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

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Abstract

China's One Child Policy ('OCP') imposed an exogenous fertility constraint and changed the family size. What are the consequences of this policy on education investment and gender inequality? I use difference-in-difference-in-difference(DDD) strategy to compare the education outcomes between boys and girls with different types of household registration status (*Hukou*) during the pre- and post-OCP periods. The results show that children born during the post-OCP period, on average, stay in school longer and are more likely to continue their education beyond the compulsory education. Moreover, this effect was stronger for girls, whose resources were usually taken by their brothers during the pre-OCP period. My results imply that with smaller families, gender gap in education narrowed. Furthermore, I also show that the singletons generations, as a product of the OCP, now by themselves, prefer fewer children, compared to the contemporary non-singletons. Possible reasons include singletons' less gender preference and tighter income constraint. Overall, this study reveals the social benefits of family planning policy in terms of improving female education achievement and reducing gender inequality.

Keywords: Family Planning, fertility, education, gender inequality.
JEL: J13, J16, D04, I24.

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1 Introduction

In late October 2015, the Chinese government announced that it was ending the more than 30-year-old One Child Policy ('OCP'),which raised another wave of debate over fertility choice. However, the literature so far mostly looked at downside aspects of the OCP. For example, Edlund et al(2013) associates criminality with the abnormal sex ratio that is possibly caused by the OCP; Qian(2009) looks at the only-child disadvantage in school enrolment in rural China; Zhu, Lu & Hesketh (2009) shows how sex selective abortion and the OCP determine the abnormal sex ratio in rural China. The previous literature ignores the potential positive effects of the OCP on children's educational attainments and gender inequality. This paper aims to fill this gap by looking at the consequences of one child policy for girls.

Since Becker and Lewis (1973)'s idea that quantity and quality of children might be inversely related to each other, economists have been trying to find the evidence in favor of this hypothesis. The findings are quite mixed. For instance, Rosenzweig & Wolpin(1980) and Hanushek(1992) provides evidence for a negative correlation between family size and children's schooling performance. However, Angrist, Lavy & Schlosser (2005) do not find evidence of the quantity-quality trade-off in Israel. So the question remains open. Furthermore, the previous literature does not relate the question of quantity-quality tradeoff to gender disparities. In this paper, I use China' OCP as a plausible exogenous shock to the family size, and then I employ difference-in-differece-in-difference strategy to compare the education outcome between boys and girls across different social status during the pre- and post- OCP periods. As the fertility constraints decreased the number of children per family, and thus, the education resources assigned to each child increase, then, with the plausible assumption that education is a normal good, the education outcome for children is expected to be higher. There are some previous studies that use the OCP to study whether reductions in fertility increase human capital investments on children. Rosenzweig & Zhang(2009) is a particularly relevant one, in which the authors examine the effects of twinning by birth order, and finds that an extra child at parity one or at parity two significantly decreases the schooling performance and the assessed health of all children in the family.

Girls' schooling and gender inequality in education has drawn a continuing attention since long ago. A number of studies, such as Dollar & Gatti (1999), Klasen(2002) and Klasen & Lamanna (2009), provide cross-country evidence for the negative impact of gender inequality in education and employment on economic growth. Some recent studies like Hsieh, et al(2013) and Cavalcanti & Tavares(2015) try to quantify the negative effect with macroeconomic models. The results from

these previous literature suggest that gender inequality in education directly affects economic growth by lowering the average level of human capital. By this means, the OCP implicitly contributes to the economic growth of China by reducing gender inequality and improving human capital investment in women.

In the theoretical framework originated from Becker and Lewis (1973), there is an interaction between quality and quantity of children in parents' budget constraint so that the marginal cost of quantity can depend on the quality of children, and vice versa. Moreover, this framework assumes that all children in a family get the same investment, and thus have the same quality, regardless of their gender. Most later empirical studies implicitly assume the same, and very few look into the gender-specific outcomes. Nevertheless, parents can choose to improve the quality of some children, and keep the others at lower quality, especially when the family has a tight budget.

