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The motherhood penalty in China: Magnitudes, trends, and the role of grandparenting☆

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ABSTRACT

This paper estimates the labor market impacts of parenthood in China. We find that becoming a mother has negative impacts on women's labor outcomes. But the impacts appear to recover sooner than what has been found in other countries. A decomposition exercise suggests that parenthood plays a limited role in explaining the large gender inequality in China's labor market. We document a form of intergenerational arrangement that is prevalent among Chinese families: Upon the arrival of a child, grandmothers substantially reduce market labor supply and provide much of the childcare. Grandparents' help with childcare likely plays an important role in alleviating the motherhood effect. Suggestive evidence indicates that in return, grandparents who help with childcare receive more intra-family transfers and report higher subjective wellbeing. We further show that the motherhood effect, though relatively small, has increased substantially over the past decades. The rising gender gap in the labor market, the declining state sector that historically provides more flexible accommodations for working mothers, and the abolishment of the one-child policy all suggest a rising burden of motherhood on labor market outcomes.

1. Introduction

Across the world, women's labor outcomes are negatively and persistently impacted by the arrival of the first child, while men's are barely scathed (Kleven et al., 2019a, 2019b). After decades of progress in gender equality, this "child penalty" on women relative to men has become the major contributor to the remaining gender gap in western industrialized countries (Cortes and Pan, 2020).

Compared with other countries, China presents an interesting case: It has a high gender inequality that has risen rapidly in the past few decades. Between 2010 and 2018, the residual gender earnings gap is 40.0%.[1] In the same period, China has one of the highest female employment rates in the world (Panel A of Fig. 1). Compared with selected developed, developing, and transitional economies, China has an exceptionally high female employment rate for those between the mid-20 s and 30 s, the age range in which women are most likely to be childbearing or having small children. Indeed, the employment rate of Chinese women with small children is high and increases quickly as the child ages (Panel B of Fig. 1). For instance, only 65% of the American women with a three-year-old work in the

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[1] This figure is based on the authors' calculation using the China Family Panel Studies. Log annual earnings are residualized from a set of education and age indicators.

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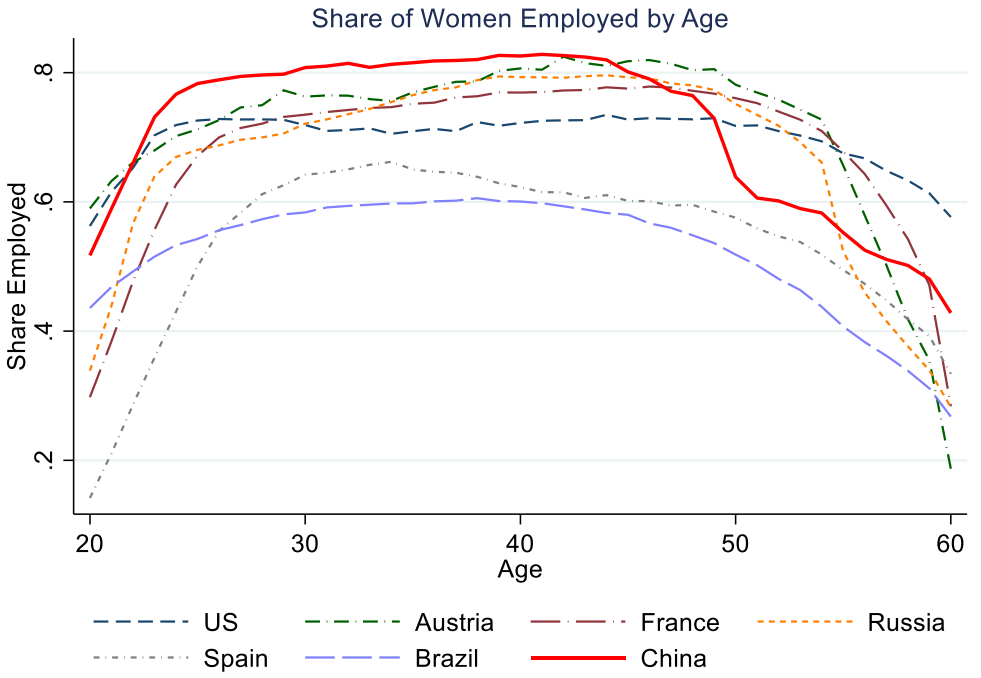
Panel A: Female employment rate by age



Panel B: Female employment rate by age of the youngest child

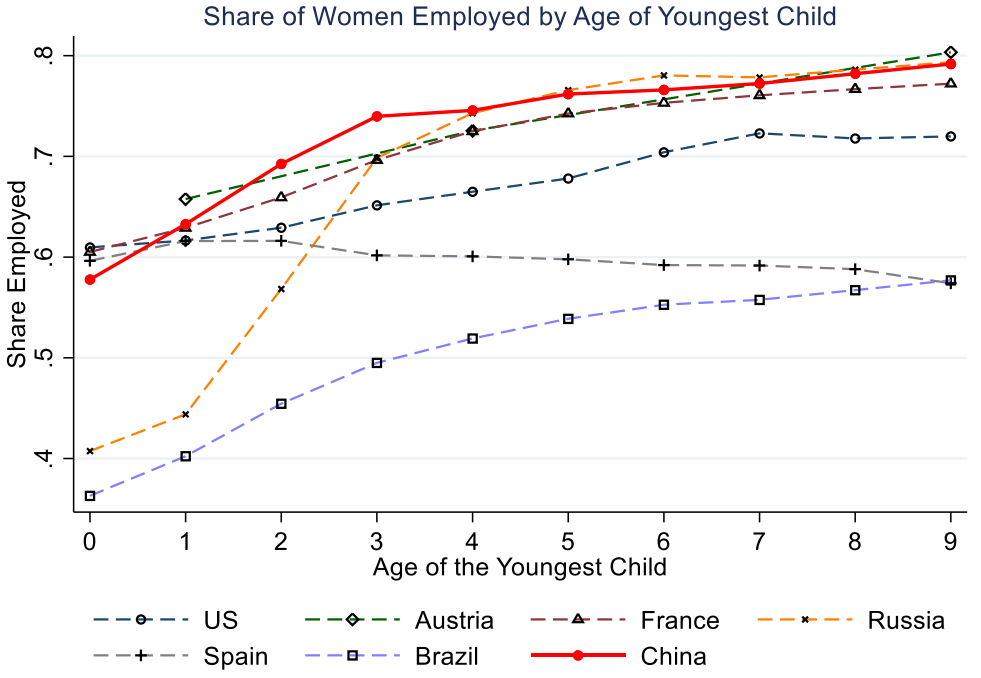


Fig. 1. Female employment rate in China and selected countries.
Panel A: Female employment rate by age.
Panel B: Female employment rate by age of the youngest child.
Note: The employment rates for China are based on the 2010 Population Census, while those for other countries are based on data from IPUMS in the 2010s (the exact year varies slightly across countries).

labor market, while three-quarters of their Chinese counterparts do. The high employment rate of women with small children seems to suggest a less pronounced motherhood effect in China.

This paper estimates the causal effects of the birth of the first child on parents' labor market outcomes in China using a new household longitudinal study. Adopting an event study approach (Kleven et al., 2019b), we find that the motherhood effect is initially large for Chinese women. Relative to the pre-pregnancy period, the share of women in the labor force declines by 40 percentage points (p.p.) in the year of childbirth. Afterward, however, women's labor supply recovers quickly. When the child reaches age five, women's labor force participation and work hours are not considerably below the levels implied by pre-pregnancy trends. Similar to their labor supply responses, women's earnings decline sharply after the childbirth but recover quickly. These labor market effects are comparable to those found in Nordic countries such as Denmark but much smaller than other industrialized countries such as the United States and Germany (Kleven et al., 2019a) or other East Asian countries such as South Korea (Park, 2021). Consistent with findings in other countries, Chinese men experience no significant changes in their labor market outcomes after the birth of the first child. According to a simple decomposition exercise, the child penalty can explain up to one-third of China's gender earnings gap, a much smaller share than what has been found in developed countries.

We explore possible explanations for the modest child penalty in China vis-à-vis substantial gender disparity, prevalent gender discrimination in the labor market,[2] and limited market options for childcare.[3] One popular intra-family arrangement stands out: Conventionally, Chinese grandparents are heavily involved in childcare. The help is prevalent: About 35% of new mothers in our sample report receiving grandparents-provided childcare in the first year a child is born. The percentage remains largely constant up till the child reaches the school age. Around 78% of mothers report receiving some form of grandparents' help when the child is between zero and seven years old. The help is also substantial: Grandparents take over as the primary caregiver during the daytime in over half of the cases when a child reaches age two. 30% of the two-year-olds are primarily cared for by their grandparents during the nighttime.

To provide childcare, grandparents need to shift away from labor market activities. We show this with a panel of older people. Event-study analysis indicates that older women substantially reduce their labor supply upon the arrival of their first grandchild, which is consistent with the observed sharp decline in the employment rate of Chinese women after age 45 (Panel A of Fig. 1). We find no such effects on first-time grandfather's labor market outcomes, suggesting that the labor market impact of grandparenthood is also gender-biased.

Mothers who receive grandparent-provided childcare experience much smaller interruptions in their careers relative to those who do not. Specifically, the initial shocks to employment rate, hours worked, and earnings are about one-third to 50% smaller for those who receive such help. Mothers also recover from negative shocks much sooner. When the child reaches age two, we cannot statistically reject that grandparent-assisted mothers' labor supply has recovered to its pre-pregnancy trend. In contrast, the motherhood effect without grandparents' help is more persistent, with no sign of their labor supply reverting to its initial trend by the end of the sample period. To partially account for selection into grandparenting, we predict the probability of receiving grandparent-provided childcare using a rich set of observed characteristics and include the interactions between the predicted probability and a full set of event time dummies. While this approach does not entirely rule out endogeneity issues, it is reassuring that we obtain quantitatively similar results.

We investigate plausible explanations for grandparenting. We find no evidence of Chinese households deliberately taking advantage of the generational gap in education and transfer childcare obligations to grandmothers whose labor is valued less in the market. We find that grandparents who have provided childcare report higher levels of subjective well-being and are more likely to receive old-age support from their adult children, even if they are no longer taking care of their grandchildren. These findings suggest that caring for grandchildren not only has consumption value for the elderly but also is a way to invest for future old-age support.

Other factors are associated with the magnitude of the motherhood effect. In particular, we show that the motherhood effect is larger for women who work in the private sector and those who have more than one child.

The magnitude of the motherhood effect may have evolved as China's economic and demographic structures have changed substantially over the past decades. Longitudinal data on individuals and households are not available for earlier periods. To estimate historical motherhood effects, we use the population censuses and intra-decennial population surveys (both are cross-sectional datasets) and adopt the pseudo-event study method proposed by Kleven et al.(2022). This approach creates a synthetic population of "future parents" who are observably similar to the observed parents. Our estimates suggest the motherhood effect has been growing rapidly in China over the past three decades. In the 1980s, having a child created barely a dent in women's labor supply; by the 2010s, women's labor force participation rate was 25 p.p. lower in the year of childbirth and remained about 5 p.p. lower in year 5.

We argue that the trend of the enlarging motherhood effect is likely to continue with China's economic and demographic transitions. Economically, the market reforms and the relative retreat of the state sector have brought about a sharp rise in gender disparity in the labor market outcomes (e.g., Gustafsson and Li, 2000; Zhang et al., 2008). Demographically, a rapidly aging population and the plummeting birth rate has recently caused the government to relax birth restrictions. Based on our estimates, these changes will likely impose heavier burdens on women's careers. Those trends may explain why, despite the relatively modest child penalty, young couples in China have hitherto lukewarm responses to recent policies promoting fertility.

[2] For example, Kuhn and Shen (2013) present explicit and almost universal gender discrimination using a large sample of online job posts in China.

[3] Most daycare centers in China do not admit children under age three. Public kindergartens or preschools are designed for children aged 3-6. Some privately-operated childcare programs provide care for children aged 0-3 but are in short supply (Wang et al., 2021).

This paper contributes to the large and rapidly growing literature on the gendered effects of children on labor market outcomes (Angelov et al., 2016; Kleven et al., 2019a, 2019b; Sieppi and Pehkonen, 2019; Cortes and Pan, 2020; Lundborg et al., 2017). The literature mostly focuses on western developed countries. Among the few exceptions, Berniell et al. (2021) find that motherhood leads to job informality in Chile. East Asian countries share similar family values and gender cultural roles. Dumauli (2019) finds that the presence of children at home is associated with lower wages for Japanese mothers, although she does not look at changes in mother's labor force participation, which is low in Japan. Using a similar event study approach, Park (2021) documents substantial child penalties in South Korea. Employment and earnings decline by about 70% upon the arrival of the first child. Similar to our findings, the child penalty in South Korea is mostly driven by the extensive margin, but unlike what we find in this paper, the labor market outcomes of Korean women seem never to recover from that shock. This paper is among the first to present evidence on child penalty in China, which is an important developing and transitional economy.[4]

Existing papers in the literature typically find large and persistent negative effects of children on mothers' labor market outcomes and virtually no impact on fathers. They also suggest that motherhood currently stands out as a key determinant of the gender disparity in labor market outcomes in high-income countries. For example, child penalty can account for 80% of the gender earnings gap in Denmark (where the overall gender earnings gap is 24%, Kleven et al., 2019b), or 65% of that in the United States (where the overall gap is 45%, Cortes and Pan, 2020). In contrast, we find that Chinese women suffer from a less persistent motherhood effect on labor outcomes. Our findings suggest that child penalty only accounts for less than 30% of the existing gender earnings inequality in China (which is 54% overall).

