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Impact of Family Planning Policy on Gender Inequality: Evidence from China

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Abstract

The investments parents make in their children can be gender specific. I study the impact of family planning policies on gender-specific outcomes. Empirically, this paper uses China's Family Planning Policy (FPP), enacted in 1971, to understand how a reduction in the number of children in a family can generate gender-specific outcomes. I mainly use the diff-in-diff strategy to compare the educational outcomes of boys and of girls born before and after the FPP was implemented. I find that while post-FPP-born children generally complete higher levels of education, this effect is particularly stronger for girls. This finding is robust to (1) using the diff-in-diff-in-diff strategy by incorporating another dimension of variation: different fertility constraints imposed by the FPP on the ethnic majority Han than those imposed on ethnic minorities; and (2) using a different measure of educational outcomes: the probability of pursuing an education beyond the compulsory education period. In addition, I document that the FPP also has an impact on changing women's preference for their child's gender. Post-FPP-born women show a more pronounced change in gender attitudes and exhibit less son preference than their male counterparts.

Keywords: Family Planning Policy; Fertility; Education; Gender Inequality.

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1 Introduction

Since Becker and Lewis (1973) introduced the idea that the *quantity* and *quality* of children may be inversely related to each other, parents' decision making regarding investments in their children's human capital has received much attention. Parents' investments in their children may not only depend on quantity, but also can be gender specific. However, so far no systematic evidence has been produced on the relationship between the quantity and quality of children when parents have a gender preference, and it is not clear whether reducing the number of children in the family has equal effects on improving the *quality* of both genders. This paper fills this gap in the literature by examining the gender-specific effects of family planning policies on children's educational outcomes.

Previous theoretical work (e.g. Davies and Zhang, 1995) has shown that, in the presence of a gender preference, parents' investments in their children's human capital become more complicated and may generate gender-specific outcomes. However, empirical investigations on this subject are methodologically challenging, since parents who prefer fewer children may endogenously be more pro-gender equality, which makes it difficult to causally identify the relationship between the number of children in a family and gender-specific human capital investments. I address this identification problem by taking advantage of the family planning policy enacted in China in 1971.

To control the rapidly growing population, in 1971 the Chinese central government approved a family planning policy (FPP) that has been in effect, with some adjustments, ever since[1]. The FPP had different impacts on the family size of agricultural Hukou households and non-agricultural Hukou households[2]. Specifically,

[1]In 1978, the FPP was tightened to restrict each household to only one child, a regulation that became known as the "One Child Policy". Four years later, in 1982, the One Child Policy was revised to allow eligible families to have a second child; as of 2016, every family is permitted to have two children. Please see Section 2.1 for more details.

[2]Hukou is the household registration system in China. It classifies every Chinese resident, regardless of his/her ethnicity, as either agricultural or non-agricultural. This classification originated in the 1950s and has passed from generation to generation ever since. Section B.2 provides

the FPP caused a greater drop in the number of children per family in agricultural households than in non-agricultural families, because agricultural households generally had a greater demand for large familes. Moreover, the FPP imposed different birth constraints on families based on the parents' ethnicities. Compared to the ethnic majority group, Han, exceptions to the FPP were granted to ethnic minorities until 1978. This empirical setting allows me to overcome identification problems by using the differences-in-differences (DID) and differences-in-differences-in-differences (DDD) strategies to identify the causal effect of reducing the number of children in a family on educational outcomes for boys and for girls.

To estimate the effect of the FPP on the relative educational attainment of boys and of girls, I first compare the number of years of education completed for boys with the number completed for girls for cohorts born before and cohorts born after the FPP was enacted . My identification is based on the assumption that, in the absence of the FPP, the educational attainment of boys and girls should be parallel. Second, because agricultural families typically had many more children before the FPP was implemented, I find that the policy had a greater impact on reducing the number of children in agricultural Hukou families, and then I exploit this additional dimension of variation between agricultural Hukou and non-agricultural Hukou families. This allows me to further validate my identification strategy by testing whether the effect of the FPP on gender-specific educational outcomes was more pronounced in the Hukou group that experienced a greater drop in the number of children per family.

I find the FPP impacted girls more than boys with respect to the level of education attained. The DID estimates indicate that from pre- to post-FPP period, the level of education attained by girls increased by 0.5 years more than the increase in the level attained by boys. The magnitude of the effect is large and significant. Consequently, girls' faster growth in years of education after the implementation of the FPP effectively narrowed the education gender gap by nearly half. The DDD

more details.

estimates indicate that the effect was more pronounced in agricultural girls: from pre- to post-FPP period, non-agricultural girls' education levels increased by 0.35 more years than did non-agricultural boys' education levels, whereas agricultural girls' education levels increased by 0.49 more years than agricultural boys' education levels did. This reflects a faster rate of reduction of the education gender gap for agricultural households than for non-agricultural households. The results are robust and significant after controlling for birth prefecture fixed effects, cohort fixed effects, and time linear trend. These results indicate that in China, where son preference is prevalent, reducing the number of children in a family had a sizable impact on improving the educational attainment of girls and reducing the education gender gap.

I perform additional checks to ensure that my results were not driven by other confounding factors. First, using the same strategy, I estimate the effect of the FPP on higher educational attainment, which I define as education beyond ninth grade (equivalent to a post-secondary education). This exercise allows me to disentangle the effect of the FPP from the effect of the compulsory nine-year education policy that has been in place since 1986. The results are significant and in line with my main findings: from pre- to post-FPP period, the rate of continuing into post-secondary education increased by 7.3 percentage points more for girls than it increased for boys; this effect was 6.7 percentage points higher for agricultural girls, suggesting that my main findings are not just picking up the supply-side effects of the compulsory education policy. Second, in placebo tests, I repeat the same strategy using ethnic minorities as a placebo group. I find that the effect of the FPP on gender-specific educational attainment was significantly higher for the ethnic majority, Han, than for ethnic minorities, who are subject to fewer birth restrictions. The results provide additional evidence to support my identification strategy, suggesting that my main findings do not simply reflect a catch-up effect in girls' educational attainment. Third, to address the concern that if parents did gender selections, it may threaten my identification strategy by having an endogenous effect on the child's gender, I first show that gender selections are unlikely to affect my results because prenatal gender-revealing technology was not available for the period of my study and infanticide was costly and inefficient[3]. I also demonstrate that my results are robust with the inclusion of prefecture-year gender ratios.

Next, I explore potential mechanisms to explain why, in a society with a strong son preference, reducing the number of children in a family could favour girls. I lay out three explanations. First, reducing the number of children may change parents' perceptions about the role of women and, thus, reduce their son preference, so that relatively more resources may be allocated to daughters. Second, if parents view spending for their children's education as a form of consumption, reducing the number of children in a family may reduce the total costs of raising children, generating an effect similar to increasing the household income. The implied increase in household income can then induce an income effect on educational spending for sons and daughters. Third, if parents view spending on their children's education as a form of investment, when the availability of higher-return products (sons) decreases, risk-averse parents may increase their investment in daughters for risk diversification purposes. Using data on gender ratio and son preference, I present evidence against the first channel that the FPP might decrease parents' son preference. For the second and third explanations, I provide indirect evidence that suggests that the risk diversification channel appears most in line with the data patterns.

In addition, using the same DID strategy, I show that the FPP had a significant impact on weakening the son preference of the post-FPP born cohort members, and this effect was particularly pronounced for females. This result is consistent with the channel of income effect and the channel of risk diversification, and against the channel of parents' son preference changing, providing additional evidence to

[3] Figure A1 notes that the gender ratio was not skewed to any significant degree until the 1980s, when the prenatal gender-revealing technology became widely available and abortion became the dominant way for parents to select their child's gender.

support my conclusion on the three channels as noted previously. The findings suggest that son preference and, more generally, gender attitudes are not immutable and can be changed by increasing females' educational attainment levels, by creating a more equal growing environment for boys and girls and by freeing women from the burden of excessive fertility and childcare.

Overall, the findings presented in this paper show that the FPP, while targeting a reduction in fertility rates, have also indirectly reduced gender inequality in educational attainment and weaken son preference. Previous work on this subject has not connected family planning policy to gender inequality reduction. Moreover, most previous studies focused on the negative aspects of the FPP (Qian, 2009; Zhu et al., 2009; Edlund et al., 2013). This paper fills the resulting gap in the literature by investigating the positive effects of the FPP, namely, improving educational opportunities for girls and changing gender attitudes. I also contribute to the literature on the quantity-quality trade-off of children by showing that the quality outcomes of reducing the quantity of children can be very different for the two genders. Lastly, this article speaks to the literature on the determinants of gender preference. Though previous studies have suggested a strong persistence in gender attitudes across generations, I provide evidence that gender attitudes can be changed through multiple channels.

This paper is closely related to Huang et al. (2015), who independently studied a similar topic —the impact of the One Child Policy on the education of girls in China —using a different empirical methodology. My paper is different from theirs in two important respects. First, I examine a more general version of family planning policy. Thus, my research generates more practical policy implications for countries that are considering population growth reduction strategies. Second, in addition to the immediate and positive effect of eliminating the education gender gap, my paper also examines the long-term impact of the FPP on changing gender attitudes. Finally, the results of this paper shed light on potential mechanisms behind the impact of the FPP.

The rest of this paper is organised as follows: Section 2 describes the empirical strategy and policy background. Section 3 describes the data and presents the empirical results. Section 4 presents further evidence to understand the mechanism. Section 5 discusses the findings and provides additional findings on gender preference. Finally, Section 6 concludes the paper.

2 Empirical Strategy

Empirical investigations on the relation between the quantity of children in a family and human capital investment inequality among children often face identification challenges: parents who prefer fewer children may endogenously be more pro-gender equality, which makes it difficult to causally identify the effect of reducing family size on the two genders. I address this identification problem by taking advantage of family planning programmes in China, which created an exogeneous shock to the size of families. Hence, in addition to between-gender comparisons of educational attainment, I also examine the second difference between cohorts born before the FPP was implemented and those born after.

2.1 Background

Family planning programmes in China were officially launched in 1971 upon the approval of *The report on the work of the family planning policy* by the State Council of China and were included in the 4th *Five-Year Plan(1971-1975)*. Soon after, family planning offices were set up at all administrative levels, and birth control work was carried out. The objective of the family planning campaign at that time, as advocated in the campaign slogan, was “one is not too few, two is perfect, and three is too many”. Later, in the 1973 national family planning symposium, a more explicit policy “later, less frequent and fewer” (“晚、稀、少”)

was introduced. “Later” refers to women must not get married by age 23 and give birth to their first child by age 24; “less frequent” indicates the birth spacing must be no less than three years; “fewer” reflects the policy restriction limiting couples to having no more than two children. The policies for agricultural and non-agricultural households were the same until 1982[4]. The target population of the FPP is China’s majority ethnic group - Han, which accounts for 93% population. Ethnic minorities were not as restricted as Han citizens[5].