What makes the present study different from previous studies is that I consider the gender-specific impact of reduction in quantity on the quality of children. This is especially salient in societies that prefer sons where sons are usually have higher priority for resources transferred from parents, and are treated better than daughters. The different treatment leads to different outcomes in education and earnings, and consequentially economic and social status in adulthood. Thus reinforces male dominance, and leads to persistent gender inequality. Sons are generally preferred to daughters for economic reasons. Qian(2008) uses price of tea and orchard to proxy for the sex-specific income, and shows that in areas where men have higher earnings, girls survival rate is lower; Rosenzweig & Zhang(2012) associates the gender difference in schooling with the differences in comparative advantage with respect to skill and brawn between men and women. Besides, sons are preferred by parents since they are usually responsible for providing financial support to parents when they retire. This phenomenon is common in societies that do not have well-run medical care and social security systems (Coeurdacier, Guibaud, & Jin, 2013, 2014 provide a good explanation), thus parents invest in sons to secure their future income after retirement. Since the OCP was implemented in the 1970s, because of the exogenous enforcement of children reduction, the children in each family have fewer siblings than children during the pre-OCP period, and thus each child receives more resources for personal development. Since during the pre-OCP period, girls always had to give resources to their brothers, the hypothesis is that any full or partial removal of between-siblings competition will provide girls more investment. In addition,during the post-OCP period, parents do not have as many children to choose from in whome to invest as parents did during the pre-OCP period, so the

preference for sons will weaken as a result. Therefore, we expect to observe a faster education increase in girls than in boys after the policy was implemented.

In this study, I use difference-in-difference-in-difference(DDD) strategy to compare the education outcomes between boys and girls with different types of household registration status (*Hukou*) during the pre- and post-OCP periods. *Hukou* is a household registration system in China since 1949. It labels an individual with either 'Agricultural' or 'Non-agricultural' registration status, which is inherited from the individual's mohter. Therefore it is an exogenous birth-subscribed system. The practice of the OCP directly depends on the *Hukou* status of an individual. Briefly, a 'Non-agricultural' individual is strictly restricted to have only one child, but an 'Agricultural' individual is allowed to have more than one child conditional on the sex of the first child. The detailed OCP practice follows in the Background section. In the current paper, I make use of this exogenous variation in an individual's *Hukou* status to determine his/her family size. I find that the OCP has a significant positive effect on girls' education after controlling for the common time trend, living place, sex ratio, and government education investment. The education of an Agricultural girl, on average, improved by 0.88 more years than that of boys, and Non-Agricultural girls improved by 0.32 more years. In the robustness check, I look at the education outcome beyond the 9-year public education, and find the same result. Then I use the minority subset as a placebo test. Minorities enjoy more flexibility in their fertility choice. The OCP generally allows minorities to have two children regardless of the sex of the first child, and *Agricultural* minorities, in particular, can apply to have more than two children. Therefore we would expect a attenuated effect of the OCP on improving girls' education. The findings confirms this hypothesis. *Agricultural* minorities do not show significant change in their education.

The second part of this study is to look into intergenerational externality of the OCP on fertility choice. Since the enforcement of the OCP, hundreds of millions of families have been used to have only one daughter. Perceptions have changed, appropriately. A son is no longer a must-have. Consequently, the gender preference changed, as well. This may be particularly true for those who are singletons. Therefore we should expect to see that singletons, compared to the non-singletons, are more likely to stop fertility when their first child is a girl. Besides, since singletons are the only one to take care of their parents,while non-singletons can share the burden between siblings, singletons bear more economic pressure. As a result, the singleton generations, by themselves, prefer fewer children, compared to the contemporary non-singletons.

This paper will contribute to the literature in multiple ways. I show that family planning policy can have gender-specific outcomes and reduce gender inequality; Besides, I provide more evidence to the classic children quality-quantity trade-off puzzle. In addition, I find that the family planning policy can have intergenerational externality on fertility choice. The findings can help us to better understand fertility decisions in developing countries.

This paper is organized as follows: In Section 2, I provide background information about the One Child Policy in China and the *Hukou* registration system and list the detailed conditions under which individuals are eligible to obtain a second-child permit. In Section 3, I focus on the impact of the OCP on gender-specific education outcomes. In Section 4, I show that the OCP can have persistent impact on singleton's fertility choice. Section 5 is the conclusion.