Prior studies also find that it is difficult to close the gender gap caused by the child penalty. The child penalty does not seem to stem from biological differences (Kleven et al., 2021), yet it nevertheless reflects some fundamental differences between men and women (Andresen and Nix, 2021). Existing studies show that popular social policies, such as subsidizing childcare (Havnes and Mogstad, 2011) and extending maternity leave (Kleven et al., 2020), have at best limited impacts on alleviating the child penalty on women relative to men (Cortes and Pan, 2020). Informal intra-family arrangements could instead be effective, as our findings suggest that grandparenting substantially reduces child penalty. However, such arrangements are embedded in the culture and tradition, and are not easily transplantable in a different society.

This study contributes to the literature on intra-family inter-generational transfers. Although many studies look at money transfers (e.g., Li et al., 2010), few examine time transfers.[5] In this study, we consider time transfer by grandparents in the form of childcare in a developing country. Grandparent-provided childcare appears to be a desirable arrangement where formal childcare and eldercare are insufficient: It reduces career interruptions to mothers, increases grandparents' subjective well-being, and better secures old-age support from their adult children. It may also improve the labor market allocation as Chinese women's education levels have improved substantially over the past few decades (Rosenzweig and Zhang, 2013). The aggregate labor market efficiency arguably has more to lose if prime-age women must leave the labor market to care for young children.

Our work also adds to a small literature on older workers' labor market responses to grandparenthood. Our estimates of grandmother's labor supply response are much larger than estimates obtained in other countries. In China, grandmotherhood reduces labor force participation by 17.7 p.p. By contrast, previous studies find that the birth of a grandchild would reduce the labor participation of grandmothers by 8.5 p.p. in Austria (Frimmel et al., 2020), 5 p.p. in the US (Rupert and Zanella, 2018), and 1.8 p.p. in Denmark (Gørtz et al., 2020).

The rest of the paper is organized as follows. Section 2 describes the institutional background. Section 3 introduces the data and the empirical method. Section 4 presents the baseline results on child penalty and explores the role of grandparenting. Section 5 shows the evolution of the motherhood effect in China over the past few decades and discusses its future trajectory. Section 6 concludes.

2. Institutional background

During the days of China's planned economy, employment opportunities for workers in the urban sector is close to be guaranteed. Today, Chinese women still have a high employment rate compared with developed and other transitional economies (Fig. 1). However, since the market reforms in the urban sector started in the 1980s, income inequality has increased drastically (Ge and Yang, 2014). So has gender disparities. Zhang et al. (2008) show that among urban workers, the gender earnings gap increased from 15% in 1988 to 27% in 2004. In the 2010s, according to our own calculation, the gender gap reached 35%, an unprecedentedly high level since the reform started.[6]

Fertility was strictly controlled by the country's well-known one-child policy. The policy was first introduced in the late 1970s, with

[4] Using the personnel record from a large IT company in Beijing, Chen et al.(2021) estimates large *within-firm* child penalties that persist twelve years after the birth of the first child. Wang (2019) finds that the motherhood effect for rural Chinese women is larger and persists longer if the child is a boy. Liu et al. (2022) find that having a second child would reduce the weekly labor supply of women by 7-12 hours.

[5] Cardia and Ng (2003) use a general equilibrium model to show that intergenerational transfers of time in the form of grandparent-provided childcare can increase the labor supply of the parent generation. Mukherjee (2020) studies the inter-generational transfer of money and time transfers in a developed-country context. Maurer-Fazio et al. (2011) show that coresidence with elders significantly increases prime-age women's labor force participation in urban China. Guo et al. (2018) shows that having a second child increases the likelihood of co-residence of a grandparent and leaves parental labor supply unaffected. They interpret their findings as evidence of grandparent-provided childcare mitigating the otherwise negative fertility impacts on parental labor supply.

[6] The gender earnings gap in the 2010s is calculated based on the China Family Panel Studies data in 2010-2018.

some conditional exemptions granted to the rural population and ethnic minorities. The following two decades have only seen limited adjustments to the policy. Major reforms did not take place until the late 1990s, when a few provinces began to allow couples who were themselves the only child to have two children. In 2002, this practice was formally recognized as a national policy in the country's *Law on Population and Family Planning*, although the remaining provinces adopted it in years spanning from 2002 to 2011. Facing a rapidly aging population and a declining birth rate, birth control policies were swiftly lifted in recent years. In November 2013, a new policy further relaxed the legal restriction on fertility by allowing couples to have two children if either of them was the only child. In October 2015, the central government formally announced the end of the one-child policy, allowing all couples to have two children. A new policy enacted in May 2021 further allowed all couples to have up to three children. Our main sample covers between 2010 and 2018, a period during which the one-child policy was rapidly dismantled.

Urban mothers enjoy a decent coverage of maternity benefits, the generosity of which is comparable to many developed countries. Working women are entitled to 98 days of paid maternal leave with a 100% replace rate. Such policy has been in place since 1951, when the length of maternal leave was originally set to 56 days. It was extended to 90 days in 1988, and further to 98 days in 2012. Since 1988, nursing mothers have been entitled to two half-hour breaks per day to feed their children under the age of one upon returning to work. If breaks are not taken during a shift, the mother's work schedule can be reduced by one hour. No overtime or night shifts are supposed to be arranged for nursing mothers. Mothers with rural *hukou* but work in urban areas may not be able to enjoy their *de jure* maternity benefits fully, as they are disproportionately employed in informal or domestic private sectors, where regulations regarding maternity benefits are often poorly enforced.

Many mothers in urban areas used to be able to send their infants and toddlers to daycare centers run by the state-owned employers. Most of these state-owned institutions, mainly state-owned enterprises, were privatized during the late 1990s and earlier 2000s. As a result, their subsidiary childcare services were no longer available to urban residents. Private childcare centers have not filled this void soon enough and are often in short supply. Although available as an alternative informal arrangement, in-house caregivers are not widely affordable for ordinary families. Female migrant workers, typically unable to afford urban childcare, often have no choice but to leave their children in their hometowns. These children are usually taken care of by their extended families, usually grandparents.

Like many East Asian countries, multi-generational co-residence is prevalent in China. Population censuses since 1982 show a persistently high levels of married couples with young children living with grandparents. Grandparenting is common. Chen et al. (2011) document that grandparents play a large role in taking care of young children, especially among those who live together. In our data, the 2018 China Health and Retirement Longitudinal Study (CHARLS) shows that around 60% of the grandparents aged 45–70 reported having provided childcare for their working adult children. As shown in the China Family Panel Studies (CFPS) data of the same year, over 44% of children aged 2–7 were primarily cared for by their grandparents. The active role of grandparents in caring for children is deeply rooted in China's traditional family values and norms, which stress a strong connection and mutual support among members of the extended family (Logan and Bian, 1999; Rosenzweig and Zhang, 2014). It is widely accepted that grandparents have the responsibility to help take care of their grandchildren, and adult children have the responsibility to provide old-age support to their elderly. Grandparenting is particularly helpful to mothers, who traditionally take most of the child-caring work. Using three waves of population censuses, Maurer-Fazio et al. (2011) show that the presence of young children is associated with lower labor force participation of the mother, while the presence of grandparents is associated with a higher labor force participation.

China's labor market has become increasingly competitive since the market reform, a potential reason for why working mothers often find themselves overstretched between work and childcare and why the willingness to have children has been low. With a declining work-dependent ratio and a population soon predicted to be shrinking, the government in recent years has been eager to encourage births and has considered extending the retirement age. But such policies may have reverberating effects on the child penalty and young couples' willingness to have children.

3. Data and empirical method

3.1. Data and sample

Our main analysis is based on data from the CFPS, a nationally representative longitudinal survey that runs biennially since 2010. The baseline survey follows about 15,000 households and 30,000 individuals. It contains a wealth of demographic and labor market information at the individual level, as well as detailed information about the interactions among members of the nuclear and the extended families. Our core estimation sample covers five waves of surveys from 2010 to 2018.

The CFPS fits our needs in several aspects. First, its panel structure seeks to track every respondent across waves regardless of their residential location. Second, the data record information on the exact date of birth, which is crucial for the study of the dynamic effects of childbirth. Third, family members can be linked across generations even if they do not live in the same household. This unique feature allows us to measure the potential labor market impacts of a grandchild on grandparents and the related intergenerational transfer of time. Fourth, the data contain information on intergenerational family support and the childcare arrangements, which is useful for us to better explore mechanisms.

It is worth pointing out that the CFPS has a relatively small sample size compared with the larger datasets and administrative records used in other studies in this literature. Administrative records of personal information linked over multiple years are not available in China. In fact, the CFPS is among the first nationally representative longitudinal surveys that goes back long enough to apply an event study estimation. Due to its small sample size, our results are somewhat less precisely estimated. Yet we show that the overall pattern remains salient. Later in the paper, we also estimate the motherhood impacts by constructing synthetic groups using population censuses and surveys, which are much larger datasets. We get similar yet more precise estimates.

Table 1
Summary statistics (CFPS 2010–2018).

Panel A: Summary statistics of individual characteristics					
	mean	**S.D.**	**min**	**max**	**observations**
Mothers					
Time-invariant Characteristics					
Birth year	1988	3.83	1964	1999	879
Birth year of first child	2014	1.95	2011	2017	879
Age at first Childbirth	25.42	3.67	17	48	879
First child is male	0.52	0.50	0	1	879
Multiple births (yes = 1)	0.24	0.43	0	1	879
Grandparent's childcare (yes = 1)	0.56	0.50	0	1	820
Observed frequency	3.50	1.04	2	5	879
Time-varying Characteristics					
College education	0.36	0.48	0	1	2882
Labor force participation	0.64	0.48	0	1	2667
Hours worked (per week)	26.69	27.09	0	147	2517
Monthly earnings (in 2010 price)	1196	1790	0	19,859	2436
Fathers					
Time-invariant Characteristics					
Birth year	1987	4.39	1962	1998	865
Birth year of first child	2014	1.80	2011	2017	865
Age at first Childbirth	27.25	4.19	17	52	865
First child is male	0.50	0.50	0	1	865
Multiple births (yes = 1)	0.26	0.44	0	1	865
Grandparent's childcare (yes = 1)	0.59	0.49	0	1	807
Observed frequency	3.52	1.01	2	5	865
Time-varying Characteristics					
College education	0.35	0.48	0	1	2865
Labor force participation	0.94	0.25	0	1	2614
Hours worked (per week)	44.64	25.08	0	168	2347
Monthly earnings (in 2010 price)	2575	3243	0	77,089	2240
Grandparents					
Time-invariant Characteristics					
Birth year	1963	5.59	1948	1976	1678
Birth year of first grandchild	2014	1.78	2011	2017	1678
Male	0.48	0.50	0	1	1678
Observed frequency	50.80	5.32	40	65	1678
Age at birth of first grandchild	3.50	0.98	2	5	1678
Time-varying Characteristics					
Labor force participation	0.76	0.43	0	1	5327
Hours worked (per week)	29.21	28.18	0	168	4444

Panel B: Sample size by survey year					
	2010	2012	2014	2016	2018
Mothers (panel)	394	613	637	662	581
Fathers (panel)	360	631	641	650	583
Grandparents (panel)	707	1200	1281	1217	1049

Note: This table reports the summary statistics of our baseline estimation samples. The data are from the five waves of the CFPS between 2010 and 2018. For the parents' sample, we exclude agricultural and self-employed workers, women who report having their first child after age 50, and men who report having their first child after age 55. For the grandparents' sample, we focus on those who can be linked to the parents' sample and report having their first grandchild between the ages of 40 and 65. Monthly labor earnings are assigned to be zero when the individual is not working in a given year. See Section 3.1 for details.

We make a few sample restrictions for our main analysis. We focus on those who become parents or grandparents for the first time during 2011–2017. Our preferred sample includes only individuals whom we observe at least once before and once after the arrival of the first child or grandchild. For the parents' sample, we exclude agricultural and self-employed workers as they do not report their individual earnings. Also excluded are women who report becoming mothers for the first time after 50, as well as first-time fathers after 55. For the grandparents' sample, we focus only on those who can be linked to our parents' sample and had their first grandchild between the ages of 40 and 65. These sample restrictions leave us with an unbalanced panel of 879 mothers, 865 fathers and 1678 grandparents. An average individual in the sample is observed for 3.5 times.

The main outcomes of interest are labor force participation, work hours, and monthly earnings (bonuses and subsidies included) from the primary job. The earnings measure is in 2010 price for easy comparison across years. Individuals who are not working are assigned zero work hours and zero earnings. We construct a measure of parents' or parents-in-law's help with household chores or

children for new mothers. We do not analyze grandparents' earnings because half of them work in the agricultural sector and do not report earnings.

The summary statistics of the estimation samples are reported in Table 1. On average, fathers are slightly older, though not more likely to have college education than mothers. There are substantial gender gaps in the labor market: Mothers have a labor force participation rate that is 30 p.p. lower than fathers', work 18 hours (or 40.2%) less per week, and earn 53.6% less.

