


The motherhood effect on labour market outcomes: evidence from South Korea

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We examine mothers' relative labour market outcomes around the first childbirth in South Korea, a country with the highest gender pay gaps and the lowest fertility rate among the OECD countries. Using an event study approach, we find that while fathers remain unaffected, mothers' earnings drop sharply by 66.2 per cent over the long run, mostly driven by a reduction in labour force participation. For women who continue to work, motherhood lowers the probability of entering male-dominated occupations and industries but increases the probability of working in female-dominated occupations and industries. Finally, we find that motherhood has a stronger negative effect on labour market outcomes for less-educated mothers, young mothers, mothers who first bear children within two years of marriage, and mothers with three or more children.

Introduction

In South Korea (Korea hereafter), female labour force participation has continued to expand; however, the labour force participation rate of married women in their thirties who experience childbirth is still significantly lower than that of married men. Increased investment in female education and career coupled with a lower employment rate for women than the Organisation for Economic Co-operation and Development (OECD) average suggests that there is room to improve women's labour market outcomes in Korea.

Early literature has discussed the role of human capital, discrimination, and taste differentials to explain the widening gender gap in the labour market (Altonji and Rebecca 1999). However, as women obtain equal education and job opportunities, at least in developed countries, more recent papers focus on the role

of parenthood to explain persistent gender inequality and its slow convergence rates in labour market outcomes. The phenomenon is termed 'motherhood penalty', 'child penalty', or 'family gap' (Waldfogel 1998; Budig and England 2001; Avellar and Smock 2003; Glauber 2007; Gangl and Ziefle 2009), implying that parents face a trade-off between childcare and labour market decisions.

In this paper, we examine the parenthood effect on gender inequality in the labour market in Korea. In particular, we show how parenthood has been costly for women relative to men and how this 'child penalty' evolves over time. When they become parents, mothers tend to leave the workforce or take more time off from their careers than fathers. They set on a trajectory of lower lifetime labour force participation and earnings relative to their male counterparts. By adopting a quasi-experimental approach based on an event study, as per Kleven et al. (2019b), we measure the child

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penalty around the first childbirth in several labour market outcomes, such as labour force participation, earnings, hours worked, and wage rate. We exploit the panel structure of the Korean Labor and Income Panel Study (KLIPS) to analyse how the first childbirth affects an individual's labour market outcomes and how the effects change over time by comparing labour market trajectories of mothers relative to fathers.

As shown in Figure 1, the gender gaps in labour force participation and wages in Korea have steadily declined over the past 30 years. In 1992, 53.3 per cent (that is, 41 percentage points lower than men) of women participated in the labour force, and women earned about 53 per cent of what men earned; however, the gender gaps in labour force participation and wages shrank to 22 percentage points and 31 per cent, respectively, in 2020. Despite the progress in recent decades and the low fertility rate (that is, the total fertility rate of 0.84 in 2020¹—was the lowest rate in the world), Korea's gender gap in labour force participation remains higher than the OECD average, and the gender gap in wages is the highest among the OECD countries in 2021.² Korea has one of the most pronounced gender pay gaps, the lowest fertility rate, and very severe gender inequality, making it a unique setting in which to study the relationship between having a child and labour market outcomes among women relative to men.

When estimating the short- and long-run effects of children on fathers' and mothers' labour market trajectories, we find that parenthood has a significant and persistent effect on mothers' labour market outcomes, while fathers remain largely unaffected. Mothers experience a sudden dip in earnings immediately after the first child's birth, and its effect does not converge to the original level of earnings over time. In the long run, mothers'

labour earnings fall by 66.2 per cent, and their labour force participation rate lowers by 35.4 per cent relative to fathers. Among working parents, mothers' hours worked are reduced by 7.3 per cent, and mothers' wage decreases by 16.6 per cent compared to fathers. The sharp decrease in earnings largely comes from the extensive margin, suggesting that mothers respond and adjust to their newborn child by withdrawing from the labour force.

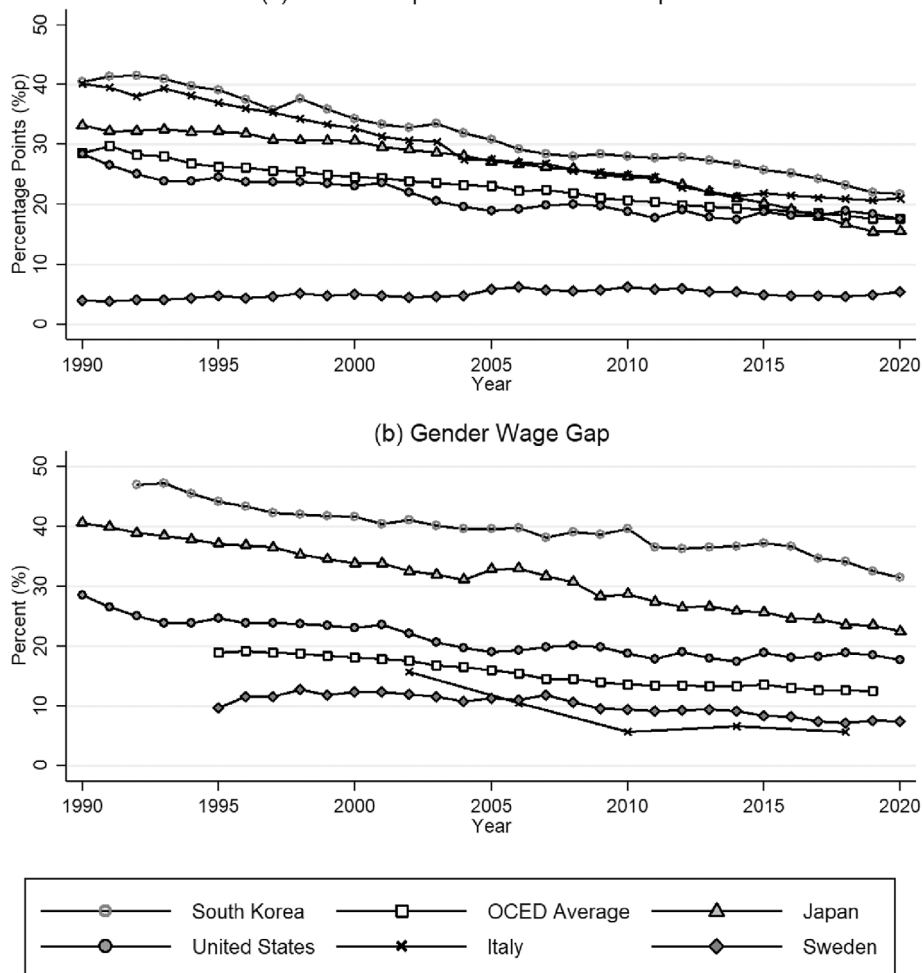
To explore potential mechanisms behind the child penalty, we examine how mothers change their occupations and industries in response to the first childbirth. The result shows a persistent decrease in mothers' probability of working in male-dominated occupations and industries after the first child is born, while there is no change for fathers. Mothers' probability of working in female-dominated occupations and industries continues to increase over the long run. Finally, we analyse heterogeneous impacts of children by mothers' characteristics, such as education, age at first childbirth, duration between marriage and first birth, and the number of children. The results show that motherhood has a larger negative impact on labour market outcomes for less educated and young mothers, and delaying the first childbirth can act as a buffer against withdrawal from the labour force. The long-run child penalties in both labour force participation and earnings increase with the number of children.

Our research contributes to three strands of the existing literature. First, we provide an international comparison of the long-run child penalty in Korea with other developed economies. Our results indicate that the long-run earnings penalty (that is, 66.2 per cent) is much higher than in the Scandinavian countries (that is, 21–27 per cent), the English-speaking countries (that is, 31–44 per cent), and the German-speaking countries (that is, 51–61 per cent). Second, we contribute by analysing the interplay between parenthood and

¹ Source: Korean Statistical Information Service (web: https://kosis.kr/statHtml/statHtml.do?orgId=101&tblId=DT_1B8000F&language=en).