2 Background

2.1 Family Planning Policy

Briefly, in 1962, the State Council of China issued a policy document encouraging families to use birth control; however, the policy was not followed up in the next 10 years until 1971 when the State Council of China approved *The report on the work of the family planning policy* stressing the importance of family planning; in the same year the family planning policy was included in the 4th *Five-Year Plan(1971-1975)*. The policy slogan at that time was 'one is not too few, two is perfect, and three is too many'. Later, in the 1973 the first national family planning symposium, a more explicit policy 'Later, less frequent and fewer' ("晚、稀、少")[1] was introduced. "Later" means woman must not get married before 23 and give the first birth before 24; "Less frequent" means the birth spacing must be no less than three years. "Fewer" means a couple cannot have more than two children. 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. This strict One Child Policy lasted 3 years before it was relaxed in 1982, when the government begun to issue a second-child permit that grants families the right to have a second child. Note that not every family is entitled to a second child, only families that satisfy certain conditions. The conditions for obtaining a second-child permit are discussed in details in the next section. The second-child permit emerged as a way to solve the unexpected sex-selection behaviors that took place in regions that highly

[1]The central government website provides brief population policy evolution chronicles, see $http://www.gov.cn/zhengce/2015-02/09/content\_2816919.htm$

preferred sons after the strict OCP went into effect. The consequential imbalanced sex ratio and its unintended impacts have been documented in many works (for example, see Angrist, 2002). In the 1970s and early 1980s, sex-selection behavior usually took the form of female infanticide, which was not as effective. The sex ratio did not become further more imbalanced until the introduction of ultrasonic fetal sex diagnosis in the late 1980s. Figure A1 plots the sex ratio time series.

2.2 The Household Registration (*Hukou*) System

Since the conditions for obtaining a second-child permit are closely linked to an individual' s *Hukou* status, I herewith briefly explain the *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 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 by requiring anyone seeking officially sanctioned rural-urban migration to complete a dual approval process. (for more details, please see Zhang and Chan(1999) which provides a complete summary of the *Hukou* system).

2.3 Conditions for obtaining a second-child permit

The second child permit application began in 1982. As mentioned before, not every family is entitled to a second child, but only families that satisfy certain conditions. The conditions are different for *Han* (the major ethnicity in China, accounting for 93% population) and minorities: Compared to *Han*, any minority are entitled to have a second child[2].

Nevertheless, the conditions are more strict and complex for *Han*, who are the main target of the policy. To make it easier to understand, it can be thought of as a two-criteria process. Parents are entitled to have a second child if they meet

[2]Some minorities can have a third child, depending on the size of the minority

either of the criteria. The first criterion depends on whether the parents are both singletons.

Table 1: First criterion: Whether parents are both singletons

Mother	**Father**	**Eligibility**
Singleton	Non-singleton	No. Go to 2nd criterion
Non-Singleton	Singleton	No. Go to 2nd criterion
Singleton	Singleton	Yes

From Table 1, if both parents are singletons, the parents are 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 the singletons are very few and the chance to marry another singleton is therefore very small.

When neither the father nor the mother is a singleton, the second criterion applies, which depends on the second classification of *Hukou* of the mother and the sex of the first child.

Table 2: Second criterion: *Hukou* of the mother and the sex of the first child

Hukou	**Sex of the first child**	**Eligibility**
Agricultural	Boy	No
Agricultural	Girl	Yes
Non-Agricultural	Boy	No
Non-Agricultural	Girl	No

The table 2 shows that only *Agricultural* mother with the first child being a girl are eligible to have a second child. In contrast, a *Non-Agricultural* mother cannot apply to have a second child regardless of the sex of her first child. The conditions may appear odd at first because it seems that *Agricultural* families are privileged in fertility. This conditional privilege is determined by two facts specific to *Agricultural* families: (1)*Agricultural* families generally have a stronger desire for sons as men are more productive in agricultural activities; (2) rural areas are where most sex-selection behaviors take place. This condition thus provides incentive for strong son-preferred families to keep the first child when it is a girl. Overall, to solve the lack of men in agricultural production and remedy the sex-selection problem,

Agricultural families have the privilege of having a second child when the first child is a girl.

If a family does not meet the conditions but insists on having more children, an economic penalty will apply. To give an idea of how large the fine is, in Beijing it is roughly 3 to 10 times an individual's annual disposable income[3], which is a fairly large amount of money to an ordinary family. In addition to the economic penalty, anyone who works for the government or any state-owned corporations would face unemployment if she did not meet the conditions but had a second child. There are other narrow categories under which parents are free to have a second child, such as when the first child has an intellectural disability, etc. Since these are minor cases that are not representative of the population, I dismiss them in the analysis.