3.2. Empirical method

We estimate the impact of children on a parent's (or a grandparent's) outcomes based on an event-study approach, defining the first child's (or first grandchild's) year of birth as the event, as in Kleven et al. (2019b). Specifically, we model a given outcome y for individual i in year t as:

$$y_{it} = \alpha + \sum_{\tau^{min},\ \tau \neq -2}^{\tau^{max}} \beta_\tau \mathbf{1}\left[\tau = t - c^i\right] + \sum_a \gamma_a \mathbf{1}[a = Age_{it}] + \theta X_{it} + \delta_t + \varepsilon_{it} \quad (1)$$

We index the event time, i.e., time relative the birth of a child, by τ. The second term on the right-hand side is a full set of event-time dummies, where c denotes the calendar year in which person i has the first child or grandchild, and $\mathbf{1}[\tau = t - c^i]$ is an indicator for person i in year t having had the first child (grandchild) τ years ago. Negative values of τ indicate having a first child (grandchild) $|\tau|$ years in the future. To allow for potential impacts of pregnancy on the outcomes of interest (Kuziemko et al., 2018), we omit the event time dummy at $\tau = -2$, so the event-time coefficients measure the effects of children relative to the year just before pregnancy. For positive τ's, the coefficients β_τ trace out the post-birth dynamic trajectories of the outcome for parents or grandparents. For negative τ's, coefficients β_τ capture the pre-trends of the outcome before the birth. In our analysis, τ runs from its minimum value, up to four years before birth, to its maximum value, up to seven years after birth, depending on the actual length of the sample period. Following the literature (Kleven et al., 2019b; Kuziemko et al., 2018; Berniell et al., 2021), we also include a full set of age dummies to control non-parametrically for individual-specific age profiles, and a full set of year dummies to control flexibly for common time trends such as business cycles. Additional controls include residence-specific dummies for education categories and *hukou* (urban vs. rural and local vs. non-local). We specify all the outcome variables in levels rather than in logs, so we can keep zero values for any outcome, e.g., earnings and hours of work, in the data. Standard errors are clustered at the individual level.

This event-study approach needs two identifying assumptions to estimate the causal effects of children. First, women should not have perfect control over the exact timing of conception and birth. Second, there is no unobserved factors unrelated to fertility that change sharply around the birth of a child. Under these assumptions, we can interpret the corresponding discontinuity in outcome as the causal effect of having a child (or a grandchild).

The validity of those assumptions can be partly verified by the trend before childbirth. If there are other confounding factors affecting both childbirth and the labor market outcomes, or if there is selection into childbirth, we are likely to observe some pre-trend in the outcome variables.

A legitimate concern is related to the use of unbalanced panels. As we do not observe the same individuals in each of the event time periods, our event study result could be affected by changes in sample composition across different event windows. To rule out this possibility, we analyze individual predetermined characteristics, such as pre-childbirth education, *hukou* status, social status, and measures of sector and occupation, with a similar event-study framework. Reassuringly, we find that these predetermined variables are smooth around the event, suggesting that our main findings are unlikely driven by composition changes across different event time (see Appendix Fig. 4).

While the event study approach has become popular recently, there has been a large literature that exploits natural experiments that determine family size. Such natural experiments include twins (Rosenzweig and Wolpin, 1980; Bronars and Grogger, 1994; Guo et al., 2018; Liu et al., 2022) and the gender mix of children (Angrist and Evans, 1998). We believe that empirical evidence from instrumental variable (IV) estimations and event studies should be viewed as complements. While a good IV credibly isolates exogenous variation of a subpopulation and estimates a local effect, the event study has the advantage of getting at the average treatment effect. Neither approach is a silver bullet, though. The validity of the instrumental variable is ultimately not testable. For the event study approach, the parallel trends before childbirth is a strong test for its identification assumptions. We caution future researchers on this topic of the importance of using the empirical method that is appropriate for the specific setting they face.

4. The labor market impacts of motherhood

4.1. Baseline results

We find that the negative impacts of childbirth on labor market outcomes for Chinese women are substantial in the short run but tend to dissipate at a fast rate, as shown in Fig. 2. As defined above, the coefficients displayed here are measured at event time τ relative to two years before the childbirth ($\tau = -2$), having controlled for age and year fixed effects. Also plotted are the 95% confidence intervals associated with each event coefficient. Panel A shows the estimated effects on labor market participation. It shows that women begin to reduce their labor force participation during pregnancy. In the year of childbirth, women experience a large drop in labor force participation, by around 40 p.p. on average. However, the recovery is rather speedy. Mothers' labor force participation gradually rises and recovers to the point substantially close to its pre-pregnancy trend when the child turns five. The effects on

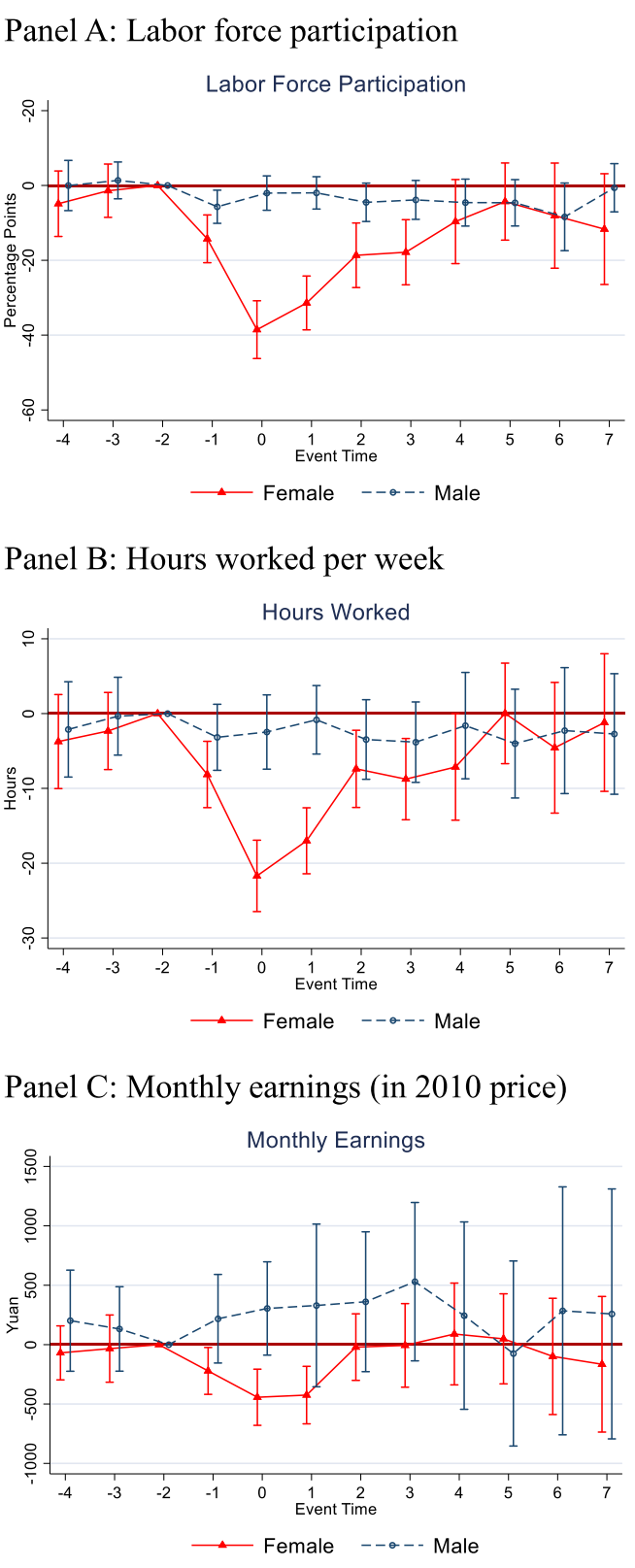


Fig. 2. Effects of first childbirth on parental labor market outcomes.
Panel A: Labor force participation.
Panel B: Hours worked per week.

Panel C: Monthly earnings (in 2010 price).
Note: The figures show event time coefficients estimated from Eq. (1) relative to the counterfactual outcome, absent of children, separately for men and women, and for different outcomes. Event time is indexed to the year of the first childbirth. The estimation samples include all individuals whom we observe the event of childbirth in the CFPS between 2010 and 2018. The 95% confidence intervals around the estimates are based on standard errors clustered at the individual level.

women's hours of work exhibit a similar pattern, as shown in Panel B. Hours of work remain stable until pregnancy, when they start to decrease and reach a minimum in the first year after the childbirth. On average, new mothers cut their weekly labor supply by 20 hours in the year of childbirth, or a 67% reduction compared with the pre-motherhood period. Their hours of work begin to bounce back soon after that and recover to near the pre- pregnancy trend when the child turns five. The reduction in labor supply also has negative impacts on labor earnings, as is evident in Panel C. Women tend to experience a sharp decrease in earnings, around RMB 500 per month on average, or about 46% of the pre-pregnancy average, in the year when the child is born. The negative effect persists and remains significant for another year, then it reverts to zero from the third year after the childbirth, although the point estimates are not very precise. For all three labor market outcomes, there is little evidence of any pre-existing trend prior to pregnancy.[7]

To examine whether the negative effect we have found on hours worked and earnings for women are mostly driven by individuals exiting the labor force (the extensive margin) or by those who remain in the labor force but reduce hours (the intensitve margin), we perform an analogous event study with the sample restricted to workers. Compared to the full sample used in Fig. 2, this new sub-sample excludes persons who never worked in event times -4, -3, and -2 and all the non-employed person-years. Unlike the full-sample estimates for females shown in Fig. 2, the new results for working women, displayed in Appendix Fig. 1, show no significant decline in either hours worked or earnings. Together with the corresponding full-sample estimates, these results suggest that previously found large negative motherhood effects on hours and earnings are mostly driven by new mothers leaving the labor force. Further event-study results also suggest no significant shifts to or out of the public sector or changes in occupation after childbirth (Appendix Fig. 2).

In order to make our results directly comparable with findings in the previous literature, we convert our estimates of level changes to percentage changes relative to the counterfactual outcome without children implied by our estimation model. More specifically, for each event time τ, we calculate the percentage effect as $P_\tau = \widehat{\beta}_\tau / E[\widetilde{Y}_{it\tau}|\tau]$, where $\widetilde{Y}_{it\tau}$ is the predicted outcome at event time τ from Eq. (1) when the event terms are subtracted.

The negative effects of motherhood on labor supply and earnings that attenuate in the long run in China stand in stark contrast to the persistent effects found in other countries. Appendix Fig. 3 compares the labor market impacts of motherhood in China to those in several richer countries, which are reproduced from the analysis in Kleven et al. (2019a).[8] In both Denmark and in the U.S., the negative effects of motherhood on labor force participation seem to be smaller than those in China for the first two years after childbirth (Panel A). While the post-birth decline in labor participation in Germany is almost double of that in China. Interestingly, in all three rich countries, the initial drop in participation looks like the beginning of a permanent decline, which persists over a ten-year horizon. Although our data do not allow us to observe mothers' labor outcomes beyond the seventh year, the estimate becomes very small (in absolute value) and statistically indistinguishable from zero within a five-year window. Similarly, Panel B of the same figure shows that the negative effect of motherhood on earnings in China converge faster toward zero than those in Denmark and the US do, although the short-term impacts are similar in size for these three countries. While women in the two richer countries have not recovered from the initial impacts ten years after childbirth, their Chinese counterparts experience a speedier recovery in merely two years. Compared to Chinese mothers, the German women tend to experience a much deeper and more sustained negative motherhood effect on earnings following the birth of their first children.

The rapid attenuation of motherhood effects in China makes one wonder whether Chinese fathers reduce their labor supply to shoulder the burden of childcare. Kleven et al. (2019a), for example, show that the small effect of fertility on women's labor market outcomes found in Sweden is accompanied with a negative short-term effect on men. Our event-study analysis of fathers suggests that this is not quite the case in China. As shown in Fig. 2, Chinese men experience no statistically significant or economically meaningful changes in their labor supply (participation and hours) and earnings after the arrival of the first child, just like most of their foreign counterparts analyzed in the literature.

4.2. The role of children in aggregate gender inequality

The rapid attenuation of motherhood effect also implies that child penalty would contributes less to the aggregate gender inequality in China. To measure the exact contribution of child penalty, we adopt the procedure proposed by Kleven et al. (2019b) to decompose the observed gender pay gap into components attributable to the differential effects of children and other factors such as education. We make use of the estimated event-time coefficients for mothers (β_τ^w) and fathers (β_τ^m) separately during the whole sample period between 2010 and 2018. Control variables include background characteristics such as province of residence, household registration

[7] The negative impacts on women's labor outcomes during pregnancy might reflect either the lack of protection for pregnant women against employer discrimination in China (Burnett, 2010; Woodhams et al., 2009) or the cultural belief that pregnancy is a vulnerable period that needs rest and recuperation (Lee et al., 2009). Whatever the actual mechanism, the negative impacts of pregnancy that we estimate do not necessarily reflect selection on unobserved behavioral changes as we find no differential trends before conception.

[8] Kleven et al. (2019a) also estimates child penalties in Sweden, the UK, and Austria. For clearer presentation, we do not include the motherhood effects in those countries, which are of similar magnitudes with the effects in Denmark, the U.S., and Germany discussed here.