² Korea also ranked the last among the OECD countries regarding the female share of seats on boards of the largest companies: only 8.7 per cent of board members are women. Women make up 19 per cent of the legislative members in the national parliament and 15.6 per cent of the total number of employees in managerial positions—figures much lower than the OECD average (Source: OECD Gender Data Portal. <https://www.oecd.org/gender/data>).

Figure 1
Gender gap in selected countries
 (a) Gender Gap in Labor Force Participation



Notes: Data from the OECD. Panel (a) illustrates the gender differential in labour force participation defined as the average labour force participation rate of men minus that of women aged 25–54. Panel (b) shows the gender wage gap defined as the differentials between male and female median earnings divided by the male median earnings, restricting to full-time employees.

occupational and industrial segregation (Buchmann and McDaniel 2016; Hook and Pettit 2016; Cortés and Pan 2017). One of the post-child effects is that women switch their occupations and sectors in response to motherhood. Lastly, we contribute to the literature by investigating various heterogeneous effects using mothers' different characteristics.

Literature review

Numerous studies have examined the effect of having children on female labour market outcomes. The timing of marriage and childbirth are important decisions; when and how many children to have and how much time

women should devote to the market work is a joint decision problem (Nakamura and Nakamura 1992). Previous research attempted to solve the potential endogeneity problem of having children on family labour supply by applying the instrumental variables method, such as using twin births (Rosenzweig and Wolpin 1980) and the sex composition of siblings (Angrist and Evans 1998) as instruments for the number of children. One potential limitation of using these instrumental variables is that they can be used only to examine the impact of having an extra child, rather than looking at the effect of the first child. The latter presumably has a much greater impact on the labour market participation among women.

An event study framework is used to alleviate the endogeneity problem of children (Angelov et al. 2016; Kuziemko et al. 2018; Sieppi and Pehkonen 2019; Kleven et al. 2019b; Berniell et al. 2021) in the absence of reliable instrumental variables for having the first child. Kleven et al. (2019b) studied the effect of children on the gender gap in the labour market using Danish administrative data. They showed that the arrival of children generated a long-run gender inequality in earnings of around 20 per cent, driven by lower levels of participation, working hours, and wages. Sieppi and Pehkonen's (2019) study also confirmed the negative effect of children on labour earnings in Finland, where the long-run child penalty was 25 per cent. Berniell et al. (2021) investigated the child penalty in Chile and found that informal labour market opportunities, such as temporary jobs and jobs without contracts, allowed more flexible work schedules and acted as buffers for new mothers leaving the labour market.

There are few studies on the impacts of children on female labour market outcomes in Korea. Chun and Oh (2002) discussed the effect of the number of children on female labour force participation using the sex of the first child as an instrumental variable. They

found, in 1996, that an additional child lowered the probability of working for married women by 27.5 per cent. Nam (2010) used the number of daughters as an instrumental variable for having one more child and discovered that having a third child had a large negative effect on female labour force participation in the 1980s. Ma (2013) showed that Korean women typically dropped out of the labour market when anticipating motherhood.

In Korea, the share of births for unmarried women is significantly lower than in other developed economies. Thus, marriage and birth are far more intertwined. Lee et al. (2008) found a 40 to 60 per cent lower probability of married women participating in the labour market than single women in urban Korea. Yoo and Lee (2020) showed the employment rate of married women continued to decline during the first six years after being married, dropping about 46 percentage points after six years of marriage. In addition, earned income for married women fell as a direct consequence of the lowered employment rate. There has been relatively limited research on quantifying the long-run child penalty in Korea, particularly in the dynamic effects of children. Our findings show how the effects of children differ for fathers and mothers and how they evolve by tracing the dynamic trajectory of those effects.

Estimation strategy

We estimate the effect of first childbirth on fathers' and mothers' labour market outcomes using the event study method proposed in Kleven et al. (2019b). Event studies can provide causal estimates of the post-child effect if the timing of the event, which is the year of the first childbirth, is independent of the evolution of an individual's baseline labour market outcomes (Sun and Abraham 2021).³

³ Kleven et al. (2019b) provide two identification checks of such an approach: one is the difference-in-differences event study, and the other is estimating the local treatment effect of having a third child based on a sibling sex mix instrumental variable. Section "Robustness Checks" discusses the results using the first type of robustness check. For a more detailed discussion on the identification assumptions in the event study approach, refer to Borusyak et al. (2022) and Sun and Abraham (2021).

Fertility choices may not be exogenous if women who invest less in education and career have higher chances of leaving a job or reducing working hours before pregnancy (that is, the pre-child effect of future children). However, the event of first childbirth creates a sudden change in labour outcomes that is, presumably, not correlated with unobserved determinants of those outcomes; evolution in the absence of such an event should be smooth over time (Kleven et al. 2019b).

We denote the first childbirth as the event $\tau=0$, and all years are indexed relative to the event year (for example, $\tau=-1$ expresses a previous year in which the parents give birth to the first child). The analysis includes the event dummies from four years before the first childbirth to ten years after the first childbirth.⁴ For a panel of $i=1, \dots, N$ individuals observed yearly for all or some $t=1, \dots, T$ calendar years, we run the following separate regression for men and women:

$$Y_{it}^g = \sum_{\tau=-4, \neq -1}^{\tau=\tau^{\max}} \beta_{\tau}^g \mathbb{1}[\tau=t-c^i] + \sum_a \gamma_a^g [a=age]_{it} + \delta_t + \varepsilon_{it} \quad (1)$$

where Y_{it}^g denotes the labour market outcomes for individual i of gender g in year t . Event time τ is defined as year t minus the calendar year in which an individual i had his or her first child c^i . For the right-hand side of Equation 1, we include a full set of event time dummies, age-in-years dummies, and calendar year dummies. We omit the base category of event time dummies at $\tau=-1$ so that all the event time coefficients, β_{τ}^g , can be interpreted as the impact of children relative to the year before the first childbirth. Adding age-in-years fixed effects and survey-year fixed effects on our baseline specification allows us to control for life-cycle trends and time trends.

As per Kleven et al. (2019b), we plot β_{τ}^g coefficients to show the within-person evolution of outcome variables relative to the event of parenthood, conditional on age and year fixed effects. We convert the estimated level

effects into percentage effects by calculating $P_{\tau}^g \equiv \hat{\beta}_{\tau}^g / E[Y_{it}^g | \tau]$, where $\tilde{Y}_{it}^g = \sum_a \tilde{\gamma}_a^g Age_{it}^a + \hat{\delta}_t$ (that is, the prediction of the model omitting the effects of the event time dummies). Then, P_{τ}^g captures the event time τ effect of children as a percentage of the counterfactual outcome absent children, and P_{τ}^g is zero when the event time, τ , equals -1 . We plot the different gender-specific impacts of children P_{τ}^f , P_{τ}^m separately for fathers and mothers across the event times and estimate using robust standard errors clustered at the individual level. We also define a child penalty on mothers relative to fathers at event time τ as follows:

$$P_{\tau} \equiv (\hat{\beta}_{\tau}^f - \hat{\beta}_{\tau}^m) / E[\tilde{Y}_{it}^m | \tau] \quad (2)$$

Having estimated the impacts of children on fathers and mothers separately, we can calculate the child penalty, which measures the percentage by which mothers fall behind fathers due to first childbirth at event time τ . The long-run child penalty is the average value of the penalties from event time five to ten.

Data and descriptive statistics

Data

The primary data source for this study is the KLIPS from 1998 (1st wave) to 2019 (22nd wave). The KLIPS is a longitudinal study surveying a representative sample of Korean households and individuals, which contains a rich set of socio-demographic information, including relevant labour market outcome variables at the individual level. For our purpose, we construct the year of the first childbirth by tracking married couples and their first child's age, allowing us to study the dynamics of labour outcomes before and after couples first become parents.

