period), for example, parental leave eligibility expanded significantly from parents with a child below age 1 to those with a child below age 8. Parental leave payments during the first three months increased from around $230 per month to a 80% replacement rate (with minimum $540, maximum $1,150).[5] Early childhood education and care service are also subsidized so that enrollment rates among children under age 5 is now 82% (OECD, 2023a). Despite these improvements, however, South Korea's public family spending still remains lower than the OECD average (1.4% of GDP vs. 2.1%; OECD, 2023b).

3 Data and Empirical Strategy

3.1 Data

The analysis is based on administrative records obtained from the National Health Insurance System (NHIS). The NHIS data covers all residents because South Korea provides universal health insurance. The data consists of multiple databases on health insurance eligibility, medical records, and household members, which can be linked using unique individual identifiers. The eligibility database provides monthly socioeconomic variables such as age, sex, type of health insurance, and earnings. Employer information, including firm ID, size, location, and industry classification, can be linked to the individual on an annual basis. The medical records database contains comprehensive information on healthcare utilization, including details such as the date treatment was initiated and the type of procedure or surgery performed. The data is available from 2002 to 2020.

Because 99.8% of births in South Korea occur in hospitals, the medical records database

and shifts in attitudes among the younger generation (Hwang, 2023).

[5] We use the exchange rate of 1 USD $\approx$ 1,300 KRW (Korean won) throughout the paper.

allows us to identify the timing of first childbirth. We define a woman's first childbirth as her earliest birth among all recorded births in the data, for which the procedure code indicates that it was her "first" birth.[6] We use the date of treatment to define a woman's year and month of first childbirth.

Information on labor market outcomes can be obtained from the eligibility database because employment status and health insurance type are linked: employee-insured, self-employed insured, medical aid, and dependents. All regular employees and employers with at least one employee are eligible for employee insurance, and are obligated to pay insurance fees determined as a percentage of their monthly earnings.[7] Medical aid is a form of public assistance to provide low-income groups with healthcare, and comprise less than 2% of our sample. All other individuals who are neither employee-insured, medical aid, nor their dependents are eligible for self-employed insurance. Fees for the self-employed insured depend on factors such as property, age, and sex.

Data on monthly labor earnings are therefore only available for the employee-insured. When monthly labor earnings is missing, we consider it to equal zero. Earnings are measured in 10,000 Korean won (KRW) and are adjusted to 2020 values using the Consumer Price Index. Employment is defined as being employee-insured.[8]

3.2 Sample Construction

Our main sample is mothers who gave first childbirth between 2005 and 2015, so that we can observe outcomes at least three years before and five years after first childbirth in the 2002–2020 NHIS data. We focus on women born between 1976 and 1985, categorizing

[6] See Table A1 for procedure codes associated with delivery. Because the doctor assigns the procedure code, there is a chance of error. Individuals who had multiple "first" childbirths according to the procedure codes account for 1.4% of all mothers. In this case, we use the earliest record as the first childbirth.

[7] Non-regular workers with short-term contracts may not be employee-insured.

[8] Because non-regular workers with short-term contracts may not be employee-insured, the employee-insured rate can underestimate the employment rate. According to authors' calculations using data from the Economically Active Population Survey, about 7% of employed women between ages 25–39 may not be employee-insured.

them into five-year groups 1976–80 and 1981–85, for cross-cohort comparisons. These cohorts are young enough to capture the recent decline in fertility to lowest-low levels in South Korea but old enough for us to observe prime childbearing ages.

Given the window of 2005–2015, age at first childbirth in the data is cohort-specific by construction. For the 1976–80 cohort, we observe first childbirths at ages 25–39, while for the 1981–85 cohort, we observe first childbirths at ages 20–34. Because the child penalty can differ by mother's age, we may find cohort differences in the penalty simply due to the difference in observable ages at first childbirth. To address data truncation, we therefore restrict the sample to women who had their first child between the ages of 25 and 34 (the age range which overlaps for both cohort groups), then apply weights to the 1976–80 sample to match the distribution of age at first childbirth of the 1981–85 sample. In all our main analysis, we present results from the weighted sample. This age range covers the vast majority of births among women in these cohorts (Figure A1).[9]

To construct the sample of husbands of the women who gave first childbirth, we use information from the household members database. The data contains the identification number of the household head and the relationship codes for each household member at the monthly level. We identify husbands based on the relationship codes in the month of first childbirth.[10] For precision, we only use the household head or spouse of the household head codes, which cover 83.4% of our women sample (67.9% as wife of household head and 15.5% as household head). Husbands older than age 60 are excluded. Couples with missing data during the 97 months period are excluded. This leaves us with a final balanced panel sample of 593,997 couples for the 1976-80 cohort and 536,157 couples for the 1981-85 cohort.

[Table 1 here]

Table 1 presents the summary statistics of women and their husbands 12 months be-

[9] According to authors' calculations using data from the Vital Statistics and Population Projections, 78% of women born between 1976 and 1985 gave first childbirth within the age range of 25 and 34.
[10] We do not impose restrictions on divorce thereafter.

fore first childbirth ("reference month"). As aforementioned, weights are applied to the 1976-80 cohort to match the age at first childbirth distribution of the 1981-85 cohort, so the average age are the same at 28 years for both groups of women. Men's cohort grouping is based on their wives' year of birth rather than their own (for convenience, we also label them 1976–80 and 1981–85 men). Men are on average 31 years old at the reference month. The share employee-insured are higher for the more recent cohort among both women (by 8%p) and men (by 4%p). The recent cohort also report higher monthly earnings. Regional distribution are similar across cohorts, with about half of the sample living in the capital city Seoul and nearby regions (Gyeonggi & Incheon).

3.3 Identifying Child Penalty

As in prior studies in the literature, we use an event study framework to estimate the effect of first childbirth on earnings. The regression specification is as follows:

$$Y_{ism}^{g} = \sum_{j \neq -12} \alpha_j^g \cdot I[j = t] + \sum_k \beta_k^g \cdot I[k = age_{is}] + \sum_y \gamma_y^g \cdot I[y = s] + \nu_{ism}^g \tag{1}$$

where i denotes individual, s year, m month, and g group (gender and/or cohort). t denotes event time relative to the month of first childbirth. $I[j = t]$ is an indicator variable which equals to 1 if the event time $j = t$, and 0 otherwise. Likewise, $I[k = age_{is}]$ and $I[y = s]$ are indicator variables for age equal to k, and year equal to y, respectively. The reference period is $t = -12$, so each estimate of the event time dummy is the impact relative to one year before first childbirth. Life-cycle and time trends are controlled non-parametrically via the inclusion of all age and year dummies.

To express the child penalty in percentage terms rather than levels, we follow the conversion proposed by Kleven et al. (2019a). Specifically, the child penalty at event time

t for group g is defined as:

$$P_t^g \equiv \frac{\hat{\alpha}_t^g}{E[\tilde{Y}_{ism}^g | t]} \tag{2}$$

where $\tilde{Y}_{ism}^g = \hat{\beta}_{age_{is}}^g + \hat{\gamma}_s^g$ is the average predicted outcome excluding the event time dummies. The child penalty of group g at event time t (P_t^g) can thus be interpreted as the percentage change in outcome compared to the counterfactual value if childbirth had never occurred. Note that $\tilde{Y}_{ism}^g$ reflects yearly shocks and age profiles of the group, so it increases over time as age profiles grow, and is larger for men than women (Figure A4).

Given the endogeneity of the decision to have children, the event study framework leverages the timing of childbirth rather than the decision to have children. Event study analysis thus provide estimates of causal effects when the timing of the event is random. In our setting, if the timing of first childbirth is uncorrelated with other unobserved factors, the estimates of event time dummies prior to first childbirth should be close to zero. However, significant pretrends are observed in the literature on child penalties, which pose a challenge to interpreting the coefficients as genuinely causal. For example, upward-sloping pretrends are found among both women and men in Norway, Denmark, Sweden, Austria and Finland (Andresen and Nix, 2022b; Kleven et al., 2019b; Sieppi and Pehkonen, 2019). Downward-sloping pretrends are found among women in the U.S. and U.K (Kleven et al., 2019b).

An alternative approach is to use a control group, as it requires a milder assumption to establish causal inference. Even if mothers exhibit a significant pretrend before first childbirth, the effect relative to the control group may be considered causal if the control group displays a similar (parallel) pretrend. However, as we will demonstrate in the next section, we do not observe parallel pretrends between women and their husbands. Therefore, we present the child penalties of women and men separately, and do not wish to make strong causal claims.

4 Child Penalties Across Cohorts

We first present the effect of first childbirth on earnings for the entire sample of women born between 1976 and 1985. Figure 1 shows the estimated child penalties at event time t for both women and men following equation (2), namely P_t^w and P_t^m, with red indicating estimates for women and blue indicating estimates for men. 95% confidence intervals are marked in light gray, but are not noticeable because the estimates are very precise. The coefficient at $t = -12$, the reference month, is set to 0. Because we are not making cohort comparisons here, we do not use weights on the 1976–80 cohort.