2.4 Impact of the OCP on the family size

After learning the policy, one might want to know if the OCP actually binds in China. Though estimating how much the reduction in the population is due to the OCP is not within the scope of this paper, I show on Figure 1 that the OCP effectively reduces the average family size since its implementation in the 1970s. Specifically, Figure 1 plots the average number of children ever born in a family. The average number of children per family remained stable at between 4 and 5 before 1970, and experienced a large drop in the 1970s. The average number decreases to 3.5 from 1970 to 1975, and further drops to 2.5 by 1980. Figure 2 is a comparison with the contemporary United States and Japan with data from the World Bank. The number in Figure 2 is more dramatic as it includes the total fertility rate[4]. Both figures show a great decrease in the number of children born per family in China during the 1970s after the OCP was introduced. Previous researchers have tried to estimate how much the reduction in fertility is attributed to the OCP, such as McElroy and Yang (2000), who estimate that removal of the policy would increase fertility by a third of a child per family. Multiple data show that a great deal of the reduction in the number of children is due to this policy, at least in the 1970s.

[3]Beijing Municipal Peoples Government Order No.111, Secion 5

[4]The number of children who would be born per woman if she/they were to pass through the childbearing years bearing children

3 Impact of the OCP on the education of girls

3.1 Interaction between number of children and gender-specific investment in each child

In this section, I develop a model of gender specific educational investment decision. I start with the basic Becker's framework and then I introduce to the model a parameter δ that represents parents' gender preference.

A Simple Model

Consider a parent with some level of altruism. Children's consumption enters her utility function.

$$\max \quad U^p(X_p, X_c) \tag{1}$$

$$s.t. \quad PX_p + t_c \leq I_p$$

$$PX_c \leq t_c$$

where X_p is the private good consumed by parent, and X_c is private good consumption by children, which is a sum of all children. $X_c = \sum_i^n X_{ci}$.
I_p is family income. $t_c = \sum_i^n t_{ci}$ is the transfer of resources from parents to children. It can be interpreted as money invested and time cost to raise children. At equilibrium, the budget constraints bind. The equilibrium condition for maximizing the utility function given by equation (1) subject to the income constraint is $\frac{MU_p}{MU_c} = \frac{P}{P} = 1$. A parent would transfer just enough resources to children so that parents would receive the same utility from increments to his own or to children's consumption.

Now introduce a parameter δ to capture parent's gender preference. $\delta > 1$ if a family prefers sons to daughters. The gender difference lies in t_{ci}, the amount of resources each group receives. Assume sons have priority to claim resources, then what remains will be shared by daughters. The resources distribution then follows:

$$\begin{cases} t_{cs} = \delta \dfrac{t_c}{n} \quad for\ each\ son \\ t_{cd} = \dfrac{t_c - \delta \frac{t_c}{n} n_s}{n_d} \quad fir\ each\ daughter \end{cases}$$

Where n is the number of children in the family $n = n_s + n_d$. n_s is the number of sons, and n_d is the number of daughters.

Proposition 1: *Daughters who have fewer siblings get more resources than those*

who have many siblings

Substituting $n_s = n - n_d$ into the resource distribution and rearrange, each daughter's resource can be rewritten as

$$t_{cd} = (\frac{1-\delta}{n_d} + \frac{\delta}{n})t_c$$

Comparing it with t_{cs}, the difference comes from the part $\frac{1-\delta}{n_d}t_c$. As forementioned, a boy-preferred family will have a $\delta > 1$, thus $\frac{1-\delta}{n_d}t_c < 0$, and so $t_{cd} < t_{cs}$. A higher δ will lead to a larger difference between daughters and sons. This part can be interpreted as a substitution effect: a parent substitutes the consumption on daughters with consumption on sons. The larger the δ is, the more parent would prefer sons, and the less resources the daughter would obtain.

When the total number of children n increases, the resource shares t_{cd} and t_{cs} both decrease, implying less resource to each group. Moreover, if the number of daughters n_d increases, the difference between sons and daughters will get larger. This can be interpreted as a negative income effect to daughters.

With the two effects, a daughter in a more boy-preferred family with more siblings will get less resource.

To link it to education achievement, think of education as a normal good, and it is (weakly) increasing in the investment an individual makes. This is intuitive. With all the other conditions hold equal, individuals who get more resources are more likely to obtain higher education outcome. As shown earlier, girls are usually at disadvantage in acquiring resources, thus their education attainment is on average lower than boys.

Hypothesis 1. The difference in education between boys and girls $\frac{1-\delta}{n_d}t_c$ should become smaller when the number of daughters n_d decreases, as a consequence of an exogenous decrease in the total number of children n born in a family.