⁴ Therefore, long-term effects may include not only the impact of the first child but also the impact of siblings after the first child is born.

Our sample includes only those individuals we observed at least once before and once after the first childbirth. Then, the sample consists of individuals who had their first child between 1999 and 2018. We restricted the sample to fathers, whose age at the first childbirth was between 20 and 60-years-old, and mothers, whose age at the first childbirth was between 20 and 50-years-old. Also, we do not impose any restrictions on the parents' marital status. The final sample is composed of an unbalanced panel of 1213 fathers and 1205 mothers in one year before the first childbirth.

We estimate the child penalties on labour force participation, earnings, hours worked, and wages. Labour force participation takes a value of one if an individual is currently employed or actively searching for a job and zero if otherwise. Earnings are defined as the average monthly wage for wage and salary workers and the average monthly income for self-employed individuals. Earnings are imputed as zero for the unemployed. Thus, the effect on earnings may reflect the decrease in working hours, low productivity, or income loss due to discrimination and income loss due to voluntary or involuntary unemployment. Hours worked per week and hourly wage (= monthly earnings/hours worked per week \times 4.3) are only observable for working individuals. All monetary variables, such as earnings and wages, are inflation-adjusted using the 2015-base consumer price index.

Descriptive statistics

Table 1 shows the summary statistics of fathers and mothers a year before they first become parents. Before the first child was born, fathers, on average, are about three years older than mothers. The fathers' average

labour force participation rate is 94.8 per cent, whereas that of mothers is 65 per cent, resulting in a difference of 30 percentage points. For earnings unconditional on working, mothers earn 1,230,600 KRW (that is, 984 USD as of 2nd June 2022) less per month relative to fathers. Among the employed, fathers spend an average of 50.7 hours per week at their jobs, whereas mothers work an average of 44.7 hours per week, which led to a six-hour difference in work hours between parents. Working mothers earn an average of 9990 KRW per hour while working fathers earn an average of 12,230 KRW per hour. In other words, working mothers earn 82 per cent of what working fathers earn.

Estimation results

Baseline results: the impact of children

Panel (a) in Figure 2 shows the event time estimates of labour force participation separately for fathers and mothers. The labour force participation paths of fathers and mothers start to diverge around the time of the first childbirth and slightly recover after that.⁵ The child penalty in labour force participation amounts to 46.2 per cent in the short run (that is, the average value between event time zero to four); however, it decreases to 35.4 per cent in the long run. For instance, 65 per cent of mothers participate in the labour force a year before the first childbirth, but only 38.4 and 45.7 per cent of mothers decide to stay in the labour force at five and ten years after the first childbirth, respectively.

A similar pattern is observed in panel (b) in Figure 2, showing the earnings gap between fathers and mothers; however, the earnings gap persists over time. Mothers experience a

⁵ Panel (a) in Figure 2 also indicates that women may start reducing their labour supply after marriage. According to Yoo and Lee's (2020) findings, the probability of employment dropped significantly by 12 percentage points in the first year of marriage, and its effect extended to 46 percentage points by the 6th year of marriage, which is also likely to include the effect of childbirth. They also found that earnings of married women decreased continuously after marriage due to the decreased probability of employment. We add the role of marriage in female labour market outcomes in Appendix A using our sample and confirm that women start to withdraw from the labour market in the first year of marriage, although the size of the decline in labour force participation is much smaller (that is, 15 percentage points) compared to the size of the decline after the first childbirth (that is, 28.2 percentage points).

Table 1
Summary statistics of one year before first childbirth

Variables	Men		Women		Difference
	Mean	S.D.	Mean	S.D.	
<i>Panel (a) Whole sample</i>					
Birth year	1975.6	5.565	1978.2	5.363	−2.530***
Age at first child born	32.357	3.974	29.720	3.592	2.637***
<i>Highest education achieved</i>					
High school grad. or below	0.273	0.446	0.286	0.452	−0.013
Community college grad.	0.242	0.429	0.309	0.462	−0.066***
University grad. or above	0.485	0.500	0.405	0.491	0.080***
Labour force participation	0.948	0.222	0.650	0.477	0.298***
Monthly earnings	230.971	133.734	107.911	108.892	123.060***
Number of individuals	1213		1205		
<i>Panel (b) Employed sample</i>					
Hours worked (per week)	50.659	12.425	44.712	10.992	5.947***
Hourly wages	1.223	0.636	0.999	0.566	0.225***
Number of individuals	1111		737		

Notes: The values are calculated based on one year before the first child's birth. Earnings and wages are CPI-adjusted, and monthly earnings take the value of 0 if an individual is unemployed. The sample is restricted to those observed at least once before and once after the first childbirth. The final sample is a panel of 1191 men and 1186 women for monthly earnings and a panel of 1089 men and 718 women for hourly wages due to the missing values in earnings and wages.

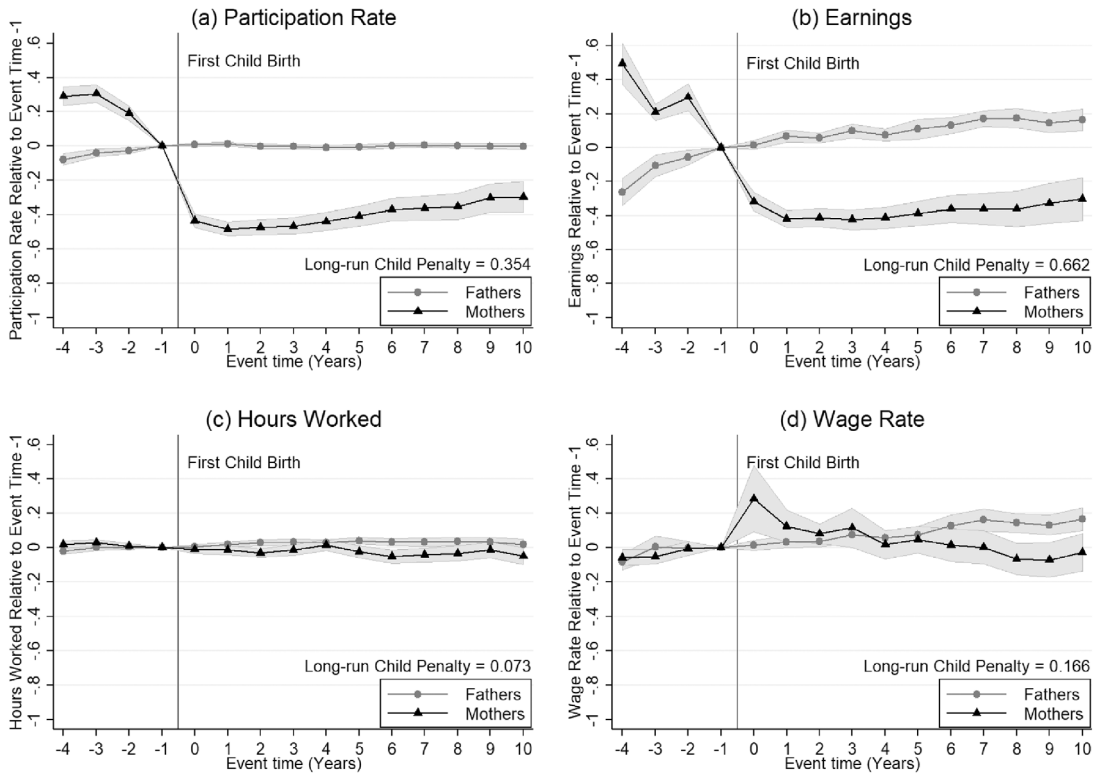
sharp decline in earnings following the first childbirth, and their earnings never recover their original status, whereas men are unaffected or even positively affected. More specifically, mothers experience an earnings drop of 42 per cent the year immediately after the first child's birth. In comparison, fathers experience a slight earnings increase of 6.7 per cent during the same period. Consequently, the child penalty in mothers' earnings, relative to fathers', amounts to 52 per cent in the short run, and it increases to 66.2 per cent in the long run. For instance, mothers earn 107.9 ten thousand KRW a year before the first childbirth; however, their earnings reduce to 66.1 and 75.3 ten thousand KRW at five and ten years after the birth of the first child.