The predominant method of birth control at that time was the IUD (intrauterine device). Other methods used included tubal ligation and vasectomy. Forced abortions also took place in some circumstances when a woman was found to be carrying an out-of-quota child. Figure 1 shows the volume of the different types of birth control surgeries since 1971. This implies that the strength of the compulsory birth controls has remained quite stable since the policy went into effect, except in 1983[6]. Figure A2 shows that the FPP has significantly decreased the population growth rate, lowering it by more than half in the first ten years since its implementation. The decrease in family size is also reflected in the total fertility rate. Figure 2a shows that the average number of births dropped from 5.8 births per woman when the FPP was first introduced to 2.2 births per woman 10 years after the implementation. Figure 2b shows that the drop mainly occurred in agricultural households. Intuitively, before agriculture was mechanised, the work done in fields required a large amount of physical labour, so agricultural households had a greater demand for large familes; thus, the FPP had a greater impact on the family size of agricultural households.

[4]In March 1978, a stricter policy, later commonly known as the One Child Policy, was adopted. Then in 1982, the family planning policy was revised to allow families that satisfied certain conditions to have a second child. Please see B.1 in Appendix for more details.

[5]During this period, the policy for ethnic minorities was “In less populated minority areas, technical guidance for family planning should be given to those who have birth control willingness.”. From 1978 onwards, “Exceptions to the One Child Policy can only be granted to ethnic minorities with a population of 10 million or less. Couples of those ethnicities can have two children, and some may have three, but four children are not allowed.”

[6]From 1982 to 1983 a more aggressive protocol “first birth IUD, second birth tubal ligation” was temporarily enforced nationwide.

2.2 Hypothesis

To test whether reductions in family size had gender-specific education outcomes, I first considere how family size affected the educational attainment of girls versus how it affected boys during two periods: (1) before 1971, when there were no constraints on family size; and (2) after 1971, when the FPP imposed restrictions on family size. In particular, I expect to find a greater increase in educational attainments for girls than for boys in the post-FPP period.

Second, to avoid confounding the effect of the FPP with other policies or events that took place during the same period, I further test whether the gender-specific effect of the FPP on educational attainment varied with the effectiveness of the intervention across different Hukou groups. In particular, I test whether the effect of the FPP on girls' educational attainment was stronger in the Hukou group that experienced greater reductions in family sizes. This group was also the one with higher initial fertility rates before the FPP was enacted. I expect that girls in Hukou group with higher initial fertility rates pre-FPP will show a greater increase in educational attainment after implementation of the FPP, compared to the increase experienced by girls in the other Hukou group.

2.3 Identification strategy

Using the DID approach, I estimate the effect of a decrease in family size on relative female human capital accumulations by comparing the average education level achieved by boys to the average achieved by girls for two cohort groups: one born before implementation of the FPP and the other born after. Comparing the educational attainment level of boys to that of girls across cohorts differences out time-invariant gender characteristics. Comparing between the two genders within cohorts differences out changes over time that affect the cohorts similarly. The identifying assumption of the DID approach is that in the absence of the FPP, the education level of boys and girls should be parallel. The parallel trends assumption would be threatened if the two genders experienced different pre-trends in educational attainment, which may cause the DID estimate to capture differences between boys and girls for reasons other than the reduction in family size. An illustration of the years of education completed by boys and girls shows that this is not the case. Figure 3a plots the years of education completed by boys and girls for each birth cohort. The vertical distance between the two lines shows that, prior to implementation of the FPP, boys consistently completed one more year of education than girls, whereas after the FPP, girls' educational attainment increased at a much faster rate than boys' educational attainment. In the 10 years after implementation of the FPP, the education gap between boys and girls dropped to 0.3 years. Hence, if pre-trends can be extrapolated into the post-FPP period, the DID estimates would not capture differences in pre-FPP trends in the education attainment levels of boys and girls.

For the DID estimate, I restrict the sample to the cohorts born between 1961 and 1981, which encompasses 10 years before and 10 years after implementation of the FPP, and exclude ethnic minorities. I estimate the following equation:

$$Edu_{ipc} = \phi_1 girl_i + \phi_2 post_c + \beta(girl_i \times post_c) + t_c + \gamma_p + \alpha + \epsilon_{ipc} \tag{1}$$

The educational attainment of an individual i, born in birthyear c and prefecture p, is a function of $girl_i$, the individual's gender; $post_c$, a dummy variable that indicates if the individual is born after 1971, and the interaction terms between $girl_i$ and $post_c$; t_c, cohort fixed effect; γ_p, prefecture fixed effect. The reference group is individuals born during the 1961—1970 period. It and all of its interaction terms are dropped. If the decrease in family size increased girls' educational attainment levels, then it should be reflected in an increase in girls' average years of education relative to boys' for cohorts born after the FPP, $\beta > 0$.

Though the FPP went into effect in 1971, it might affect individuals born a few years earlier than 1971. Consider, for example, the third child in a three-children family. If, in the absence of the FPP, the family might end up with more children. In the presence of the FPP, the family had to stop after having three children. Therefore, even the third child born prior to the implementation of the FPP would benefit from the reduction in family size. In other words, there is a portion of children who get treated, even though they were not assigned to the treatment group, based on using 1971 as the cut-point year. The existence of "takers" in the reference group does not threaten the validity of my identification strategy. The estimated effects of the FPP using 1971 as the cut-point would be biased downward, so the actual effect of the FPP on narrowing the gender education gap should be larger than estimated.

One pitfall of the DID approach is that it may confound the effects of the FPP implementation with the effects of other changes that occurred during the pre- or post-FPP period; for example, the compulsory nine-year education law, which took effect in 1986, aiming to keep all school-aged children (6—15 years old) in school for a minimum of nine years, may generate supply-side effects, which may confound with the demand-side effects of the FPP. I address this concern by examining individual educational attainment beyond nine years in the robustness check.

Another concern of the DID approach is if, at the time of the FPP, there is a change in attitude towards girls' getting more education for unobserved reasons. For example, if families who have daughters born after 1971 suddenly became more progressive regarding their daughters' education for unobserved reasons other than reductions in family size, or if there were a sudden change in returns on girls' education, then the estimates of the effect of the FPP would capture both the effects of reductions in family size and the effects of the change in attitude or returns. Although I cannot directly resolve this problem, I provide evidence that this is not likely the case by exploiting exogeneous variations in the reduction in family sizes according to Hukou status. My identification is based on the assumption that the FPP had a greater impact on the family size of agricultural households, for which birth restrictions resulted in greater reductions in family sizes. Recall as shown in Figure 2b, for the period 1970—1980, the total fertility rate for agricultural Han households dropped by nearly 4 births, while the rate for non-agricultural Han households dropped by 2.1 births, implying that the FPP had the greatest impact on the family size of agricultural households. Thus, the identifying assumption is that the effects on agricultural households and non-agricultural households should not be very different if brought about by changes in attitudes towards girls' education or changes in returns to education. If agricultural households and non-agricultural households show significant differences in the growth of girls' educational attainment, at a minimum, we would not expect agricultural girls to show a more pronounced change than non-agricultural girls, unless it were due to a catch-up effect. In the placebo test, I show changes did not result from the catch-up effect by comparing the educational attainment of girls relative to that of boys between agricultural Han and agricultural ethnic minorities.

Using the DDD approach, I estimate the effect of a decrease in family size on relative female human capital accumulations by exploiting variations in the family size reductions caused by the FPP. To illustrate the effect differences between agricultural individuals and non-agricultural individuals, I plot the average years of education completed by boys and by girls for agricultural and non-agricultural Hukou status, respectively. Figure 3a shows that since the implementation of the FPP in 1971, girls' educational attainment levels have grown faster than boys' levels. Figure 3b and 3c shows that by 1981 the agricultural education gender gap ($male's\ education - female's\ education$) dropped by 0.6 years (from 1 to 0.4), while the non-agricultural education gender gap dropped by 0.5 years (from 0.5 to 0). I estimate the DDD effects of reductions in family sizes on education gender gaps using the following equation:

$$
\begin{aligned}
Y_{ipc} = &\phi_1 girl_i + \phi_2 post_c + \phi_3 ag_i \\
&+ \beta_1(girl_i \times post_c) + \beta_2(girl_i \times ag_i) + \beta_3(ag_i \times post_c) \\
&+ \theta(girl_i \times ag_i \times post_c) + t_c + \gamma_p + \alpha + \epsilon_{ipc}
\end{aligned} \tag{2}
$$

The educational attainment of an individual i, born in birthyear c and prefecture p, is a function of $girl_i$, the individual's gender; ag_i, the individual's Hukou status, equal to 1 if the individual has agricultural Hukou; $post_c$, a dummy variable that indicates if an individual is born after 1971, and all the interaction terms between $girl_i$, ag_i and $post_c$; t_c, cohort fixed effect; γ_p, prefecture fixed effect. The reference group is individuals born from 1961 to 1970. It and all of its interaction terms are dropped. If reductions in family size improved girls' educational attainment, given that agricultural families experienced the greatest drop in family size, agricultural girls should have the most pronounced improvement in their education attainment, $\theta > 0$.

To further validate the parallel trends assumptions, I examine whether the effect of the FPP on girls' educational attainment occurred more rigorously for those born in the years closest to the FPP starting year by regressing individuals' years of education on their genders, Hukou status, birth year dummy variables, and interaction terms between the three for all birth years:

$$
\begin{aligned}
Y_{ipc} = &\phi_1 girl_i + \sum_{\tau=1961}^{1981} \phi_{2\tau} d_\tau + \phi_3 ag_i + \sum_{\tau=1961}^{1981} \beta_{1\tau}(girl_i \times d_\tau) + \beta_2(girl_i \times ag_i) \\
&+ \sum_{\tau=1961}^{1981} \beta_{3\tau}(ag_i \times d_\tau) + \sum_{\tau=1961}^{1981} \theta_\tau(girl_i \times ag_i \times d_\tau) + t_c + \gamma_p + \alpha + \epsilon_{ipc}
\end{aligned} \tag{3}
$$

The educational attainment of an individual i, born in birthyear c and prefecture p, is a function of $girl_i$, the individual's gender; ag_i, the individual's Hukou status, equal to 1 if the individual has agricultural Hukou; d_τ, a dummy variable that indicates if the individual is born in cohort τ, and all the interaction terms between $girl_i$, ag_i and τ; t_c, cohort fixed effect; γ_p, prefecture fixed effect. This specification allows for anticipatory effects of FPP on agricultural girls ($\theta_{1961}, \theta_{1962}, \ldots, \beta_{1970}$) and post-FPP effects ($\beta_{1972}, \beta_{1973}, \ldots, \beta_{1981}$). The reference group is individuals born in 1970, one year before the start of the FPP. It and all of its interaction terms are dropped. $\sum_{\tau=1961}^{1981} \phi_{2\tau} d_\tau$ and $\sum_{\tau=1961}^{1981} \beta_{1\tau}(girl_i \times d_\tau)$ impose the parallel trends assumption for boys and girls while allowing for girl-specific trend. $\sum_{\tau=1961}^{1981} \theta_\tau(girl_i \times ag_i \times d_\tau)$ further allows agricultural girls to have a specific trend. This is flexible because I allow potential pre-existing gender-specific trends and gender-Hukou-specific trends with the assumption that pre-existing trends should be extrapolated into post-FPP periods in the absence of the FPP. Given that agricultural families experienced the greatest decrease in family size, my identification strategy will be validated if we observe a significant change in θ_τ, the slope of agricultural-girl-specific trend around the implementation of the FPP.