3.2 Empirics

This section intends to show the empirical result in the impact of the OCP on the gender-specific education outcomes.

3.2.1 Identification Strategy

The identifying assumption for the empirical analysis is that controlling for an individual's *Hukou* status, if in absence of the OCP, the education attainment of

boys and girls should have parallel trend over time. Hence, the identification for this paper comes from the exogenous changes in the number of children per family imposed by the OCP across cohorts and *Hukou* status. This makes it possible to use a difference-in-difference-in-difference(DDD) to identify the causal effects. The DDD can be resolved into a twofold difference-in-difference(DD): (1) the causal effect of an reduction in number of siblings on education outcomes for boys and girls within each *Hukou* category. (2) since the OCP imposes different conditions for obtaining a second child permit for *Agricultural* and *Non-Agricultural* families, another DD strategy across *Hukou* can be used to identify the difference in the effects for *Agricultural* and *Non-Agricultural* children.

One may argue that there may exist sex-selection behaviors and thus the gender of a child may not be completely exogenous. Literature has looked into the ways that sex ratio may influence education outcome. For instance, Angrist(2002) observes that the sex ratio may affect the way marriage markets work and thus can have a differential impact on the education of men and women. A high sex ratio (more men than women) may make the marriage market more competitive for men, and thus incentivize them to improve their attractiveness by attaining higher education. The opposite would happen for women as a consequence of a less competitive marriage market. Thus we would expect the education level of men to increase and that of women to decrease. Another view argues the opposite: A high sex ratio will make the average education of girls higher because girls born after the policy is implemented are more likely to be the surviving girls whose parents are themselves more progressive. To learn more about the sex ratio in China, I plot the sex ratio graph during 1949-2000 on Figure A1. The data are from the 1982, 1990 and 2000 censuses. All three show that the sex ratio remains between 1 and 1.07 before 1982. Given the natural rate of 1.06, it should not be interpreted as aberrant. Recent work such as Chen et al. (2013) and Lin et al.(2014) suggest that the availability of sex detection technology may have been the proximate cause for the increase in the 1980s sex ratio. Nevertheless, to eliminate the concern, I include the prefecture-year sex ratio in the regression.

Another confonding factor I control for is the regional variation in education resources over time. Due to the incomplete data in China before the 1980s, the cross-regional government education investment data are difficult to find. Thus, I use the number of primary school teachers as a proxy for education investment. Before the 1990s, almost all the schools are public schools sponsored by the state, so the government education expenditures should be highly correlated with the number of teachers hired.

3.2.2 Data

The main data in this section are from 2000 China 0.95% census, which incorporates basic demographic and educational information. I restrict the data to *Han* individuals born during 1960-1982 to make sure that the youngest generation had at least completed pre-university education by 2000. The education outcomes are measured as the total schooling years according to an individual's highest education degree. The data on the primary school teacher is from the China Statistical Yearbook 2014, measured at prefecture-year level.

3.2.3 Empirical Results

Figure 3 displays the gender-specific education attainment over time. Notice that the education attainment of *Non-Agricultural* children strictly overrides *Agricultural* children. Possible reasons for the significant difference are (1) *Agricultural* children are more likely to live and attend schools in rural areas, where education resources are not as rich as urban areas. Besides, *Agricultural* children are more likely to do farm work and higher education is not as valued in agriculture as in urban industries; (2) Previous literature has looked into this performance disparity and tried to establish a causal link with one's social identity. For instance, Afridi, Li and Ren(2015) documents that the institutionally imposed social identity, *Hukou* itself, can significantly reduce the performance of rural students.

Figure 4 and 5 illustrate the education attainment for *Agricultural* and *Non-Agricultural* children, respectively. The yearly growth are also shown. From 1960 to 1970, the education gap between boys and girls is large and steady with yearly growth around 0. Since 1970, girls have shown significantly accelerating growth in education, and the gender gap narrowed by the beginning of the 1980s. To compare the education attainment of boys and girls before and after the implementation of the OCP, the main DDD specification is as follows:

$$\begin{aligned} Y_{ic} = \; & \alpha + \beta_1 \; Girl_i + \beta_2 \; Post_c + \beta_3 Agricultural_i \\ & + \gamma_1 \; (Girl_i \times Post_c) + \gamma_2 \; (Girl_i \times Agricultural_i) + \gamma_3 (Post_c \times Agricultural_i) \\ & + \theta_1 (Girl_i \times Post_c \times Agricultural_i) + \xi \; X_i + \eta F_i + \epsilon_{ic} \end{aligned} \tag{2}$$

Where Y_{ic} is years of education that an individual has completed. $Girl_i = 1$ if the individual is female. $Post_c = 1$ if an individual is born in 1971 or later. $Agricultural_i = 1$ if an individual has her *Hukou* status registered as *Agricultural*, 0 if *Non-Agricultural*. X_i is additional controls including the sex ratio and the primary school teacher quantiles. F_i are birthplace and birth year fixed effects.

