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ABSTRACT

Unintended Consequences of Family Planning Policies on the Breastfeeding Gap between Sons and Daughters*

We examine the effect of a Chinese family planning policy (FPP) known as ”Later, Longer, and Fewer” on the gender gap in breastfeeding. We find that FPP increased the daughter-son breastfeeding gap in favor of sons in rural areas. Mean intensity of the FPP predicts the gender gap to be 35% greater than the gap without FPP. The effects are explained by the skewed gender composition of last-born children produced by sex-selective stopping behavior. The findings indicate a way in which FPP, in the context of son preference, widens gender gap in child development.

JEL Classification: J1, J13, J16, J18

Keywords: family planning, son preference, breastfeeding, ”Later, Longer, Fewer” campaign

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1 Introduction

Family planning policies (FPP) designed to restrict excess fertility may have unintended consequences in the context of strong son preference. On the one hand, fertility restriction may encourage son-seeking fertility behaviors that lead to gender-biased outcomes, such as skewed gender ratio among children (Cai and Lavely, 2003; Ebenstein, 2010; Johansson and Nygren, 1991). On the other hand, reduced family size could benefit both sons and daughters through the quantity-quality trade-off (Becker and Lewis, 1973), possibly narrowing the gender gap in life cycle outcomes in the long run (Jayachandran, 2015).

Breastfeeding is an important part of early childhood parental investment that may be significantly gender-biased, with potential consequences for the distribution of outcomes across genders and social welfare. A large body of studies have shown that breastfeeding significantly affects developmental outcomes of children, including cognitive development, and adult outcomes such as educational attainment and income (Binns et al., 2016; Horta and Victora, 2013; Koh, 2017; Victora et al., 2015). Breastfeeding also predicts short- and long-run health outcomes, including infant mortality, obesity, diabetes, asthma, and blood pressure (Binns et al., 2016; Salone et al., 2013; Victora et al., 2016). The consequences of FPP on breastfeeding has been under-investigated, however, because of data limitations. Most studies on FPP effects in China rely on exogenous fertility shock in the 1970s and 1980s to estimate its causal effect but limit the focus to the outcomes in adulthood, such as education and height, because breastfeeding data during this period is not readily available (Zhang, 2017).

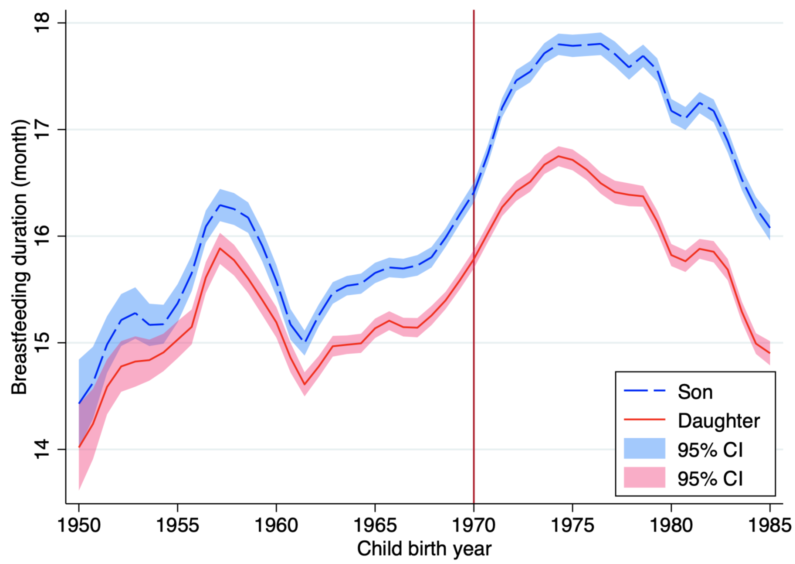
This study investigates the effects of FPP in China on the gender gap in breastfeeding duration. We focus on the "Later, Longer, Fewer" (LLF; *wan xi xiao* in Chinese) policy that was implemented in China in the early 1970s because it marks the beginning of one of the most stringent FPP in the world and precedes the better-known One Child Policy (OCP). LLF significantly reduced fertility (Scharping, 2003; Wang et al., 2013) and, by some accounts, contributed more to the fertility restriction of China than OCP did (Babiarz et al., 2020; García, 2022; Gietel-Basten et al., 2019; Zhang, 2017). LLF reduced the total fertility rate by as much as 0.88 births per year throughout the 1970s (Babiarz et al., 2020) while OCP reduced it by only 0.3 births per woman between 1979 and 2000 (García, 2022). Further, LLF preceded the Reform Era, a period of unprecedented economic and social change that coincided with the implementation of the OCP. Breastfeeding by mothers affected by LLF would mostly be completed before the onset of OCP or economic reforms.

We use the Two-Per-Thousand National Survey of Fertility and Contraception, conducted by the State Family Planning Commission of China in 1988. It provides pregnancy histories of over 500,000 ever-married women, including breastfeeding duration for every birth. To identify the effects of FPP on the gender gap in breastfeeding duration, we compare across pre- and post-FPP birth cohorts as well as geographic variation of FPP intensity, following a difference-in-differences strategy.

Figure 1 previews our main results that FPP widens the gender gap in breastfeeding duration to the disadvantage of daughters. These effects were entirely concentrated in the rural region, where son preference is prevalent (Figure A1). Analyzing breastfeeding duration by cohort, the gender gap started to increase in rural China from the cohorts born in the 1970s, after the introduction of LLF, and remained persistent for those born in the 1980s. Our difference-in-differences estimates imply 35%, or approximately 1.5 weeks, longer gender gap in breastfeeding at the mean intensity of LLF than the gap at without fertility restriction.

We then investigate why the gender gap in breastfeeding duration widens when fertility is restricted. We find that the effects are primarily driven by the change in gender composition of the children within birth order, making the last-born child more likely to be a son. First, with the implementation of LLF, the last-born child in a family were more likely to be a son than a daughter. This is consistent with parents with son preference engaging in fertility

Figure 1: Breastfeeding duration by gender of child in China, 1950–1985



Notes: Data come from Two-Per-Thousand National Survey of Fertility and Contraception of 1988. Both urban and rural samples are included.

stopping behavior in which they stop having children only after a son is born (Babiarz et al., 2020). Second, regardless of gender, the last-born child in a family tended to be breastfed longer than their earlier born siblings, because the fertility-suppressing effects of breastfeeding or the pregnancy-induced breastfeeding cessation are not issues for the last child. This pattern is consistent with the previous findings that mothers in developing countries tend to breastfeed later-born children longer than earlier-born children (Haan et al., 2014; Jayachandran and Kuziemko, 2011; Li et al., 2020). Our econometric analysis confirms that controlling for the last-child status greatly reduces the estimated effect of FPP on the gender gap in breastfeeding. In other words, FPP increases the gender gap in breastfeeding by making it more likely for sons than daughters to be the youngest child in the family who are breastfed longer.

This study contributes to the literature on gender inequality in rural China. Rural China is known for strong son preference, leading to a gender gap in parental investment, education, income, and health, among others (Burgess and Zhuang, 2002; Murphy et al., 2011).

Previous literature documented the role of the One Child Policy, the spread of ultrasound technology, and income increases following land reforms in exacerbating the expressions of son preference in rural China (Almond et al., 2019; Chen et al., 2013; Ebenstein, 2010). This study refines our understanding of the gender gap in breastfeeding duration by demonstrating that LLF policy exacerbated preexisting differences in breastfeeding by sex of infant.

We highlight the role of birth order and son-biased fertility stopping behavior in widening the gender gap in breastfeeding duration. Earlier studies showing the gender gap in breastfeeding conjectured that fertility-suppressing effects of breastfeeding ("lactational amenorrhea") explained their findings (Chakravarty, 2015; Hafeez and Quintana-Domeque, 2018; Jayachandran and Kuziemko, 2011). We show that the gender gap comes from skewed gender composition within birth order generated by son-biased fertility stopping behavior, which may affect breastfeeding duration through parents attempting to avoid lactational amenorrhea or by breastfeeding cessation because of pregnancy.

2 Background

2.1 Family Planning Policies in China in the 1970s

The LLF was the first serious family planning campaign in the People's Republic of China outside of urban areas (Lavely and Freedman, 1990; Scharping, 2003). Since the mid-1950s, food shortage and overpopulation concerns led the government to implement fertility control. However, those attempts were relatively short-lived and constantly interrupted by the Great Leap Forward, the Great Famine, and Cultural Revolution (Banister, 1987; Scharping, 2003). Moreover, the disconnect between Mao's belief in "More people, more power" and the idea of reducing fertility made it difficult for the government to promote the campaigns actively (Scharping, 2003; Zhang, 2017).

While the Cultural Revolution was in motion in the late 1960s, the economy stalled and the total fertility rate exceeded six births per woman. With rising concerns over food shortages, the government resumed birth control policies (Peng, 1996; Zhang, 2017). Urban fertility was already in decline since the early 1960s, in part because of urban family planning programs. The "Later, Longer, and Fewer" policy initiated in 1971 was the first sustained program also targeting rural households.

LLF encouraged "later" marriages (23 for women; 25 for men), "longer" time between births (at least four years), and "fewer" births (at most two for urban families; three for rural families). Although the campaign was voluntary in principle, many of the coercive tactics used in OCP were first used during LLF (Whyte et al., 2015; Babiarz et al., 2020). Local birth planning enforcers kept records of past births, contraceptive usage, and menstrual cycles to monitor pregnancies. Women were pressured to undergo an abortion in case of pregnancy without permission, be sterilized, or have IUDs inserted, when they reached mandated birth parities. Women who failed to comply were harassed at work by their superiors and were threatened that their children would be ineligible for public services. The number of IUD insertions and female sterilizations more than doubled from 1971 to 1975 (Whyte et al., 2015).