3 Data and Empirical Results

3.1 Data

The analysis of girls' educational attainment relative to that of their male counterparts uses the 1% sample of the 2000 China population census, which contains data on gender, birth year and educational attainment. I restrict the sample to individuals born between 1961 and 1981, which is 10 years before and 10 years after the FPP was implemented in 1971. The 10-year period should be long enough to establish a trend that can be extrapolated into the post-FPP period. The upper boundary is set at 1981 so that, by the time the survey was conducted, all individuals in the sample were at least 18 years old or older and, therefore, should have completed high school. Otherwise, the sample would have contained individuals who would eventually complete high school but had not done so yet, and the effect of interest would have been underestimated. The educational outcome in the main analysis is measured by the years of education completed based on the individual's highest education degree. Table 1 presents the summary statistics of the sample. The average demographic characteristics between agricultural and non-agricultural households and between Han and ethnic minorities are similar[7].

Gender selection has been accused of being a major negative consequence of the FPP: constrained by the policy, parents who prefer a specific gender strongly over the other gender may choose to select the gender of their child. If gender selections were prevalent, it would pose challenges to the exogeneous aspect of an individual's gender, thus threatening my identification strategy. Using findings from previous literature and data, I show that gender selections are not likely to affect my results. First, gender-selective abortions in China were rare until the 1980s, when gender detection technology - ultrasound B - became available. Prior to the adoption of ultrasound B, gender selection usually took the form of infanticide, child abandonment or neglect, all of which are very costly in terms of both time and labour because pregnancies must be carried to term before the gender of the child is revealed. Because it was practically difficult to obtain prenatal gender-selective abortions before the introduction of ultrasound B, and the cost of post-birth gender selection was also high, gender selection rarely impacted cohorts born before the 1980s. Figure A1 plots the sex ratios from 1955 to 2000. It shows that the sex ratio remained between 1 and 1.07 before 1982. Given the natural rate of 1.06, it should not be interpreted as aberrant. This figure also lends support to the findings in the existing literature that the availability of gender detection technology was the prominent cause for the increase in the sex ratios in the 1980s. In addition, to provide additional evidence to support my identification strategy, I also show that my results are robust with the inclusion of prefecture-year sex ratios.

[7]Migration rate is higher in non-agricultural households. Although it is highly unlikely that the difference in migration undermines the validity of my identification strategy, I show that my results are robust by using a sample with migrants dropped. The result is available upon request.

3.2 Results

I explore the over-birth cohorts and across-gender variations in individuals to estimate the gender-specific effects of the FPP on individuals' human capital accumulations. The DID estimates from Equation (1) using individuals' years of education completed as a dependant variable are shown in columns (1)—(3) in Table 2. Column (1) presents the results, including birth cohort fixed effects, and column (2) includes birth prefecture fixed effects. Column (3) includes a linear time trend as a substitute for birth cohort fixed effects. The variable of interest here is $girl_i \times post_c$, which is the estimated mean impact of the FPP on girls' levels of educational attainment relative to boys' levels. Estimates from all the specifications show that the effect of the FPP on girls' educational attainment is positive and significant: compared to girls born prior to implementation of the FPP, girls born in the post-FPP period show a greater increase in years of education completed than boys who were born in the same birth cohort and living in the same prefecture. All the specifications, regardless of including birth cohort fixed effects or including a linear time trend, yield similar estimates, all statistically significant at the level of 1%. They all show that the years of education completed for girls born in the post-FPP period increased by 0.5 more years than the years completed by boys. The magnitude of the effect is large and significant. Consequently, girls' faster growth in years of education completed after implementation of the FPP effectively reduced the gender gap in education by nearly half.

To further explore variations in the reduction in family size across Hukou groups, I report the results for the DDD estimation of Equation (2). The FPP had a greater impact on the family size of agricultural households, for which birth restrictions resulted in greater family size reductions. Compared to the DID specification, the DDD specification further includes ag_i, a dummy variable for an individual's Hukou status, and all the interaction terms between $girl_i$, $post_c$ and ag_i. The results for the DDD estimation are presented in columns (4)—(6). Column (4) presents the results, including birth cohort fixed effects, and column (5) includes birth prefecture fixed effects. Column (6) includes a linear time trend as a substitute for birth cohort fixed effects. The variable of interest here is $girl_i \times ag_i \times post_c$, which is the estimated mean impact of the FPP on agricultural girls' educational attainment levels relative to the attainment levels of agricultural boys, compared to the educational attainment levels of non-agricultural girls relative to that of non-agricultural boys. Consistent with my hypothesis, I find that the FPP had the greatest effect on the educational attainment of agricultural girls. In particular, girls born in agricultural households in the post-FPP period experienced the most pronounced growth in educational attainment levels, compared to the growth in levels for girls in non-agricultural households. Estimates from all the specifications, regardless of the inclusion of birth cohort fixed effects or a linear time trend, yield similar estimates, all statistically significant at the 1% level. They all show that from pre- to post- FPP period, the educational attainment levels of non-agricultural girls increased by 0.35 years more than the levels of non-agricultural boys, whereas the educational attainment levels of agricultural girls increased by 0.49 years more than the levels of agricultural boys. The magnitude of the effect is significant and meaningful. It implies that the gender gap in education was narrowing at a faster rate for agricultural households than for non-agricultural households.

Figure 4 plots the vector of coefficient estimates for θ_τ from equation (3). They show that for cohorts born prior to the implementation of the FPP, the growth in educational attainment levels for agricultural girls were not significantly different from the growth in the levels of other groups (agricultural and non-agricultural boys and non-agricultural girls) and were constant across cohorts. The estimated coefficients became significantly positive for cohorts born around the time the FPP was implemented, when agricultural households started to undergo greater reductions in family size. After the FPP, the coefficient estimates were consistently positive, which suggests that the educational attainment of agricultural girls continued growing at the fastest rate, compared to the growth in rates of other groups. These results lend support to the main results estimated using the DID and DDD methods[8]. In particular, these results provide further evidence in favour of my identification that for cohorts born after implementation of the FPP, girls' educational attainments levels increased faster than boys' attainment levels, and that agricultural girls' educational attainment levels increased faster than non-agricultural girls' educational attainment levels, both of which are attributable to the reduction in family size as an outcome of the FPP and not to other changes.

3.3 Robustness checks

If the enforcement of the nine-year compulsory education policy raised girls' participation in primary and secondary education up to ninth grade, my empirical strategy will confound the effect of the FPP with the effect of the nine-year compulsory education law. This policy came into effect in 1986 with the goal of keeping all school-aged children (6—15 years old) in school for a minimum of nine years. One possible channel that the nine-year compulsory education policy may confound with my results is through reducing the cost of education. This policy authorised a reduction in tuition fees in public primary and secondary schools; thus, parents might use the money saved to fund their children's education beyond the compulsory nine years. However, this is unlikely to happen in China. The amount saved in tuition fees from primary and secondary education are not comparable to the costs of post-secondary and higher education. According to a report by the Rural Education Action Project (REAP), China has the highest tuitions in the world for public senior high schools, nearly three times the world's second-highest tuition in Indonesia. It costs, on average, 1,100 RMB (approximately 160 U.S. dollars) per

[8] Coefficients estimates for $girl_i \times post_c$ from DID specification are plotted in Figure A3 in Appendix. It shows similar patterns. The coefficient estimates for cohorts born after implementation of the FPP were consistently positive, suggesting that the educational attainment levels of girls born after implementation of the FPP grew faster than the attainment levels of boys.

student per year in rural regions[9] and three years of high school tuition in rural China accounts for 82% of the net per capita income of rural people (Liu et al., 2009; NBS, 2008). . Hence, pursuing an education beyond the compulsory nine years is not simply a result of reallocating education budgets. Instead, parents need to make serious investment decisions as well as adjust family consumptions and savings accordingly.

In order to disentangle the effect of the FPP on girls' educational attainments from the effect of the nine-year compulsory education policy, I perform robustness checks, using an alternative measure of educational attainment: whether an individual completed more than the compulsory nine years of education. Specifically, I use the same specification as in the DDD regressions with the outcome variable substituted by a dummy variable, equal to 1 if the highest level of education an individual achieved exceeded ninth grade, and 0 otherwise. Results are presented in Table 3. Columns (1)—(3) show the DID results and columns (4)—(6) show the DDD results. Columns (1) and (4) present the results, including birth cohort fixed effects, and columns (2) and (5) include birth prefecture fixed effects. Columns (3) and (6) include a linear time trend as a substitute for birth cohort fixed effects. Similar to the main results in section 3.2, I find that the FPP had the greatest effect on the educational attainment levels of agricultural girls, measured by the probability of completing more than nine years of education. In particular, girls born in agricultural households in the post-FPP period experienced the most pronounced increases in the probability of completing more than nine years of education —equivalent to attaining a post-secondary level of education —compared to agricultural boys and non-agricultural boys and girls. Coefficient estimates of $girl_i \times post_c$ from all the specifications, as shown in columns (1)—(3), showed that compared to pre-FPP born cohorts, post-FPP born girls' probability of continuing into post-secondary education increased by 7.3% more than the probability for boys. Coefficient esti-

[9]This amount does not include costs such as housing and everyday living expenses.

mates of $girl_i \times ag_i \times post_c$ from all the specifications, as shown in columns (4)—(6), shows that, compared to the pre-FPP born cohorts, the probability of post-FPP born non-agricultural girls continuing into post-secondary education increased by 1.8% more than the probability for non-agricultural boys; for agricultural girls, compared to pre-FPP born cohorts, the likelihood of post-FPP born girls continuing into post-secondary education increased by 8.5% more than the likelihood for boys. The results imply that the education gender gap created by the difference in rates of males and females continuing into post-secondary education was narrowing at a faster rate for agricultural Hukou individuals than for their non-agricultural counterparts. These findings are consistent with my main findings that use individuals' years of education as outcomes, suggesting that my findings are robust by using alternative measures of educational attainment.

3.4 Additional placebo tests

To provide additional evidence in favour of my identification strategy, I test whether the effect of the FPP on ethnic minorities was similar to the effect on the ethnic majority, Han. In section 2.1, I discussed the different births restrictions the FPP imposed across Han and ethnic minorities in China. In brief, ethnic minorities were not as restricted as Han citizens, and birth restrictions on ethnic minorities went into effect a few years later than they did for the Han population. Figure 2b clearly shows differences in the timing and in reductions in the number of births under the FPP between ethnic minorities and Han. In particular, Hans' fertility rates fell right after implementation of the FPP, whereas ethnic minorities' fertility rates did not fall until 1975. Furthermore, given similar fertility rates between ethnic minorities and agricultural Han at the time when the FPP became effective, in the 10 years after implementation of the FPP, agricultural Han's fertility rates dropped by nearly 4 births, whereas ethnic minorities' rates dropped by 2.5 births. Hence, ethnic minorities could serve as a placebo to verify my identification strategy. To test whether the effect of the FPP on ethnic minorities was similar to the effect on Han citizens, I estimate a regression equation similar to the DDD specification as in Equation (2). Due to the vast differences between agricultural and non-agricultural populations in the reductions in fertility rates, to tease out the heterogeneous effect across Hukou groups within Han populations and focus on the comparison of the effects between ethnic minorities and Han, I restrict my sample to agricultural population and then compare the effects of the FPP between agricultural ethnic minorities and agricultural Han by estimating the following equation:

$$
\begin{aligned}
Y_{ipc} = &\phi_1 girl_i + \phi_2 post_c + \phi_3 Han_i \\
&+ \beta_1(girl_i \times post_c) + \beta_2(girl_i \times Han_i) + \beta_3(Han_i \times post_c) \\
&+ \theta(girl_i \times Han_i \times post_c) + t_c + \gamma_p + \alpha + \epsilon_{ipc}
\end{aligned}
\tag{4}
$$

The educational attainment of an individual i, born in birthyear c and prefecture p, is a function of $girl_i$, the individual's gender; Han_i, the individual's ethnic group, equal to 1 if the individual is of Han ethnic; $post_c$, a dummy variable that indicates if an individual is born after 1971, and all the interaction terms between $girl_i$, Han_i and $post_c$; t_c, cohort fixed effect; γ_p, prefecture fixed effect. The reference group is individuals born from 1961 to 1970. It and all of its interaction terms are dropped. If reducing the number of children increased girls' educational attainment, given that the birth limitations were stricter for Han citizens, Han girls should have the most pronounced increase in their educational attainment, $\theta > 0$.