Table I shows the regression results. The significant negative coefficient of *Girl* indicates that girls are at a disadvantage in obtaining education during the pre-OCP period. The positive coefficients of $Post \times Girl$ indicates that girls born during the post-OCP period stay in school significantly longer, and the gender gap in education significantly narrowed. For instance, column (5) shows that in the pre-OCP period, *Non-Agricultural* girls on average attend school 0.609 years less than *Non-Agricultural* boys; during the post-OCP period, the gender gap narrows by one half. Similarly, the *Agricultural* girls on average attend school 0.428 years less than *Agricultural* boys, and the gap narrowed by 0.233 in the post-OCP period. Moreover, Comparing the gender gap changes in *Agricultural* and *Non-Agricultural* groups indicates that the OCP has a larger impact on improving the education of *Agricultural* girls.

The magnitude of the coefficients suggest that the effect of the OCP is not negligible. The institutionally imposed family planning policy effectively reduced the number of children in a family and thus made the previously education-deprived girls to obtain more education. The narrowed gender gap in education will bring about long-lasting effect on the gender inequality in the society and on the economic growth.

3.2.4 Robustness Check

To conduct a robustness check to the main specification, I make use of the Nine-Year Compulsory Education policy that was implemented in 1985. This policy aims to keep all the schooling-age children (6-15) in school until they complete 9th grade. As education is compulsory and almost free of charge (no tuition in public schools; parents need to pay only a small amount of money to cover books and other material expenses), the education level rises partly for this reason. As higher education costs much more than 9-year public schooling, parents have to make an investment decision subject to their family budget. Before the One Child Policy was implemented, most families could not afford the expenses to support all their children to continue their education, and thus had to decide which one to send to school and which one do not. Usually, boys are prioritized over girls within a family, and consequently receive more education than girls. To tease out this confounding effect, I look at the chance of getting a higher education (education beyond 9th grade). The outcome variable is a binary varibale, equal to 1 if an individual has more than 9 years education, 0 otherwise. The regression result can be found in Appendix Table A1 and Table A2 , and the main effects are the same: Girls are more likely to continue education, compared to boys, after the OCP was implemented.

3.2.5 Placebo Test

As mentioned in the background section, the OCP imposes a more loose condition on minorties in China. Minorities are generally allowed to have two children, regardless of the sex of the first child. *Agricultural* minorities, in particular, can apply to have three or more children. Accordingly, when performing the same regression with minorities, we will expect to find a significant result for $Post \times Girl$, but not significant for $Post \times Girl \times Agricultural$, because an *Agricultural* minority did not experience a sharp drop in family size, and therefore the girls would not benifit much from the quantity-quality tradeoff. Table 3 is the regression result. Column (2) shows that during the post-OCP period, the education level of minority boys has improved approximately the same amount (0.4 years) as that for *Han* boys. As expected, the coefficient of $Post \times Girl$ in the minorities group is significant and similar to that for *Han*, implying a significant and positive effect of the OCP on the education of *Non-Agricultural* girls. The insignificant results of $Post \times Girl \times Agricultural$ and $Post \times Agricultural$ are consistent with our expectation, which implies that the effect of the OCP on improving the education of *Agricultural* girls is not significant different from zero. This placebo test validates the identification strategy and provides further evidence to hightlight the quality-quantity trade-off mechanism that is brought on by the OCP.

4 Intergenerational Externality of the One Child Policy

Since 1982, *Agricultural Hukou* holders have been permitted to obtain a second-child permit conditional on the first child being a girl. Since *Hukou* is a birth-subscribed system dating back to the establishment of the PRC, *Hukou* together with the sex of first child can be seen as exogenous to the number of children in a family. As a consequence, most OCP children are either a singleton or have one sibling. It has been almost 40 years since the OCP was formulated, and the oldest OCP generations are already old enough to make fertility decisions of their own. Therefore, I am interested in whether there are systematic difference in fertility decisions between singletons and non-singletons. As far as I know, no previous study has examined the relationship between being a singleton and her fertility preference. A plausible guess is that since singleton girls are not treated differently as they grow up, they are more likely to develop more neutral gender preferences, which will be reflected in their fertility decision. Another source

is income effect. Since singletons are the only ones to financially take care of their parents, while non-singletons can share this expenditure, singletons have less money left to raise children, which will also be reflected in their fertility decision.