Fertility started to decline rapidly in the 1970s with the implementation of LLF, as seen in Figure A2. The total fertility rate fell from nearly 6 in the early 1970s to 2.7–2.8 at the end of the decade, unusually low for a low-income agrarian society (Babiarz et al., 2020; Wang et al., 2013; Whyte et al., 2015). The sex ratio of births also began to rise during this period (Coale and Banister, 1994; Gu and Roy, 1995). LLF increased women's marriage age by nearly a year on average and increased birth intervals after the first birth, contributing to overall fertility decline (Babiarz et al., 2020; Feeney and Feng, 1993; Wang and Yang, 1996).

LLF was followed in 1979 by the introduction of the OCP, as the post-Mao reformers attempted to further slow China's population growth and make economic growth on a per capita basis the central tenet of its political legitimacy (Cai and Wang, 2021). OCP incentivized couples to have only one child using financial rewards and punishments including fines, higher fees for public services, and reduced access to health and education services for their children (Scharping, 2003). Further, mass campaigns of contraceptive operations (mainly IUD insertions and sterilizations) and abortions for out-of-plan pregnancies were used (Babiarz et al., 2020).

2.2 Son Preference and the Gender Gap in Breastfeeding

Sex differences in breastfeeding duration have been observed in many populations with family systems favoring sons. For example, in India, Jayachandran and Kuziemko (2011) found that breastfeeding duration is lowest for daughters without older brothers, likely because cessation of breastfeeding hastens a return to an ovulatory state necessary to conceive a son. Similar patterns are reported in other countries also known as having son preference, such as Egypt (Chakravarty, 2015) and Pakistan (Hafeez and Quintana-Domeque, 2018).

China's patrilineal family system emphasizes having at least one son, leading to the gender gap in life outcomes (Murphy et al., 2011). For example, Song and Burgard (2008) compared the gender gap in height in China and in the Philippines using longitudinal data covering children's ages from 0 to 17 and found that boys' height advantage over girls is greater in China than in the Philippines, with weaker tradition of son preference compared to China. Chae et al. (2023) found that while health improved for the Chinese population overall, rural females experienced slower height growth compared to men and urban women.

Breastfeeding was virtually universal throughout China until recent decades (Graham et al., 1998; Lavely, 2007; Shi et al., 2008). The breastfeeding rate in major cities remained above 90 percent in the first four months of a child's life even in the 1990s (Xu et al., 2009). A few studies investigated the gender gap in breastfeeding in parts of China. Shi et al. (2008), in a low-income rural county in Hebei, observed that while nearly all infants (95.5%) were breastfed, girls were more likely to be fully breastfed than boys. Boys were both breastfed and given infant formula, which was considered an expensive and nutritionally superior alternative to breastfeeding (Xu et al., 2009). Graham et al. (1998) studied the implications of son preference on breastfeeding using household surveys in two rural counties of Anhui province. They found that girls were breastfed for shorter durations than boys, especially girls who had only older sisters.

3 Data and Empirical Strategy

3.1 Data

We use the "Two-Per-Thousand" National Survey of Fertility and Contraception of 1988 (NSFC), a nationally representative survey conducted by the State Family Planning Commission to monitor China's birth planning program. The survey provides complete fertility and contraceptive history records of each woman surveyed in addition to their basic personal information, including the year and month of each pregnancy, birth order and breastfeeding duration for each child. The sample unit of the survey was the small neighbourhood group in cities and the village group in rural areas, of which 13,966 were selected.[1]

We restrict the sample to live births born in rural areas between 1962 and 1979 to avoid the confounding effects of OCP, born to mothers between ages of 15 and 49, and having complete breastfeeding information available. We further remove outliers with breastfeeding duration longer than 48 months, yielding 655,011 out of 1,110,036 cases. We focus on the rural population because urban China experienced a significant decline in fertility rates in

[1] This survey used stratified, clustered, and non-proportional probability sampling. The provinces formed 30 strata; under each province, five strata were formed by street committees, towns, rural townships under cities and suburbs, rural townships under counties, and state farms (regiments). The sample fractions of each province were determined by the total 1986 year-end population and estimates of their sample size. Within provinces, samples were selected systematically according to random principles, with equal proportions selected within strata.

Table 1: Sample restrictions

Description	Pregnancy Cases		Women	
	N	% of (a)	N	% of (a)
Original sample	1,235,071		418,517	
Original rural sample (a)	1,100,036	100.0%	353,883	100.0%
— Children born between 1962 and 1979	671,292	61.0%	216,099	61.1%
— Mother's age at birth between 15 and 49	671,183	61.0%	216,071	61.1%
— Breastfeeding information available	659,506	60.0%	214,432	60.6%
— Breastfeeding duration $\leq$ 48 months	655,011	59.5%	213,934	60.5%
Final sample	655,011		213,934	

the 1960s, which may have been driven by the early government fertility control policies, as discussed in Section 2. In addition, we observe substantial differences in the long-term trends of breastfeeding duration between urban and rural areas, as seen in Figure A1. Furthermore, we do not see any significant changes in the gender gap of breastfeeding duration in urban China.

We exclude pregnancy cases born before 1962 because the NSFC data is left-censored, which would introduce selection bias. The NSFC survey was conducted in 1988 and included women aged between 15 and 57 (i.e., women born between 1931 and 1973), most of whom were too young to give birth in the 1950s.[2] Figure A3 compares the birth year distribution in the NSFC with that of the 1990 Population Census and clearly shows that the NSFC is left-censored. Every birth cohort born before 1950 accounts for at least 1% of the total distribution in the census, while that is almost zero in the NSFC. Therefore, we exclude those born before 1957. We picked the 1957 cohort as a cutoff considering that the average mother's age at childbirth is 26 years old, and the oldest woman in our sample was 26 years old in 1957. We also excluded children born during the Great Famine period which ended in 1961. The final sample therefore includes children born in and after 1962.

[2]For example, the oldest birth cohort was only 19 years old in 1950, and pregnancy cases in 1950 were few.

The main sample restrictions raise two concerns. First, child mortality cases are included in the sample. Figure A4 shows that about 4% to 12% of children died between age 0 and 4, which accounts for a nontrivial fraction of observed deaths in the sample. We include them on the basis that child mortality could be a consequence of breastfeeding, but mortality may also have truncated breastfeeding duration. Second, we exclude observations born before 1962, which may lead to sample selection bias. To deal with these concerns, we show that our results are robust with respect to excluding observations in which children were observed to have died, and to including observations born before 1962.

Table 2 presents summary statistics of the main sample. Boys are breastfed longer than girls by 0.72 months on average, and the gender differences are statistically significant at a 1% level. Girls have more siblings than boys, and the difference is statistically significant at a 1% level. This difference arises from girls having more younger siblings than boys. In contrast, the number of older siblings is almost the same between genders. The gender differences in the number of younger and older siblings are likely explained by son-biased fertility-stopping behavior in which a woman continues giving birth until a son arrives. Average birth spacing is about 2 years and 10 months (2.8 years), longer than the average breastfeeding duration (15–17 months). The average year of birth is 1970 for children and 1943 for mothers, which means the mothers were about 45 years old on average at the survey time in 1988. The differences by the child's gender are significant for birth spacing, mother's education and mother's birth year, although the magnitudes of these differences are unlikely to be substantively meaningful.

Table 2: Summary statistics

Mean (SD)	Sons (a)	Daughters (b)	Diff (a-b)
Months of breastfeeding	16.56	15.85	0.72***
	(9.10)	(8.48)	
Birth order	3.06	3.05	0.00
	(1.91)	(1.91)	
Number of siblings	3.70	3.92	-0.22***
	(2.06)	(2.02)	
Number of younger siblings	1.64	1.86	-0.23***
	(1.50)	(1.54)	
Number of older siblings	2.06	2.05	0.00
	(1.91)	(1.91)	
Number of sisters	1.85	1.93	-0.08***
	(1.43)	(1.49)	
Number of brothers	1.85	1.99	-0.14***
	(1.40)	(1.33)	
Birth spacing with the first younger sibling[1)]	2.89	2.80	0.10*
	(1.58)	(1.47)	
Birth spacing with the youngest older sibling[2)]	2.82	2.82	0.01**
	(1.46)	(1.45)	
Birth year	1970.80	1970.81	-0.02
	(4.94)	(4.93)	
Mother's birth year	1943.82	1943.85	-0.03*
	(6.88)	(6.86)	
Mother's education: 9 years or above	0.09	0.09	0.001**
	(0.29)	(0.28)	
Observations	336751	318260	

Notes: 1) The youngest among siblings are excluded as they have no younger siblings. 2) The firstborn individuals are excluded because they have no older siblings. 3) * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

3.2 Empirical strategy

3.2.1 Conceptual Framework

With higher cost of additional fertility under the fertility restriction, parents who attempt multiple children would be more likely to be those trying to have at least one son after having a daughter. In other words, parents with son preference will engage in relatively more intense son-biased fertility stopping behavior compared to those without son preference (Babiarz et al., 2020). As a consequence, the gender ratio becomes more skewed in later birth order when FPP and son preference are combined. Similar finding is reported with respect to OCP by Ebenstein (2010).