[Figure 1 here]

Three key patterns emerge in Figure 1. First, as in prior studies, we find a substantial drop in women's earnings after first childbirth but not in men's earnings. Women's earnings is reduced by 35% at $t = 0$, and continues to fall for the next six months, resulting in a 42% short-run child penalty. This level of impact persists without recovery for at least five years after childbirth; the child penalty at $t = 60$ is 41.3%.[11] The magnitude is much larger than the child penalty found in Norway (21%, Andresen and Nix 2022b), Denmark (24%, Kleven et al. 2019a), Sweden (35%, Kleven et al. 2019b) and is comparable to that of the United Kingdom (45%, Kleven et al. 2019b).

Second, the sharp decline in women's earnings begins during pregnancy, prior to childbirth. Compared to the reference month, women's earnings are 6% lower at $t = -9$, around the time when the pregnancy would have become known to the woman. The drop in earnings reaches 32% by $t = -1$. This accounts for roughly 78% of the child penalty within the first year after childbirth.

Third, pretrends in earnings profiles exist, and are not the same for women and men. Women's earnings are downward-sloping from around two years prior to first childbirth whereas men's earnings are slightly upward-sloping before that period, although much

[11] This is very similar in magnitude to Kleven et al. (2023), which find a child penalty of 40% five years after first birth using cross-sectional data in South Korea.

flatter than women's overall. This pattern is consistent with evidence on the "marriage penalty" for women, and the fact that marriage typically precedes childbirth in South Korea by on average 1.8 years (Yoo and Lee, 2020).[12]

[Figure 2 here]

The child penalty in Figure 1 may be due to either women exiting the labor market or switching to lower-paid jobs. Figure 2a and Figure 2b explore these possibilities by showing the results on employment and earnings conditional on employment, respectively. Figure 2a shows that the effect of first childbirth on employment, as proxied by employee insurance, is substantial. Women's employment rate falls sharply from several months before first childbirth and is lower by 35% at $t = 0$. Interestingly, the impact on employment plateaus from about 4 months to 14 months post-childbirth at around 40% then we observe another small but noticeable drop toward 45% from 18 months post-childbirth. Because South Korea offers a 90-day maternity leave and up to one year of parental leave, during which female workers can maintain their employment, the result suggests that women may be quitting their jobs once the parental leave expires.

In contrast, when we examine earnings conditional on being employee-insured in Figure 2b, the dynamics are relatively flat for both women and men. Although this result should be interpreted with caution given that employment itself is endogenous, Figure 2 suggests that the extensive margin of labor supply is likely the major driver of the child penalty for women in South Korea.

[Figure 3 here]

Given this general pattern in the whole sample, now we investigate whether there are meaningful cohort differences in the child penalty. Figure 3 presents the result on earnings by sex and cohort group. Estimates for women in the 1976–80 and 1981–85 cohorts

[12] Extramarital births are very rare, comprising less than 2% of all births in South Korea. The NHIS data does not have information on date of marriage. The average time gap between marriage and childbirth for the 1976–85 cohorts is calculated by the authors using the Vital Statistics.

are shown in orange and red, respectively. Estimates for men whose wives were born between 1976 and 1980 are in light blue, and for men whose wives were born between 1981 and 1985, the estimates are in dark blue. As aforementioned, we reweight the sample of women in the 1976–80 cohort to match the age at first childbirth distribution of the women in the 1981–85 cohort to eliminate potential differences that arise due to data truncation. Men are assigned the same weight as their wives.

Husbands' earnings dynamics are similarly flat across the two cohort groups. The child penalty is close to zero, although husbands with wives in the more recent cohort present a slightly larger earnings loss of about 4.2% in the longer run compared to 1.2% among husbands of women in the earlier cohort.

We find a more noticeable cohort difference among mothers. After exhibiting similar pretrends, the earnings dynamics diverge across the two cohort groups from the time of first childbirth. The more recent cohort experiences a *greater* earnings loss in the short run, with a gap of 5.3%p at $t = 12$ (45.7% vs. 40.4%). After about 18 months, the cohort gap gradually narrows and disappears when the child is around four years old, both groups experiencing a similar long-run child penalty of 43.5%.[13] Considering the expansion of family-friendly policies in South Korea, it is quite surprising to find that the long-run child penalty did not decrease at all and that the short-run child penalty even increased.

5 Potential Mechanisms

In this section, we explore potential mechanisms underlying the increase in child penalty across cohorts. First, we study changes in the the composition of mothers in subsection 5.1. Second, we investigate changes in mothers' behavioral responses to childbirth

[13] The estimate is not exactly the same as in Figure 1 because we use age-at-childbirth weights in the cohort analysis. Among women in the 1976–80 cohort, younger mothers would be given more weight, and the child penalty tends to be larger for younger mothers.

in subsection 5.2.

5.1 Composition of Mothers

The characteristics of parents may have changed over time, especially considering the significant increase in childlessness in South Korea. Table 1 indicates that some baseline characteristics of (would-be) parents differ across cohorts. Women in the 1981–85 cohort and their husbands are more likely to be employee-insured (by 7.6%p and 3.7%p, respectively) and have higher monthly earnings on average than women in the 1976–80 cohort and their husbands. On the other hand, the recent cohort sample are slightly less likely to be living in the capital city, Seoul, before first childbirth (by 2.3%p).

We therefore test how the finding on child penalties is affected when we address differences in observable characteristics across cohorts. Specifically, we use inverse probability weighting (IPW) to reweight the sample of 1976–80 cohort to match the 1981–85 cohort on baseline characteristics. We estimate the probability of being a woman in the 1981–85 cohort using a logistic model, represented by the propensity score (p). When selecting variables for calculating the propensity score, it is important to include baseline characteristics that may influence the size of the child penalty (Andresen and Nix, 2022b). We include the woman's employment status, earnings, her husband's employment status, his earnings, and their region of residence one year prior to first childbirth. Baseline earnings can be related to the size of the child penalty if, for example, mothers with higher earnings have stronger attachment to the labor market. Region can be associated with gender norms (Hwang et al., 2019) or the availability of market childcare. As before, age at first childbirth is included in the estimation to address data truncation.[14]

Weights $p/(1-p)$ are assigned to the 1976–80 sample, while a weight of 1 is assigned to the 1981–85 sample. Intuitively, the IPW strategy creates a more analogous group by

[14]Common support plots are presented in Figure A2. While the IPW does not precisely match the distribution of age at first childbirth across the two cohorts, it is reassuring to find that the distributions remain nearly identical (Figure A3).

assigning greater weights to women in the 1976–80 cohort who share similar baseline characteristics with women in the 1981–85 cohort. The implementation of IPW would narrow the difference in child penalty between cohorts if the difference in characteristics of mothers between cohorts is the main reason.

[Figure 4 here]

Figure 4 shows the impact of children on earnings with IPW weighting in conjunction with the main result. Because women in 1981–85 are assigned a weight of one, their estimates remain the same as in Figure 3. The child penalty for the 1976–80 cohort, however, also seems unaffected with IPW.[15] The finding suggests that the difference in baseline characteristics of mothers between the two cohorts alone is insufficient to explain the difference in child penalty.

5.2 Further Outcomes

Because the difference in baseline observables does not seem to explain the cohort difference in child penalty, we examine additional outcomes to better understand the underlying mechanism. First, we again separately examine the impact on employment and earnings conditional on employment. Figure 5a presents the result on employment. There are no discernible differences between cohorts among both women and their husbands. As in Figure 2a, women's employment trajectories depict a sharp decline followed by a plateau for about a year and then another small dip.

[Figure 5 here]

Examining earnings conditional on employment, Figure 5b shows that the estimates for women in the 1976–80 cohort are positive for the first three years post-childbirth, albeit small in magnitude. The estimates for women in the 1981–85 cohort are generally

[15] The downward pre-trend becomes flatter with IPW. This pattern may arise if mothers who receive greater weights are one who have lower marriage penalty.

negative albeit also close to zero. Because the sample is not a balanced panel for this exercise, the result is suggestive evidence of a relatively more positive selection of mothers in employment in terms of earnings among the earlier cohort.

[Figure 6 here]

Next, we study leave of absence to investigate whether the plateau of employment is associated with parental leave. While the exact type of leave is not specified in the NHIS data, parental leave constitutes the majority of leave of absence among female employees in South Korea.[16] We construct a dummy variable that equals one if an individual is on leave while employed, and 0 otherwise. Given that parental leave eligibility and benefits have become more generous over time, we expect an increase in usage among recent cohorts.

Figure 6a shows that women in the 1981–85 cohort are twice as likely as women in the 1976–80 cohort to be on leave after childbirth. The sharp increase in the share of women on leave coincides with the timing of their first childbirth, substantiating that the majority of leave of absence in our sample is parental leave. The peak is around 6 months post-childbirth, when the probability of taking leave is 17% among the more recent cohort and 8% among the earlier cohort. Husbands, on the other hand, exhibit a flat zero. This result suggests that parental leave partly contributes to the larger child penalty among the more recent cohort of mothers.