Table 4 in the Appendix presents the results for the placebo tests according to Equation (4). Columns (1)—(3) show the results using years of education as an outcome variable, and columns (4)—(6) show the results using a dummy variable of whether an individual's educational attainment exceeded nine years. Coefficient estimates of $girl_i \times Han_i \times post_c$ in all the specifications are significantly positive. They show that the FPP had a greater impact on increasing the educational attainment levels of ethnic Han girls, compared to the impact on girls of ethnic minorities. The results provide additional evidence in favour of my identification strategy, suggesting that my main findings do not merely pick up a catch-up effect in girls' education.

4 Understanding the mechanism

Having shown empirical findings on the link between reducing the number of children in a family and improvement in girls' educational attainment levels, I turn to understanding the mechanism. In the absence of the FPP, the educational attainments of boys and girls are substantially different in China because parents prefer to invest in sons rather than daughters. The FPP may operate through three channels to increase relative educational attainment levels for girls. First, it may increase parents' incentives to invest in the education of their daughters if, for some reason, reducing the number of children in a family changes the parents' perceptions about the role of women and reduces parents' son preference or increases parents' daughter preference. Second, reducing the number of children in a family may reduce the total costs of raising children, generating an effect similar to increasing household income. If parents view spending for their children's education as a form of consumption, the implied increase in household income can then induce an income effect on the educational spending for sons and daughters. Third, if parents view children's educational spending as a form of investment and view sons and daughters as different types of investment products, and if parents prefer sons because sons are expected to yield high returns, when fewer products are available for parents to invest in (i.e. when birth restrictions are imposed that reduce the number of children in a family and, thus, the number of sons), risk-averse parents may increase their investment in their daughters' education for risk diversification purposes.

Using census data on gender ratio and suvey data on son preference, I present evidence against the first hypothesis that the FPP might decrease parents' son preference. For the second and third channels, although the data used in this paper do not allow for a distinction between the second and the third channels, I provide indirect evidence that suggests that my empirical findings are more in line with the third channel.

The first hypothesis makes the prediction that decreases in the number of children in a family should increase the relative desirability of having daughters for parents. To examine this, I plot China's gender ratio at birth and total fertility rate for each year since 1960. The plot is shown in Figure 5. It shows that in the 1980s, under a stricter version of the FPP (i.e. the One Child Policy), average births per woman experienced more decreases. Yet, when gender detection technology, which substantially reduces the cost of gender selection, became available, the gender ratio spurred. These patterns suggest that birth restrictions or reduced family size did not increase parents' daughter preference. Hence, the first explanation can be ruled out.

To disentangle the second explanation regarding the effect of increases in household income and the third explanation regarding risk diversification, we need data on Chinese household decision making since the 1960s, which are difficult to obtain. Although the data available do not allow me to identify the exact channel between the second and third explanation, I discuss the possibility of the second and the third explanation in the context of China during the 1970s and 1980s. The second explanation assumes education to be a normal good, and it requires diminishing returns on children's education for income effect to happen, so that when household income increases, parents may substitute consumption of their son's education with consumption of their daughter's education. By contrast, the third explanation does not assume diminishing returns on education; instead, it assumes that investing in higher education involves more risks than investing in primary and secondary education. In reality, lacking wage data by educational level from the 1970s makes it difficult to empirically test the second explanation's assumption of diminishing returns on education; however, there are several reasons to think that this is not the primary reason. First, before the 1978 market reform, there was no private sector and employment by state-owned enterprises was virtually exclusive to non-agricultural Hukou holders. Transfer of Hukou status from agricultural to non-agricultural was highly restricted, with acceptance to university being a major channel[10]. Carter (1997) estimates that the per capita income of urban residents was more than double that of rural residents in 1978. Moreover, agricultural Hukou households were unable to access state welfare programs (Young, 2013). In a word, the much higher earnings and the superior welfare that were associated exclusively with non-agricultural Hukou status made non-agricultural Hukou status very appealing. Transfer of Hukou status from agricultural to non-agricultural was highly restricted, with acceptance to university being a major channel. Hence, given that acceptance to university was a major channel to transfer Hukou status from agricultural to non-agricultural, it is doubtful that higher education before 1978 had diminishing returns, which contradicts the assumption of the second explanation. Second, a number of previous research has estimated returns on education in the post-1978 reform period. Zhang et al. (2005) estimates the marginal return on education to be similar across education levels in 1988[11]. Moreover, the estimates of marginal returns to completing university compared to completing senior high school grew much faster than marginal returns on lower education levels and exceeded the marginal return on completing junior high to a large extent since 1990. These estimates suggest increasing returns on education in the post-1978 period, which seems to invalidate the assumption of diminishing returns in the second ex-

[10] Official quotas were at 0.15-0.2% per year and actual conversion rates were at about 1.5%per year (Young, 2013).

[11] Zhang et al. (2005) estimates that in 1988, the marginal return on completing junior high school, compared to only completing primary school or below, was 13.9%; the marginal return on completing senior high school compared to completing junior high school was 11%, and the marginal return on completing university compared to completing senior high school was 12.2%.

planation.

For the third explanation of risk diversification, the risks of investing in higher education are, to a large extent, associated with the chances of being admitted to university. Historical data on Chinese university admission rates, as shown in Figure A4, indicates that in 1977, the university admission rate was only 5%, and throughout the 1980s and early 1990s, admission rates were usually below 30%. These statistics seem to suggest it is reasonable for parents to diversify risks among children. To see how this mechanism works, I consider three scenarios. First, in the absence of the FPP, a family is likely to have more than one son and one daughter, so when making education investment decisions, risk diversification can be done among the sons. Second, in the presence of the FPP, if a family has both a son and a daughter, risk diversification is likely to happen between the son and the daughter; thus, compared to the first scenario, daughters, on average, are more likely to benefit from their parents' investment in their education. Third, in the presence of the FPP, if a family has only a daughter, the parents are very likely to invest in the daughter's education as long as returns on education are higher than saving rates.

5 Discussion

This section provides an interpretation of the empirical results, discusses the economic implications of increasing girls' relative educational attainment levels and considers the long-term effect of the FPP on reducing parents' preference for sons. The results suggest that reductions in family size benefit girls in the form of receiving more education, not only by increasing girls' participation in primary and secondary education, but also by improving girls' opportunities to obtain a higher education degree, which is necessary in order for females to participate in the high-skilled labour market and is an essential step to reducing gender inequality in the labour market. This finding may help to explain China's relatively high female labour participation rate among Asian countries[12] and China's fast economic growth in the 1990s. Moreover, increasing females' relative education can increase women's bargaining power in the marriage market and in intra-household decision making. Literature has revealed that the mother's education is more closely related to the child's welfare than the father's, suggesting that improving education opportunities for females (i.e. future mothers) can generate positive intergenerational effects on future generations.

In Section 4 I discussed the most possible channels through which the FPP can affect girls' educational attainment. Evidence suggests that the FPP worked through channels other than changing parents' son preference. As son preference plays such an important role in determining gender inequality in intra-household decision making, if son preference endures, the gender-equalising effect of the FPP would last only for the time period it is in place. Therefore, it is worthwhile to investigate whether the son preference of those who were born under the FPP differs from the son preference of older cohorts.

5.1 Additional Findings on Son Preference

This question is related to the research area on the determinants of son preference. Previous literature suggests that cultures, social norms, economic motives, education level and other social and individual factors may all affect one's gender preference (Bourne and Walker, 1991). Another strand of literature suggests a strong persistence in gender attitudes across generations as gender role attitudes can be transmitted from parents to children (Farre and Vella, 2013). Implementation of the FPP provides a good social experimental setting to study if girls, when being given a fairer amount of resources and investments in childhood and adolescence,

[12] According to the Human Development Report by the United Nations, China's female labour participation rate was 72.7% in 1990, in contrast to 47.2% in Hong Kong, 47.1% in South Korea, 50.1% in Japan and 50.7% in Singapore.

can develop a weaker son preference when they grow up and become adults.

Hence, a similar DID strategy can be employed to test the hypothesis that women born in post-FPP period have a weaker son preference than men. For the DID estimate, I restrict the sample to the cohorts born from 1961 to 1990 and estimate the following equation:

$$Y_{ipc} = \phi_1 female_i + \phi_2 post_c + \beta(female_i \times post_c) + t_c + \gamma_p + X_{ipc} + \alpha + \epsilon_{ipc} \quad (5)$$

The son preference of an individual i, born in birthyear c and prefecture p, is a function of $female_i$, the individual's gender; $post_c$, a dummy variable that indicates if the individual is born after 1971, and the interaction terms between $female_i$ and $post_c$. γ_p and t_c are province and cohort fixed effects to control for all time-invariant differences between provinces and changes over time that affect all individuals similarly. X_{ipc} are individual-level covariates, including individual's age and education level. The reference group is individuals born between 1961 and 1970. It and all of its interaction terms are dropped. If the FPP weakened females' son preference, then it should be reflected in a decrease in females' son preference relative to males for cohorts born after FPP, $\beta > 0$.

To test if the FPP weakened females' son preference, I use data from the China Family Panel Studies (CFPS)[13], which contains questions on attitudes and perceptions that can enable testing of the hypothesis. CFPS is a nationally representative sample[14]. The baseline data in CFPS were collected in 2010 and were followed up in 2012 and 2014. For my study, I use the 2014 wave and restricd my sample to individuals born from 1961 to 1990 to ensure that individuals in the sample were old enough to have formed a stable gender preference. In particular, CFPS sur-

[13] China Family Panel Studies (CFPS) is funded by the 985 Program of Peking University and carried out by the Institute of Social Science Survey of Peking University.

[14] The sample is drawn from 25 provinces in China, the collective population of which accounts for 95% of the total Chinese population. It is randomly selected within populated regions and less populated regions to reflect huge regional differences in population.

veyed respondents' son preference by asking the following question "How much do you agree with the statement 'A family must have at least one son'?" Respondents then answered on a 1 to 5 scale with 1 representing "I do not agree at all" and 5 representing "I completely agree". I use respondents' answers to this question as a measure of their son preference, and then I repeat the same DID identification strategy as in Equation (5) to estimate the impact of the FPP on females' son preference. In some specifications, I include individual-level covariates, such as the individual's age and education level. Furthermore, multinomial logistics regressions are also estimated using the same DID strategy to further investigate changes in individuals' answers to the question on son preference.