4.1 Conceptual model framework

As fore mentioned, parents invest in children in order to receive future return when they retire. So an adult not only needs to financially support their own children but also to make transfer to their parents. To take both into account, I utilize an overlapping generation model to demonstrate.

There are three periods, t, t+1 and t+2, representing young, middle and old ages respectively. Individuals supply labor at young and middle, make fertility decisions in the end of period t, raise children in period t+1, and retire in period t+2. Consider an individual born at t, the individual earns the competitive wage $w_{y,t}$ at young and $w_{m,t+1}$ at middle age. $q(n_t)$ is the probability of having at least a son in all the children. Intuitively, it is an increasing concave function with n_t. For example, suppose the unconditional probability of bearing a son or a daughter is equal. When a family chooses to have only one child, the probability of having a son is 0.5; when a family chooses two children, the probability of having at least a son becomes higher at 0.75 ($= 1 - 0.5^2$), and similarly, for a family with 3 children, the probability $q(n_t)$ is 0.875 ($= 1 - 0.5^3$).

I normalized the utility of having daughters to 1, and the utility of having sons to γ. Thus a boy-preferred family will have a $\gamma > 1$. Since child sex is ex-ante unknown, a family makes decision only on how many children n_t to have . The expected utility from children is $q(n_t)log(\gamma) + (1 - q(n_t))log(1)] = q(n_t)log(\gamma)$.

Assume there is no tax. The utility of the individual takes the following term:

$$\max_{c_{y,t},c_{m,t+1},n_t} U_t = log(c_{y,t}) + \mathbb{1}_{n_t>0}\left(v[log(\alpha) + q(n_t)log(\gamma)]\right) + \beta log(c_{m,t+1}) + \beta^2 log(c_{o,t+2}) \tag{3}$$

$$\begin{aligned} s.t. \qquad c_{y,t} + a_{y,t} &= w_{y,t} \\ c_{m,t+1} + a_{m,t+1} &= w_{m,t+1} + R_{t+1}a_{y,t} - T_{m,t+1} \\ c_{o,t+2} &= R_{t+2}a_{m,t+1} + T_{o,t+2} \end{aligned}$$

The discount rate $0 < \beta < 1$. $\mathbb{1}_{n_t>0} = 1$, if an individual has child $n_t > 0$; else, $\mathbb{1}_{n_t>0} = 0$, if an individual does not have child. $v > 0$ is the preference for children

in general. Having child generally brings $log(\alpha)$ amount of utility to an individual.

At young, an individual can borrow a fraction θ of the present value of his future labor income. Assume that the credit constraint on the young is binding. The net asset holding at the end of period t is

$$a_{y,t} = -\theta \frac{w_{m,t+1}}{R_{t+1}} \tag{4}$$

$T_{m,t+1}$ is the total transfer from middle age individuals at t+1 to parents and children.

$$T_{m,t+1} = w_{m,t+1}(\phi_{t+1} n_t + \psi_{t+1}) \tag{5}$$

Where ϕ and ψ are the proportion of wage transfered to the individual's children and parents, respectively.

Similarly, $T_{o,t+2}$ is the transfer received from children when old.

$$T_{o,t+2} = \psi_{t+2} w_{m,t+2} n_t \tag{6}$$

Solve this maximization problem (proof in Appendix), and get the optimal consumption at t+1 .

$$C_{m,t+1} = \frac{1}{1+\beta}[(1-\theta)w_{m,t+1} - T_{m,t+1} + \frac{T_{o,t+2}}{R_{t+2}}] \tag{7}$$

The F.O.C wrt n_t implies that

$$vlog(\gamma)\frac{\partial q(n_t)}{\partial n_t} R_{t+2} c_{m,t+1} + \frac{\beta}{1+\beta} R_{t+2}(-w_{m,t+1}\phi_{t+1}) + \beta^2(\psi_{t+2} w_{m,t+2}) = 0 \tag{8}$$