A caveat when interpreting leave utilization is that one first needs to be employed in order to take leave. Higher utilization of leave may thus simply be the result of higher proportion of employed women in the recent cohort. To address this issue, we therefore investigate how the estimates would change when we use hypothetical earnings, replacing zero earnings of workers on leave with their earnings right before (one month) taking

[16] For example, in 2015, parental leave accounted for 81% of all leave among female public officials (Ministry of Personnel Management, 2015).

leave. In this way, we can assess child penalties across cohorts without the drop in earnings due to parental leave.[17]

Figure 6b shows the result with replaced earnings. Notably, we observe a reversal in the cohort gap of women's child penalty compared to Figure 3. The child penalty for women in the 1981–85 cohort is now consistently *smaller* than that for women in the 1976–80 cohort, both during pregnancy and post-childbirth. The initial child penalty gap of approximately 2.5%p shortly after birth widens over time, with cohort 1981–85 experiencing a child penalty approximately 4.8%p smaller 60 months later. The findings suggests that parental leave significantly contributes to the difference in child penalties between cohorts. Meanwhile, the results are unaffected for husbands because very few of them take leave to start with.

[Figure 7 here]

Lastly, we examine women's total number of children. Because the child penalty includes the impact of any subsequent children, it is likely to be larger for the cohort group with more children overall. Figure 7 shows the result on number of children for women.[18] As the event is defined as the first childbirth, all coefficients are 0 before $t = 0$ and jumps to 1 exactly at $t = 0$. The number of children appears to gradually increase starting from around 17 months after first childbirth. The total number of children is similar across cohorts, with slightly more children among women in the 1981–85 cohort by the fifth year (1.78 vs. 1.82). Although cohort fertility rates are declining (Figure A1), the finding indicates that conditional on having the first child, women in the more recent cohort are slightly more likely to have a second child than the earlier cohort.

[17] This analysis implicitly assumes that if women do not take parental leave, they will continue to work (and earn full earnings). However, it is possible that women may leave their jobs in the absence of parental leave, potentially leading to an underestimation of the child penalty.

[18] We do not examine men here, because we can only identify childbirth for women. Without divorce, the results would be identical for husbands.

6 Conclusion

This paper studies child penalty in the country with the world's lowest fertility rate, South Korea, using administrative data covering the entire population from 2002 to 2020. Employing an event study analysis based on first childbirth, we find that mothers born between 1976 and 1985 experience an earnings loss of over 41% by the fifth year after first childbirth, with most of the reduction occurring during pregnancy. Comparing cohorts 1976–80 and 1981–85 reveals an *increase* in women's child penalty in the short run from 40% to 46%.

To understand why the short-run child penalty is larger among the more recent cohort, we analyze mothers' characteristics prior to first childbirth as well as other outcomes following first childbirth. Despite the increase in childlessness during the study period, the primary explanation for the difference in child penalty between cohorts does not appear to arise from changes in mothers' characteristics such as employment or earnings prior to childbirth. The result from inverse probability weighting, which aligns baseline characteristics across cohorts, produces outcomes similar to the main results. Although the extensive margin of labor supply is an important source of the child penalty itself, we find that it also does not explain the difference in child penalty between cohorts. Instead, we show suggestive evidence that the higher uptake of parental leave among recent mothers contributes to their larger child penalty. We also find that the recent cohort of women are slightly more likely to have subsequent children, conditional on having the first child.

More broadly, our findings indicate that the child penalty need not decrease over time in all developed countries. Particularly in societies with rising childlessness, the combination of expanding family-friendly policies and selection into motherhood can create a more complex outlook.

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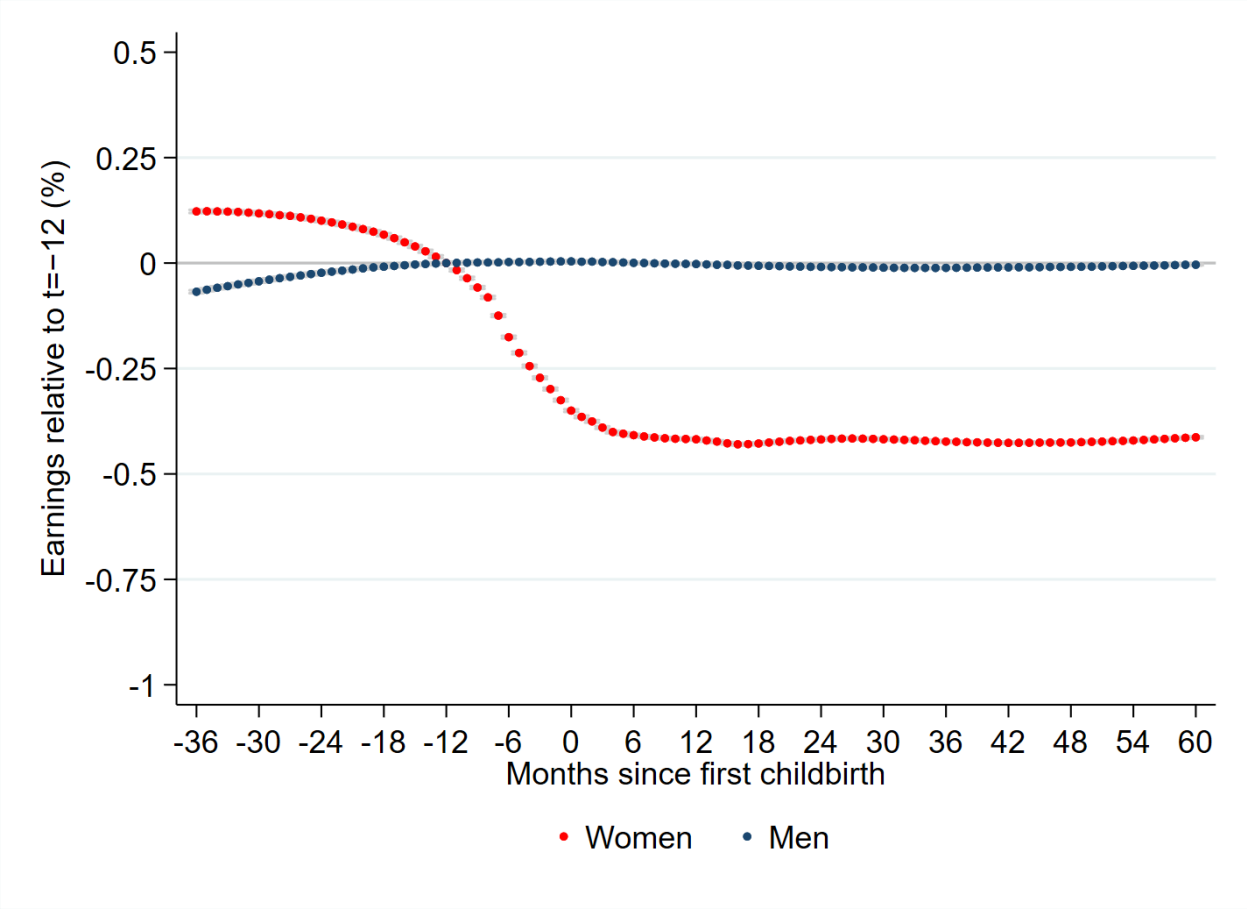
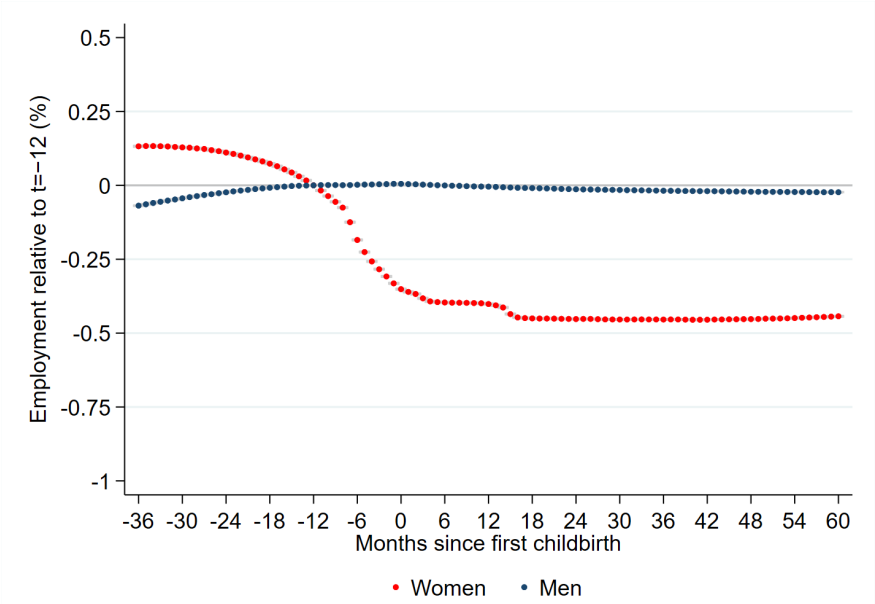
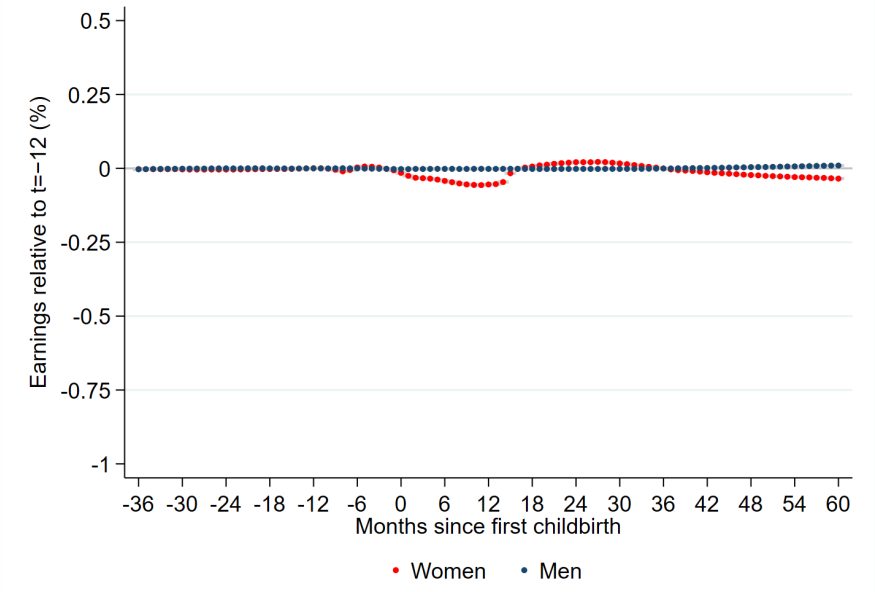