Parents face a trade-off with ongoing breastfeeding and subsequent fertility. One mechanism that forces this trade off is lactational amenorrhea, which is temporary infertility during and after breastfeeding. Immediately after childbirth, a mother experiences a relatively short period of infertility of up to two months called postpartum amenorrhea, but a breastfeeding mother can experience longer period of infertility called lactational amenorrhea (Bongaarts and Potter, 1983). Frequent suckling by the infant leads to physiological responses in women that produce breastmilk while also suppressing ovulation, delaying pregnancy so effectively that it is considered a type of birth control (McNeilly, 2001). This state can be prolonged by frequent suckling and longer breastfeeding duration.

Another mechanism linking breastfeeding and pregnancy is that the start of pregnancy may signal an appropriate moment to wean a nursing infant. Studies show that mothers tend to stop breastfeeding during pregnancy in part because of decline in breastmilk production (Moscone and Moore, 1993). Further, mothers in developing countries may find it challenging to meet the nutritional requirement of breastfeeding during pregnancy. Pregnancy was most often cited as the reason for stopping ongoing breastfeeding among a sample of mothers in India (Jayachandran and Kuziemko, 2011).

In summary, the mechanisms discussed above imply that the FPP may exacerbate the gender gap in breastfeeding duration in favor of boys because (1) breastfeeding duration tends to be longer at higher birth order as parents approach their desired family size, (2) in the presence of son-biased fertility stopping behavior, the gender gap in breastfeeding duration emerges because of a higher son-to-daughter gender ratio among later births, and (3) parents with son preference engage in more intense son-biased fertility stopping behavior under the strict fertility restriction.

3.2.2 Empirical model

We examine whether the gender gap in breastfeeding duration has increased in response to FPP implementation. We test this by comparing the breastfeeding duration of the cohorts born while FPP was being implemented to earlier cohorts. Further, we measure the degree of exposure to FPP for each mother and see whether the enlarged gender gap is attributable to higher exposure to FPP restrictions.

Equation (1) estimates breastfeeding duration for every birth cohort t as a function of child's gender, reflecting the presence of son-favouring breastfeeding behaviours. Of particular interest are changes in the gender gap across birth cohort t, particularly before and after FPP implementation in the early 1970s. We estimate:

$$Breastfeed_{imt} = \alpha_0 + \alpha_1 Son_i + \sum_{\tau=1963}^{1979} \gamma_t \mathbb{I}[\tau = t] \cdot Son_i + \alpha_2 \mathbf{X}_{imt} + \varepsilon_{imt} \tag{1}$$

where $Breastfeed_{imt}$ is the number of months a mother m reported having breastfed child i who was born in year t. Son_i is an indicator for i being a son. We include interaction terms between Son_i and child birth year t dummy variables and omit that of the 1962 birth cohort. $\mathbb{I}[\tau = t]$ is an indicator that equals 1 in year t and zero otherwise. The coefficient for the interaction term, γ_t, captures the gender difference in breastfeeding duration among individuals born in year t, representing the within-cohort gender gap. It enables us to see how the gender gap in breastfeeding duration has changed over time. $\mathbf{X}_{imt}$ is a vector of controls that always includes region (sample-unit) fixed effects[3] and dummy variables indicating each child birth year, mother's birth year and mother's education level. We also expand the set of controls to check the robustness of our results, such as including birth order, the number of siblings or mother-fixed effects. ε_{imt} is an error term. We use robust standard errors clustered at the sample-unit level.

While equation (1) relies on variations across birth years to gauge the policy effect, equation (2) uses a direct measure of the policy exposure. Equation (2) estimates the FPP effect on the gender gap in breastfeeding duration using the mothers' exposure to the FPP. Intuitively, this equation tests if the gender gap in breastfeeding is greater for mothers who were exposed to the FPP relatively more intensively and for a longer period of time. The equation is:

$$Breastfeed_{imt} = \beta_0 Son_i + \beta_1 Son_i \cdot FPP_m + \beta_2 FPP_m + \beta_3 \mathbf{X}_{imt} + u_{imt} \tag{2}$$

where $Breastfeed_{imt}$ is the number of months a mother m reported having breastfed child i who was born in year t. Son_i is an indicator for a son; FPP_m measures to what extent i's mother's fertility was restricted by the FPP during her fertile period, or the number of children a woman would have given birth to based on the pre-FPP fertility profile. We follow Chen and Fang (2021) to generate FPP_m.[4]

[3]The sample-unit region is the neighborhood small group, the village small group, and collective households at the same level. Our main sample includes individuals living in 2,607 counties (or districts) and 13,121 unit regions.

[4]Chen and Fang (2021) defined FPP as:

$$FPP_{p,c} = \sum_{a=15}^{49} [AFR_p(a)\dot{I}[c+a > T_p]] \tag{3}$$

where $FPP_{p,c}$ is the policy exposure for province p for cohort c and $AFR_p(a)$ is the provincial age-specific

β_1 is the coefficient of interest, capturing gender differences in the FPP effects on breastfeeding duration. $\mathbf{X}_{imt}$ includes the same set of controls as in equation (1). u_{imt} is an error term. We use robust standard errors clustered at the sample-unit level. Panel (a) of Figure A5 shows that the FPP variable is relatively evenly distributed between 0 and 7. Panel (b) shows that children born later have been exposed to the effects of the FPP more severely, in part because the mother was younger when the FPP was implemented.

4 Results

4.1 Descriptive findings

We begin with a description of the gender gap in breastfeeding duration, combining both rural and urban regions. Figure 1 shows that breastfeeding duration rapidly increased for both male and female infants during the 1950s. This trend can be attributed to improved infant survival due to aggressive public health interventions implemented in the early and mid-1950s, including control of parasites and improvements in sanitation, particularly in rural areas.[5] The trend reversed in the late 1950, coinciding with the Great Famine (1959–1961), then recovered afterwards. The duration started to decrease again around the mid-1970s, in part because of widespread availability of breast milk substitutes (Xu et al., 2009). Figure

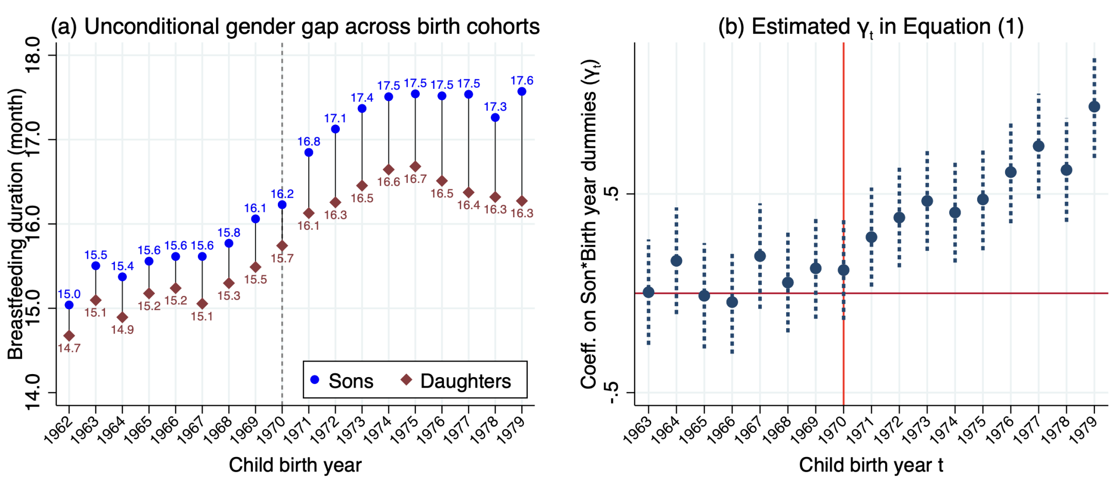
fertility rate for age a in 1969. We use residential province information at the survey time in the calculation. T_p is the establishment year of the Family Planning Leading Group for province p, which is assumed to be the LLF introduction timing. This information is available in Chen and Fang (2021) appendix Table A1. Intuitively, $FPP_{p,c}$ represents the counterfactual fertility, which is the number of children a woman would have given birth to, based on the pre-LLF fertility profile in 1969. The age-specific fertility information is from Coale and Li (1987).

[5]Health interventions in the 1950s aimed to improve sanitation and reduce the prevalence of intestinal parasites, as well as eradicate pests such as rats, flies, mosquitoes, and bedbugs. These measures were particularly successful in reducing infant mortality rates. Research suggests that by 1957, infant mortality rates and crude death rates had decreased by half (Banister, 1987). See Babiarz et al. (2015) for details.

A1 in the Appendix shows that this pattern is driven by those in the rural area. Breastfeeding duration in the urban area remained relatively flat until the mid-1970s when it began to decline. As discussed in Section 3.1, for this reason, we restrict the sample to the rural area only for the rest of the analysis.

The left panel of Figure 2 shows that sons are on average breastfed longer than daughters regardless of birth year in rural China. This gender gap remained relatively stable throughout cohorts born in the 1960s (also in the 1950s, as seen in Figure 1), but the gap began to widen from the cohorts born in the 1970s when LLF was in effect. The gender differences stayed below 0.5 months among pre-1970 birth cohorts, but jumped to 0.7 (=16.8-16.1) months for the 1971 cohort, then increased to more than a month by the 1976 cohort.

Figure 2: Gender gap in breastfeeding for each birth cohort in rural China



Notes: 1962 cohort is the omitted category in the model shown on the right panel.

To check what factors are associated with the widened gender gap, we regress a dummy variable indicating a son on individual breastfeeding duration and present the results in Table 3. Columns (1) to (3) show that sons are breastfed longer than daughters by about 0.73 months on average, even after accounting for sample-unit and birth year fixed effects and the mother's characteristics. Column (4) adds a set of dummy variables for family size, and the gap is reduced by 37%. Adding both fixed effects of family size and birth order, as seen in Column (6), explains more than half of the gender gap estimated in column (3), which suggests that changes in family size and birth order together may address the gender gap changes under the FPP.