The results are presented in Table 5. The OLS estimates are shown in columns (1)—(3). Column (1) presents the results without individual covariates and fixed effects; Column (2) includes living province fixed effects and cohort fixed effects and Column (3) further includes individual covariates. The variable of interest here is $post_c \times female_i$, which is the estimated mean impact of the FPP on females' son preference relative to males' preferences. Estimates from all the specifications show that the effect of FPP on females' son preference is positive and significant: compared to females born prior to the introduction of the FPP, females born in the post-FPP period have significantly weaker son preference than males who were born in the same birth cohort and lived in the same province. All the specifications, regardless of including individual covariates and/or birth cohort and living province fixed effects, yield similar estimates, all statistically significant at 1% level. They all show that for cohorts born after implementation of the FPP, females' son preference was 0.3 points weaker than that of males. The magnitude of the effect is large and significant. Given that the average son preference is 3.6 for cohorts born before FPP, the results imply that for cohorts born in the post-FPP period, the son preference of males decreased by 0.34 (according to the results in column (2)), equivalent to a 9.4% drop, and females' son preference decreased by 0.31 more points, equivalent to a 17.8% drop.

The multinomial logistics regression results, as shown in columns (4)—(6) in Table 5, provide further evidence for the hypothesis that the FPP weakens women's son preference. The specifications are similar to those of the OLS. The strongest son preference group ($Y = 5$, "I completely agree") is left as the reference group. The results suggest that for cohorts born in the post-FPP period, there are significantly more women than men who have weaker son preferences at 1 or 2 ("I do not agree at all" or "I do not agree most of the time"). Figure 6 plots the son preference of males and females for each cohort born between 1949 and 1994. It shows that pre-FPP-born males and females did not differ in son preference, and since the implementation of the FPP in 1971, post-FPP-born males showed a small amount of decrease in son preference, while post-FPP-born females showed significant decreases in son preference.

These results suggest that the FPP can have positive effects in weakening son preference, though mostly on females. Regarding how the FPP can affect females' son preference, multiple channels may work. First, the FPP favoured girls, who received more education, and then girls' improved education levels changed their views of female worth (Pande et al., 2005). Second, the FPP helped free women from the burden of excessive fertility and childcare and allowed more women to participate in the labour force, which may also change women's views of female worth. Third, by reducing the number of children in a family, the FPP helped create a fairer environment for girls and made the competition between boys and girls more equal. As adolescence is usually a critical period for children to shape values and attitudes, a fairer environment may help reverse the traditional mindset of male superiority. As privilege is usually invisible to those who have it, boys would not experience as much change as girls in receiving education investments and having a fairer competition, so it is reasonable to see more pronounced changes in females' gender attitudes than in those of males. The findings suggest that son preference and, more generally, gender attitudes are not immutable and can be changed by increasing females' education levels, by creating a fairer growing environment for boys and girls and by freeing women from the burden of excessive fertility and childcare.

6 Conclusion

This paper shows the effects of reducing the number of children in a family on gender-specific educational attainment in China. By examining the implementation of the FPP in China since the 1970s, this paper addresses the endogeneity problem in estimating the causal effect of reducing the number of children on gender-specific quality outcomes.

I find that from the pre- to the post-FPP period, girls' education increased 0.5 more years than boys, and the effect was more pronounced in agricultural girls. From the pre- to the post- FPP period, non-agricultural girls increased the length of their education by 0.35 more years than non-agricultural boys, whereas the amount of education completed by agricultural girls increased by 0.49 more years than agricultural boys. These results indicate that, in China where son preference is prevalent, reducing the number of children in a family had a sizable impact on improving the educational attainment of girls and reducing the education gender gap. These empirical findings appear most in line with the interpretation that parents view children's educational spending as a form of investment; thus when sons become less available, parents increase their investment in daughters for risk diversification consideration. In addition, I document that the FPP has had a positive impact in changing gender attitudes. Post-FPP-born women show a more pronounced change in son preference than men. The findings suggest that son preference and, more generally, gender attitudes are not immutable and can be changed by increasing females' education levels, by creating a fairer growing environment for boys and girls and by freeing women from the burden of excessive fertility and childcare.

These findings make contributions to the literature on children's quantity-quality trade-off and to the study of family planning policy and the determinants of gender preference. More specifically, this paper reports some of the previously overlooked social benefits of the FPP with respect to improving female education and reducing son preference. By these means the FPP can help previously education-deprived women to receive more human capital investment. The findings also have significant policy implications for societies with a high fertility rate and strong gender preference. Thus, further research can examine whether similar results hold for other outcomes and in other contexts.

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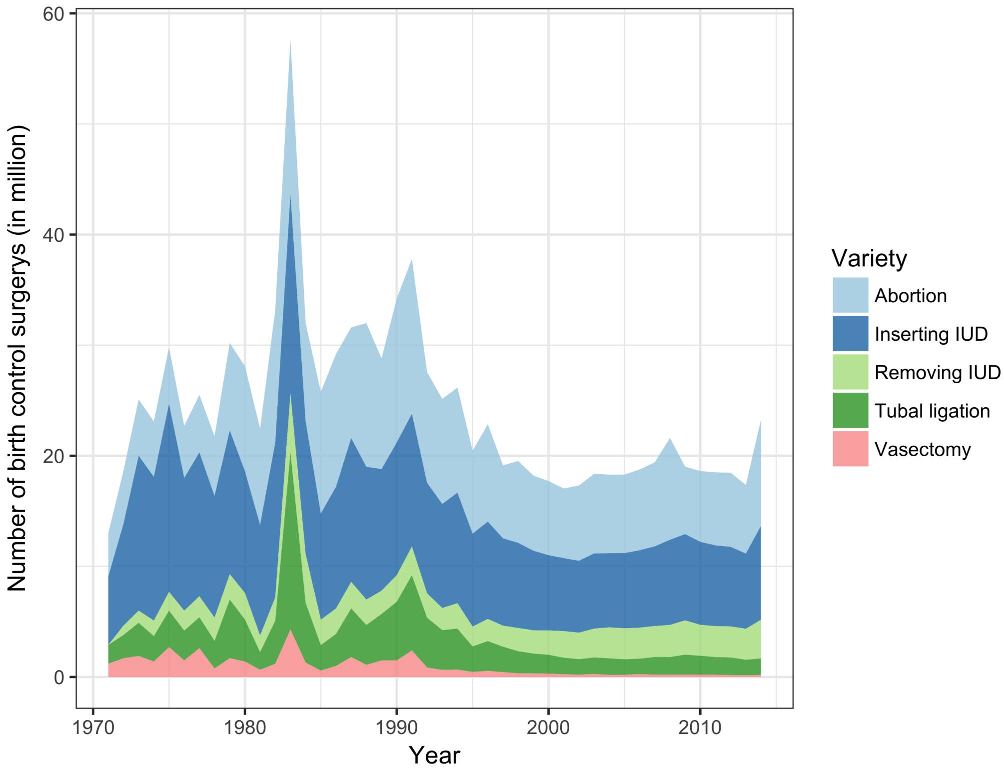


Figure 1: The Volume of The Birth Control Surgeries (in millions)

Notes: This figure shows the volume of the birth control surgeries (in millions) in China imposed by the family planning policy since 1971. It implies that the strength of the compulsory birth controls has remained quite stable since the policy went into effect.

Source: 2015 China Health and Family Planning Policy Statistics Yearbook

(a) Whole Population (b) By Group

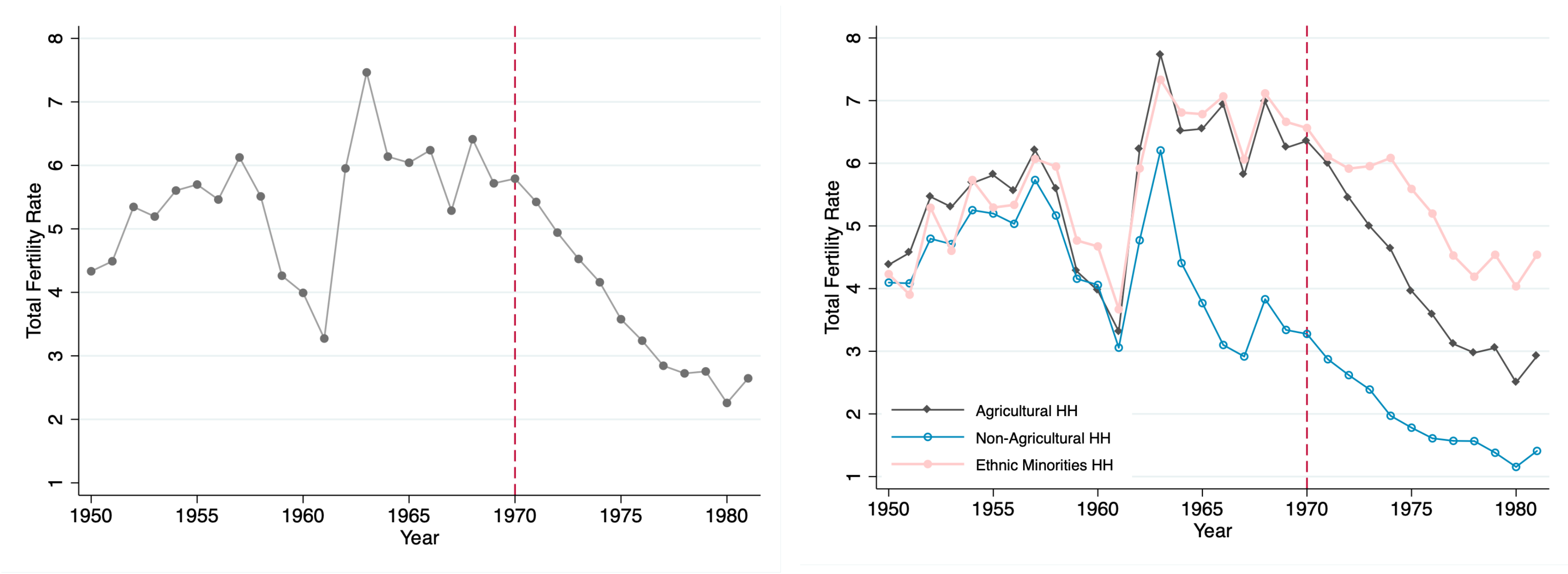


Figure 2: Total Fertility Rate

Notes: This figure shows the time trend of total fertility rate in China, which is defined as the average number of children that would be born to a woman at fertile age (15-49). The red verticle line marks the year before the start of the FPP. Panel (a) shows the total fertility rate for the whole population. It shows that the FPP extensively reduced the total fertility rate, from 5.8 births per woman in 1970 to 2.2 births per woman in 1980. Panel (b) shows the total fertility rate for agricultural Han households, non-agricultural Han households, and ethnic minorities (including both agricultural and non-agricultural households), respectively. It shows that for the period 1971—1980, the total fertility rate for agricultural Han households dropped by nearly 4 births, the rate for non-agricultural Han households dropped by 2.1 births, and the rate for ethnic minorities dropped by 2.5 births, implying that the FPP had the greatest impact on the family size of agricultural Han households.

Source: 1986 China Family Planning Policy Statistics Yearbook.