Figure 1: Impacts of Children on Earnings

Notes. The figure shows the event time coefficients estimated from equation (1) as a percentage of the counterfactual outcome absent children as defined in equation (2), for women and men separately. The sample consists of a balanced panel of women born between 1976 and 1985 who gave first childbirth between 2005 and 2015, and their husbands identified at $t = 0$. 95% confidence intervals are shown in light gray.



(a) Employment



(b) Earnings Conditional on Employment

Figure 2: Impacts of Children on Employment and Earnings Conditional on Employment

Notes. The figure shows the event time coefficients estimated from equation (1) as a percentage of the counterfactual outcome absent children as defined in equation (2), for women and men separately. The sample consists of women born between 1976 and 1985 who gave first childbirth between 2005 and 2015, and their husbands identified at $t = 0$. Figure (b) excludes individuals who are on leave or are not employee-insured. 95% confidence intervals are shown in light gray.

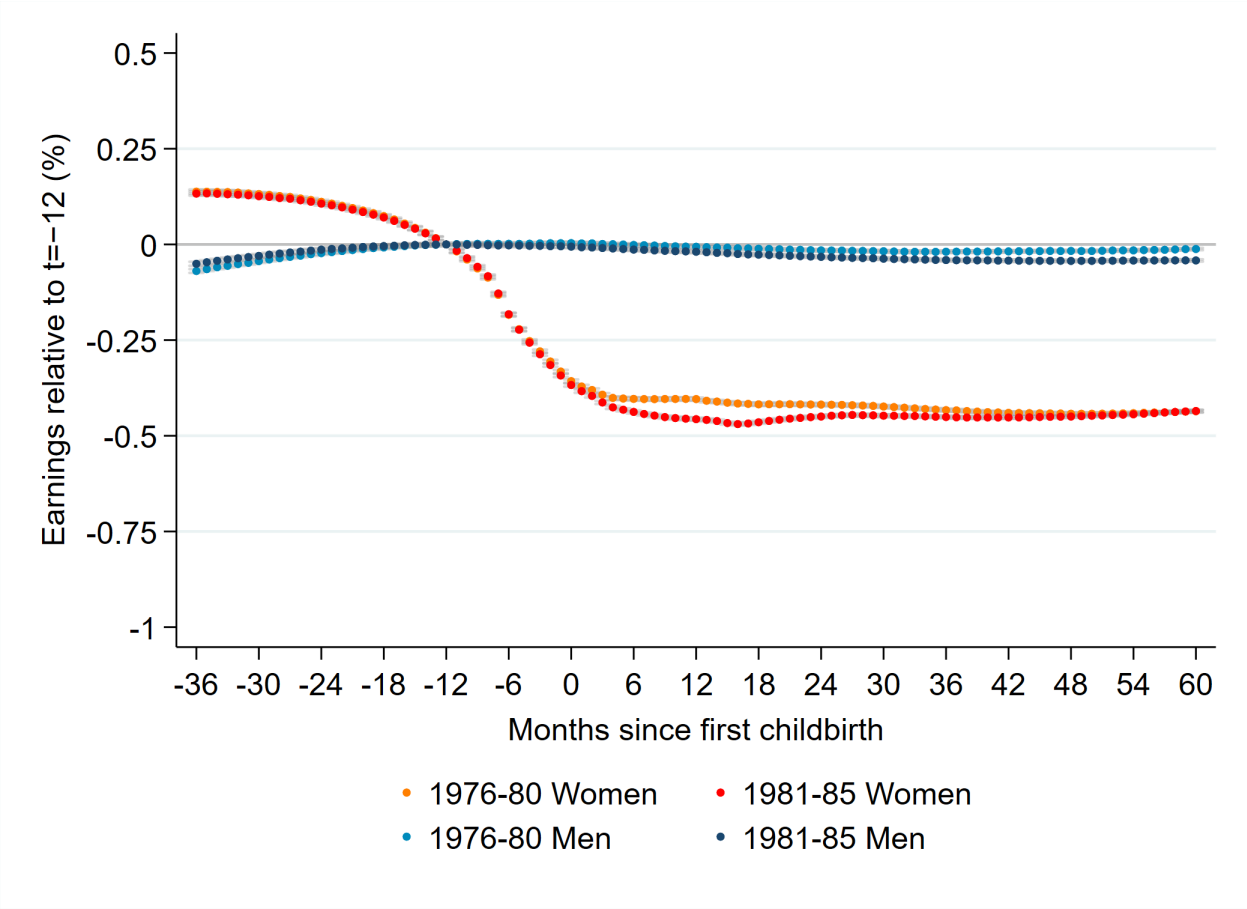


Figure 3: Impacts of Children on Earnings by Cohort

Notes. The figure shows the event time coefficients estimated from equation (1) as a percentage of the counterfactual outcome absent children as defined in equation (2), for each group separately. The sample consists of a balanced panel of women born between 1976 and 1985 who gave first childbirth between 2005 and 2015, and their husbands identified at $t = 0$. Men's cohort grouping is based on their wives' year of birth. Weights are applied to women in the 1976–80 cohort (and their husbands) to match the distribution of age at first childbirth of women in the 1981–85 cohort. 95% confidence intervals are shown in light gray.