Table 3: Gender gap in breastfeeding duration

Dependent variable: Breastfeeding duration	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Coefficient on Son dummy	0.729***	0.729***	0.724***	0.453***	0.727***	0.300***	0.431***
	(0.022)	(0.022)	(0.022)	(0.021)	(0.022)	(0.021)	(0.026)
Fixed effects included:							
Sample-unit region	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Child birth year		Yes	Yes	Yes	Yes	Yes	Yes
Mother's birth year			Yes	Yes	Yes	Yes	
Mother's education			Yes	Yes	Yes	Yes	
Birth order					Yes	Yes	Yes
Number of siblings				Yes		Yes	
Mother fixed effect							Yes
Observations	655011	655011	655011	655011	655011	655011	655011
Adjusted R^2	0.155	0.163	0.181	0.215	0.184	0.228	0.422

Note:
1) We regress the outcome variable – breastfeeding duration measured in month – on a dummy variable indicating a son;
2) Robust Standard Errors (SEs) are presented in parentheses;
3) SEs are clustered at the sample-unit region level;
4) * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

4.2 Main results

The right panel of Figure 2 plots the estimates of γ_t from equation (1), which captures changes in gender breastfeeding duration gap for cohort t relative to the gap of the reference group (the 1962 cohort). The results suggest that gender differences in breastfeeding duration began to increase after the 1971 cohort, which coincides with the beginning of LLF implementation. The gender gaps for cohorts born between 1963 and 1970 are not significantly different from those of the reference group.

The results are robust to different sets of control variables and different samples. Figure A6 shows the estimates of equation (1) controlling for additional covariates, including mother fixed effects. As discussed in Section 3, we also investigate the potential for sample selection bias in Figure A7. We use (a) a sample that excludes observations of children who suffered child mortality and (b) a sample that includes those born between 1950 and 1985, then estimate equation (1). The results from these samples do not show any evidence of selection bias. Moreover, Figure A8 (a) provides the estimates using the final sample excluding one-child observations and confirms the robustness of our results.

We further exploit the regional variations in the FPP intensity and examine its effects on the gender gap in breastfeeding duration by estimating equation (2). The results in Table 4 show that the gender gap in breastfeeding duration increases as the mother is exposed to more strict fertility control.[6] Column (1) in Table 4 shows that a unit increase in FPP increases the breastfeeding duration by approximately 22 days for daughters and 25 days for sons, widening the gender gap by 12% with respect to the sample mean. The average FPP in our sample is 3.22.[7] Therefore, at the average intensity of FPP implementation, the gender gap in breastfeeding duration is predicted to be about 1.5 weeks, or almost 35% longer than if there were no FPP (0.089 months $\times$ 3.22 births $\times$ 30 days = 8.60 days). For mothers exposed to FPP with the highest intensity in the sample, the gender gap in breastfeeding duration is predicted to be longer by almost 76% compared to the mothers not subjected to FPP at all (0.089 months $\times$ 7 births = 0.623 months). Table A1 confirms that the results are not sensitive to alternative sample definitions excluding deceased children or including cohorts born before 1962.

Columns (2) to (5) of Table 4 show that the main results in column (1), based on the coefficient estimates on $Son \times FPP$, are robust to a set of different controls including the

[6]Due to missing information on provincial-level LLF introduction timing in Chen and Fang (2021), observations from five provinces (Inner Mongolia, Hainan, Qinghai, Ningxia and Xinjiang) are excluded from the analysis sample.

[7]This means that the average mother in our sample is predicted to have given 3.22 more births in the absence of FPP according to the model.

Table 4: Gender gap in breastfeeding duration by FPP intensity

Dependent var.: Breastfeeding duration	(1)	(2)	(3)	(4)	(5)
Son	0.816^{***}	0.495^{***}	0.819^{***}	0.309^{***}	0.483^{***}
	(0.022)	(0.022)	(0.022)	(0.022)	(0.023)
FPP	0.748^{***}	0.449^{***}	0.606^{***}	0.139^{***}	
	(0.051)	(0.051)	(0.051)	(0.050)	
Son $\times$ FPP	0.089^{***}	0.043^{***}	0.090^{***}	0.018	0.031^{***}
	(0.011)	(0.011)	(0.011)	(0.011)	(0.012)
Fixed effects included:					
Sample-unit region	Yes	Yes	Yes	Yes	
Child birth year	Yes	Yes	Yes	Yes	Yes
Mother's birth year	Yes	Yes	Yes	Yes	
Mother's education	Yes	Yes	Yes	Yes	
Number of siblings		Yes		Yes	
Birth order			Yes	Yes	Yes
Mother fixed effects					Yes
Observations	566248	566248	566248	566248	566248
Adjusted R^2	0.186	0.221	0.189	0.235	0.425

Note:
1) The outcome variable is breastfeeding duration measured in month;
2) Robust Standard Errors (SEs) are presented in parentheses;
3) SEs are clustered at the sample-unit region level, which incluldes the neighbourhood small group, the village small group and collective households;
4) Column (1) includes the same set of covariates on the right panel of Figure 2. Columns (2) to (5) additionally include other fixed effects presented in the table. We include a set of dummy variables indicating each value of the corresponding variable to control for fixed effects;
5) * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

sibling size fixed effects, birth order fixed effects, and mother fixed effects, in each model. The exception is shown in column (4), controlling for both sibling size fixed effects and birth order fixed effects at the same time. Accounting for both of these effects reduces the coefficient sizes of the *Son* indicator (representing the gender gap in the absence of FPP) and the FPP variable to be the smallest among the models considered. The interaction term coefficient is now close to zero and insignificant. Comparing the results in column (2) and (4) shows that controlling for birth order in addition to the number of siblings reduces the estimates of all three coefficients towards zero. As in the case of Table 3, a combination of birth order and the number of siblings may play an important role in explaining the effects of FPP on breastfeeding duration and its gender gap.

4.3 Explaining FPP effects on the gender gap in breastfeeding duration

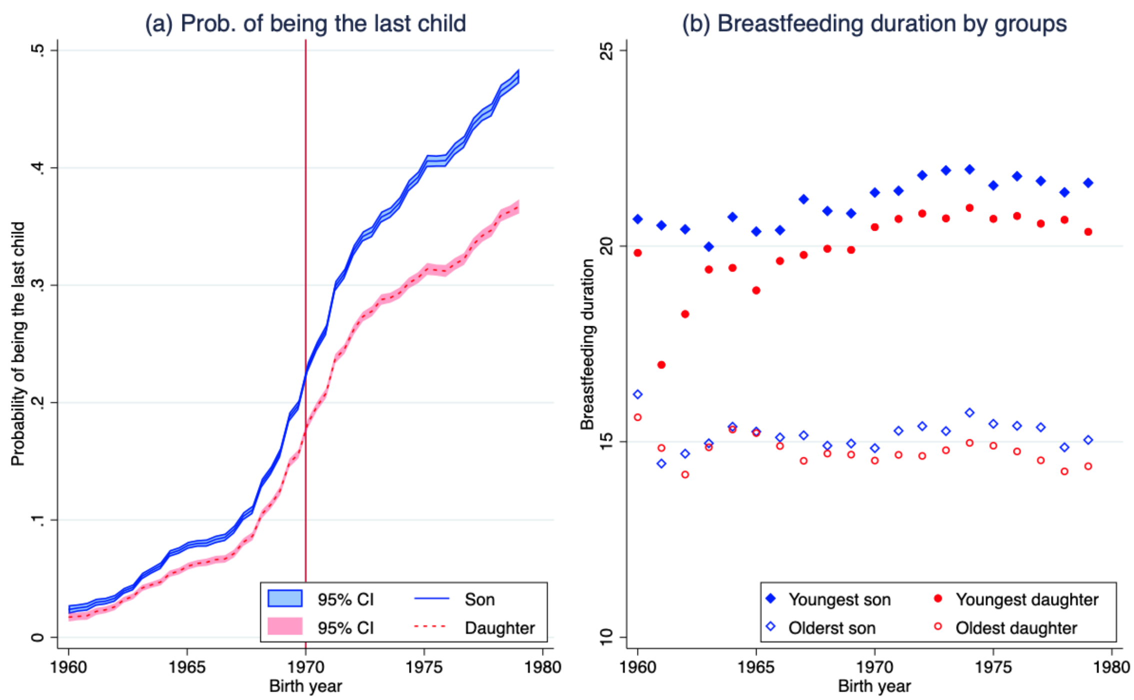
The main results suggest that FPP increased breastfeeding duration overall but to different extents for sons and daughters, ultimately widening the gender gap. Now we further explore the linkage between the results on the breastfeeding gender gap and FPP. Specifically, we proceed by establishing that FPP promoted son-biased fertility stopping, leading to a more biased gender ratio among the last born children. Then we examine whether it can explain our main results.

First, the left panel of Figure 3 shows that a son is more likely to be the last child on average, which presumably reflects the prevalence of son-biased fertility stopping behaviors in rural China. In other words, a mother is more likely to stop having children after having a son than after having a daughter. The proportion of individuals who are the youngest among the siblings rapidly increased after 1970. This increase was faster among sons, enlarging the gender gap at the highest birth order in the family.