Panels (c) and (d) in Figure 2 show the event time estimates of hours worked and the wage rate. For those who continue to work in the labour market, the evolutions of working fathers and mothers are parallel in the pre-child period. Compared to labour force participation and earnings, those effects are relatively small in magnitude; on average, mothers' hours worked fall by 3.7 per cent, whereas their hourly wages increase by

7.8 per cent over the initial four years of the first childbirth. Those penalties increase to 7.3 and 16.6 per cent in the long run. Despite the lowered child participation penalty in the long run, the widening gaps in hours worked and wage rates combine to worsen the long-run earnings differentials between fathers and mothers. The long-run effect and child penalty will capture the effect of the first child and the overall effect of children, including the additional costs of siblings born thereafter.

The main force behind widening the earnings gap between fathers and mothers is the large negative impact of motherhood on the labour supply, in both the extensive and intensive margins. In other words, mothers pay a significant earnings penalty after the first childbirth, as they are more likely to exit the labour market or, even if they decide to stay in their jobs, work fewer hours. Even though this earnings impact comes from both extensive and intensive margins, the labour force participation penalty is much closer in magnitude to the earnings penalty, indicating that the extensive margin mostly drives the earnings penalty.

Figure 2
The impact of children



Notes: The graphs show event time coefficients estimated from Equation 1 as a percentage of the counterfactual outcome absent children (that is, $P_{it}^S \equiv \tilde{\beta}_{it}^S / E[Y_{it}^S | \tau]$) separately for fathers and mothers. The long-run child penalty is calculated as the average value of the penalties from event time five to ten. The sample is restricted to those observed at least once before and once after the first childbirth. The effects on labour force participation and earnings are estimated unconditional on employment status, while the effects on hours worked and wage rate are estimated conditional on working. The shaded areas represent 90 per cent confidence intervals.

Another point worth mentioning is a sudden rise in mothers' wage rate in the first child's birth year. When analysing the impacts of children on hours worked and wage rates, we restrict the sample to the employed. Thus, the estimated effects of those outcomes include any selection effects into employment. Blau and Kahn (2017) reviewed the literature on selection and the gender wage gap; they showed some evidence of the positive selection into employment in more recent years due to the appreciable improvements in female educational attainment, experience levels, and occupational choices. In such

cases, our estimates would be underestimated and serve as a lower bound of true estimates than the true parameters of children's impacts on mothers' hours worked and wage rates.

International comparisons

Next, we compare our results from Korea with those of other economies, summarised in Table 2. The size of the long-run penalty on earnings is considerably different across countries. In Scandinavian countries, the long-run earnings penalties are 21–27 per cent, and in

English-speaking countries, the long-run penalties in earnings are 31–44 per cent. Both penalties are smaller than the 51–61 per cent reduction in mothers' earnings in Germanic countries. The earnings penalties are driven from different margins across countries. In the Scandinavian and Germanic countries, the earnings penalty is driven more by the intensive margin and wage rate effect. However, the extensive margin effect is largely responsible for the earnings penalty in English-speaking countries (Angelov et al. 2016; Sieppi and Pehkonen 2019; Kleven et al. 2019a; Berniell et al. 2021). Korea ranks the highest in child penalty in earnings (that is, 66.2 per cent). The reduced labour force participation is a key driver of the earnings penalty, similar to the USA and UK.

Compared to other Western countries, Korea exhibiting the highest child penalty might be related to gender roles and family norms in a male breadwinner society. Despite no gender gap in college enrollment and growing numbers of dual-earner couples, Korean women spend about 166 minutes more (49 vs. 215 minutes) per day in unpaid work than Korean men. The gender time gap in unpaid work is much greater than the OECD average of 127 minutes (136.5 vs. 263.4 minutes) in the latest available year.⁶ Even among the dual-earner households, Korean wives spend two hours per day more on nonmarket activities than husbands (Hwang 2016). Korean couples' unequal division of household labour preexists before the first childbirth. When the first child arrives, wives' household work increases by six hours per day, whereas husbands' unpaid work decreases by 30 minutes per day on average. This discrepancy may lead some women to leave the

Table 2
Comparison of the long-run child penalties in different economies

Paper	Country	Child penalty in earnings (%)
Angelov et al. (2016)	Sweden	32
Kleven et al. (2019a)	Denmark	21
	Sweden	27
	United States	31
	United Kingdom	44
	Austria	51
Sieppi and Pehkonen (2019)	Germany	61
	Finland	25
Berniell et al. (2021)	Chile	28
Our paper	South Korea	66

Notes: Child penalty is defined as the average penalty from event time five to ten. Earnings are unconditional on employment status, and thus the effects come from both the extensive and intensive margins.

workforce entirely or spend less time on paid labour (Kim and Cheung 2019).

Robustness checks

The long-run impact of children can be biased if the evolution of labour market outcomes largely changes over a long event time window, although controlling for age and year fixed effects may alleviate some bias. Kleven et al. (2019b) proposed one solution using men and women without children as control groups in the Difference-in-differences (DID) setting. We use a DID-Event study design⁷ to check the robustness of our event study

⁶ **Source:** OECD Time Use Database (web: https://stats.oecd.org/Index.aspx?DataSetCode=TIME_USE).

⁷ The DID-event study design is based on assigning placebo births to individuals who never have children, drawing from the observable characteristics of those who do have children. Specifically, we estimate the following model:

$$\text{Age at the first childbirth}_i = \text{Female}_i + \text{Edu_max}_i + \text{Earnings}_i + \text{Birth year}_i + \varepsilon_i$$

We assign the year of placebo births by predicting the age at which individuals have their first child as a function of observable determinants such as female dummy, highest educational level received (that is, years of schooling), and earnings at age 25 or initially observed earnings. Following Kleven et al. (2019b), we drop the age dummies in the DID-event study model specification and analyse in the same way as the event study design.

results. This design compares men with children to men without children and women with children to women without children, as opposed to our gender gap estimates comparing mothers to fathers. This approach alleviates the concern that fathers may not serve as an appropriate control group of mothers because of their gender difference. We define a father penalty as the percentage by which men with children rise or fall behind men without children and a mother penalty as the percentage by which women with children fall behind women without children. The results, presented in Appendix S1, Figure B1 (Supporting information), show significant participation and earnings gaps between women with and without children, suggesting that gender, by itself, does not drive child penalties. In both labour force participation and earnings, women with and without children sharply diverge immediately after the first actual or placebo year of childbirth. The impacts slightly recover over time but never return to levels before childbearing. The long-run child penalties for women with children compared to women without children are 26.9 in labour force participation. The long-run effect on earnings, however, is smaller at 31 per cent when using women without children as counterfactuals than using men (both with and without children) as counterfactuals.

Motherhood and occupational and industrial choices

So far, we provide the event study evidence of the long-run child penalties in different labour market outcomes. The finding of the negative wage differential between fathers and mothers raises an important question: Why is there still a gender pay gap even among working parents? Much of this gap can be explained by measurable factors, such as educational attainment, job experience, and occupational and industrial segregation.

Despite the increased portion of women in high-paying occupations and industries traditionally dominated by men, women are still over-represented in low-paying occupations and industries relative to their total share of the labour force.