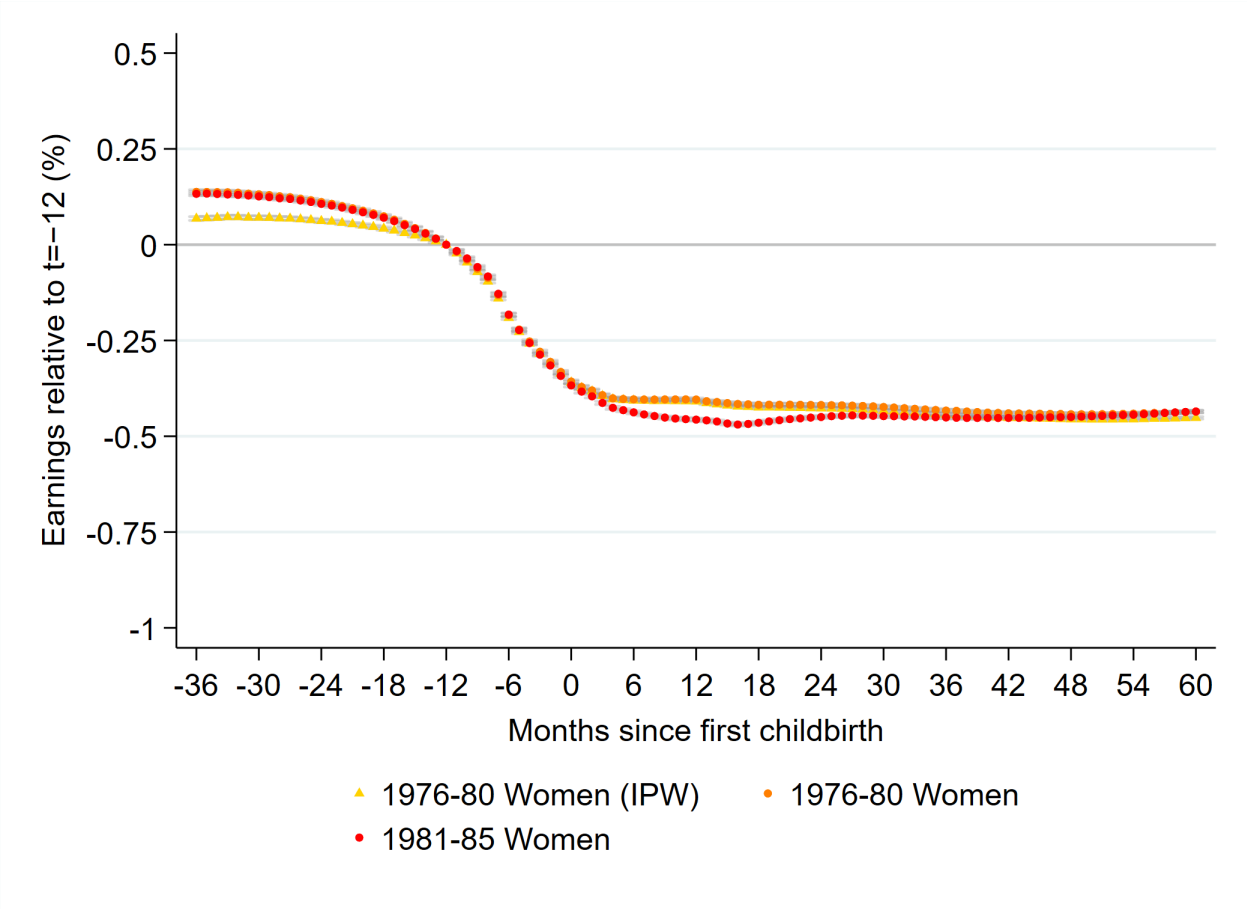
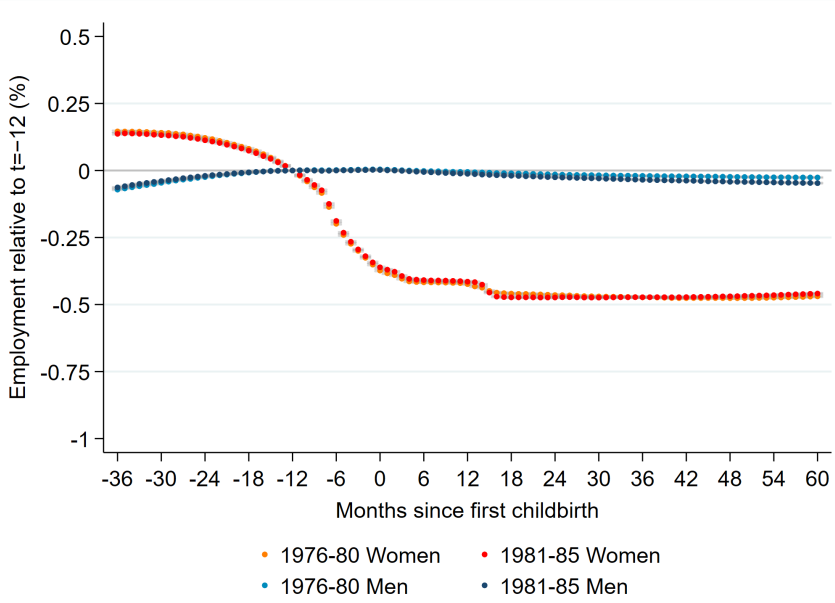
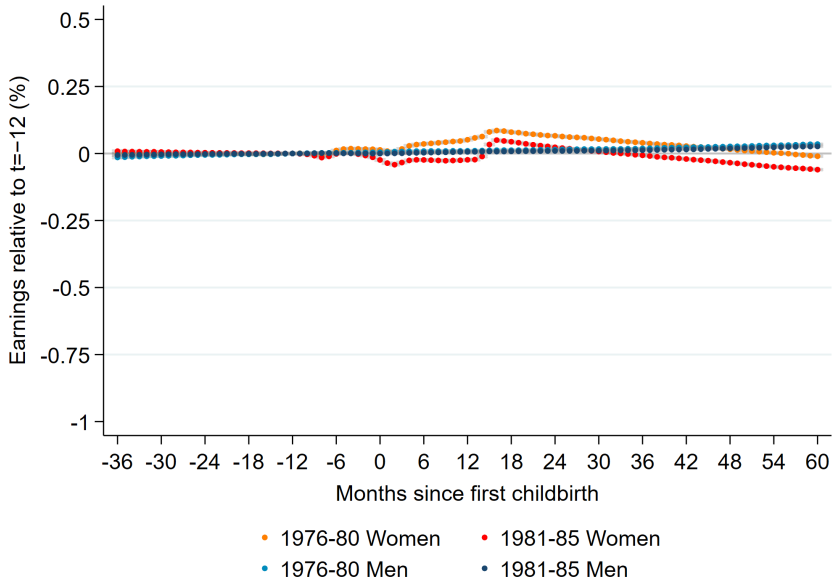


Figure 4: Impacts of Children on Earnings by Cohort, with Inverse Probability Weighting

Notes. The figure shows the event time coefficients estimated from equation (1) as a percentage of the counterfactual outcome absent children as defined in equation (2), for each group separately. The sample consists of a balanced panel of women born between 1976 and 1985 who gave first childbirth between 2005 and 2015, and their husbands identified at $t = 0$. Men's cohort grouping is based on their wives' year of birth. Weights are applied to women in the 1976–80 cohort (and their husbands) to match the distribution of age at first childbirth of women in the 1981–85 cohort. The IPW sample is based on propensity scores estimated as described in subsection 5.1. 95% confidence intervals are shown in light gray.



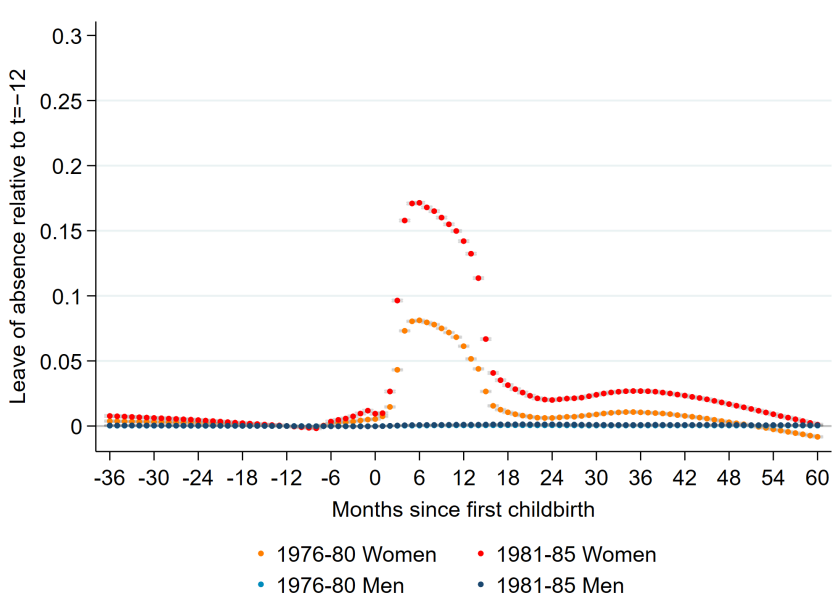
(a) Employment



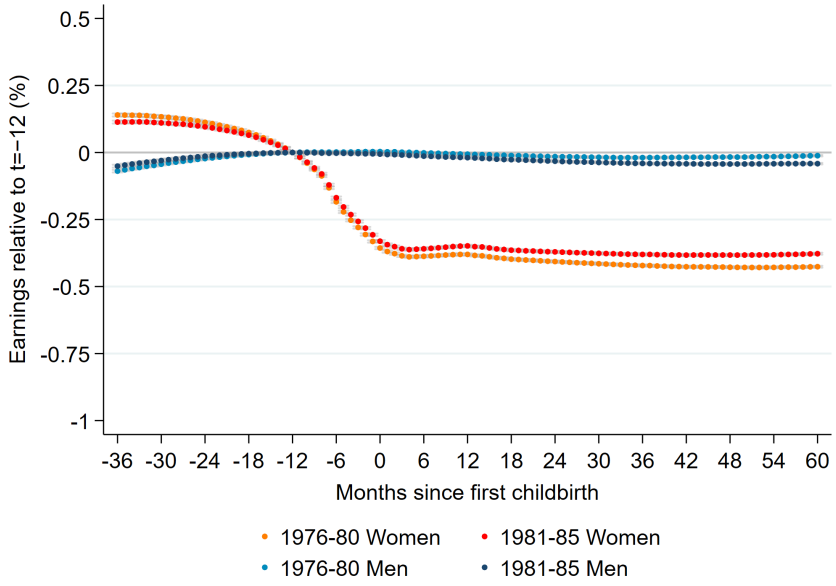
(b) Earnings Conditional on Employment

Figure 5: Impacts of Children on Employment and Earnings Conditional on Employment by Cohort

Notes. The figure shows the event time coefficients estimated from equation (1) as a percentage of the counterfactual outcome absent children as defined in equation (2), for each group separately. The sample consists of women born between 1976 and 1985 who gave first childbirth between 2005 and 2015, and their husbands identified at $t = 0$. Weights are applied to women in the 1976–80 cohort (and their husbands) to match the distribution of age at first childbirth of women in the 1981–85 cohort. Figure (b) excludes individuals who are on leave or are not employee-insured. 95% confidence intervals are shown in light gray.



(a) Leave of Absence



(b) Hypothetical Earnings during Leave

Figure 6: Impacts of Children on Leave of Absence by Cohort

Notes. Figure (a) shows the event time coefficients estimated from equation (1), and figure (b) shows the event time coefficients estimated from equation (1) as a percentage of the counterfactual outcome absent children as defined in equation (2), for each group separately. Figure (b) replaces zero earnings during leave with the earnings one month preceding leave for employees who are on leave. The sample consists of a balanced panel of women born between 1976 and 1985 who gave first childbirth between 2005 and 2015, and their husbands identified at $t = 0$. Weights are applied to women in the 1976–80 cohort (and their husbands) to match the distribution of age at first childbirth of women in the 1981–85 cohort. 95% confidence intervals are shown in light gray.