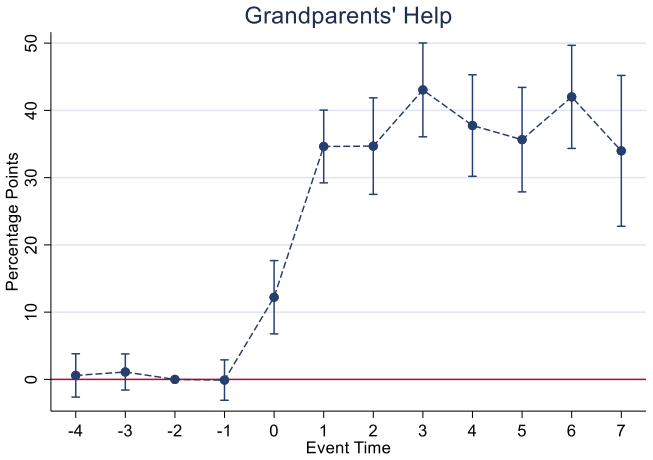


Fig. 3. Effects of first childbirth on women's probability of receiving grandparent's help.
Note: The graph shows event time coefficients relative to the counterfactual outcome, absent of children, for women's probability of receiving assistance in household chores or childcare from their parents or parents-in-law. The estimation is based on all women whom we observe the event of childbirth in the CFPS between 2010 and 2018. Event time is indexed to the year of birth of the first grandchild. The 95% confidence intervals around the estimates are based on standard errors clustered at the individual level.

information, as well as dummies for education.

Following Kleven et al. (2019b), we define the gender gap in our study period as $\Delta \equiv \{E[Y_{it}^m] - E[Y_{it}^w]\}/E[Y_{it}^m]$, namely the difference in average earnings between male and female earnings as a fraction of average male earnings. Using the specification in Eq. (1) and indexing the covariates that vary across individuals and calendar year by k, we can obtain

$$\widehat{\Delta} = \underbrace{\frac{E\left[P_\tau \widetilde{Y}_{it}^w\right]}{E\left[\widehat{Y}_{it}^m\right]}}_{\text{child penalties}} + \underbrace{\frac{\sum_k \left(\widehat{\beta}_k^m - \widehat{\beta}_k^w\right) E\left[X_{ki}^m\right]}{E\left[\widehat{Y}_{it}^m\right]}}_{\text{different returns to } X_s} + \underbrace{\frac{\sum_k \widehat{\beta}_k^w \left\{E\left[X_{ki}^m\right] - E\left[X_{ki}^w\right]\right\}}{E\left[\widehat{Y}_{it}^m\right]}}_{\text{differences in } X_s}$$

where P_τ is the child penalty at each event time τ calculated by $P_\tau \equiv (\widehat{\beta}_\tau^m - \widehat{\beta}_\tau^w)/E[\widetilde{Y}_{it}^w|\tau]$, $\widetilde{Y}_{it}^w$ is the predicted counterfactual earnings for mothers, and $\widehat{Y}_{it}^m$ is the predicted actual earnings for fathers. The first term on the right-hand side can be interpreted as the impact of child penalties on gender inequality. The second term captures the impact of different coefficients on background characteristics. The last term captures the impact of different background characteristics on gender inequality. X_s refers to the human capital and other background characteristics.

Compared to developed countries, China has a wider gender gap in earnings. For example, related studies find that the gender pay gap is 45% in the mid-2010s in the US (Cortes and Pan, 2020), and 24% in Denmark around the same time (Kleven et al., 2019b). Our calculation, however, suggests that the gender gap in China during the 2010 is around 54%.

Interestingly, the child-related gender pay gap in China is around 15%, which implies that only 29% of the subtantial gender inequality in China can be explained by gendered impacts of parenthood. This is dramatically different from industrialized countries like the U.S. and Denmark, where child penalty can account for 64% and 83% of the overall gender earning gap in the 2010s, respectively. There must be other more important factors that contribute to the gender inequality in China. Future work that aims to have a better understanding of gender inequality in China may have to pay attention to other factors besides children.

4.3. Grandparents' help and the motherhood effect

4.3.1. Grandparents-provided childcare

Grandparents in China have an enduring tradition of assisting their adult children with young children. Using the same event study approach, Fig. 3 shows that the fraction of new mothers receiving assistance in household chores or childcare from parents or parents-in-law rises sharply at their first childbirth. By the end of the first year after childbirth, mothers are about 35 p.p. more likely to receive grandparents' assistance. Overall, about 78% of mothers in our sample report having grandparents providing some form help for an extended period at some point when the child is between zero and seven years old.

Grandparents' involvement in childcare is particularly intensive. Fig. 4 shows that while the mother is the predominant caregiver for an infant, by the time the child turns two, in the majority of cases, grandparents take over as the primary caregiver during the daytime. Between age two and by the time the child reaches school age, grandparents are more likely to be the primary daytime caregiver than the mother (Panel A).

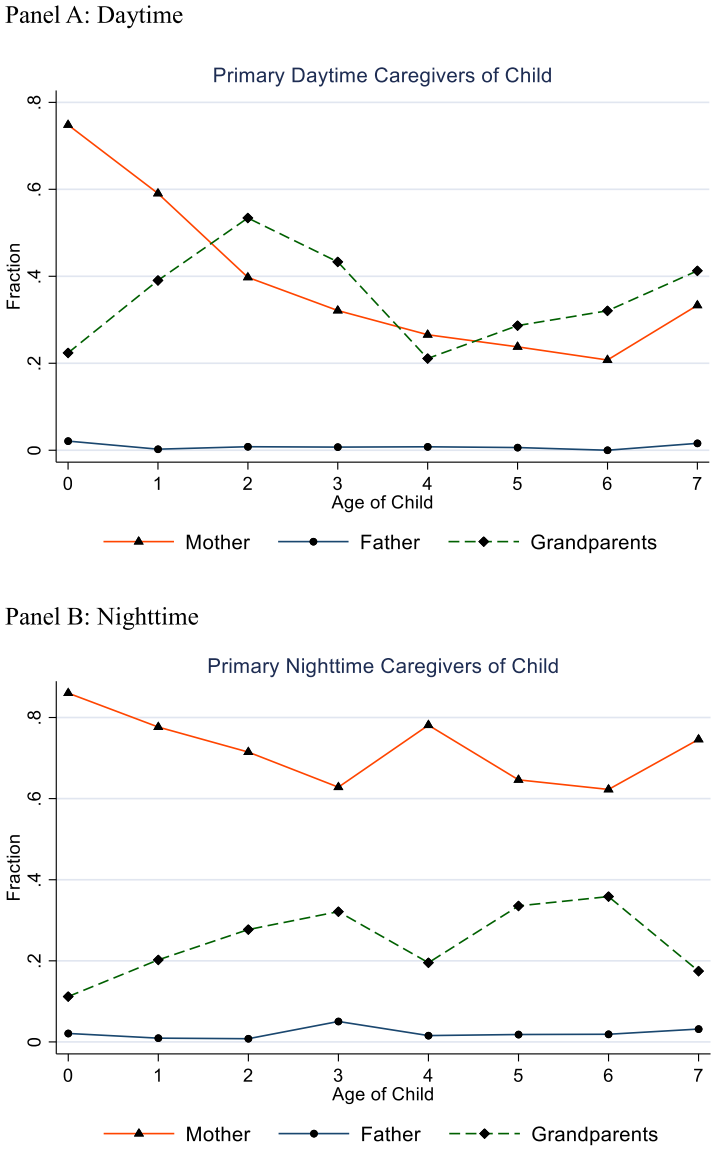


Fig. 4. Primary caregiver of child by child age.
Panel A: Daytime
Panel B: Nighttime
Note: The figures show the fraction of children cared for by different family members as a function of the child's age. Those statistics are constructed using our baseline sample from the CFPS.

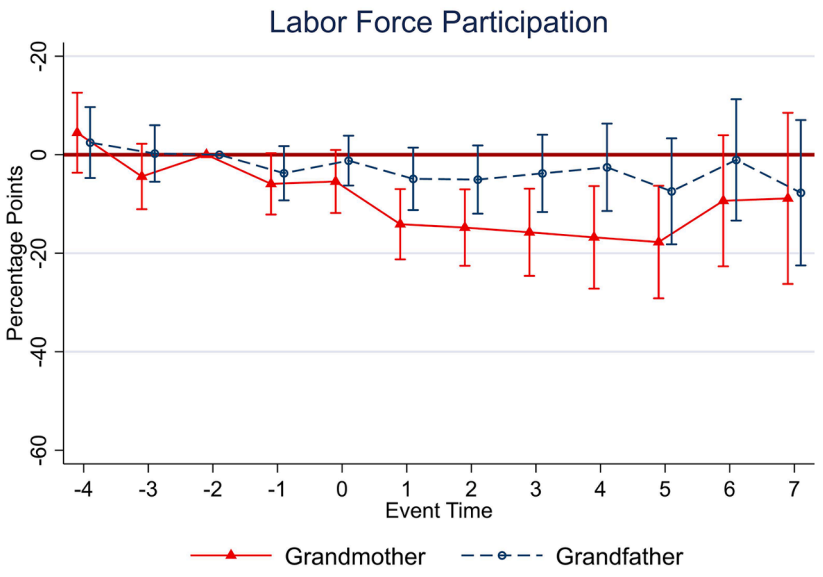


Fig. 5. Effects of grandparenthood on labor supply.
Note: The figure shows event time coefficients estimated from Eq. (1) relative to the counterfactual outcome, absent of grandchildren, for grandmothers and grandfathers. The estimation sample is from the CFPS and includes all individuals whom we observe the birth of a grandchild between 2010 and 2018. Event time is indexed to the year of birth of the first grandchild. The 95% confidence intervals around the estimates are based on standard errors clustered at the individual level.

Panel B shows that while mothers remain the primary figure in providing childcare during the nighttime, grandparents also provide substantial help there. About 30% of children above age two are primarily cared for by grandparents during the nighttime. In contrast, fathers never play a primary role in childcare at any age, either during the day or night.

We find supporting evidence for grandparents' involvement in childcare from grandparents' own perspective. Using a panel of older people and adopting a similar event study approach, we estimate the impact of the birth of the first grandchild on employment.[9] Fig. 5 shows the effects are also gender biased. Grandmothers' labor force participation declines by 5 p.p. in the year when the first grandchild is born, whereas that of the grandfathers are hardly affected. Grandmothers' labor force participation rate continues to drop thereafter at a much faster pace than the trend for grandfathers. When the grandchild turns five, the labor force participation rate would decline by around 18 p.p. relative to the pre-grandchild trend.

Our estimates of grandmother's labor supply response are strikingly larger than estimates obtained in other countries. According to our estimation, grandmother's labor force participation is 17.7 p.p. lower in the fifth year after the first grandchild is born. In comparison, previous work suggest that the birth of a grandchild would reduce the labor participation of grandmothers by 8.5 p.p. in Austria (Frimmel et al., al.,2020), by 5 p.p. in the U.S. (Rupert and Zanella, 2018), and by approximately 1.8 p.p. in Denmark (Gørtz et al., 2020). It is also worth noting that while mothers' labor market outcomes seem to recover rather quickly, shocks to grandmothers are persistent. The substantially larger reduction in labor supply of elderly women in China is consistent with our hypothesis that there is significant time transfer from grandmothers to their adult children, mostly in the form of childcare.

Taken together, these results suggest that grandparents assume a substantial portion of childcare, especially during the day. With family ties, grandparenting is also likely a reliable and trust-worthy form of childcare. Help from grandparents could potentially free up mothers' time such that they can return to work soon after giving births.

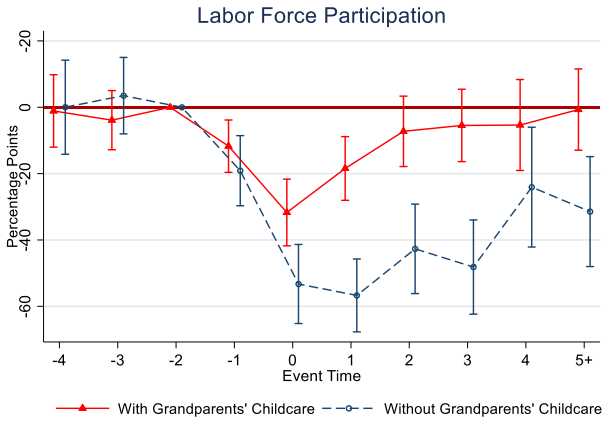
4.3.2. Motherhood effects with and without grandparent-provided childcare

We show the impacts of the first childbirth on women's labor market outcomes with and without grandparent-provided childcare. We estimate Eq. (1) separately with two subsamples defined by a binary variable indicating whether the woman reports receiving any grandparenting after childbirth during the sample period. More specifically, we treat a woman as having access to grandparents' childcare if the grandparents are reported as the main caregiver in the household at least once during the study period. If the main caregiver is a kindergarten but the grandparents are responsible for taking children to and from school, we also regard the grandparents as main caregivers. Fig. 6 reports the coefficients of the event dummies separately for the two regressions.

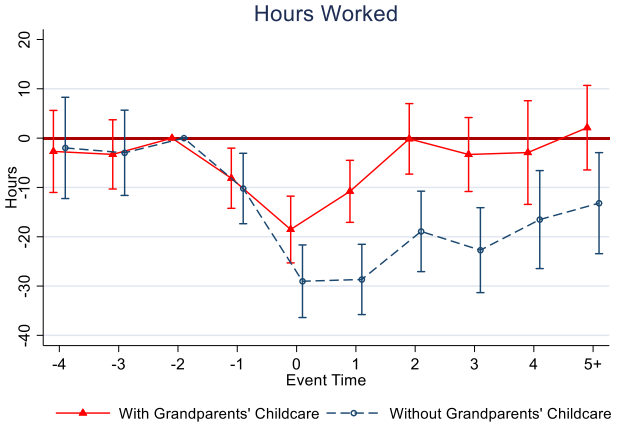
For both groups, women's labor market outcomes exhibit no particular trends before the pregnancy. New mothers who receive grandparent-provided childcare experience a smaller dip in labor supply and recover much sooner. Panel A of Fig. 6 shows that women's labor force participation starts to trend down in the year of pregnancy. In the year the child is born, the labor force

[9] The effects on work hours have similar patterns. We do not examine the effects on earnings because many of the grandparents work in the agricultural sector and do not report earnings.