Second, the right panel of Figure 3 shows that breastfeeding duration is clearly distinguished by birth order. The youngest children are breastfed for 20 months or more, while the average duration for the oldest children is less than 16 months. Gender gaps in breastfeeding duration within birth order are small in comparison, a month or less, although still substantial with respect to child development. These results are consistent with the conceptual framework in Section 3 that parents used son-biased stopping behavior which led to the gender gap in breastfeeding duration as a combination of birth order gap and a high chance that a last-born child is a son. Within birth order, the gender gap in breastfeeding is small.

In addition, Figure A9 plots the proportion of individuals by the presence of younger and older brothers and sisters. Subfigures (b) and (c) show that the gender difference in the proportion of children without younger siblings (subfigure (a)) is primarily explained by those who do not have a younger brother. In other words, daughters are more likely than sons to have a younger brother but the chance of having a younger sister is similar between sons and daughters. For example, among the 1979 birth cohort, more than 70% of sons do not have a younger brother, whereas the rate is less than 60% for daughters. Subfigures (d), (e), and (f) in Figure A9 show there is no significant gender difference in the probability of having older brothers or sisters.[8]

Figure 3: Birth order and breastfeeding duration by gender



Notes: Data come from Two-Per-Thousand National Survey of Fertility and Contraception of 1988. Rural sample only. One-child observations are excluded.

[8]The increase in the proportion of those without older siblings after 1970, combined with the increase in the proportion of those without younger sibling, implies that there are more single-child households. The drop in the proportion of those without older siblings until 1970 suggest that families with already one child went on to have at least another child. However, families were less likely to have children beyond the first two, indicated by the (slower) rise in the proportion of children without younger siblings. Having multiple children would give existing children younger siblings.

To further test this explanation, we examine whether controlling for the last-born position changes the main estimation results. To do so, we write equation (4) as follows:

$$Breastfeed_{imt} = \alpha_0 + \alpha_1 Son_i + \sum_{\tau=1963}^{1979} \gamma_t \mathbb{I}[\tau = t] \cdot Son_i + \alpha_2 \mathbf{X}_{imt} + \alpha_3 S_i + \varepsilon_{imt} \qquad (4)$$

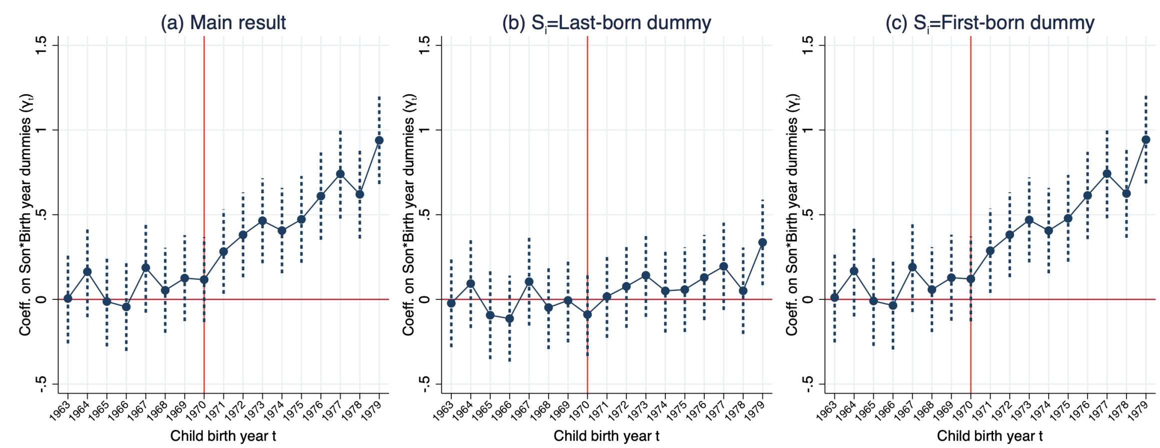
This equation adds S_i to equation (1), where S_i represents the child's relative position among the siblings. We first define S_i as an indicator that equals 1 for being the youngest of the family. We then define S_i as an indicator for being the firstborn of the family. $\mathbf{X}_{imt}$ includes regional sample-unit dummies, child birth year dummies, mother's birth year dummies and mother's education level dummies, which is the same set of covariates as in equation (1).

We compare the results of estimating equation (1) and equation (4) in Figure 4, with alternative definitions of S_i. The within-cohort gender gap is increasing increasing for cohorts born in 1970 and later, as shown in subfigure (a). In contrast, once the last-born position among siblings is accounted for, within-cohort gender gap is not significantly different from the gap observed among pre-1970 cohorts (subfigure (b)). Controlling for the first-born position does not affect the estimated within-cohort gender gap (subfigure (c)). These results are robust to excluding single-child households, as seen in Figure A8.

We further confirm these results by estimating equation (2) with indicators of being the firstborn child and the last-born child, respectively, and show the results in Table 5. Controlling for being the last-born in the family reduces the magnitude of coefficients on $Son \times FPP$ by more than half (column (2)). Controlling for being the first-born does not affect the estimates.

An implication of the parents engaging in a son-biased fertility stopping rule is that the birth spacing with the younger sibling is shorter for a daughter than for a son. Parents with son preference would hasten pregnancy after giving birth to a daughter, cutting short

Figure 4: Gender gap in breastfeeding duration, accounting for relative position among siblings



Notes: Dashed lines represent the 95% confidence intervals

breastfeeding and reducing birth spacing for daughters relative to sons. This tendency may have intensified because LLF specified birth spacing as of one its targets ("later").

Figure A10 in the Appendix shows that, consistent with this implication, birth spacing is shorter following a daughter than following a son, and only for the birth spacing with the younger sibling but not for the older sibling. The gender difference in birth spacing is not significant when analyzed using equation (1), however, as shown in Figure A11.

Evidence thus suggests that FPP may widen the gender gap in breastfeeding duration by changing the gender composition of the last-born child in a family, made possible by parents engaging in a son-biased fertility-stopping rule. With FPP, sons are more likely to be last-born children, for whom breastfeeding duration is longer because of various mechanisms related to lactational amenorrhea or pregnancy-induced breastfeeding cessation, as described in Section 3. The key behavioral mechanism by which FPP enlarges gender gap in breastfeeding duration is the son-biased fertility stopping behavior.

There are other potential mechanisms that may explain the gender gap in breastfeeding. First, the LLF may intensify the existing breastfeeding practices of parents based on son

Table 5: Gender gap in breastfeeding duration, accounting for relative position among siblings

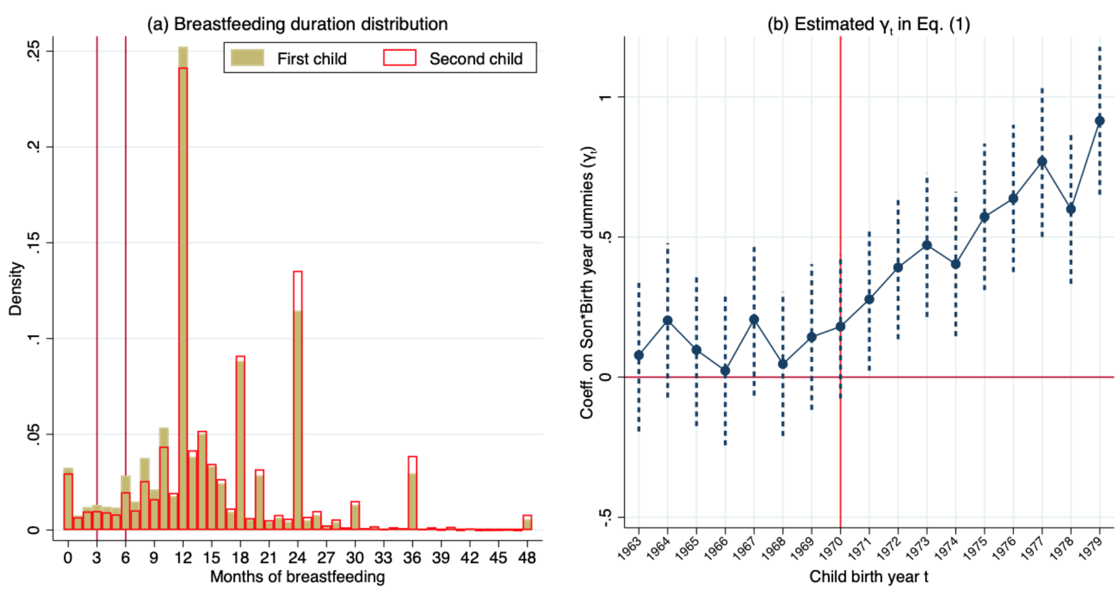
Dependent variable: Breastfeeding duration	(1)	(2)	(3)
Son	0.816***	0.504***	0.817***
	(0.022)	(0.022)	(0.022)
FPP	0.748***	0.420***	0.683***
	(0.051)	(0.050)	(0.051)
Son × *FPP*	0.089***	0.041***	0.089***
	(0.011)	(0.011)	(0.011)
Last-born child		4.903***	
		(0.030)	
First-born child			-0.511***
			(0.030)
Fixed effects included:			
Sample-unit region	Yes	Yes	Yes
Child birth year	Yes	Yes	Yes
Mother's birth year	Yes	Yes	Yes
Mother's education	Yes	Yes	Yes
Observations	566248	566248	566248
Adjusted R^2	0.186	0.223	0.186

Note:
1) The outcome variable is breastfeeding duration measured in month;
2) Robust Standard Errors (SEs) are presented in parentheses;
3) SEs are clustered at the sample-unit region level, which incluldes the neighbourhood small group, the village small group and collective households;
4) Control variables include the same set of covariates in equation (1);
5) * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$;

preference, choosing to breastfeed sons longer than daughters. However, as discussed in Section 2, infant formula was considered a nutritionally superior alternative to breastfeeding, and sons were favored in feeding infant formula, either exclusively or in combination with ongoing breastfeeding (Xu et al., 2009). Thus, it is unclear whether parental discrimination based on son preference would increase or decrease the breastfeeding gender gap.