A growing body of research shows the association between motherhood and occupational and industrial segregation. Family responsibilities, such as childrearing, may segregate fathers and mothers into and out of certain occupations and industries. Mothers are more likely to be out of the labour market and over-represented in less desirable occupations than women without children (Hook and Pettit 2016). A low share of skilled women in an occupation with long work hours suggests that women may switch to more family-friendly occupations or opt-out of the labour force to manage family and career (Cortés and Pan 2017). Buchmann and McDaniel (2016) suggested that a positive association between motherhood and wage exists in some professions with greater workplace flexibility and autonomy, such as medicine. Women tend to work as part-time workers or have jobs in industries with shorter work hours; thus, industries with higher earnings and longer working hours are male-dominated (Blau and Kahn 2017).

In order to investigate how motherhood affects women's occupational and industrial choices, we define male- and female-dominated occupations (industries) as those whose average ratio of male workers is above 0.6 and below 0.4, respectively.⁸ Table 3 shows that female-dominated occupations (industries) are more likely to be low-paying occupations (industries) with high job flexibility. In contrast, male-dominated occupations (industries) are more likely to be high-paying and long-hour occupations (industries). Appendix S1, Table B1, lists the top ten male- and female-dominated occupations and industries.

We study how the probability of having male- and female-dominated occupations

⁸ We construct the ratio of male workers in each occupation and industry (that is, number of male workers/ numbers of total workers in each occupation and industry) for the entire survey year using the cross-sectional weights.

Table 3
Descriptive statistics of occupation and industry at $\tau = -1$

	Occupation		Industry	
	Male-dominated	Female-dominated	Male-dominated	Female-dominated
Occ. or Ind. with High Job Flexibility (share)	0.067 (0.250)	0.435 (0.496)	0.095 (0.294)	0.713 (0.453)
High-paying Occ. or Ind. (share)	0.454 (0.498)	0.217 (0.413)	0.361 (0.481)	0.062 (0.242)
Low-paying Occ. or Ind. (share)	0.008 (0.089)	0.085 (0.279)	0.001 (0.032)	0.274 (0.446)
Long-hour Occ. or Ind. (share)	0.375 (0.484)	0.204 (0.404)	0.469 (0.499)	0.347 (0.477)

Notes: Occupations (Industries) with high job flexibility are defined as those with a higher ratio of part-time workers than the average value of the total occupations (industries). High-paying occupations (industries) are those that pay more than the hourly wage at the 75th percentile of the total occupations (industries). Low-paying occupations (industries) are defined as those in which the median hourly wages are below two-thirds of the median wage of the total occupations (industries). Long-hour occupations (industries) are defined as those with longer weekly hours worked than the average working hours of the total occupations (industries). Statistics are calculated with pooled data using cross-sectional weights. Standard deviations are shown in parentheses.

and industries changes with the first childbirth for working fathers and mothers. Figure 3 shows the gender-specific impacts of the first childbirth on occupational and industrial choices using the same specification as “Baseline results: the impact of children” section. All panels exhibit that working fathers and mothers are on identical pre-trends regarding their probability of having male- and female-dominated occupations and industries before parenthood. However, we see a persistent drop in working mothers’ probability of entering male-dominated occupations and industries after the first child is born. Contrarily, there is no change in working fathers’ probability of having male-dominated occupations and industries around parenthood. In the long run, the probability of having male-dominated occupations and working in male-dominated industries is lowered by 36.2 per cent and 31.7 per cent, respectively, for working mothers relative to working fathers, due to raising children.

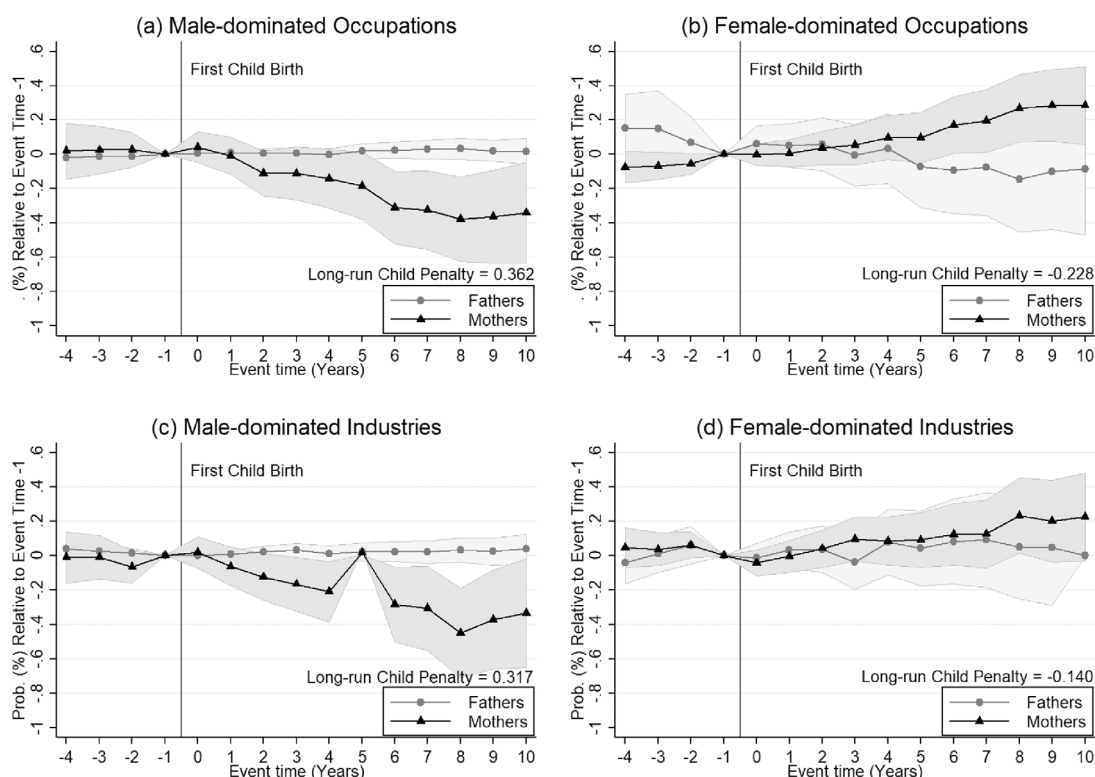
On the other hand, panels (b) and (d) in Figure 3 show opposite patterns after the first childbirth. The probability of working in female-dominated occupations and industries increases for working mothers but not for working fathers. Computing the average effect from

event time $\tau = 5$ to $\tau = 10$, the probability of having female-dominated occupations among working mothers is increased by 22.8 per cent compared to their male counterparts. The average effect of being employed in female-dominated industries is 14 per cent over the same period. These results indicate that motherhood contributes to high occupational and industrial segregation among working parents and, thus, to the gender pay gap. Our evidence suggests that mothers respond to motherhood by forgoing higher wages by changing occupations and industries with higher flexibility and relatively lower working hours.

Heterogeneous effects by mothers’ characteristics

This section analyses the impact of children on mothers’ labour force participation with different characteristics and investigates heterogeneous effects across the sample. We exclude other labour market outcomes since most of the penalties are driven by labour force participation in Korea. Previous literature suggests that the effect of having children on labour market outcomes may depend on

Figure 3
The impact of children on occupational and industrial choices



Notes: The figure shows the impacts of children on the probability of having male- and female-dominated occupations or industries conditional on employment. Event time coefficients are estimated as the percentage of the counterfactual outcome absent children for fathers and mothers separately. The long-run child penalty is calculated as the average value of the penalties from event time five to ten. The sample is restricted to those observed at least once before and once after the first childbirth. The shaded areas represent 90 per cent confidence intervals.

educational attainment, age at birth, duration between marriage and first birth, and the number of children (Blackburn et al. 1993; Amuedo-Dorantes and Kimmel 2005; Miller 2011; Troske and Voicu 2013; Goldin 2014; Kahn et al. 2014; Gough 2017; Doren 2019; Sieppi and Pehkonen 2019; Kleven et al. 2019b). We look at how the long-run child penalty varies across four dimensions: whether mothers have at least a bachelor's degree, whether mothers give birth before or after the age of 29, whether parents decide to have their first child within two years of

marriage, and whether mothers have one child, two children, or three or more children. The median values⁹ of the age at the first childbirth and the duration between marriage and first birth are used to separate the sub-groups (see Appendix S1, Figure B2).