Panel A: Labor force participation



Panel B: Hours worked per week



Panel C: Monthly earnings (in 2010 price)

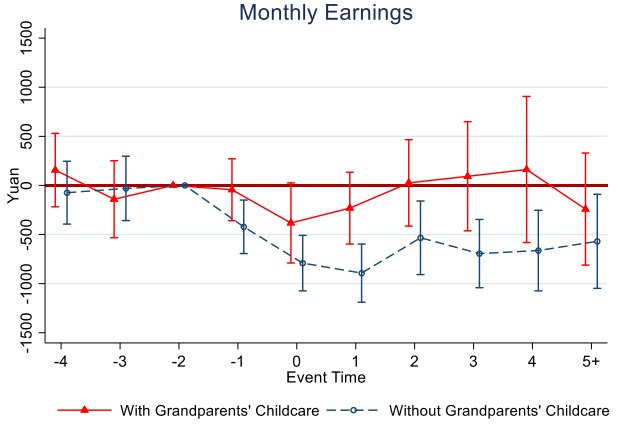


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Fig. 6. Motherhood effects with and without grandparent's help.
Panel A: Labor force participation
Panel B: Hours worked per week
Panel C: Monthly earnings (in 2010 price)
Note: The figures show the impacts of childbirth on women's labor outcomes using the split samples by woman's access to grandparents' help in childcare. We treat a woman as having access to grandparents' childcare if the grandparents are reported as the main caregiver at least once during the study period. If the main caregiver is kindergarten and the grandparents are responsible for taking children to and from school, we also regard the grandparents as the main caregivers. Event time is indexed to the year of the first childbirth. The 95% confidence intervals around the estimates are based on standard errors clustered at the individual level.

participation of those who receive grandparent-provided childcare declines by an average of about 30 p.p. When the child reaches two, the labor force participation rate is on average less than 10 p.p. lower than the pre-pregnancy trend, and we cannot reject that it has reverted to the original trajectory. By contrast, the labor force participation rate for those who do not receive grandparent-provided childcare declines by a much larger 55 p.p. It recovers only modestly in the next few years. By the time the child reaches two years old, the labor force participation rate is still down by 40 p.p., and by year four, by 20 p.p.

Impacts on hours worked and monthly earnings exhibit similar patterns: Grandparenting alleviates the initial shock to new mothers' labor market outcomes and help them to recover, to a large extent or even fully, at a much faster speed. This is consistent with the evidence presented earlier on the deep involvement of grandparents in providing childcare. Given its popularity among Chinese families and the stark contrast in the impacts of childbirth on mothers' labor market outcomes with and without grandparenting, grandparents-provided childcare has a long way in explaining the relatively small child penalty we have estimated for Chinese women.[10]

It is worth noting that the difference between the split-sample results reported in Fig. 6 is suggestive, yet it does not necessarily have a causal interpretation. Indeed, women who receive grandparents' help are different from those who do not. Appendix Table 1 reports the results from a set of probit models that show the determinants of having grandparents' help. Women who receive grandparents' help are more likely to be better educated, more likely to have an urban *hukou*, and more likely to work in the state sector.[11] If those characteristics are systematically associated with larger or smaller motherhood effect, they may confound with the role of grandparents in reducing the child penalty.

To partially alleviate this concern, we predict whether a woman receives grandparent-provided childcare based on her and her family's observable characteristics. Based on the specification in Column (8) of Appendix Table 1, in which we include a rich set of personal and family characteristics, we get a propensity score for each woman in terms of the likelihood of her receiving grandparent-provided childcare. The propensity score, as well as a full set of the interactions between the propensity score and the event dummies, are then added to the regression as control variables. Those additional variables control for the relevant heterogeneity among women in terms of their likelihood of receiving grandparent-provided childcare, and how such heterogeneity affects the trajectory of the motherhood effect over time. It is worth emphasizing that this approach is based on observed characteristics, it therefore does not address the potential endogeneity caused by unobserved factors.[12]

The results from those revised estimations are reported in graphs in Appendix Fig. 5 The estimates are somewhat noisier, likely a result of our relatively small sample size coupled with additional controls. Nevertheless, the qualitative patterns remain. All three outcomes show that women with grandparent-provided childcare experience smaller negative impacts from childbirth and recover more quickly.[13]

4.3.3. Grandparents-provided childcare as intergenerational transfer

We end our analysis of grandparenting by providing some suggestive evidence on the motives behind such behaviors. We explore the plausibility of three different motives that are not necessarily competing against each other. First, there could be an optimized specialization of labor within the extended family. As women in the younger generation often have higher earnings potentials than women from the older generation, mothers may have an (absolute, though not necessarily comparative) advantage in market work compared with grandmothers. Consequently, the extended family could potentially improve their aggregate labor market income by switching childcare tasks to grandparents. Second, grandparents may derive positive utility from childcare as they are happy assisting their adult children or simply enjoy the time spent with their grandchildren. Third, grandparents may view childcare as an investment, for which their adult children would pay back later in the form of old-age support. We examine the plausibility of each explanations

[10] We test whether the two estimates are significantly different across groups by interacting the event dummies with the group dummy. The resulting event-study estimates are deemed significant across groups if the coefficients of the interaction are statistically significant. Indeed, the estimated effects of motherhood on labor outcomes are significantly different for mothers with and without access to grandparenting.

[11] We define the state sector as state-owned enterprises (SOEs), governments, and public service sectors such as most schools and hospitals, police, and other non-government social organizations.

[12] We first calculate the propensity score, then interact it with event time dummies, instead of directly interacting the observable characteristics, such as education, sector, and *hukou* status, with the event time dummies to reduce the dimensionality of the control variables and to retain the precision of the estimation.

[13] We perform a split-sample analysis by child gender and found that having a son is associated with a smaller negative motherhood effect than having a girl. The differential impacts by child gender likely reflect son preference of grandparents, as a grandson is more likely cared for by grandparents than a granddaughter. These results are available upon request.

Table 2
Grandparenting, intergenerational transfer, and mental health.

	(1)	(2)	(3)	(4)
Panel A: Mental health (CHARLS 2018)				
	Happy (yes = 1)	**Satisfied (yes = 1)**	**Depressed (yes = 1)**	**Lonely (yes = 1)**
Grandparenting (yes = 1)	0.040***	0.025***	-0.028**	-0.061***
	(0.013)	(0.009)	(0.012)	(0.011)
Controls	Yes	Yes	Yes	Yes
Mean of dependent variable	0.6455	0.8721	0.3140	0.2017
R-squared	0.019	0.019	0.045	0.034
Observations	5973	6076	5952	5976
Panel B: Old-age support (CFPS 2018)				
	Money transfer (yes = 1)	Amount of money transfer (*yuan*)	Daytime care by children (yes = 1)	Frequency of care by children per week
Grandparenting (yes = 1)	0.003	50.430	0.100***	0.673***
	(0.026)	(34.050)	(0.026)	(0.143)
Controls	Yes	Yes	Yes	Yes
Mean of dependent variable	0.5220	251.9178	0.4251	1.4900
R-squared	0.028	0.037	0.029	0.062
Observations	2842	2823	2842	2842

Note: Panel A shows the correlations between grandparenting and subjective well-being and self-reported mental health. The sample is derived from the 2018 CHARLS and includes people between 45 and 70 who have at least one grandchild under 16. Grandparenting is a binary variable that equals one if the respondent ever took care of the grandchildren. The four outcome variables are also binary variables. We control for age, gender, education level, and hukou. Panel B shows the correlation between grandparenting and old-age support. The sample is from the CFPS and includes individuals between 65 and 85 who were not caring for their grandchildren at the time of the survey in 2018. Grandparenting is a binary variable that takes value one if at least one of the respondent's grandchildren is primarily taken care of by a grandparent in previous rounds of the survey. Control variables include the age and education of the grandparents and the gender of their adult child who is included in the survey. Robust standard errors are reported in parentheses. Significance levels: * 10%, ** 5%, *** 1%.

below.

First, we test for the plausibility of a re-optimization of the division of labor within the extended family. We do that by examining whether the effect of grandmotherhood on labor supply varies by the education gap between grandmothers and mothers. We use the difference in the pre-child years of education of the mother and the grandmother to measure the advantage in market. We then split the sample based on the median of this intergenerational education gap and re-estimate the effects of grandmotherhood for each subsample. The difference in the years of education is sizeable in the sample: at the median, mothers have six more years of education than grandmothers. If division of labor based on potential labor market income is important, we should see larger reductions in grandmother's labor supply in families where the intergenerational education gap is larger.

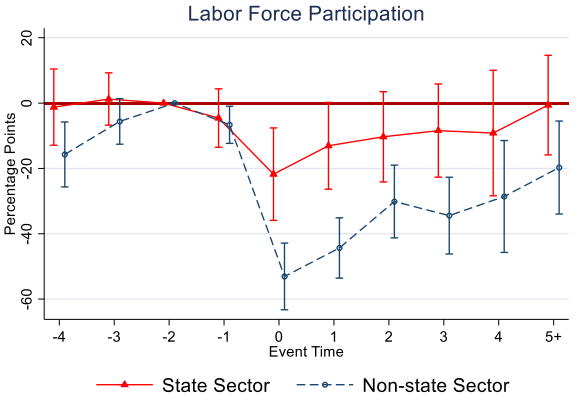
Appendix Fig. 6 reports the estimation results. In contrast to this hypothesis, we see that the grandmotherhood effects are largely unrelated to the intergenerational education gap. The reduction in labor supply after grandmotherhood are very similar for both groups at both the extensive and intensive margins.

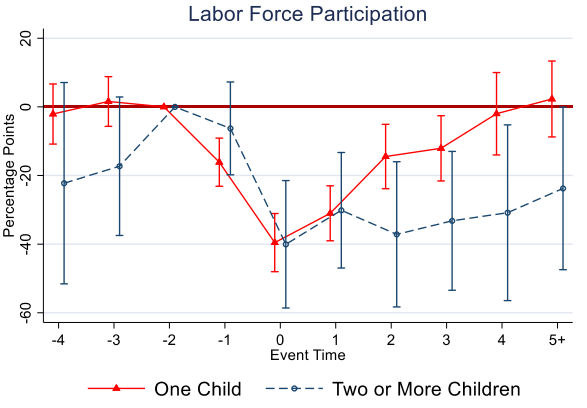
Many other factors may be at play in the intra-family reallocation of labor and the decision to shift childcare from mother to grandmother. Mothers who have much higher education levels than grandmothers are more likely to migrate. So although they have a stronger pecuniary incentive to seek grandparents' help in childcare, they are less able to do so. Similar education levels between the two generations may also suggest easier relations in a multi-generational cohabitation situation. Nevertheless, our result suggests that the motivation to exploit the "comparative advantage'' of the two generations is not dominant.

Next, we examine the plausibility of the second hypothesis by looking at how the subjective well-being is related to caring for grandchildren. We use data from the 2018 CHARLS, in which the elderly people are asked to provide a self-evaluation of their subjective well-being and mental health. The survey also elicits information about whether the respondent is providing care to their grandchildren. The sample includes grandparents aged between 45 and 70 who have at least one grandchild younger than 16 years old. As all the outcomes of interest are indicator variables, we fit linear probability models with grandparenting, another indicator for currently providing care, as the key explanatory variable. Also included in the regressions are age, gender, education level, and *hukou* of the grandparent. As the regression results in Table 2, Panel A indicates, elderly people who are caring for their grandchildren are more likely to be happy or feeling satisfied, and less likely to feel depressed or lonely. These findings, although mostly descriptive, support the hypothesis that grandparents enjoy taking care of their grandchildren.

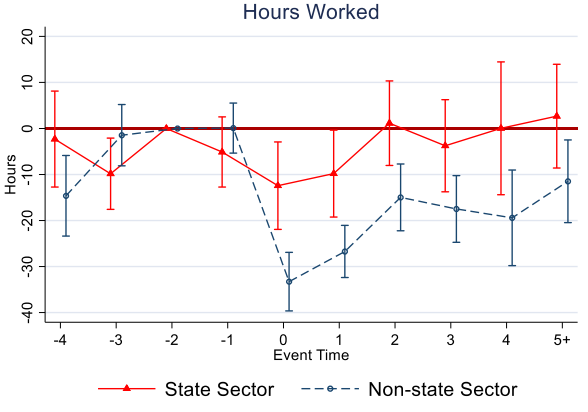
Finally, we explore the plausibility of the third mechanism by looking at how old-age support is related to the previous experience of a grandparent. The analysis is based on a sample of paternal grandparents aged 65–85 from the CFPS who were not caring for their grandchildren at the time of the survey. We construct measures of financial transfers and time-related assistance they receive from their adult children. We also have information on whether these old people have ever provided care to their grandchildren. Again, we are aware of the endogeneity of grandparenting, so the regression coefficients should be interpreted as correlational. The regression results, reported in Table 2, Panel B, indicate that grandparents who have provided childcare indeed receive better old-age support.