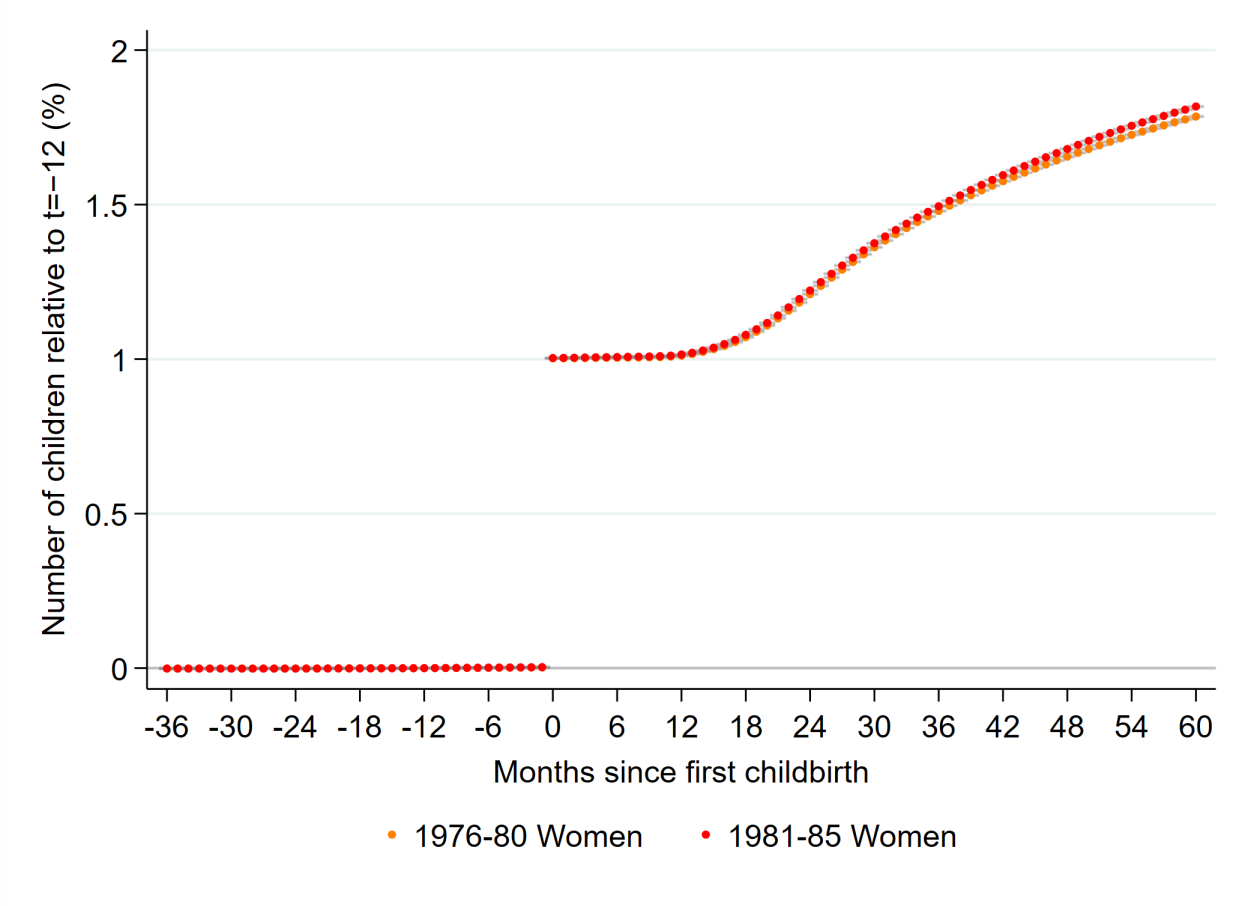


Figure 7: Impacts of Children on Total Number of Children by Cohort

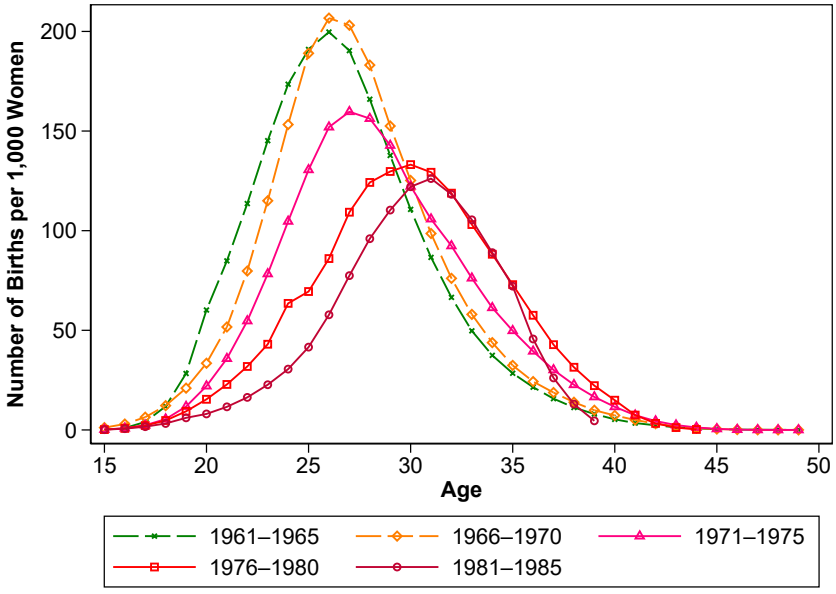
Notes. The figure shows the event time coefficients estimated from equation (1) for each group separately. The sample consists of a balanced panel of women born between 1976 and 1985 who gave first childbirth between 2005 and 2015. Weights are applied to women in the 1976–80 cohort to match the distribution of age at first childbirth of women in the 1981–85 cohort. 95% confidence intervals are shown in light gray.

Table 1: Summary Statistics 12 Months Before First Childbirth

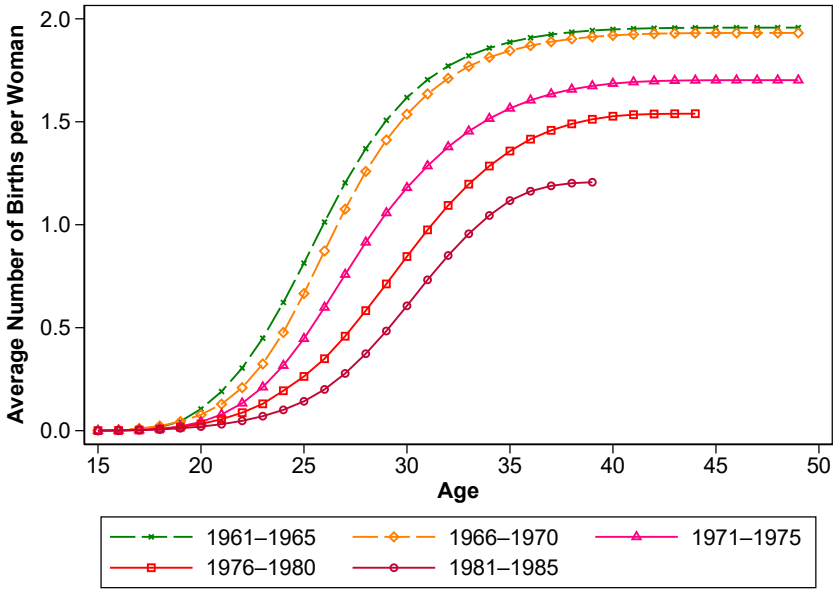
	Women			Men (husbands)		
	1976-80	1981-85	Difference	1976-80	1981-85	Difference
A. Socioeconomic characteristics						
Age	28.4126	28.4126		30.7263	30.7942	***
	(2.0993)	(2.2097)		(2.8383)	(3.0407)	
Monthly earnings (10,000 KRW)	126.3747	146.5988	***	242.9048	261.4899	***
	(145.1245)	(154.9294)		(216.3446)	(228.6483)	
B. Insurance type						
Employee	0.5232	0.5996	***	0.7529	0.7899	***
	(0.4745)	(0.4900)		(0.4098)	(0.4074)	
Dependent of employee	0.2722	0.2393	***	0.0752	0.0734	***
	(0.4229)	(0.4266)		(0.2506)	(0.2607)	
Self-employed	0.0331	0.0269	***	0.1220	0.0898	***
	(0.1699)	(0.1618)		(0.3109)	(0.2859)	
Dependent of self-employed	0.1704	0.1331	***	0.0493	0.0462	***
	(0.3572)	(0.3397)		(0.2056)	(0.2100)	
Medical aid	0.0002	0.0002	**	0.0001	0.0002	*
	(0.0118)	(0.0144)		(0.0116)	(0.0140)	
Dependent of medical aid	0.0009	0.0010		0.0004	0.0005	
	(0.0291)	(0.0312)		(0.0200)	(0.0224)	
C. Region of residence						
Seoul	0.2481	0.2249	***	0.2480	0.2222	***
	(0.4104)	(0.4175)		(0.4103)	(0.4157)	
Gyeonggi & Incheon	0.2887	0.3025	***	0.3025	0.3109	***
	(0.4305)	(0.4593)		(0.4364)	(0.4629)	
N	593,997	536,157		593,997	536,157	

Notes. The sample consists of a balanced panel of women born between 1976 and 1985 who gave first childbirth between 2005 and 2015, and their husbands identified at $t = 0$. Weights are applied to women in the 1976–80 cohort (and their husbands) to match the distribution of age at first childbirth of women in the 1981–85 cohort. Standard deviations in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

A Appendix



(a) Age-Specific Fertility Rate



(b) Cumulative Cohort Fertility Rate

Figure A1: Fertility Rate across Birth Cohorts

Notes. Data from 1981-2020 Vital Statistics merged with Projected Population. Source: Hwang (2023).