The effects of motherhood likely differ with educational attainment, as women with and without college educations are dissimilar in many ways. For example, they are expected to have different labour market trajectories, possess different levels of wealth and attitudes toward family, and face different fertility

⁹ In our sample, the median age at which women give birth to their first child is 29-years-old. The median value of the first birth interval among married women is two years.

schedules (Doren 2019). College-educated mothers may find ‘good jobs’ with family-friendly benefits that reduce the costs of childbearing and provide job flexibility (Amuedo-Dorantes and Kimmel 2005). For instance, pharmacists (that is, more linear relationship between earnings and hours worked) with children often work part-time instead of exiting the labour force (Goldin 2014).

We classify women into two groups to estimate the heterogeneous motherhood effects by educational attainment¹⁰: mothers who earn at least a bachelor’s degree and mothers who graduate from some college, high school, or less. Panel (a) in Figure 4 presents the event time estimates of labour force participation separately for college-educated mothers, non-college-educated mothers, and fathers. Less-educated mothers generally experience a more sizable drop in labour force participation upon the first childbirth than college-educated mothers; in the long run, relative to fathers, college-graduated mothers’ labour force participation rate declines by 27.9 per cent, and non-college-graduated mothers’ labour force participation rate falls by 35.4 per cent. The child earnings penalty is almost three-quarters for less-educated mothers (see Appendix S1, Table B2).

Women who become mothers at younger ages tend to invest less in human capital than women who give birth to their first child relatively late in their lives. Consequently, ‘early’ child-bearers experience greater career penalties and lower wages than ‘late’ child-bearers (Blackburn et al. 1993; Kahn et al. 2014). According to Miller’s (2011) estimates, career earnings, work experience, and average wage rates increase by 9 per cent, 6 per cent, and 3 per cent, respectively, for a year in which women decide to delay their motherhood.

Young mothers face higher child penalties in labour force participation than mothers who

postpone their pregnancy past the age of 29, as shown in panel (b) in Figure 4. In the long run, relative to fathers, the labour force participation rate decreases 44.7 per cent for mothers who bear their first child before the age of 29, while it falls to 29.7 per cent for mothers who first give birth after the age of 29. After the first child is born, both groups of mothers experience a persistent loss of earnings, but, again, the negative effect is greater for young mothers (see Appendix S1, Table B2).

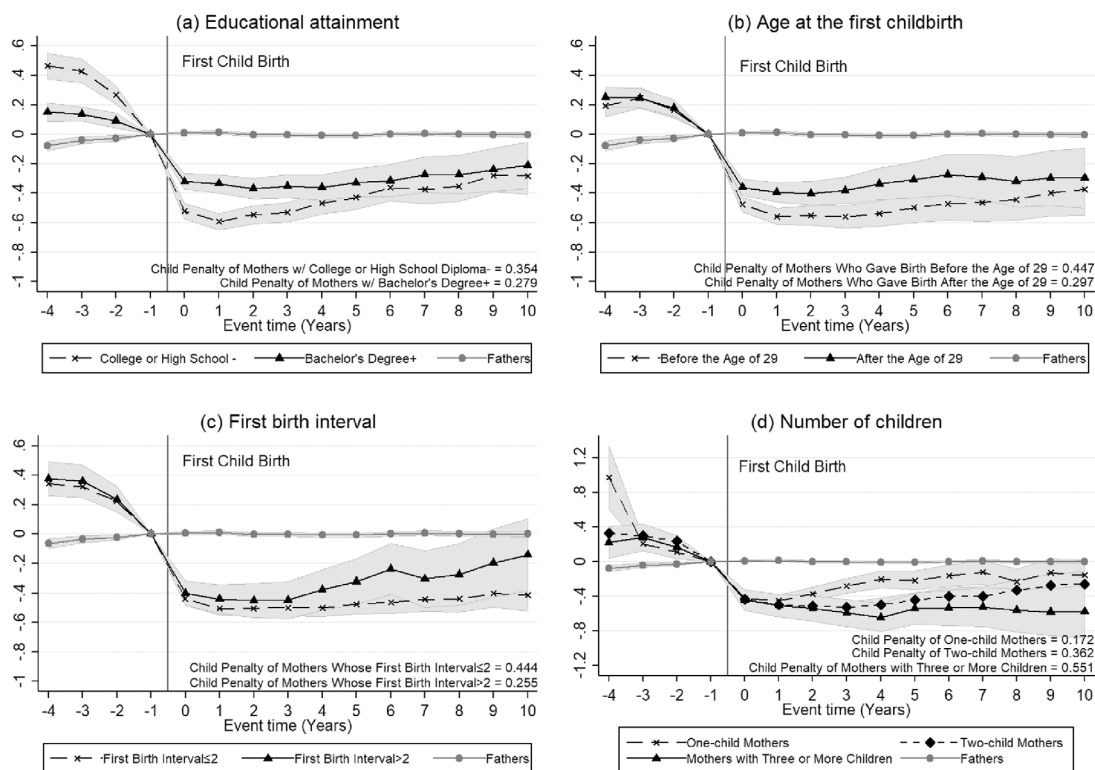
Birth spacing has a significant role in determining the effect of children on mother’s labour market outcomes. After marriage, delaying the time-to-first birth leads to higher prenatal levels of labour market involvement, mitigating the negative effects of the first childbirth on mothers’ participation and wages (Troske and Voicu 2013; Gough 2017). To estimate how the timing of birth affects the long-run child penalty, we define the first birth intervals of zero to ten years after marriage as the duration of time before married couples have their first child. We divide the sample into two groups based on the length of the marriage and first birth interval: parents whose interval is less than or equal to two and parents with an interval greater than two.¹¹

Panel (c) in Figure 4 shows that women who postpone childbearing experience lower long-run child penalties in labour force participation, whereas both groups of women experience similar earnings penalties (see Appendix S1, Table B2) for the next ten years after their first child is born. Over the long run, the labour force participation rate falls by 44.4 per cent for women who bear their first child within two years of marriage over the long run; however, women who delay their first childbirth for two to ten years after marriage are 25.5 per cent more likely to leave the labour market relative to fathers. The result suggests that delaying the first childbirth (rather than having a child immediately after marriage) may act as a buffer

¹⁰ We classify women based on their maximum educational level received during the sample period so that the definition of groups can be time-invariant.

¹¹ Divorce, separation, and bereavement can affect an individual’s labour market outcomes, leading to biased estimates in analysing the heterogeneous effect of children by the duration between marriage and the first childbirth. Thus, the sample is restricted to individuals who do not experience marital status changes during the sample period and are observed at least once before and after the first childbirth.

Figure 4
Heterogeneous effects on labour force participation by mothers' characteristics



Notes: The figure presents different motherhood impacts by mothers' characteristics, with the same specification in Figure 2. Each panel reports: (a) the child penalties of mothers with some college, high school diploma, or less and mothers with bachelor's degree and more; (b) the child penalties of mothers who give birth before the age of 29 and after the age of 29; (c) the child penalties of mothers who have their first child within two years of marriage and after; (d) the child penalties of one-child mothers, two-child mothers, and mothers with three or more children (the percentage by those mothers fall behind fathers due to children). The total number of children splits the sample as of the last observed year (1, 2, 3, or more children).

against the negative impacts of motherhood and alleviate the long-run penalty in labour force participation for mothers.