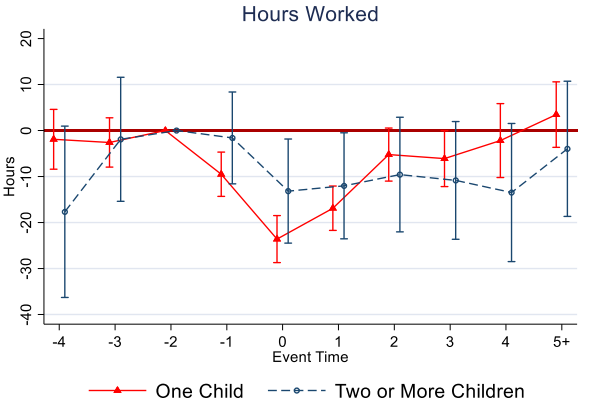
Panel A: Labor force participation



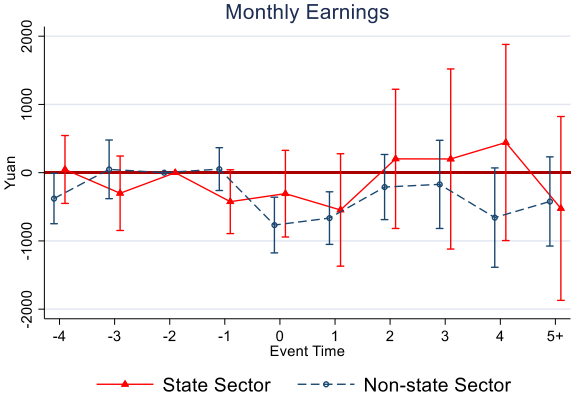


Panel B: Hours worked per week





Panel C: Monthly earnings (in 2010 price)



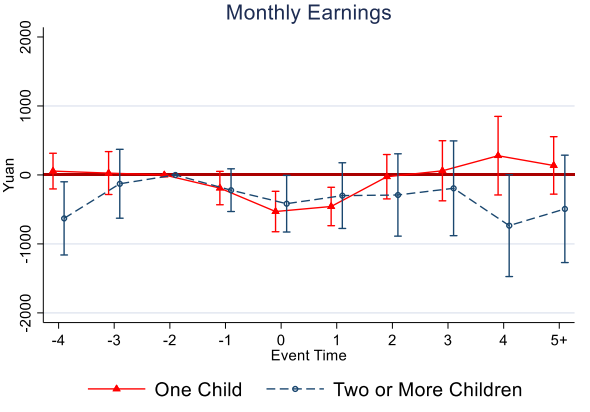


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Fig. 7. Motherhood effects by sector or the number of births.
Panel A: Labor force participation.
Panel B: Hours worked per week.
Panel C: Monthly earnings (in 2010 price)
Note: The figures show the impacts of childbirth on labor market outcomes by the women's pre-birth sector of employment (state or non-state sectors, left column) or the total number of children (one child or multiple children, right column). Event time is indexed to the year of the first childbirth. The 95% confidence intervals around the estimates are based on standard errors clustered at the individual level.

Although grandparenting does not change the occurrence of money transfer (column (1)), it increases the amount of money transfer by about RMB 50 per month (column (2)), although this effect is not precisely estimated. We also find that grandparenting is positively associated with informal care provided by their children at both the extensive and intensive margins. Providing care to grandchildren increases the probability of receiving care by nearly 10% (column (3)) and the frequency of elderly care by almost 0.7 times per week (column (4)).

4.4. Other factors associated with the magnitude of motherhood effect

4.4.1. Sector of work

We explore other factors that are associated with, though not necessarily cause, the size of the motherhood effect. One unique feature of China's labor market is its oversized, though declining, state sector. In our sample, 18.4% of women work in the state sector before childbirth. Jobs in the state sector typically provide more generous maternity leave policies and offer more flexible work arrangements that are particularly valuable for working women with young children.

We split the sample of women by the sector (state vs. non-state) they work in before the birth of their first child and estimate the motherhood effect separately for each group. Graphs on the left column of Fig. 7 show that women who work in the state sector experience a smaller motherhood effect. For example, for women in the state sector, labor force participation declines by 20 p.p. in the year of the childbirth, which recovers to about 7 p.p. below by year four. In comparison, the labor force participation of those who work in the non-state sector experience a 50 p.p. decline in the year of the childbirth and is still 30 p.p. below by year four (Panel A). Weekly hours and monthly earnings exhibit similar patterns, despite noisier estimates (Panels B and C).

4.4.2. Number of children

Our event study estimates of the motherhood effects capture the effects of the birth of the first child. Our estimates would include the impacts of additional children if they were born in the subsequent years. In fact, Kleven et al. (2019b) conduct a split-sample analysis by total fertility and find that the long-term motherhood effect on earnings increases with additional children. As such, the small and brief negative effects of children on Chinese women's labor outcomes may be partly driven by the overall low fertility rate. To explore this possibility, we conduct our event study analysis by subsamples conditional on the total number of children a woman gives birth to. Mothers with a single child account for around 80% of the whole sample. To ensure that we have enough statistical power for the estimation, we divide the entire sample into two groups: mothers with only one child and those with multiple children.

The results are presented in the right column of Fig. 7. They suggest that the negative impacts of childbirth on labor outcomes are smaller for mothers with a single child than for those with multiple births. For labor force participation (Panel A), the initial impacts on both types of mothers are similar in the first two years. However, for mothers of a single child, the labor force participation rate experiences a steady rebound afterwards and recovers to the pre-pregnancy trend when the child turns four. In contrast, the labor force participation rate for mothers of multiple births remains at a low level—40 p.p. below the pre-pregnancy trend—after more than five years since the first childbirth. Panels B and C show the results for working hours and earnings, which are somewhat less precisely estimated. Nevertheless, the point estimates for these two outcomes suggest that the recovery takes less time for mothers of a single child than for those with multiple children. These results suggest that the quick recovery of the motherhood effects we find for the whole sample may be partly attributable to the overall low fertility rate in China.

However, the large state sector and the low fertility rate in China are unlikely to be the entire story. Studies in other countries show a substantial and persistent negative impact of childbirth for workers in the public sector and women with only one child (Kleven et al., 2019b). Furthermore, the motherhood effect on hours of work and earnings for multiple-child mothers in China also appear to be less persistent than that for mothers in Europe and the U.S. (Kleven et al., 2019a).

5. Evolution of the motherhood effect in China

China is at the crossroad of a major demographic transition. Under the combined forces of improved healthcare, rising income levels, and more than three decades of the one-child policy, China's population has been rapidly aging while its birth rates have been plummeting in recent years. China's fertility rate has been below the replacement rate since early 1990s and its working-age population has peaked in around 2017.[14]

[14] See Johnston (2021) for a recent summary of the trends of China's demographic transitions.

To face mounting demographic challenges, China since 2012 enacted a series of policies that quickly reverted the one-child policy. Since March 2021, all couples are allowed to have up to three children. Central and local governments have designed various programs that aim at lifting the declining fertility rate. However, those policies have hitherto generated lukewarm responses. Couples at childbearing ages report various constraints and concerns over the prospect of having multiple children, including delays in marriage and childbearing, the rising cost of raising a child, and concerns over negative impacts of children on careers in the face of the increasingly stiffer competition in the labor market.

The relatively small motherhood effect we find appears to provide some reassurance for couples who are concerned with the negative labor market impacts of children. However, our analyses also show that the small motherhood effect is in large part due to the substantial help from grandmothers, who reduce their market labor supply to care for their grandchildren. As Fig. 1 shows, less than half of women at age 55 are employed, a much lower rate compared with other countries. As the population continues to age and the dependence ratio grows, it is expected that the retirement age (currently at 50 or 55 for women and 55 or 60 for men in most urban sectors) would have to rise. This will make grandmothers' help less available. Easy access to grandparents' help among women in our sample also benefits from the three decades of the one-child policy. An increasing share of new parents after the 2000s are themselves the single child, so grandparents' help is in excess supply. A rising fertility rate could quickly turn grandparents' time in short supply.

Our analyses on the differential motherhood effect by the sector of employment and the number of children (Fig. 7) also predict a less rosy picture. The small motherhood effect in China is in part a mechanical result of a very low fertility rate. A higher birth rate is expected to put substantially heavier burden on women. To the extent that the state sector provides policies and amenities that make it easier for working mothers to balance work and childcare, the sector has been in relative decline. Employment opportunities are increasingly tilted towards the private sector, where the competition is fiercer, gender disparity higher, and supportive amenities lacking.

To shed more light on the past and future trajectories of the child penalty, in this section, we estimate the motherhood effect in China over the past few decades. To preview the results, we find that the motherhood effect on labor supply, though remains relatively small, has been rising rapidly since the 1980s. In fact, the rising motherhood effect on women contributed to the rapid increase in the gender pay gap since the market reforms. The findings are consistent with the anecdotal evidence that young couples worry about the career impacts of having children. We argue that policies that encourage fertility should also include those aiming at reducing the child penalty on women relative to men.

5.1. Pseudo-event study approach

For earlier periods, the estimation of motherhood effect must rely on existing datasets that typically do not have a panel structure. Two problems arise when we estimate motherhood effect with cross-sectional data. First, a direct comparison of people with and without children in a cross-section does not work well because there is an apparent selection into being a parent: Parents differ in many ways, both observable and unobservable, from non-parents. Second, in cross-sectional data, we never get to know the event time for those without children because we know neither whether nor when they will have children. All we know is that the event time of a non-parent is negative.

To overcome these problems, we adopt the pseudo-event study method in Kleven et al. (2020) and create a synthetic population of "future parents" who are observably similar to parents in the cross-sectional data. Consider a parent i observed at event-time $t = 0$, in year y, with age a, and with a specific set of time-invariant (or, at least, slow-moving) demographic characteristics X_i. We match this parent i to a non-parent j observed in the same year y, with age $a - s$, and with the same set of characteristics, $X_i = X_j$. This matched non-parent j will be used as the observation for event time $t = -s$ in the "pseudo panel." With everyone assigned an event time, we then treat parents and matched non-parents as a panel and implement the event-study approach described in Eq. (1).

5.2. Data

We use the cross-sectional data from China's decennial population censuses and intra-decennial population surveys (also known as mini censuses) between 1990 and 2015. In these censuses and surveys, we can consistently measure a woman's age, whether she is a mother, and if so, the age of her youngest child. We restrict the sample of mothers to those aged 25–45, an age range for which most have finished education and had their first birth. To match women without children to these mothers, we rely on educational level, marital status, city of residence, and *hukou* status (urban vs. rural) that are consistently observed in all censuses and surveys. Censuses and population surveys are much larger datasets. For each survey year, our sample contains at least 65,000 women. For all the pseudo-event study regressions using these data, our primary outcome is labor force participation because it is the only labor market outcome we consistently observe across the years.

5.3. The motherhood effect in China, 1980s-2010s

Fig. 8 reports the results from this pseudo-event study approach and shows the evolution of motherhood effect over time. Each connected estimate series represents the motherhood effects based on a specific year of data. Note that mothers in those data gave birth before the survey, so the estimates based on data in a particular year reflect the motherhood effect several years earlier. Because our data range from 1990 to 2015, our estimates reflect the motherhood effect between the 1980s and the 2010s.

Two patterns emerge from these estimates. First, the estimated motherhood effect in the 2010s is quantitively similar to that based on

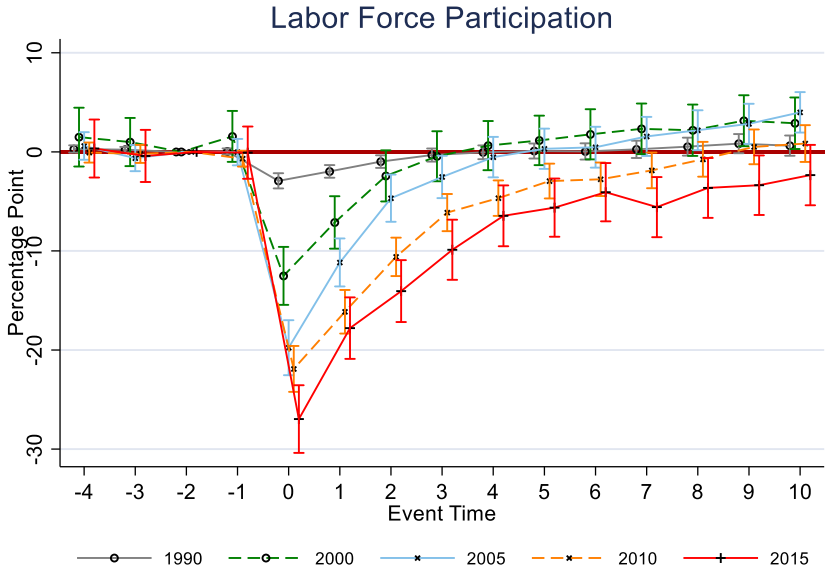

Fig. 8. Motherhood effects on labor force participation, 1990–2015.
Note: This figure describes the evolution of motherhood effect on labor force participation over time, estimated with the pseudo-event study approach described in subSection 5.1. Data are from population censuses in 1990, 2000, and 2010, as well as intra-decennial population surveys of 2005 and 2015. Each connected line represents the motherhood effects based on a specific year of data. Event time is indexed to the year of the first childbirth. The estimation samples include all individuals whom we observe the event of childbirth in the data. The 95% confidence intervals around the estimates are based on standard errors clustered at the education-hukou-city-marital status level.

the event study approach using an actual panel: Motherhood imposes an initially big negative impact that recovers quickly in the years following the childbirth. The large sample sizes of population censuses and surveys lead to more precisely estimated coefficients. Second, the motherhood effect has grown over time. In the year of first childbirth, becoming a mother reduces the labor force participation rate by 2 p.p. in the 1980s (as reflected by the 1990 Census), while the analogous effect is 27 p.p. in the 2010s (as reflected by the 2015 population survey).[15] Given any event time, the magnitude of the estimated motherhood effect is uniformly larger in a more recent sample. The motherhood effect has become unambiguously larger, and the recoveries slower, over the past three decades.[16]

6. Conclusions

In this paper, we estimate the labor market impacts of parenthood in China. Applying an event-study approach to a longitudinal data, we document several sets of results. Unlike in other countries, the negative effects of childbirth on mothers' labor market outcomes tend to attenuate quickly and revert to pre-pregnancy trends. A decomposition exercise suggests that the differential impacts of children on fathers and mothers play a small role in explaining the observed gender inequality in China's labor market. We show that the limited impacts of children on mothers may partly be driven by the large state sector employment and the overall low fertility in China.