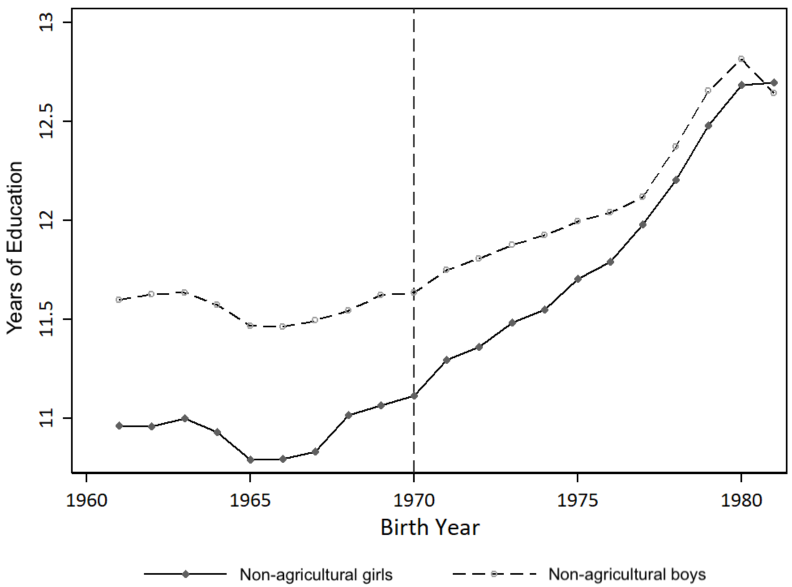
(a) Whole Population

Figure 3: Average Years of Education Completed by Boys and by Girls

Notes: This figure shows the average years of education completed by boys and by girls for agricultural and non-agricultural Hukou status, respectively. Panel (a) is for the whole population. Panel (b) is for non-agricultural Hukou individuals. Panel (c) is for agricultural Hukou individuals. In all panels, ethnic minorities are not included.

Source: 1% sample of the 2000 China population census.

(b) Non-agricultural



(c) Agricultural

Figure 3: (Continued) Average Years of Education Completed by Boys and by Girls

Notes: This figure shows the average years of education completed by boys and by girls for agricultural and non-agricultural Hukou status, respectively. Panel (a) is for the whole population. Panel (b) is for non-agricultural Hukou individuals. Panel (c) is for agricultural Hukou individuals. In all panels, ethnic minorities are not included.

Source: 1% sample of the 2000 China population census.

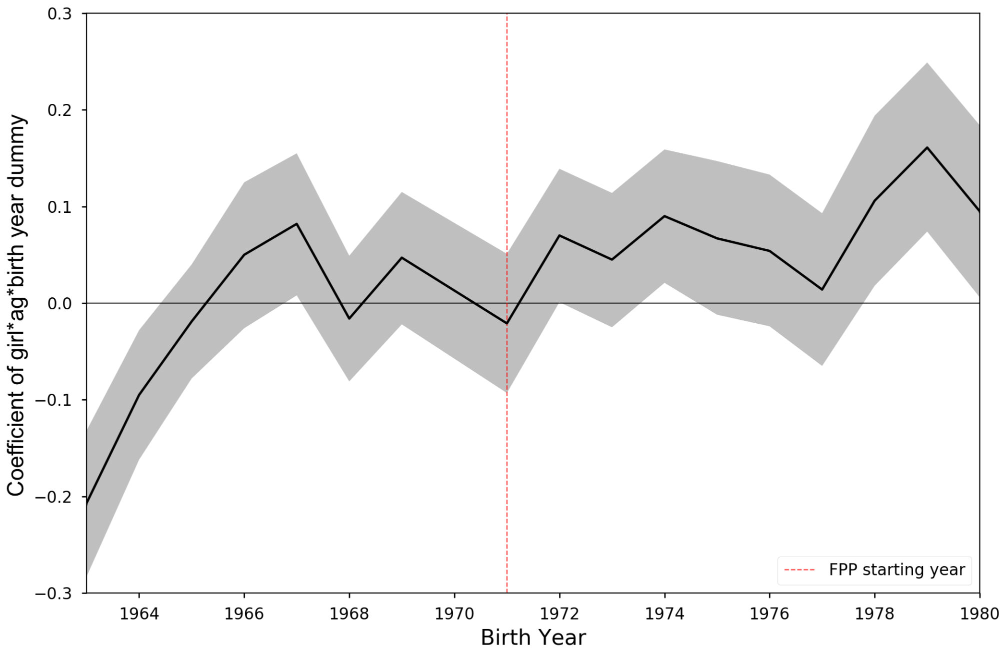


Figure 4: Change in the Linear Trend Rate of the Educational Attainment of Agricultural Girls

Notes: This figure plots the vector of coefficient estimates for the interaction term $girl \times ag \times$ *birth year dummy* from Equation (3) in the DDD estimation.

Source: 1% sample of the 2000 China population census.

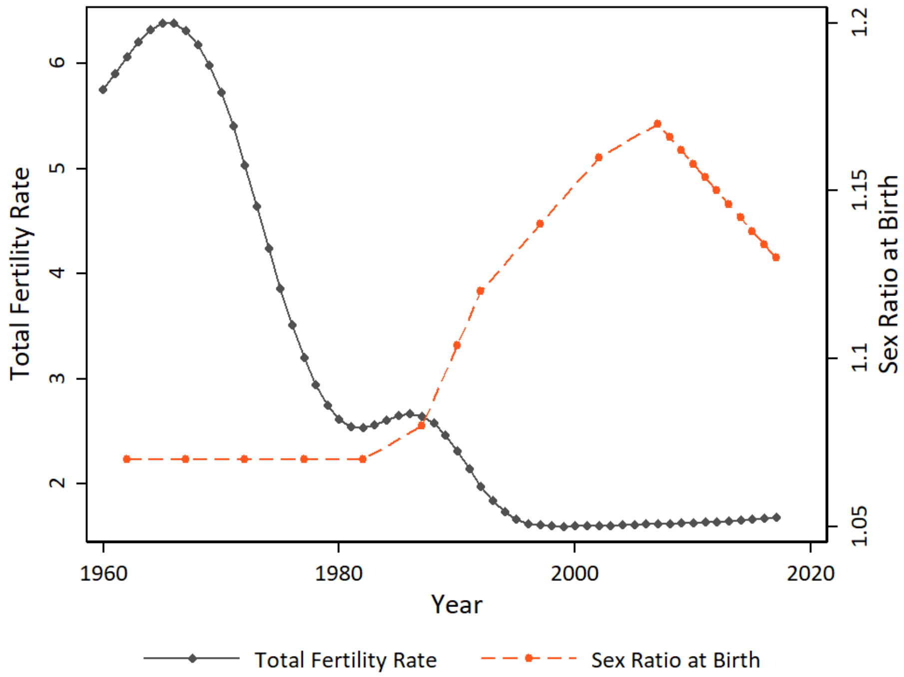


Figure 5: China's Gender Ratio at Birth and Total Fertility Rate
Notes: This figure plots China's gender ratio at birth and total fertility rate for each year. The left axis corresponds to the total fertility rate. The right axis corresponds to sex ratio at birth.
Source: the World Bank.

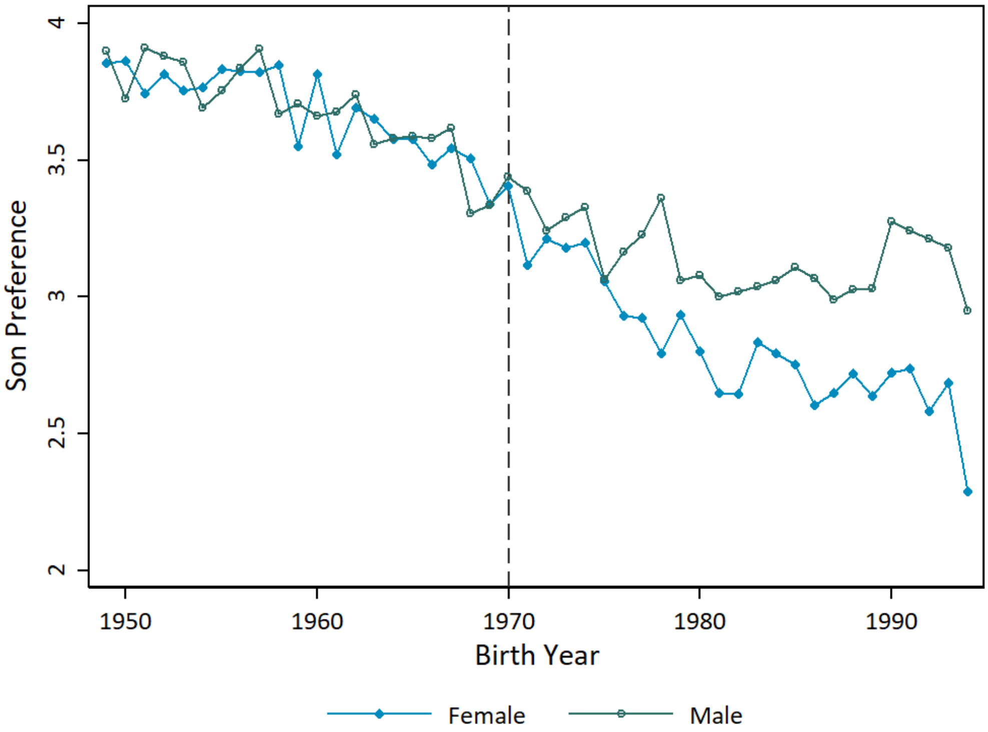


Figure 6: Son Preference of Male and Female over Time

Notes: This figure plots the son preference of males and females for each cohort born between 1949 and 1994. It shows that pre-FPP-born males and females did not differ in son preference, and since the implementation of the FPP in 1971, post-FPP-born males showed a small amount of decrease in son preference, while post-FPP-born females showed significant decreases in son preference. *Source:* 2014 China Family Panel Studies (CFPS)

Table 1: Descriptive Statistics

	Male					*Female*				
	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max
Han										
Agricultural										
Age	1,414,911	29.47	5.697	18	39	1,418,168	29.48	5.717	18	39
Education Years	1,414,911	8.276	2.315	0	19	1,418,168	7.376	2.628	0	19
Literacy	1,414,911	0.989	0.103	0	1	1,418,168	0.968	0.177	0	1
Household Size	1,414,911	3.838	1.570	1	25	1,418,168	3.996	1.520	1	25
Migration	1,414,911	0.123	0.329	0	1	1,418,168	0.165	0.371	0	1
Employment	1,414,911	0.963	0.188	0	1	1,418,168	0.879	0.326	0	1
Ever Married	1,414,911	0.732	0.443	0	1	1,418,168	0.840	0.367	0	1
First Marriage Age	1,036,342	22.57	2.584	13	39	1,191,335	21.23	2.401	13	39
Non-Agricultural										
Age	552,754	29.40	5.900	18	39	527,427	29.22	5.833	18	39
Education Years	552,754	11.85	2.803	0	19	527,427	11.41	2.749	0	19
Literacy	552,754	0.998	0.0437	0	1	527,427	0.997	0.0551	0	1
Household Size	552,754	3.129	1.490	1	22	527,427	3.250	1.433	1	22
Migration	552,754	0.271	0.445	0	1	527,427	0.288	0.453	0	1
Employment	552,754	0.789	0.408	0	1	527,427	0.684	0.465	0	1
Ever Married	552,754	0.672	0.469	0	1	527,427	0.759	0.428	0	1
First Marriage Age	371,481	24.36	2.735	13	39	400,056	22.84	2.449	13	39
Non-Han										
Age	187,668	28.79	5.825	18	39	174,782	28.78	5.823	18	39
Education Years	187,668	7.827	3.547	0	19	174,782	6.826	3.943	0	19
Literacy	187,668	0.949	0.219	0	1	174,782	0.879	0.326	0	1
Household Size	187,668	4.124	1.862	1	20	174,782	4.251	1.783	1	20
Migration	187,668	0.115	0.319	0	1	174,782	0.155	0.362	0	1
Employment Status	187,668	0.933	0.250	0	1	174,782	0.860	0.347	0	1
Ever Married	187,668	0.678	0.467	0	1	174,782	0.821	0.383	0	1
First Marriage Age	127,236	22.51	3.137	13	39	143,519	20.83	2.886	13	38

Source: 1% sample of the 2000 China population census.