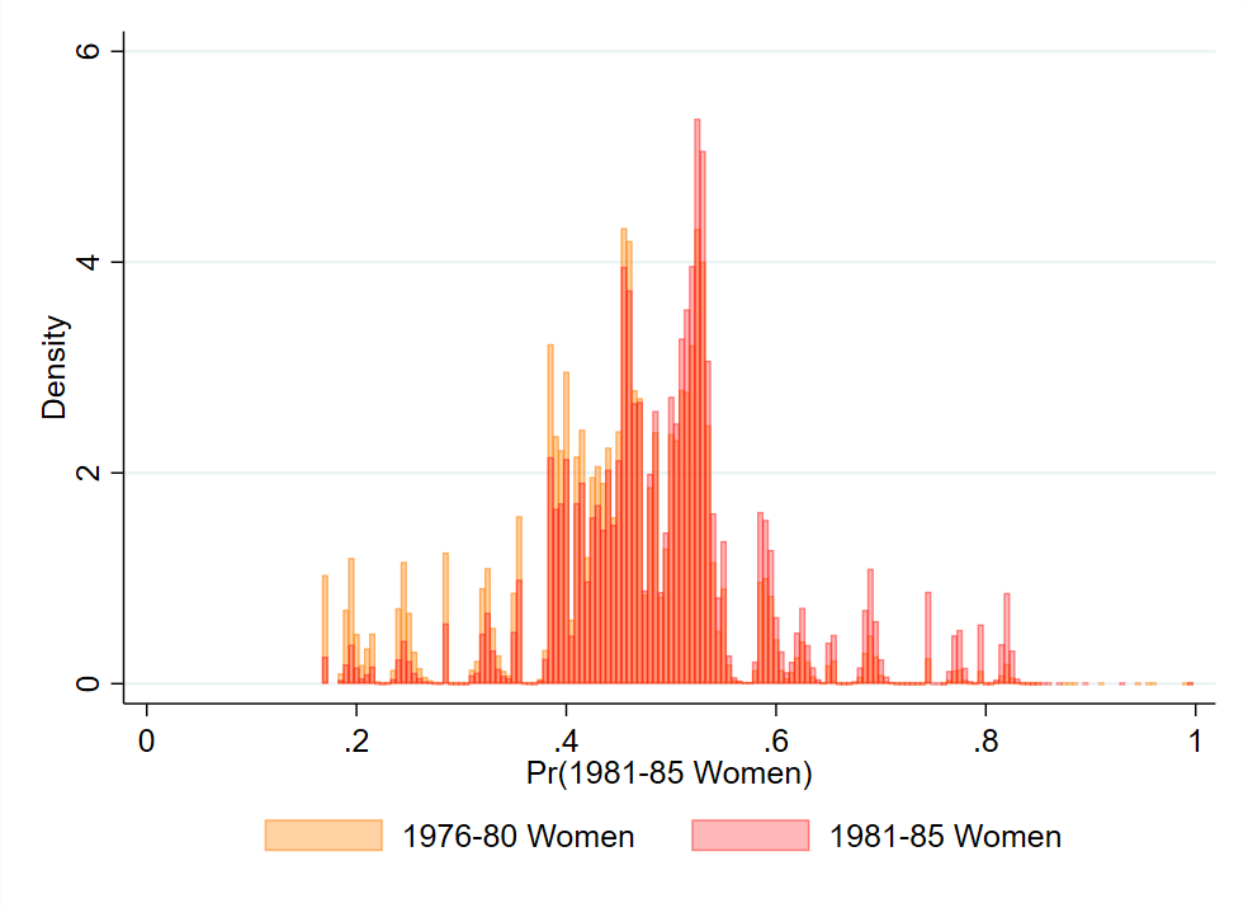


Figure A2: Common Support for Propensity Score

Notes. The figure shows the overlap between the propensity score distribution for women in the 1976–80 and 1981–85 cohort.

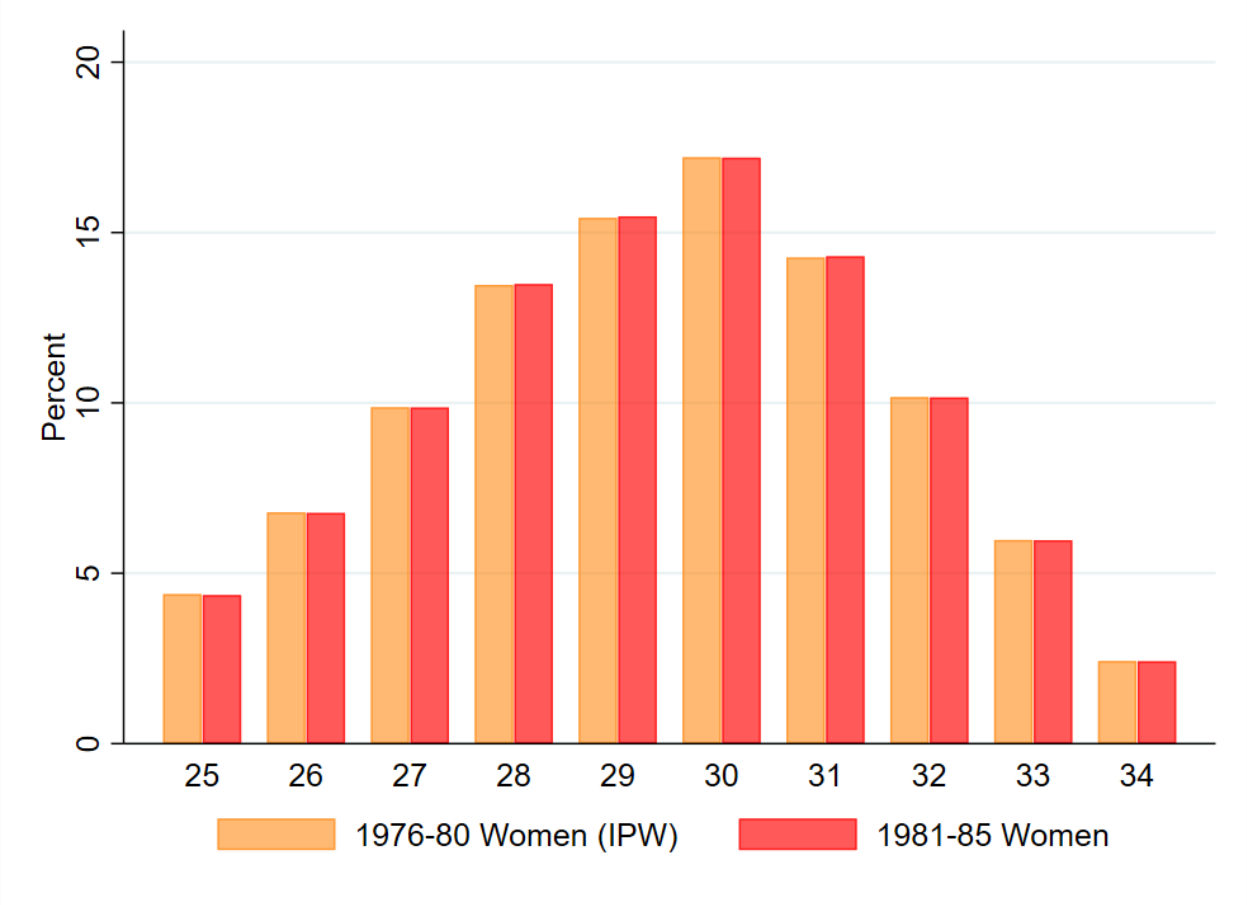
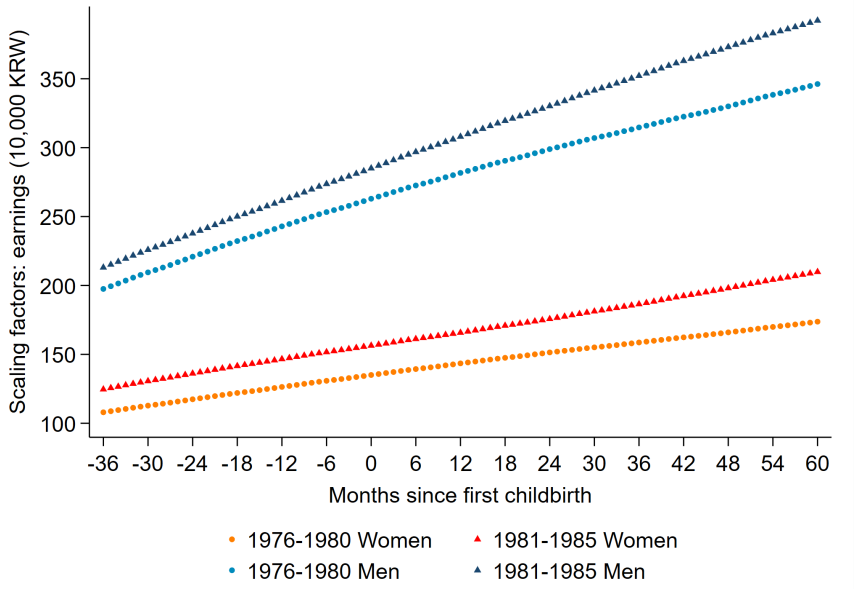
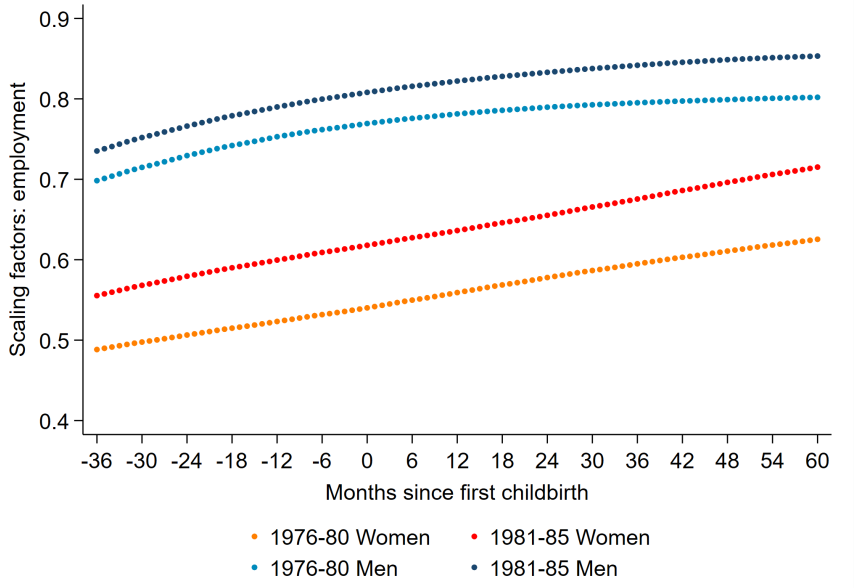