Having additional children may have more adverse gender-specific responses to the birth of the first child. Mothers may take on greater responsibility for the childcare burden in terms of time, money, and emotional investment as they have more children, resulting in lower long-term earnings for mothers (Kahn et al. 2014). Thus, we investigate whether the number of children affects parents' labour market outcomes in panel (d) in Figure 4. Confirming the results of Kleven et al. (2019b) and

Sieppi and Pehkonen (2019), we find that the long-run child penalties are highest for mothers with more than three children in both labour force participation and earnings. In part, these findings can be related to differences in socio-economic characteristics across family types. For instance, mothers with more than three children are less likely to be educated, experienced, and employed than mothers with fewer children at the baseline, that is, before giving a birth (Sieppi and Pehkonen 2019). Future mothers of one child are 5.1 percentage points (44.5 per cent vs. 39.4 per cent) more likely to have a bachelor's

degree, 7.3 percentage points (65.3 per cent vs. 58 per cent) more likely to be employed, and earn 20 ten thousand won (121.2 vs. 101.2) more than mothers of two children a year before their first childbirth.¹²

Conclusion

Even with the considerable improvement in gender equality in education, many countries still experience a substantial gender gap in the labour market. Recent papers document that motherhood is an important driver behind the gender gap in labour supply and earnings (Angelov et al. 2016; Kuziemko et al. 2018; Sieppi and Pehkonen 2019; Kleven et al. 2019a; Kleven et al. 2019b; Berniell et al. 2021). Our paper extends the literature by measuring the negative effect of children on mothers' labour market outcomes in Korea using the event study approach.

We find that the first child's arrival reduces mothers' labour force participation and earnings, and the effect persists. In the long run, mothers earn 66.2 per cent less than their male counterparts, and they are 35.4 per cent more likely than fathers to leave the labour force. The earnings penalty is higher than the estimates found in other countries, largely resulting from the extensive margin of women moving out of the labour force. Our results also suggest that motherhood contributes to the high levels of occupational and industrial segregation among working parents and, thus, to the gender wage gap.

We further investigate heterogeneous effects of children across different groups based on mothers' characteristics and find some mothers are more vulnerable than others. For instance, non-college-graduate mothers and young mothers, relative to college-graduate mothers and mothers who give first birth after the age of 29, experience higher child penalties in labour force participation and earnings. Also, mothers who give birth within a short period after marriage face greater negative consequences on labour force participation than those who delay the time after marriage for the first birth. Finally, the negative effects of becoming a mother on labour market outcomes worsen as the number of children increases.

Fathers and mothers adjust differently in their careers to balance their work and family while raising the first child. Motherhood can lead to career interruptions and a permanent negative impact on long-term earnings. Improving social benefits and relevant policies may assist mothers to remain in the labour market without any child-related participation and earnings penalties.

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References

- Amuedo-Dorantes, C. and Kimmel, J., 2005. 'The motherhood wage gap for women in the United States: the importance of college and fertility delay', *Review of Economics of the Household*, 3:17–48.
- Angelov, N., Johansson, P. and Lindahl, E., 2016. 'Parenthood and the gender gap in pay', *Journal of Labor Economics*, 34(3):545–79.
- Angrist, J.D. and Evans, W.N., 1998. 'Children and their parents' labor supply: evidence from exogenous variation in family size', *The American Economic Review*, 88(3):450–77.
- Altonji, J.G. and Blank, R.M., 1999. 'Race and gender in the labor market', *Handbook of Labor Economics*, 3:3143–3259.

¹² Summary of the heterogeneous effect is presented in Appendix S1, Table B2.

- Avellar, S. and Smock, P.J., 2003. 'Has the price of motherhood declined over time? A cross-cohort comparison of the motherhood wage penalty', *Journal of Marriage and Family*, 65(3):597–607.
- Berniell, I., Berniell, L., de la, Mata, D., Maria, E. and Marchionni, M., 2021. 'Gender gaps in labor informality: the motherhood effect', *Journal of Development Economics*, 150:102599.
- Blackburn, M.L., Bloom, D.E. and Neumark, D., 1993. 'Fertility timing, wages, and human capital', *Journal of Population Economics*, 6(1):1–30.
- Blau, F.D. and Kahn, L.M., 2017. 'The gender wage gap: extent, trends, and explanations', *Journal of Economic Literature*, 55(3):789–865.
- Borusyak, K., Xavier, J. and Jann, S., *Revisiting Event Study Designs: Robust and Efficient Estimation*, (April 19, 2022). Available at SSRN: <https://ssrn.com/abstract=2826228>
- Buchmann, C. and McDaniel, A., 2016. 'Motherhood and the wages of women in professional occupations', *RSF: The Russell Sage Foundation Journal of the Social Sciences*, 2(4):128–50.
- Budig, M.J. and England, P., 2001. 'The wage penalty for motherhood', *American Sociological Review*, 66(2):204–25.
- Chun, H. and Oh, J., 2002. 'An instrumental variable estimate of the effect of fertility on the labour force participation of married women', *Applied Economics Letters*, 9(10):631–4.
- Cortés, P. and Pan, J., 2017. 'Cross-country evidence on the relationship between overwork and skilled women's job choices', *American Economic Review*, 107(5):105–9.
- Doren, C., 2019. 'Which mothers pay a higher price? Education differences in motherhood wage penalties by parity and fertility timing', *Sociological Science*, 6:684–709.
- Gangl, M. and Ziefle, A., 2009. 'Motherhood, labor force behavior, and women's careers: an empirical assessment of the wage penalty for motherhood in Britain, Germany, and the United States', *Demography*, 46(2):341–69.
- Glauber, R., 2007. 'Marriage and the motherhood wage penalty among African Americans, Hispanics, and Whites', *Journal of Marriage and Family*, 69(4):951–61.
- Goldin, C., 2014. 'A grand gender convergence: its last chapter', *American Economic Review*, 104(4): 1091–119.
- Gough, M., 2017. 'Birth spacing, human capital, and the motherhood penalty at midlife in the United States', *Demographic Research*, 37: 363–416.
- Hook, J.L. and Pettit, B., 2016. 'Reproducing occupational inequality: motherhood and occupational segregation', *Social Politics: International Studies in Gender, State & Society*, 23(3): 329–62.
- Hwang, J., 2016. 'Housewife, "gold miss," and equal: the evolution of educated women's role in Asia and the US', *Journal of Population Economics*, 29(2):529–70 <https://doi.org/10.1007/s00148-015-0571-y>
- Kim, E.H.-W. and Cheung, A.K.-L., 2019. 'The gendered division of household labor over parenthood transitions: a longitudinal study in South Korea', *Population Research and Policy Review*, 38(4):459–82.
- Kahn, J.R., García-Mangano, J. and Bianchi, S.M., 2014. 'The motherhood penalty at midlife: long-term effects of children on women's career', *Journal of Marriage and Family*, 76(1): 56–72.
- Kleven, H., Landais, C. and Søgaard, J.E., 2019b. 'Children and gender inequality: evidence from Denmark', *American Economic Journal: Applied Economics*, 11(4):181–209.
- Kleven, H., Landais, C., Posch, J., Steinhauer, A. and Zweimüller, J., 2019a. 'Child penalties across countries: evidence and explanations', *AEA Papers and Proceedings*, 109:122–6.
- Kuziemko, I., Pan, J., Shen, J. and Washington, E., 2018. 'The mommy effect: do women anticipate the employment effects of motherhood?', *NBER Working Paper*, No.24740.
- Lee, B.S., Jang, S. and Sarkar, J., 2008. 'Women's labor force participation and marriage: the case of Korea', *Journal of Asian Economics*, 19(2): 138–54.
- Ma, L., 2013. 'Employment and motherhood entry in South Korea, 1978–2006', *Population*, 68:419–46.
- Miller, A.R., 2011. 'The effects of motherhood timing on career path', *Journal of Population Economics*, 24(3):1071–100.
- Nakamura, A. and Nakamura, M., 1992. 'The econometrics of female labor supply and children', *Econometric Reviews*, 11(1):1–71.
- Nam, K., 2010. 'The effect of having more children on women's labor force participation in Korea: an analysis using instrument variables', *Labor*, 24(3):333–56.
- Rosenzweig, M.R. and Wolpin, K.I., 1980. 'Life-cycle labor supply and fertility: causal inferences from household models', *Journal of Political Economy*, 88(2):328–48.
- Sieppi, A. and Pehkonen, J., 2019. 'Parenthood and gender inequality: population-based evidence on the child penalty in Finland', *Economics Letters*, 182:5–9.