Table 2: The Effect of the FPP I: on the Years of Education of Boys and of Girls

	Results using diff-in-diff			Results using diff-in-diff-in-diff		
	(1)	(2)	(3)	(4)	(5)	(6)
Girl	-1.058***	-1.046***	-1.047***	-0.613***	-0.619***	-0.626***
	(0.039)	(0.040)	(0.040)	(0.033)	(0.034)	(0.034)
Post	0.982***	0.944***	-0.074***	1.209***	1.110***	0.020
	(0.054)	(0.055)	(0.015)	(0.049)	(0.053)	(0.030)
Girl × Post	0.517***	0.504***	0.505***	0.345***	0.349***	0.351***
	(0.020)	(0.020)	(0.020)	(0.022)	(0.022)	(0.022)
Ag				-3.428***	-3.317***	-3.339***
				(0.054)	(0.039)	(0.039)
Ag × Post				-0.258***	-0.217***	-0.204***
				(0.042)	(0.035)	(0.037)
Girl × Ag				-0.526***	-0.515***	-0.506***
				(0.036)	(0.035)	(0.035)
Girl × Ag × Post				0.164***	0.143***	0.141***
				(0.026)	(0.024)	(0.024)
Birth prefecture FE	No	Yes	Yes	No	Yes	Yes
Birth cohort FE	Yes	Yes	No	Yes	Yes	No
Linear time trend	No	No	Yes	No	No	Yes
Observations	3,926,555	3,926,555	3,926,555	3,913,260	3,913,260	3,913,260

Notes: This table reports the effects of the family planning policy on the relative educational attainment of boys and of girls. The dependent variable is individuals' years of education. The DID estimates from Equation (1) are presented in columns (1)—(3). The DDD estimates from Equation (2) are presented in columns (4)—(6). The sample includes Han individuals born during 1961-1981. *Girl* indicates an individual's gender; *Ag* indicates the individual's Hukou status, equal to 1 if the individual has agricultural Hukou; *Post* is a dummy variable that indicates if the individual is born after 1971. The reference group is individuals born from 1961 to 1970. It and all of its interaction terms are dropped. Standard errors in parenthesis are clustered at prefecture level: * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3: The Effect of the FPP II: on Whether An Individual Completed More Than the Compulsory Nine Years of Education

	Results using diff-in-diff			Results using diff-in-diff-in-diff		
	(1)	(2)	(3)	(4)	(5)	(6)
Girl	-0.156***	-0.155***	-0.155***	-0.020***	-0.022***	-0.022***
	(0.007)	(0.007)	(0.007)	(0.002)	(0.002)	(0.002)
Post	0.134***	0.128***	-0.005**	0.104***	0.094***	-0.050***
	(0.007)	(0.006)	(0.002)	(0.005)	(0.005)	(0.003)
Girl × Post	0.075***	0.073***	0.073***	0.018***	0.018***	0.018***
	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)
Ag				-0.245***	-0.230***	-0.232***
				(0.007)	(0.007)	(0.007)
Ag × Post				0.051***	0.054***	0.056***
				(0.004)	(0.003)	(0.003)
Girl × Ag				-0.177***	-0.176***	-0.175***
				(0.006)	(0.006)	(0.006)
Girl × Ag × Post				0.070***	0.068***	0.067***
				(0.004)	(0.004)	(0.004)
Birth prefecture FE	No	Yes	Yes	No	Yes	Yes
Birth cohort FE	Yes	Yes	No	Yes	Yes	No
Linear time trend	No	No	Yes	No	No	Yes
Observations	3,926,555	3,926,555	3,926,555	3,913,260	3,913,260	3,913,260

Note: This table reports the effects of the family planning policy using an alternative measure of educational attainment: whether an individual completed more than the compulsory nine years of education. The dependent variable is a dummy variable, equal to 1 if the highest level of education an individual achieved exceeded ninth grade, and 0 otherwise. The DID estimates from Equation (1) are presented in columns (1)—(3). The DDD estimates from Equation (2) are presented in columns (4)—(6). The sample includes Han individuals born during 1961-1981. *Girl* indicates an individual's gender; *Ag* indicates the individual's Hukou status, equal to 1 if the individual has agricultural Hukou; *Post* is a dummy variable that indicates if the individual is born after 1971. The reference group is individuals born from 1961 to 1970. It and all of its interaction terms are dropped. Standard errors in parenthesis are clustered at prefecture level: * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 4: Placebo Test: The Effect of the FPP for Han and Ethnic Minorities

	Years of education completed			Beyond ninth grade		
	(1)	(2)	(3)	(4)	(5)	(6)
Girl	-1.372***	-1.347***	-1.344***	-0.178***	-0.175***	-0.175***
	(0.086)	(0.085)	(0.085)	(0.009)	(0.009)	(0.009)
Post	0.606***	0.684***	-0.260***	0.120***	0.128***	-0.0471***
	(0.066)	(0.051)	(0.038)	(0.011)	(0.009)	(0.007)
Han	1.286***	0.478***	0.484***	0.221***	0.083***	0.084***
	(0.137)	(0.081)	(0.081)	(0.021)	(0.012)	(0.012)
Girl × Post	0.420***	0.396***	0.393***	0.064***	0.060***	0.060***
	(0.039)	(0.034)	(0.034)	(0.006)	(0.005)	(0.005)
Girl × Han	0.232***	0.210**	0.210**	-0.020*	-0.022**	-0.022**
	(0.087)	(0.085)	(0.086)	(0.011)	(0.011)	(0.011)
Han × Post	0.325***	0.186***	0.157***	0.062***	0.043***	0.038***
	(0.053)	(0.039)	(0.039)	(0.008)	(0.007)	(0.007)
Girl × Han × Post	0.090**	0.095**	0.098***	0.024***	0.025***	0.025***
	(0.040)	(0.038)	(0.037)	(0.006)	(0.006)	(0.006)
Birth prefecture FE	No	Yes	Yes	No	Yes	Yes
Birth cohort FE	Yes	Yes	No	Yes	Yes	No
Linear time trend	No	No	Yes	No	No	Yes
Observations	3,123,398	3,123,398	3,123,398	3,123,398	3,123,398	3,123,398

Note: This table reports the effects of the family planning policy on the relative educational attainment of boys and of girls for Han and ethnic minorities, respectively, based on Equation (4). The sample includes agricultural Hukou individuals born during 1961-1981. The dependent variable in columns (1)-(3) is an individual's years of education. In columns (4)-(6) the dependent variable is whether an individual completed more than the compulsory nine years of education. *Girl* indicates an individual's gender; *Han* indicates the individual's ethnicity, equal to 1 if the individual is of Han ethnic; *Post* is a dummy variable that indicates if the individual is born after 1971. The reference group is individuals born from 1961 to 1970. It and all of its interaction terms are dropped. Standard errors in parenthesis are clustered at prefecture level: * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 5: The Effects of the FPP on the Son Preference of Males and of Females

	OLS			Multinomial Logistics		
	(1)	(2)	(3)	(4)	(5)	(6)
Post	-0.355***	-0.343***	-0.476**			
	(0.074)	(0.076)	(0.226)			
Female	-0.029	-0.034	-0.163***			
	(0.035)	(0.035)	(0.029)			
Post × Female	-0.318***	-0.316***	-0.228***			
	(0.055)	(0.051)	(0.062)			
$Y = 1$						
Post				0.650***	-0.105	4.442
				(0.153)	(0.280)	(3.260)
Female				0.109*	0.130**	0.373***
				(0.060)	(0.066)	(0.062)
Post × Female				0.471***	0.520***	0.416***
				(0.100)	(0.103)	(0.121)
$Y = 2$						
Post				0.321***	-0.343	1.421
				(0.100)	(0.237)	(2.781)
Female				-0.067	-0.056	0.183***
				(0.055)	(0.058)	(0.068)
Post × Female				0.441***	0.454***	0.375***
				(0.098)	(0.094)	(0.125)
$Y = 3$						
Post				0.412***	-0.033	1.366
				(0.086)	(0.280)	(2.380)
Female				-0.152***	-0.145***	0.033
				(0.055)	(0.053)	(0.069)
Post × Female				0.191**	0.201**	0.111
				(0.096)	(0.097)	(0.110)
$Y = 4$						
Post				0.100	-0.093	3.106
				(0.069)	(0.176)	(4.080)
Female				-0.087	-0.081	0.015
				(0.074)	(0.076)	(0.063)
Post × Female				0.193*	0.187*	0.192*
				(0.101)	(0.099)	(0.105)
Birth prefecture FE	No	Yes	Yes	No	Yes	Yes
Birth cohort FE	Yes	Yes	No	Yes	Yes	No
Individual covariates	No	No	Yes	No	No	Yes
Observations	17,481	17,481	15,768	17,481	17,481	15,768

Note: This table reports the effects of the family planning policy on the son preference of males and of females who were born under the FPP. The sample includes individuals born from 1961 to 1990. The son preference of an individual is measured by his/her answers to the following question: "How much do you agree with the statement 'A family must have at least one son'?" Respondents then answered on a 1 to 5 scale with 1 representing "I do not agree at all" and 5 representing "I completely agree". The OLS estimates from Equation (5) are presented in columns (1)—(3). *Female* indicates an individual's gender; *Post* is a dummy variable that indicates if the individual is born after 1971. The reference group is individuals born from 1961 to 1970. It and all of its interaction terms are dropped. Individual covariates include individual's age and education level. The multinomial logistics regression results are presented in columns (4)—(6). $Y = 5$ is left as the reference group. Standard errors in parenthesis are clustered at province level: * significant at 10%; ** significant at 5%; *** significant at 1%.