Second, parents' breastfeeding efficacy may have improved over the mother's fertility career. Studies show that mothers lacking in breastfeeding efficacy may stop breastfeeding early when they encounter obstacles in breastfeeding. Further, parents who successfully breastfed their first children are more likely to breastfeed later-born children and breastfeeding duration increases in birth order (Cohen et al., 2018; Sutherland et al., 2012). Column (5) of Table 4 shows that including mother fixed effects increases R^2 by a large amount, indicating the importance of mother's characteristics in determining breastfeeding duration. Consistent with the efficacy-based explanation, the left panel of Figure 5 shows that firstborn children are more likely to receive breastfeeding for less than 6 months than are later-born children. However, as shown on the right panel, our main results remain robust after removing observations with breastfeeding duration shorter than 6 months, which constitute a relatively small portion of the entire sample. Breastfeeding efficacy is unlikely to be the primary explanation for most of the mothers in the sample, although we do not entirely reject it.

Figure 5: Breastfeeding Efficacy problem



Notes: On the right panel, we exclude child observations of a mother who breastfed the first child for less than 6 months. Dashed lines represent the 95% confidence intervals.

5 Conclusion

Our study reveals that the implementation of LLF as part of the FPP in rural China, where son preference was prevalent, further widened the gender gap in breastfeeding duration among children. The gender gap remained wide and persistent across cohorts born in the 1970s and was more pronounced in areas where fertility was more constrained by FPP.

Furthermore, we show that the effects are explained by exacerbated son-biased fertility stopping behavior under FPP, which increased the likelihood of the last-born child being a son. The gender gap in breastfeeding duration is wider because later-born children tend to receive breastfeeding longer than earlier-born children, and sons are more likely to be last-born than daughters when parents engage in son-biased fertility stopping. Once accounting for being the youngest child in the family, the effects of FPP across cohorts or geographic variations were greatly reduced.

Studies show that even a month of breastfeeding is predictive of significant improvement in the outcomes of children. For example, an additional month of (full) breastfeeding is associated with a 30% reduction in hospital admissions by children up to age 1 (Paricio-Talayero et al., 2006), a 24% lower risk of mortality among children under age 5 (Fledderjohann et al., 2014), and up to 4% lower risk of food allergy (Van Ginkel et al., 2018). As for adolescent and adult outcomes, another month of breastfeeding is associated with significant improvement in behavioral outcomes among children aged 14 or lower, and 4% lower risk of obesity in both childhood and adulthood (Harder et al., 2005). Studies focusing on the effects of breastfeeding at least 6 months or more find that breastfeeding reduces infant mortality and health problems in childhood and increases education and income in adulthood (Binns et al., 2016; Horta and Victora, 2013).

Given that breastfeeding is an important determinant of infant health and life outcomes (Binns et al., 2016; Victora et al., 2015; Koh, 2017), our findings suggest that FPP in areas with strong son preference may widen gender gap in early childhood investment and development, with long-term consequences for well-being. These effects should be considered when implementing a strict family planning program.

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Appendices

Figure A1: Gender gap in breastfeeding duration over time by rural or urban location