- Sun, L. and Abraham, S., 2021. 'Estimating dynamic treatment effects in event studies with heterogeneous treatment effects', *Journal of Econometrics*, 225(2):175–99.
- Troske, K.R. and Voicu, A., 2013. 'The effect of the timing and spacing of births on the level of labor market involvement of married women', *Empirical Economics*, 45:483–521.
- Waldfoegel, J., 1998. 'Understanding the "family gap" in pay for women with children', *Journal of Economic Perspectives*, 12(1):137–56.
- Yoo, I. and Lee, J., 2020. 'The effects of marriage and childbearing on labor market outcomes and subjective well-being among women', *Korean Journal of Labor Economics*, 43(4):35–86.

Appendix A

The impact of marriage

Marriage and childbirth are once-in-a-lifetime events that significantly impact women's labour market outcomes. It is quite difficult to estimate the independent effect of each of these two major events. An ideal way to estimate the effect of marriage is to analyse the difference in the labour market outcome between married and single women without children. However, the effects of marriage and childbirth are hard to distinguish since the proportion of childless married women is low, and the period between marriage and the first childbirth is relatively short. In the case of South Korea, most married women give birth after marriage. The share of ex-nuptial/ out-of-wedlock births (that is, the child's parents are not registered as married to each other at the time of birth) was 2.2 per cent in 2018, which is the lowest share among OECD countries.¹³ The low proportion of children born outside of marriage reflects the high propensity of couples to marry before parenthood.¹⁴ Marriage almost always takes place before the first childbirth and has a considerable impact on women's labour market outcomes before the first childbirth.

We construct the equivalent analysis on estimating the impact of marriage on the labour market trajectories for married women relative

to married men. Divorce, separation, and bereavement can affect women's labour market outcomes differently, creating a bias in estimating the true effect of marriage. Thus, we limit our sample to individuals who have not experienced divorce, separation, or bereavement after marriage during the sample period. Figure A1 shows the impacts of marriage on (a) labour force participation, (b) monthly earnings, (c) weekly hours worked, and (d) hourly wage rate separately for married men and women. The first aspect to highlight is that married women's labour trajectories change gradually with marriage, differing from the drastic changes after the first childbirth; in contrast, married men's trajectories do not change. For most of these outcomes, the evolutions for men and women are parallel in the pre-marriage period, but married women's trajectories start diverging and open a huge gap. Importantly, the gaps persist in the long run, perhaps combined with an additional shock from the first child's birth.

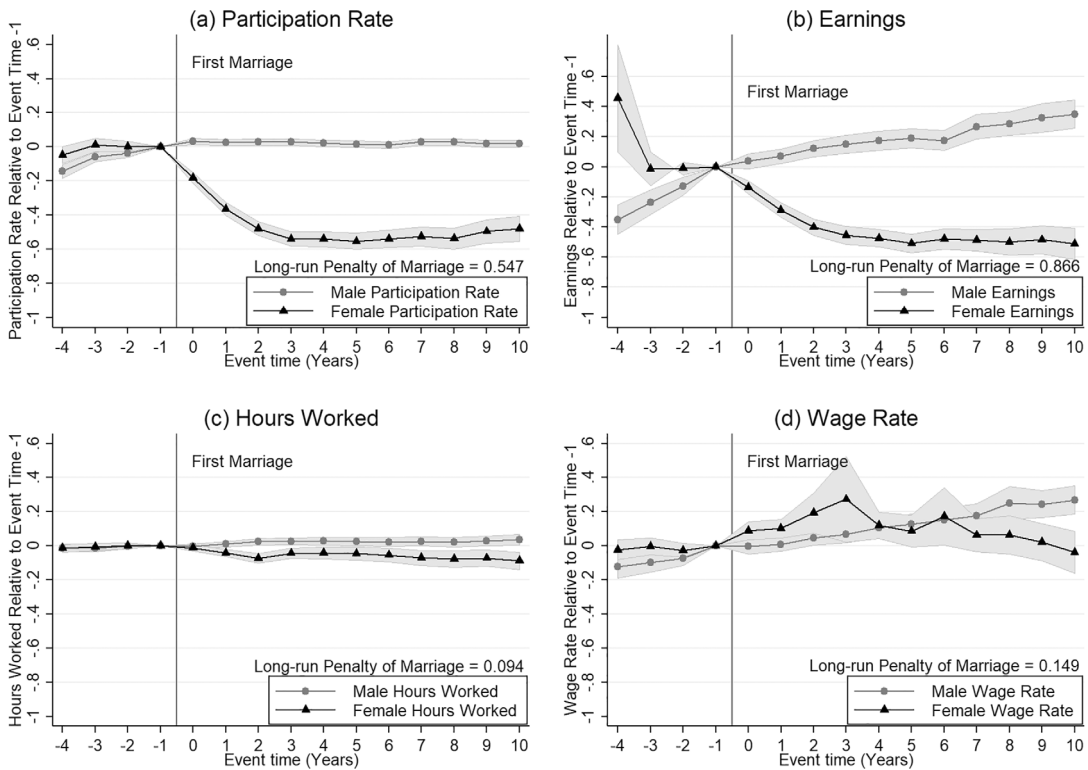
Taking the average effects from event time $\tau = 5$ to $\tau = 10$, married women's labour force participation rate declines by 54.7 per cent, and their labour earnings fall by 86.6 per cent relative to their male counterparts.¹⁵ The

¹³ The average rate across the 28 OECD countries is 40.7 per cent in 2018.

¹⁴ 'OECD Family Database', OECD, accessed June 29, 2021, www.oecd.org/els/family/database.htm.

¹⁵ For example, 82.5 per cent of women participate in the labour force a year before the first marriage, but only 36.9 and 42.8 per cent of women decide to stay in the labour force at 5 years and 10 years after the first marriage, respectively. On the other hand, 89.1 per cent of men participate in the labour market a year before they get married, and 90.6 and 90.8 per cent of men remain working at 5 years and 10 years after their first marriage. Men and women earn 204 and 131 ten thousand KRW, respectively, a year before their first marriage. Women earn 66.8 and 67 ten thousand KRW less at 5 and 10 years after the first marriage; however, men earn 38.5 and 71.3 ten thousand KRW more at those times.

Figure A1
The impact of marriage on labour market outcomes



Notes: This figure shows the impact of marriage on different labour market outcomes. Event time coefficients are estimated as a percentage of the counterfactual outcome absent marriage separately for married men and women. Each panel also reports a 'long-run penalty of marriage' (the percentage by which married women fall behind married men due to marriage). This penalty is calculated as the average value of the penalties from event time five to ten. The sample is restricted to those observed at least once before and after marriage. The effects on participation and earnings are estimated unconditionally on employment status, while the effects on hours worked and wage rates are estimated conditionally on employment. The shaded areas represent 90 per cent confidence intervals.

results suggest that the combined negative effects of marriage and children on women's labour market outcomes are higher than the effects of childbirth alone. However, the size of the immediate decline in labour force participation after marriage is much smaller (that is, 15 percentage points at $\tau=0$) than the size of the decline after the first childbirth (that is, 28.2 percentage points at $\tau=0$).

Supporting information

Additional supporting information may be found in the online version of this article at the publisher's website: <http://onlinelibrary.wiley.com/doi//supinfo>.

Appendix S1 Supplementary figures and tables.