7 Appendix

A Additional Figures

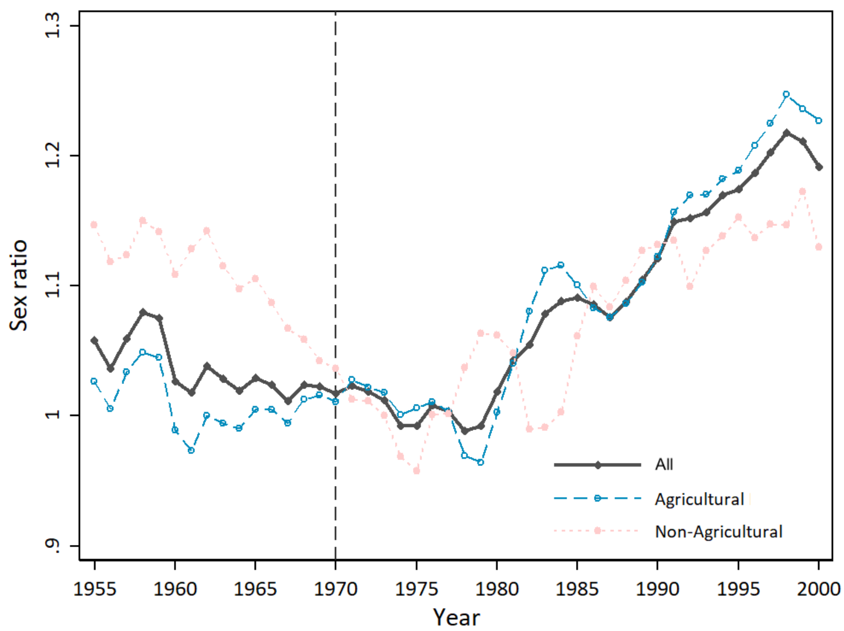


Figure A1: Sex Ratios by Birth Year in China

Notes: This figure depicts the sex ratios by birth year for all individuals, agricultural individuals, and non-agricultural individuals. It is calculated as $\frac{Number\ of\ male}{Number\ of\ female}$. It shows that the sex ratio remained between 1 and 1.07 before 1982. Given the natural rate of 1.06, it should not be interpreted as aberrant. The sex ratio becomes more skewed with the introduction of ultrasound B gender detection technology in the 1980s.

Source: 1% sample of the 2000 China population census.

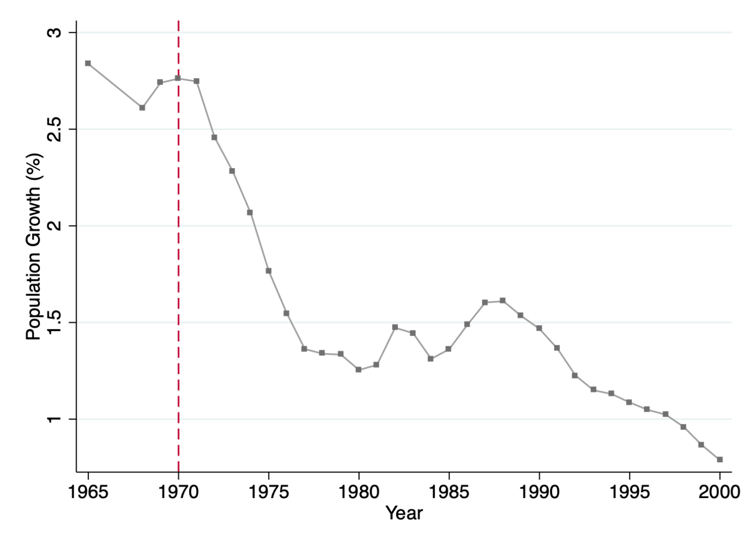


Figure A2: Population Growth

Notes: This figure shows that the population growth rate in China has significantly decreased since the implementation of the Family Planning Policy in 1971.

Source: The statistics for 1968-2000 is from the World Bank. The statistic for 1965 is from the 2015 China Health and Family Planning Policy Statistics Yearbook.

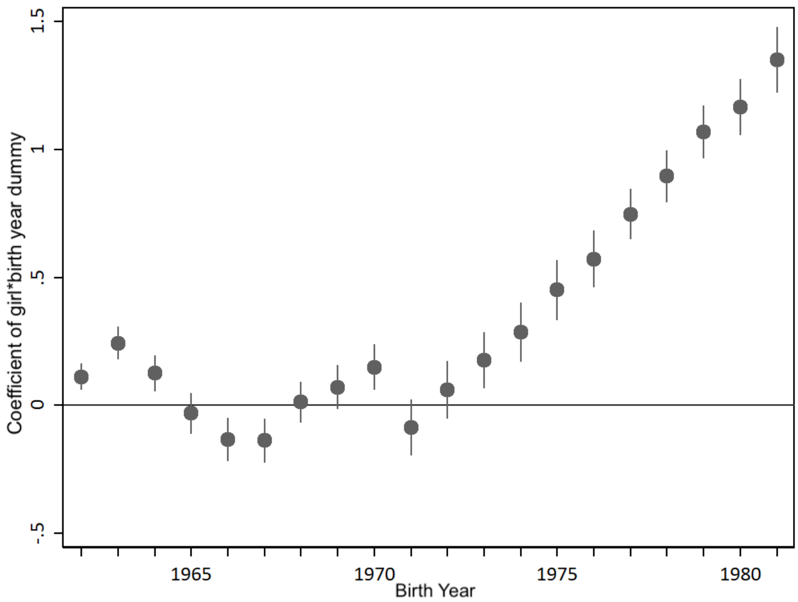


Figure A3: Change in the Linear Trend Rate of the Educational Attainment of Girls

Notes: This figure plots the vector of coefficient estimates for the interaction term *girl* $\times$ *birth year dummy* in the DID estimation.

Source: 1% sample of the 2000 China population census.

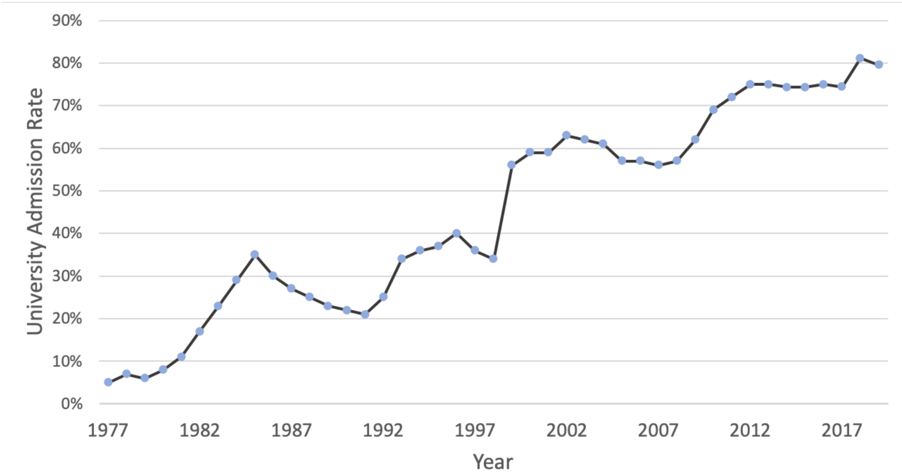


Figure A4: University Admission Rate in China
Notes: This figure depicts the university admission rate in China.
Source: Gaokao.com

B Policy Background

B.1 the family planning policy

Family planning in China has gone through three stages[15]:

1. 1962-1970 Early Attempts Stage

Concerned about the rapid population growth after the 1959-1961 Great Famine, in 1962 the State Council of China issues a policy document encouraging families to use birth control. The document points that "Family planning should be encouraged in populous regions to make procreation gradually move from an unplanned state to a planned state". In 1964 the Family Planning Commission is set up. In particular, family planning offices have been established in some urban areas. This period is a preliminary to the subsequent extensive implementation of the family planning programs.

2. 1971-1977 Family Planning Policy Implementation Stage

Family planning programs in China were officially launched in 1971 upon the approval of *The report on the work of the family planning policy* by the State Council of China and were included in the 4th *Five-Year Plan(1971-1975)*. Soon after, fam-

[15] A brief Chinese population policy evolution chronicles can be found here.

ily planning offices were set up at all administrative levels, and birth control work was carried out. The objective of the family planning campaign at that time, as advocated in the campaign slogan, was "one is not too few, two is perfect, and three is too many". Later, in the 1973 national family planning symposium, a more explicit policy "later, less frequent and fewer" ("晚丶稀丶少") was introduced. "Later" refers to women must not get married by age 23 and give birth to their first child by age 24; "less frequent" indicates the birth spacing must be no less than three years; "fewer" reflects the policy restriction limiting couples to having no more than two children. The policies for agricultural and non-agricultural households were the same until 1982. The target population of the FPP is China's majority ethnic group - Han, which accounts for 93% population. Ethnic minorities were not as restricted as Han citizens. During this period, the policy for ethnic minorities was "In less populated minority areas, technical guidance for family planning should be given to those who have birth control willingness."

3. 1978-2016 One Child Policy Stage

In March 1978, a stricter policy, later commonly known as the One Child Policy, was adopted in the Fifth National People's Congress and enshrined in the constitution. Since the second half of 1979, many places have revised the family planning regulations in accordance with the requirements of one-child birth. Except for some less-populated ethnic minorities, one-child birth is fully implemented in urban and rural areas across the country. Only difficult households in rural areas in some western provinces (Yunnan, Qinghai, Ningxia, and Xinjiang) can have two children. As of the first half of 1980, except Xinjiang and Inner Mongolia, all provinces, cities, and districts have issued interim regulations for family planning (Xinjiang and Inner Mongolia introduced regulations in 1981 and 1982 respectively), which imposes severe economic and administrative penalties on offenders.

In this period a more specific policy is made for ethnic minorities, "For ethnic minorities, exceptions to the one child policy can only be granted to those with a population of 10 million or less. Couples of those ethnicities can have two children, and some may have three, but four children are not allowed."

In 1982, the One Child Policy was revised to allow families that satisfied certain conditions to have a second child. A family can have a second child if it meets either of the two criteria: The first criterion depends on whether a couple is both singletons (the only child in their own families). If a couple is both singletons, the couple is eligible to apply for a second-child permit. This criterion can be seen as a reward to singletons, though it seldom applied before the 2000s because of the scarcity of singletons. When either person of a couple is not a singleton, the second criterion applies, which depends on the Hukou status of the mother and the gender of the first child. Only when the mother holds agricultural Hukou and the first child is a girl, the couple is eligible to have a second child. In contrast, non-agricultural couples cannot apply to have a second child regardless of the gender of the first child.

If a family does not meet the above conditions but is found to have out-of-quota children, an economic penalty will apply. To give an idea of how large the fine is, in Beijing the penalty is roughly 3 to 10 times an individual's annual income[16], which is a large amount of money for an ordinary family. In addition to the economic penalty, anyone who works for the government or any state-owned corporations would face the risk of being dismissed if he/she is found to have out-of-quota children. There are some minor exceptions for which parents are permitted to have a second child. For example, when the first child has an intellectual disability.

B.2 The Household Registration (*Hukou*) System

The household registration system was established in cities in 1951, extended to rural areas in 1955, and formalized as a permanent system in 1958. Every Chinese resident is classified by the 'status' of his/her *Hukou* registration, essentially

[16] Beijing Municipal Peoples Government Order No.111, Section 5

referred to as agricultural or non-agricultural. This classification used to determine a person's entitlements to state prerogatives. It originated from the occupational division in the 1950s. The designation of *Hukou* registration status for a person is inherited from that of his or her mother. This is very much a 'birth-subscribed' system. Changes in the *Hukou* registration were strictly controlled before the 1990s. The main channel is by employment in state-owned corporations or by admission to higher education institutions. Very limited quotas are granted every year. The classification of *Hukou* registration facilitated the state's control of rural-urban migration[17].

[17] for more details, Chan and Zhang (1999) provides a complete summary of the *Hukou* system.