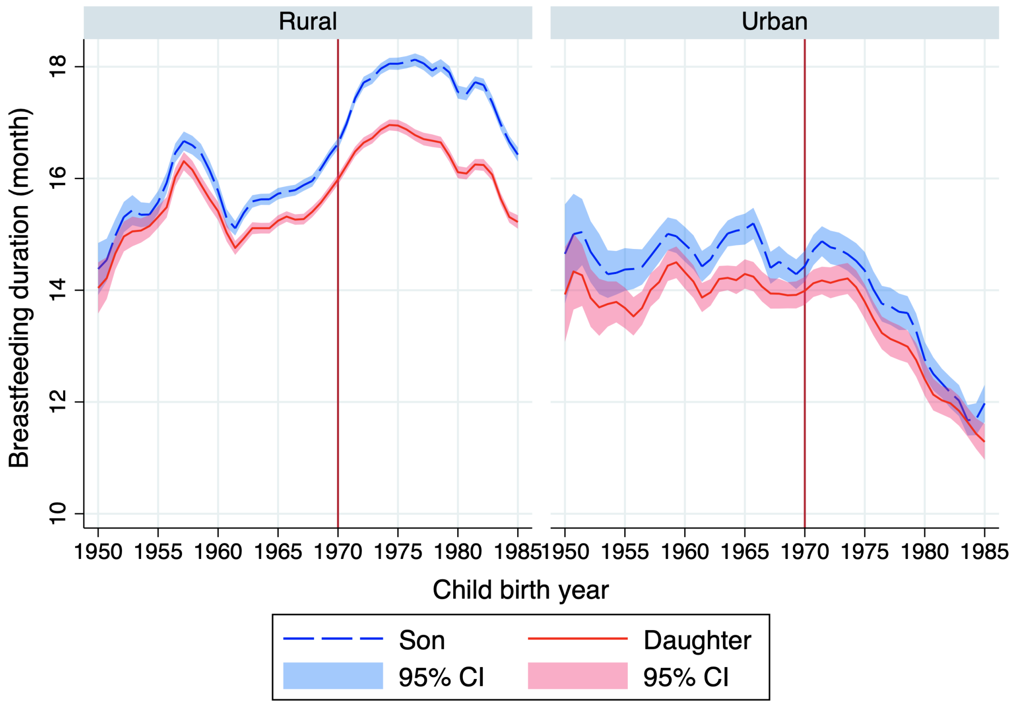


Figure A2: Total fertility rate in China between 1950-1990

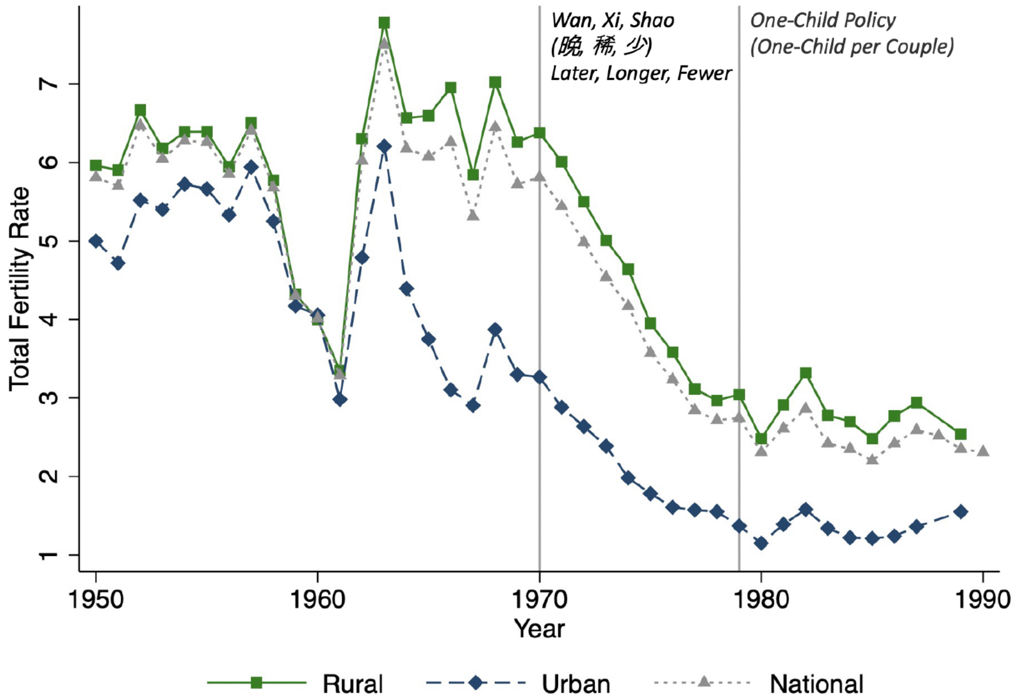


Figure A3: Distribution of birth year in Census 1990 and NSFC

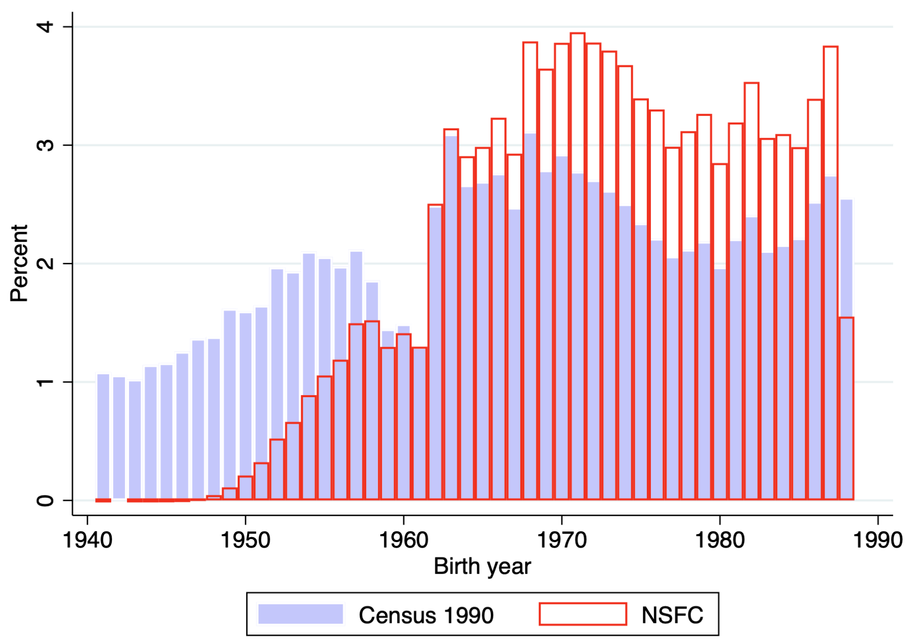


Figure A4: Proportion of children died between age 0 and 4

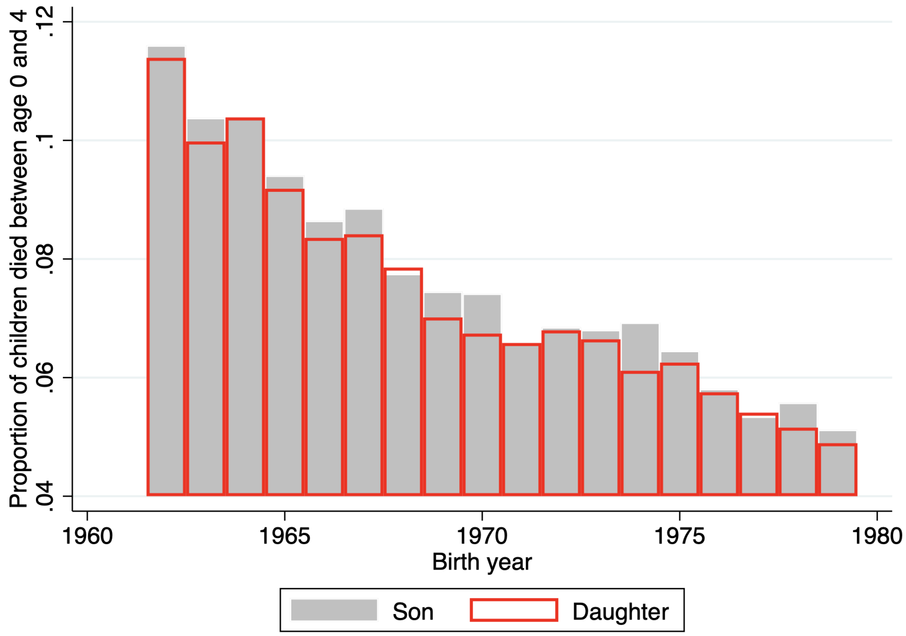


Figure A5: Family planning policy measures (FPP)

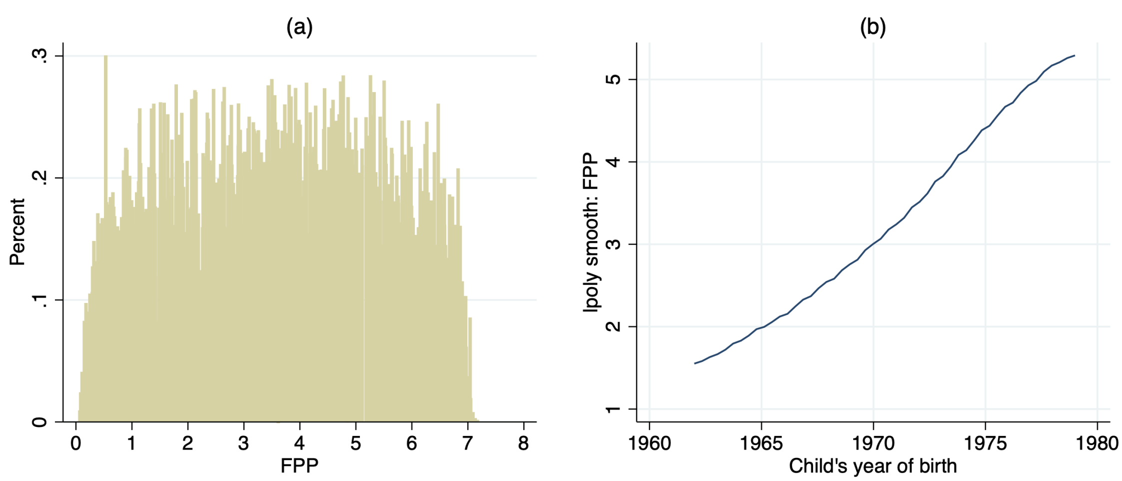
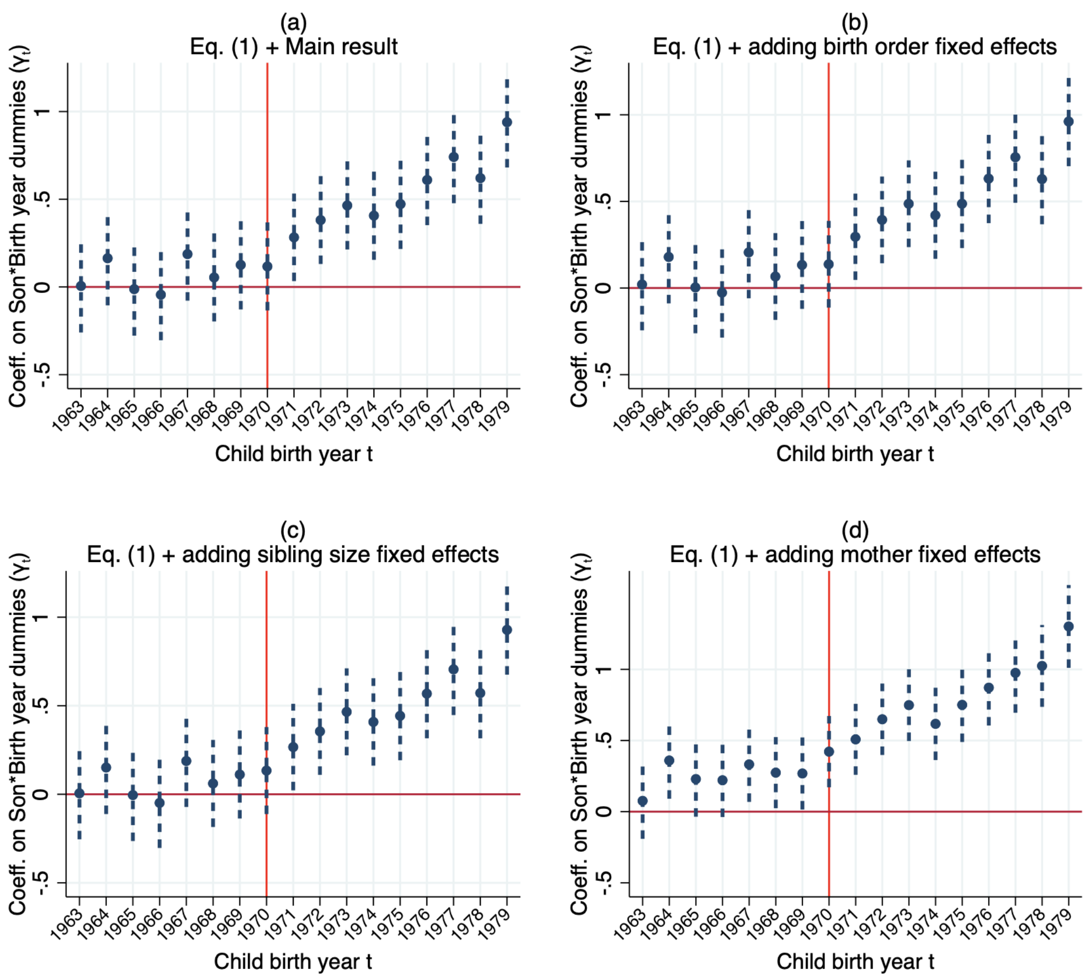
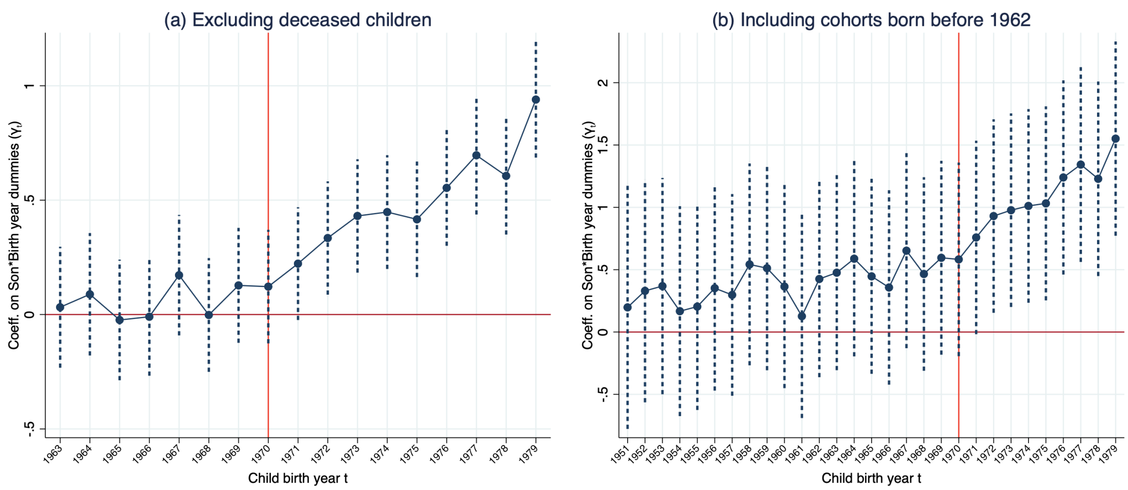


Figure A6: Gender gap in breastfeeding for each birth cohort with different control variables



Notes: Dashed lines represent the 95% confidence intervals

Figure A7: Gender gap in breastfeeding for each birth cohort with different samples