Figure A3: Age at First Childbirth Distribution, with Inverse Probability Weighting

Notes. The figure shows the percentage by age at first childbirth in each group. Inverse probability weighting is applied to women in the 1976–80 cohort.



(a) Counterfactual Earning



(b) Counterfactual Employment

Figure A4: Counterfactual Value if Childbirth had Never Occurred

Notes. The figure shows the counterfactual outcome absent children, i.e., $\tilde{Y}^g_{ism} = \hat{\beta}^g_{age_{is}} + \hat{\gamma}^g_s$ as defined in equation (1) for each group separately. The sample consists of a balanced panel of women born between 1976 and 1985 who gave first childbirth between 2005 and 2015, and their husbands identified at $t = 0$. Weights are applied to women in the 1976–80 cohort (and their husbands) to match the distribution of age at first childbirth of women in the 1981–85 cohort.

Table A1: Procedure Codes for Delivery

Procedure codes	Description
R3131	induced delivery (primiparous) - first fetus
R3133	induced delivery (primiparous) - from second fetus in multiple pregnancy
R3136	induced delivery (multiparous) - first fetus
R3138	induced delivery (multiparous) - from second fetus in multiple pregnancy
R3141	forceps and vaccum delivery (primiparous) - first fetus
R3143	forceps and vaccum delivery (primiparous) - from second fetus in multiple pregnancy
R3146	forceps and vaccum delivery (multiparous) - first fetus
R3148	forceps and vaccum delivery (multiparous) - from second fetus in multiple pregnancy
R4351	normal delivery (primiparous) - first fetus
R4352	forceps delivery, vaccum delivery, and induced delivery (primiparous)
R4353	normal delivery (primiparous) - from second fetus in multiple pregnancy
R4354	forceps delivery, vaccum delivery, and induced delivery (primiparous) - from second fetus in multiple pregnancy
R4356	normal delivery (multiparous) - first fetus
R4357	forceps delivery, vaccum delivery, and induced delivery (multiparous)
R4358	normal delivery (multiparous) - from second fetus in multiple pregnancy
R4359	forceps delivery, vaccum delivery, and induced delivery (multiparous) - from second fetus in multiple pregnancy
R4360	breech delivery
R4361	breech delivery (primiparous)
R4362	breech delivery (multiparous)
R4380	vaginal birth after cesarean section
R4501	cesarean section - hysterectomy - first fetus
R4503	cesarean section - hysterectomy - from second fetus in multiple pregnancy
R4504	cesarean section - subtotal hysterectomy - first fetus
R4505	cesarean section - total hysterectomy - first fetus
R4506	cesarean section - hysterectomy - multiple pregnancy
R4507	cesarean section - subtotal hysterectomy (primiparous) - first fetus
R4508	cesarean section - subtotal hysterectomy (multiparous) - first fetus
R4509	cesarean section - total hysterectomy (primiparous) - first fetus
R4510	cesarean section - total hysterectomy (multiparous) - first fetus
R4511	cesarean section delivery - first fetus
R4512	cesarean section delivery - from second fetus in multiple pregnancy
R4513	initial cesarean section delivery - first fetus

R4514	repeated cesarean section delivery - first fetus
R4515	initial cesarean section delivery - multiple pregnancy
R4516	repeated cesarean section delivery - multiple pregnancy
R4517	initial cesarean section delivery (primiparous) - first fetus
R4518	initial cesarean section delivery (multiparous) - first fetus
R4519	initial cesarean section delivery (primiparous) - multiple pregnancy
R4520	initial cesarean section delivery (multiparous) - multiple pregnancy
R5001	cesarean hysterectomy (primiparous) - multiple pregnancy
R5002	cesarean hysterectomy (multiparous) - multiple pregnancy
RA311	induced delivery (primiparous) - first fetus - for disabled with certificate
RA312	induced delivery (primiparous) - from second fetus in multiple pregnancy - for disabled with certificate
RA313	induced delivery (multiparous) - first fetus - for disabled with certificate
RA314	induced delivery (multiparous) - from second fetus in multiple pregnancy - for disabled with certificate
RA315	forceps and vaccum delivery (primiparous) - first fetus - for disabled with certificate
RA316	forceps and vaccum delivery (primiparous) - from second fetus in multiple pregnancy - for disabled with certificate
RA317	forceps and vaccum delivery (multiparous) - first fetus - for disabled with certificate
RA318	forceps and vaccum delivery (multiparous) - from second fetus in multiple pregnancy - for disabled with certificate
RA361	breech delivery (primiparous) - for disabled with certificate
RA362	breech delivery (multiparous) - for disabled with certificate
RA380	vaginal birth after cesarean section - for disabled with certificate
RA431	normal delivery (primiparous) - first fetus - for disabled with certificate
RA432	normal delivery (primiparous) - from second fetus in multiple pregnancy - for disabled with certificate
RA433	normal delivery (multiparous) - first fetus - for disabled with certificate
RA434	normal delivery (multiparous) - from second fetus in multiple pregnancy - for disabled with certificate
V0111	fee for delivery (primiparous)
V0112	fee for delivery (primiparous) - visit out of hours
V0113	fee for delivery (primiparous) - from 10pm to 6am
V0121	fee for delivery (multiparous)
V0122	fee for delivery (multiparous) - visit out of hours
V0123	fee for delivery (multiparous) - from 10pm to 6am
V0131	fee for delivery (breech extraction)
V0132	fee for delivery (breech extraction) - visit out of hours
V0133	fee for delivery (breech extraction) - from 10pm to 6am

W0200	vaginal delivery of fetus at outreach clinic - first fetus
W0201	vaginal delivery of fetus at outreach clinic - from second fetus in multiple pregnancy
W0203	vaginal delivery of fetus at outreach clinic - visit out of hours - first fetus
W0204	vaginal delivery of fetus at outreach clinic - visit out of hours - from second fetus in multiple pregnancy
W0330	vaginal delivery of fetus at rural health center - first fetus
W0331	vaginal delivery of fetus at rural health center - from second fetus in multiple pregnancy
W0333	vaginal delivery of fetus at rural health center - visit out of hours - first fetus
W0334	vaginal delivery of fetus at rural health center - visit out of hours - from second fetus in multiple pregnancy
W0430	vaginal delivery of fetus at health center - first fetus
W0431	vaginal delivery of fetus at health center - from second fetus in multiple pregnancy
W0433	vaginal delivery of fetus at health center - visit out of hours - first fetus
W0434	vaginal delivery of fetus at health center - visit out of hours - from second fetus in multiple pregnancy