Due to traditional family values, grandparenting is common in China. We show that a substantial share of older women quit jobs or reduce work hours to offer help to their daughters or daughters-in-law upon the arrival of their first grandchild. We find empirical support for the important role grandmothers play in taking care of their grandchildren and alleviating the child penalty on mothers relative to fathers. New mothers with grandparents' help experience a much smaller decline in labor supply and recover much sooner. The arrangement is mutually beneficial. Grandparents who care for their grandchildren report better subjective wellbeing. Those who have provided help in childcare to their adult children later receive better old-age support.

Using decennial population censuses and intra-decennial population surveys between 1990 and 2015 and adopting a pseudo-event study approach, we show despite the motherhood effect remaining relatively small, it has grown rapidly in the decades since the market reforms. This is striking because the overall fertility rate declined rapidly during this period. Our paper thus provides several important policy implications.

First, the crucial role of grandparenting in alleviating the motherhood penalty has implications for the recent policy discussion of

[15] The minor discrepancies in the estimated motherhood effect on labor force participation based on CFPS 2010-2018 and the Population Survey 2015 are likely from slight differences in data coverage, survey questions, and identifying assumptions of actual event study and pseudo-event study approaches. We also estimate the motherhood effects by province using the 2015 population survey data and a pseudo-event-study approach, and found that they are unrelated with either the social norm of mother's role in childcare (measured with data from the China General Social Survey (2017)) or the availability of public-provided childcare facilities (the number of kindergartens per thousand children aged 3-6). The detailed results are available upon request.

[16] In contrast, Kleven (2022) show that the motherhood effect on employment has been declining over the last few decades in the US.

extending the retirement age. Our results suggest that one potential unintended consequence of older retirement age is that grandmothers are less likely to be available to take care of young children. According to the findings of this paper, this is likely to harm younger women's labor market outcomes substantially.

Second, we argue that policies aiming at encouraging childbirth should take into consideration the substantial labor market penalties on mothers. Grandmothers may provide invaluable help for some households, yet other policies, such as broadly accessible childcare and family-friendly amenities at the workplace, are still needed in order to narrow the labor market inequalities across genders and socioeconomic backgrounds.

Appendices

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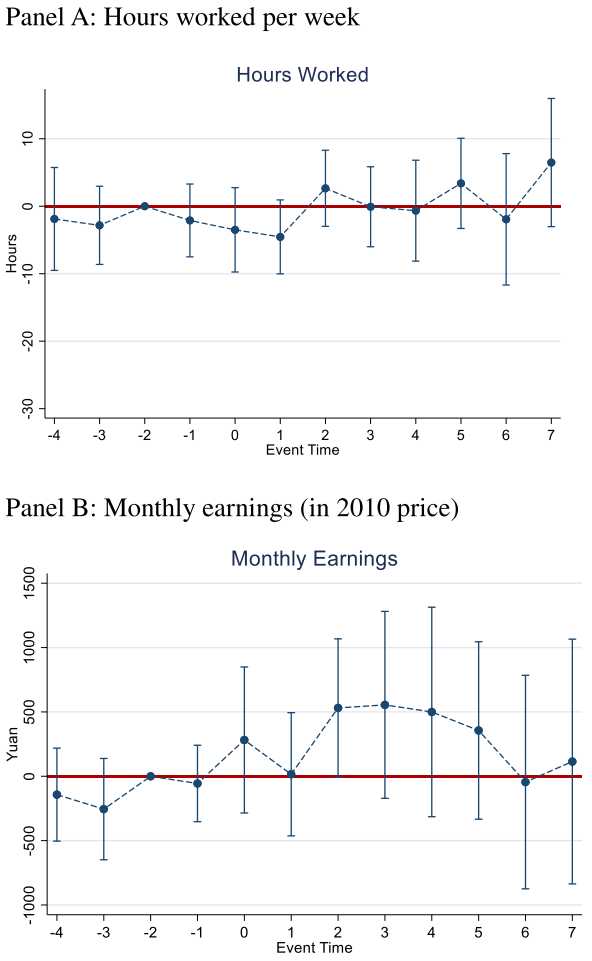
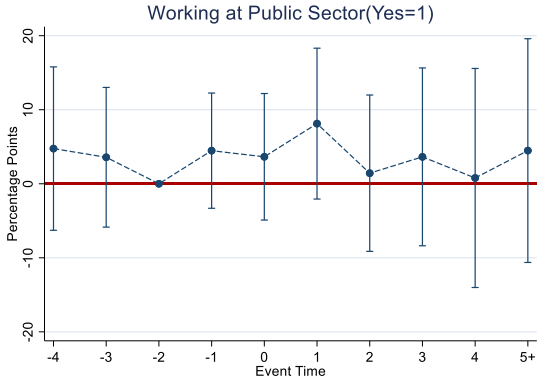
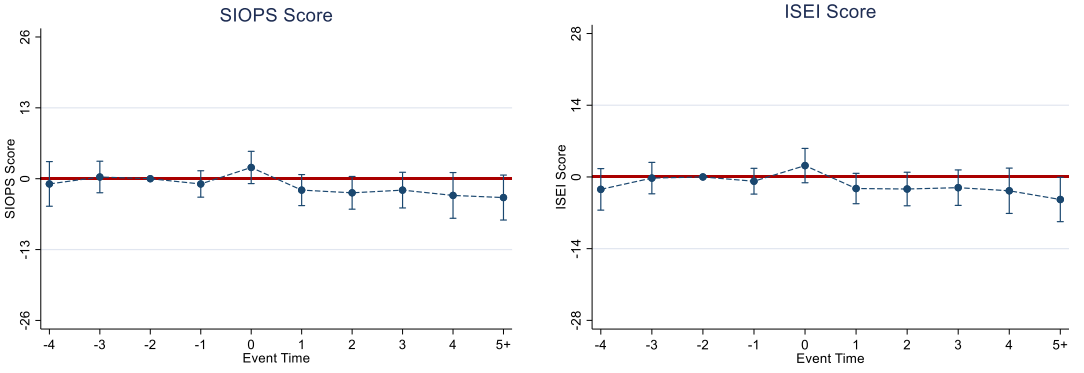


Appendix Fig. 1. Effects of first childbirth on working women's labor market outcomes
Panel A: Hours worked per week
Panel B: Monthly earnings (in 2010 price)
Note: The figures show event time coefficients estimated from Eq. (1) relative to the counterfactual outcome, absent of children for women, and for different outcomes. Event time is indexed to the year of the first childbirth. The estimation samples include all women whom we observe the event of childbirth in the CFPS between 2010 and 2018 while excluding the persons who never worked in event times -4, -3, and -2 and all the non-employed person-years. The 95% confidence intervals around the estimates are based on standard errors clustered at the individual level.

Panel A: Probability of public sector job

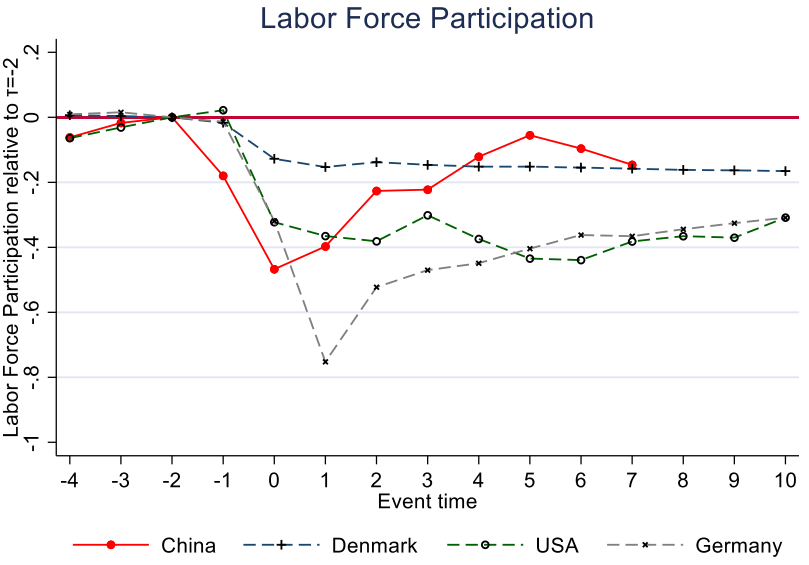


Panel B: Occupational indices (SIOPS score and ISEI score)

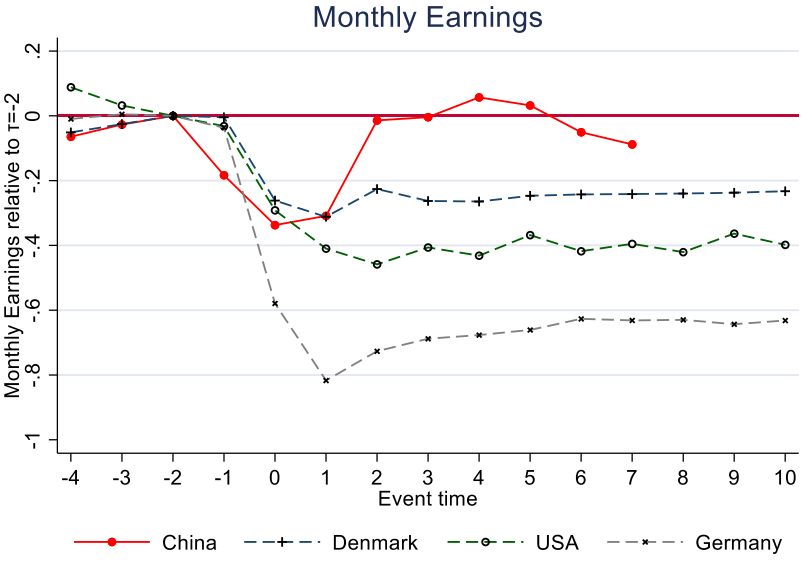


Appendix Fig. 2. Effects of first childbirth on working women's industry and occupation
Panel A: Probability of public sector job
Panel B: Occupational indices (SIOPS score and ISEI score)
Note: The figures show event time coefficients estimated from Eq. (1) relative to the counterfactual outcome, absent of children, for women, and for different outcomes. Event time is indexed to the year of the first childbirth. The estimation samples include all individuals whom we observe the event of childbirth in the CFPS between 2010 and 2018. Standard International Occupational Prestige Scale (SIOPS) scores were constructed by sociologist Donald Treiman in 1977 by averaging the results of prestige evaluations carried out in approximately 60 countries. The International Socio-Economic Index of occupational status (ISEI) is an alternative measure of occupational status developed by Treiman and collaborators in 1992 using comparably coded data from 16 countries. The 95% confidence intervals around the estimates are based on standard errors clustered at the individual level.