Notes: Dashed lines represent the 95% confidence intervals

Figure A8: Gender gap in breastfeeding duration, excluding only children

Notes: Estimation results are based on Equation (1). One-child observations are excluded. Dashed lines represent the 95% confidence intervals

Figure A9: Proportion of having no siblings by sibling gender and order

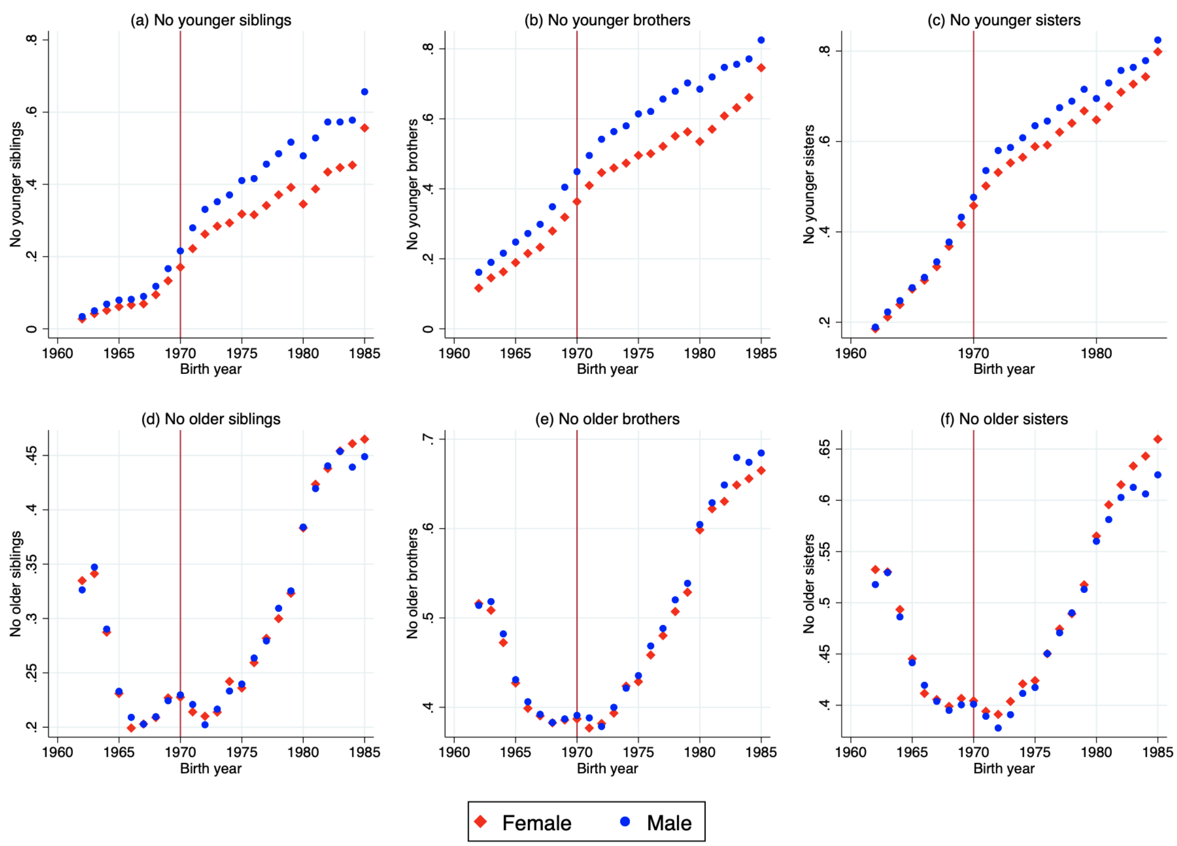


Figure A10: Gender gap in birth spacing with younger or older siblings

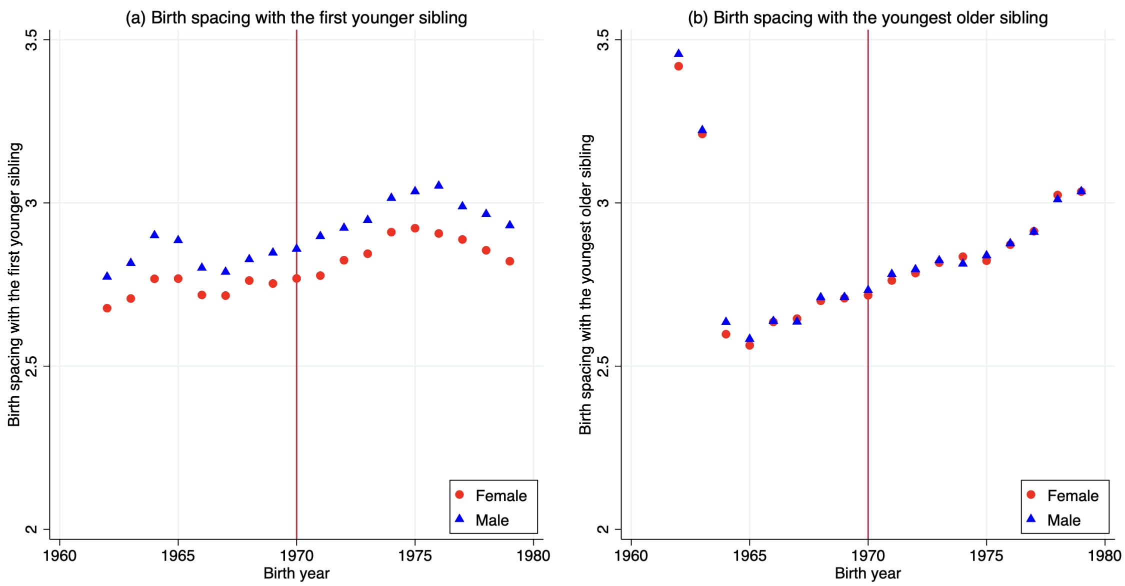
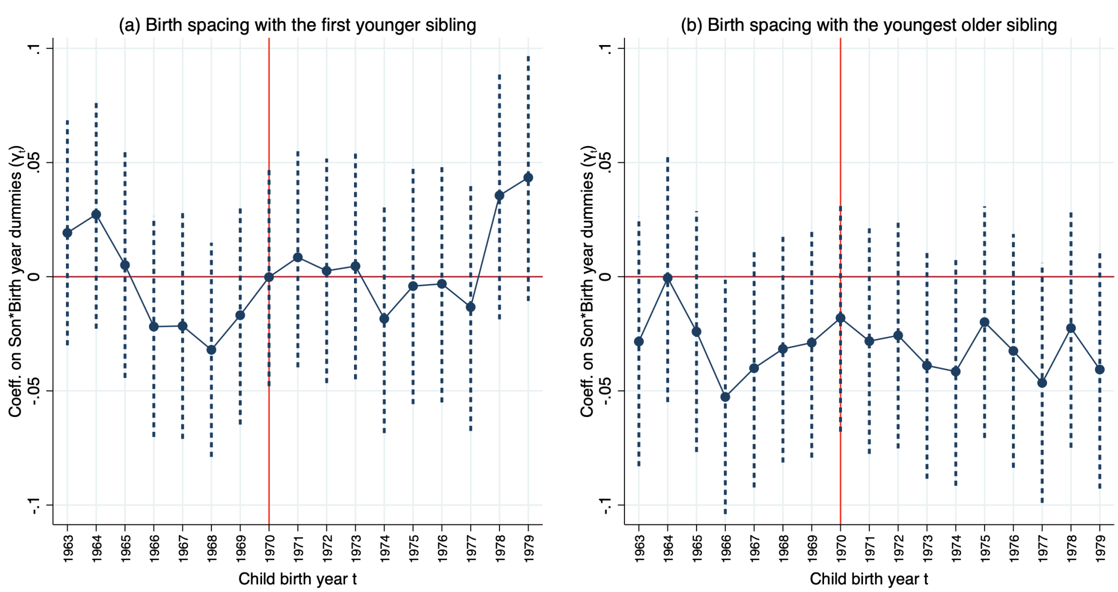


Figure A11: Gender gap in birth spacing across birth cohorts



Notes: Deceased children are excluded. Dashed lines represent the 95% confidence intervals.

Table A1: Robustness check

	Excluding deceased children			Including cohorts born before 1962		
Dependent variable: Breastfeeding duration	(1)	(2)	(3)	(4)	(5)	(6)
Son	0.978***	0.674***	0.979***	0.930***	0.587***	0.931***
	(0.021)	(0.021)	(0.021)	(0.023)	(0.023)	(0.023)
FPP	0.678***	0.367***	0.598***	0.662***	0.627***	0.657***
	(0.049)	(0.048)	(0.049)	(0.048)	(0.047)	(0.048)
Son $\times$ *FPP*	0.104***	0.057***	0.104***	0.110***	0.043***	0.110***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Last-born child		4.466***			5.561***	
		(0.029)			(0.032)	
First-born child			-0.622***			-0.051*
			(0.029)			(0.029)
Fixed effects included:						
Sample-unit region	Yes	Yes	Yes	Yes	Yes	Yes
Child birth year	Yes	Yes	Yes	Yes	Yes	Yes
Mother's birth year	Yes	Yes	Yes	Yes	Yes	Yes
Mother's education	Yes	Yes	Yes	Yes	Yes	Yes
Observations	517800	517800	517800	671985	671985	671985
Adjusted R^2	0.232	0.267	0.233	0.187	0.223	0.187

Note:
1) The outcome variable is breastfeeding duration measured in month;
2) Robust Standard Errors are clustered at the sample-unit region level and presented in parentheses;
3) Control variables include the same set of covariates in Equation (2);
4) * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.