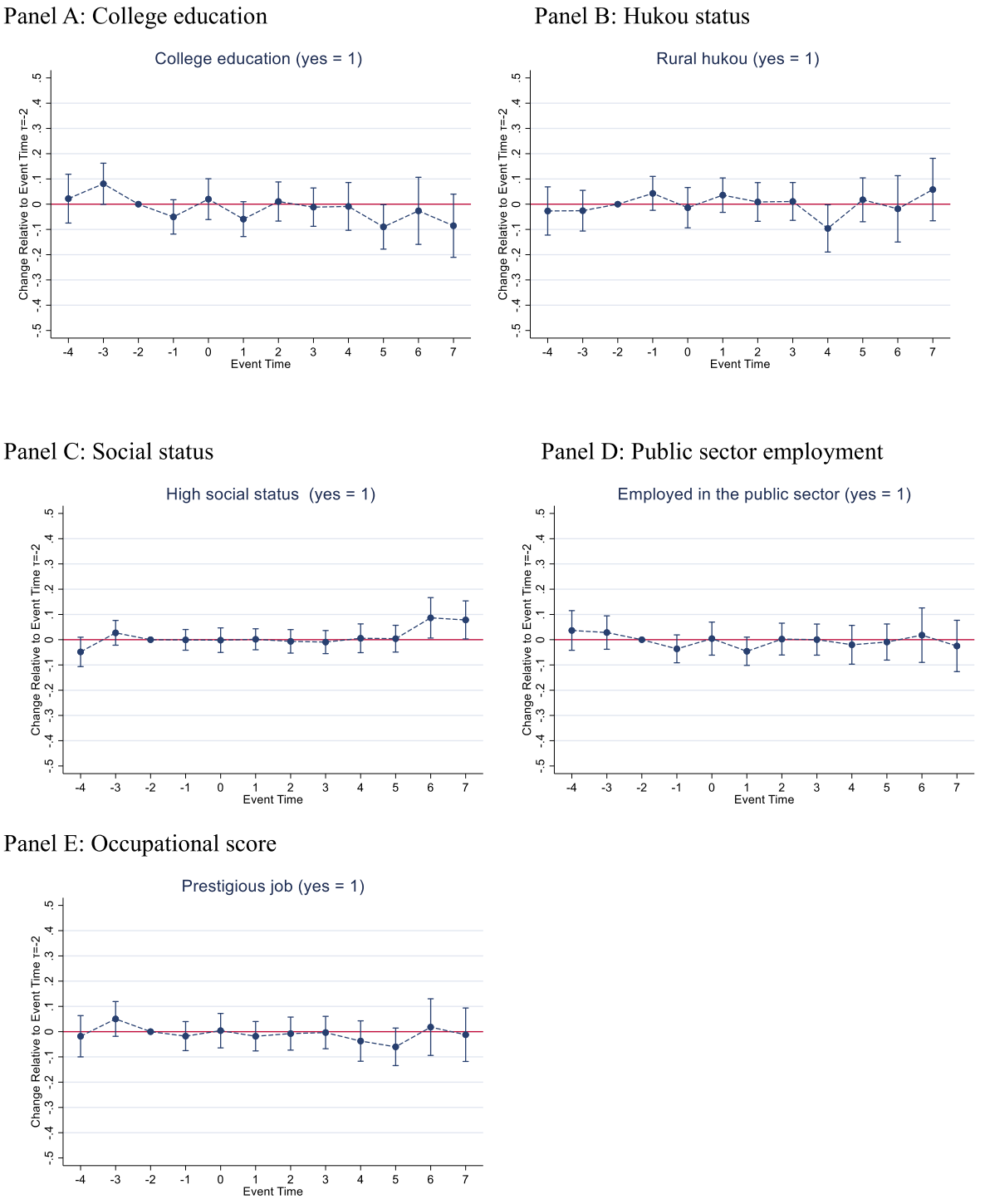
Panel A: Labor force participation



Panel B: Earnings



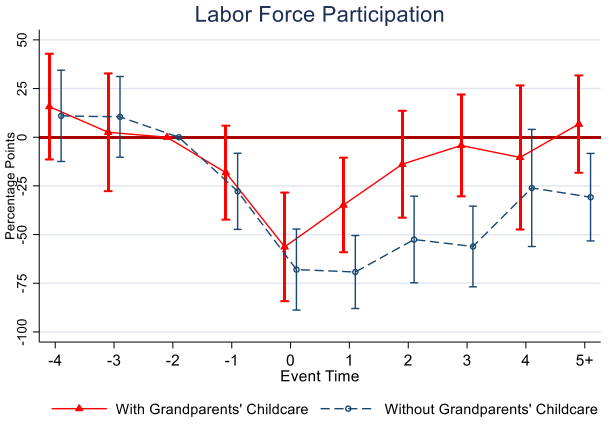
Appendix Fig. 3. Motherhood Effects in China and in Selected Western Countries
Panel A: Labor Force Participation.
Panel B: Earnings.
Note: The figures compare the percentage effects of motherhood in China with the analogous estimates in Kleven et al. (2019a). The effects for China are calculated from the level estimates reported in Fig. 2. Event time is indexed to the year of the first childbirth.



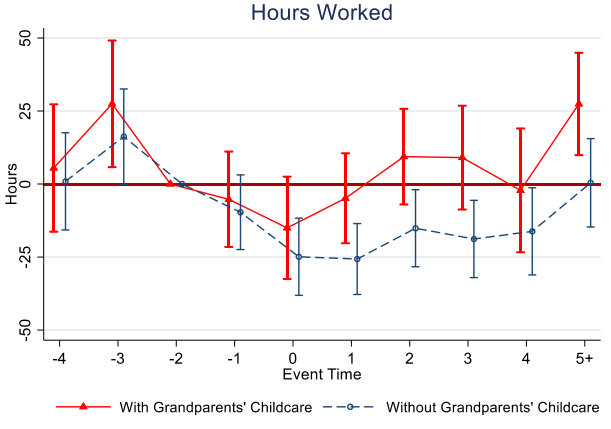
Appendix Fig. 4. Selection on predetermined characteristics of mothers

Note: The figures show the estimates from a model specification that is similar to Eq. (1) but without control variables. The dependent variables are the mother's characteristics measured before childbirth. Event time is indexed to the year of the first childbirth. The estimation samples include all individuals whom we observe the event of childbirth in the CFPS between 2010 and 2018. The 95% confidence intervals around the estimates are based on standard errors clustered at the individual level.

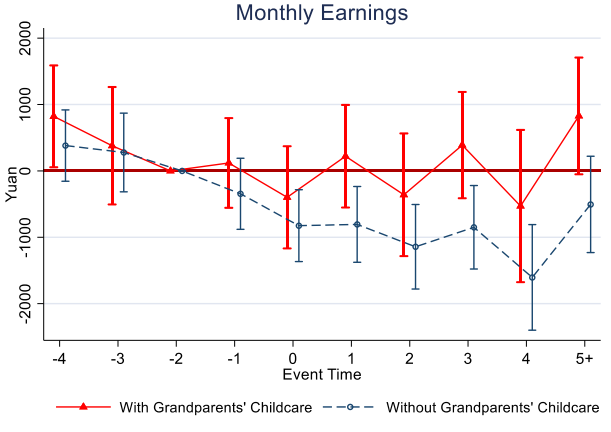
Panel A: Labor force participation



Panel B: Hours worked per week



Panel C: Monthly earnings (in 2010 price)



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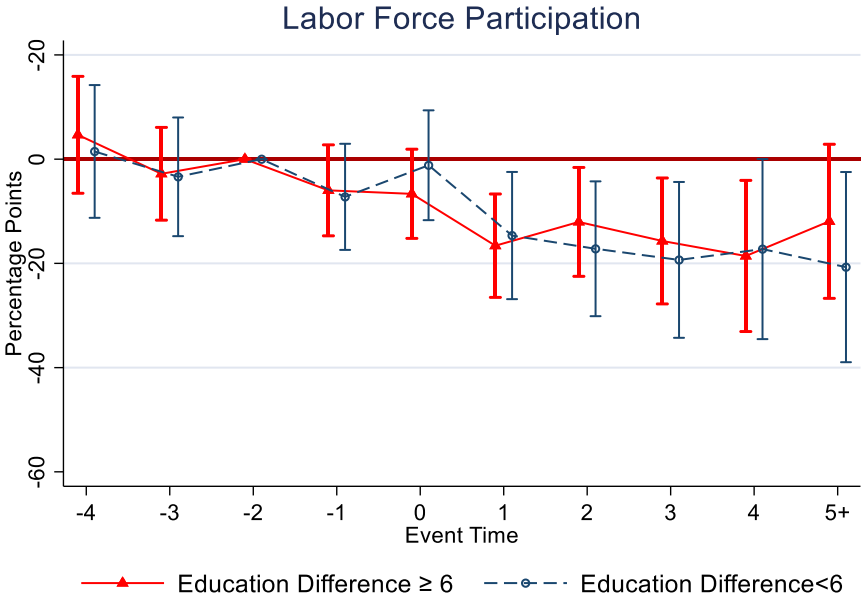
Appendix Fig. 5. Motherhood effects with and without grandparent's childcare
(Controlling for the estimated propensity score interacted with full set of event dummies)
Panel A: Labor force participation
Panel B: Hours worked per week
Panel C: Monthly earnings (in 2010 price)
Note: The graphs report the differential child penalty by access to grandparents' childcare help while controlling for the heterogeneity generated by the observable factors that contribute to access to grandparents' childcare help. We treat a woman as having access to grandparents' childcare if the grandparents are reported as the main caregiver at least once during the study period. If the main caregiver is kindergarten and the grandparents are responsible for taking children to and from school, we also regard the grandparents as the main caregivers. The propensity score is predicted using the model in column (8) of Appendix Table 1. See SubSection 4.3.2 for more details. Event time is indexed to the year of the first childbirth. The 95% confidence intervals around the estimates are based on standard errors clustered at the individual level.



Appendix Fig. 6. Grandmotherhood effects by intergenerational education gap
Note: The figure is constructed in the same way as in Fig. 5 and shows the grandmotherhood effects on labor supply but splitting the sample by whether the educational gap between the mother and the grandmother is above the sample median, which is six years. Event time is indexed to the year of birth for the first grandchild. The 95% confidence intervals around the estimates are based on standard errors clustered at the individual level.

Appendix Table 1
Using mother's and other family members' characteristics to predict the probability of have access to grandparent-provided childcare (Probit model).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Grandparent-provided childcare (yes = 1)							
Mother has college education (yes = 1)	0.608***							
	(0.055)							
Mother's years schooling		0.096***						
		(0.007)						
Primary school (yes = 1)			0.404**	0.422**	0.410**	0.420**	0.420**	
			(0.192)	(0.192)	(0.194)	(0.195)	(0.201)	
Middle school (yes = 1)			0.538***	0.518***	0.407**	0.393**	0.425**	
			(0.179)	(0.179)	(0.183)	(0.184)	(0.190)	
High school (yes = 1)			0.977***	0.903***	0.790***	0.767***	0.783***	
			(0.181)	(0.182)	(0.187)	(0.188)	(0.194)	
Three-year college (yes = 1)			1.188***	1.053***	0.904***	0.888***	0.934***	
			(0.184)	(0.187)	(0.193)	(0.194)	(0.200)	
University (yes = 1)			1.322***	1.118***	0.978***	0.936***	1.010***	
			(0.187)	(0.196)	(0.203)	(0.205)	(0.211)	
Postgraduate degree (yes = 1)			1.664***	1.437***	1.184***	1.122***	1.301***	
			(0.289)	(0.295)	(0.313)	(0.315)	(0.319)	
Rural hukou (yes = 1)				-0.165**	-0.146**	-0.142**	-0.176**	-0.398***
				(0.067)	(0.072)	(0.072)	(0.079)	(0.096)
Non-public sector (yes = 1)				0.099	0.066	-0.131	-0.161*	-0.246**
				(0.060)	(0.061)	(0.094)	(0.098)	(0.110)
Public sector (yes = 1)				0.179**	0.191**	-0.001	-0.023	-0.080
				(0.083)	(0.086)	(0.109)	(0.113)	(0.132)
Husband's education dummies					Y	Y	Y	Y
Grandmothers' education dummies					Y	Y	Y	Y
Earning quintile dummies						Y	Y	Y
Province FE							Y	
Mother's education level × province FE								Y
Observations	2517	2517	2517	2517	2511	2511	2508	2140
Goodness of Fit (%)	58.72	63.53	63.53	63.49	65.35	63.80	66.23	70.00

Note: The estimation sample is based on the 2010 to 2018 waves of the CFPS. All characteristics are measured in the last period before childbirth. The goodness of fit is the percentage of correct predictions by the model.

Appendix Table 2
Summary statistics for the CHARLS 2018 sample.

	Mean	S.D.	Min	Max	Observations
Male	0.47	0.50	0	1	6188
Age	59.92	6.31	45	70	6188
Rural hukou	0.83	0.38	0	1	6188
Grandparenting (yes = 1)	0.56	0.50	0	1	6176
Happy (yes = 1)	0.65	0.48	0	1	5986
Lonely (yes = 1)	0.20	0.40	0	1	5989
Depression (yes = 1)	0.31	0.46	0	1	5965
Satisfied (yes = 1)	0.87	0.33	0	1	6089

Note: This table reports the summary statistics of the analysis of elders' mental health in Table 2. The sample is derived from the 2018 CHARLS and includes people aged between 45 and 70 with at least one grandchild under 16.

Appendix Table 3
Summary statistics for the cross-sectional data from China's decennial population censuses and intra-decennial population surveys.

	Mean	S.D.	Min	Max	Observations
Census 1990					
College Education	0.01	0.12	0	1	806,740
Rural Hukou	0.77	0.42	0	1	806,740
Age	29.49	4.18	21	50	806,740
Labor Force Participation	0.92	0.28	0	1	806,740
Census 2000					
College Education	0.06	0.24	0	1	71,968
Rural Hukou	0.73	0.44	0	1	71,842
Age	30.38	3.82	21	50	71,968
Labor Force Participation	0.87	0.34	0	1	71,968
Population survey 2005					
College Education	0.13	0.33	0	1	107,524
Rural Hukou	0.67	0.47	0	1	107,431
Age	31.28	4.42	21	50	107,524
Labor Force Participation	0.80	0.40	0	1	107,524
Census 2010					
College Education	0.23	0.42	0	1	142,872
Rural Hukou	0.58	0.49	0	1	142,865
Age	31.34	4.71	21	50	142,872
Labor Force Participation	0.79	0.41	0	1	142,872
Population survey 2015					
College Education	0.27	0.44	0	1	65,813
Rural Hukou	0.47	0.50	0	1	65,813
Age	32.14	4.92	21	50	65,813
Labor Force Participation	0.70	0.46	0	1	65,813

Note: This table reports the summary statistics of the dataset we use in estimating the evolution of motherhood effect over time. Data are from population censuses in 1990, 2000, and 2010, as well as intra-decennial population surveys of 2005 and 2005. Following Kleven et al. (2022), we restrict the age of woman at first birth to be between ages 25–45.

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