Proposition 2: *Individuals with higher gender preference (larger γ) will want to have more children (larger n_t)*

From equation(8), we can get an expression for $\frac{\partial n_t}{\partial \gamma}$ (proof in Appendix),

$$\frac{\partial n_t}{\partial \gamma} = -\frac{\frac{1}{\gamma}\frac{\partial q(n_t)}{\partial n_t}}{\frac{\partial^2 q(n_t)}{\partial {n_t}^2} log(\gamma)}$$

As aforementioned, $q(n_t)$ is an increasing concave function of n_t, thus $\frac{\partial q(n_t)}{\partial n_t} > 0$ and $\frac{\partial^2 q(n_t)}{\partial {n_t}^2} < 0$. Besides, a boy-preferred family will have $\gamma > 1$, and thus $log(\gamma) > 0$. All together lead to $\frac{\partial n_t}{\partial \gamma} > 0$. The positive relationship shows that individual with high γ will have a high n_t, that is, to have more children.

Proposition 3: *Individuals who need to transfer a larger amount of income to*

their retired parents (larger ψ_{t+1}) will want to have fewer children(smaller n_t)

Again from equation (8), we can derive the relationship between ψ_{t+1} and n_t(proof in Appendix).

$$\frac{\partial n_t}{\partial \psi_{t+1}} = \frac{\frac{\partial q(n_t)}{\partial n_t} w_{m,t+1}}{\frac{\partial^2 q(n_t)}{\partial {n_t}^2}(1+\beta)c_{m,t+1}} < 0 \; because \; of \; the \; concavity \; of \; q(n_t)$$

Literally, for adults who bear a heavier burden to take care of their retired parents, they tend to want fewer children. This particularly concerns the situations in China, where social security insurance, especially endowment insurance, is not complete, and therefore the responsibility of supporting the elderly still falls on the shoulders of their children. Since singletons do not have siblings to share this responsibility, they usually face a higher ψ_{t+1}.

Proposition 2 and 3 predict the following hypothesis:

Hypothesis 2. As singleton daughters possibly have a more neutral gender preference (smaller γ) and more financial obligations for the retired parents (larger ψ_{t+1}), when making fertility decisions, they should want fewer children (smaller n).

4.2 Empirics

4.2.1 Data

The data I use in this section are from China Family Panel Studies (CFPS), funded by the 985 Program of Peking University and carried out by the Institute of Social Science Survey of Peking University. The baseline data were collected in 2010, and were followed up in 2012. Since I am looking at the fertility decision of the singleton generation, the singleton generation must be old enough to make fertility decisions. According to Fu et al.(2013), more than 75% of women choose to have a second child before age 32; therefore, I limit the sample to mothers who are at least older than 32, at which age the family structure has very likely been determined.

4.2.2 Empirical result

To learn if there is a causal relationship between being a singleton and her fertility preference, I run the following regression:

$$\begin{aligned} Y_i = \quad & \alpha + \beta_1 \; Singleton_i + \beta_2 \; First \; Child \; being \; a \; Girl_i \\ & + \beta_3 (Singleton_i \times \; First \; Child \; being \; a \; Girl_i) + \gamma \; F_i + \epsilon_i \end{aligned}$$

Where Y_i is the dependent binary variable, equal to 1 if the individual has more than one child, 0 otherwise. $Singleton_i$ equals to 1 if the mother is a singleton in her own family, 0 otherwise. $First \; Child \; being \; a \; girl = 1$ if the first child is a girl, 0 if it is a boy. F_i are controls including living place and birth year fixed effect.

Table 4 shows the regression result. The individuals in the sample have birth years spanning 1971 to 1981. The youngest generation is age 32 by the time of the survey. The coefficients could be interpreted as an individual's fertility preference conditional on knowing the sex of the first child. Recall that the OCP states that if an individual herself is a singleton, she could find a singleton husband and then they would be eligible to have second child with no fine applied, but the result shows that being singleton actually makes her preference to have more than one child decrease by 13%. In addition, conditional on having a daughter as the first child, a singleton mother is 15% less likely to want more children.

The regression result confirms the hypothesis that singleton individuals are less likely to have more children. To the best of my knowledge, this finding has not been documented in previous literature. The reason behind this finding could be many: gender preference, income constraint, etc. In section 4.1, I provided a conceptual model to illustrate how gender preference and income constraint can affect an individual's fertility chocie. It is difficult to identify the only mechanism since preference is endogenous and based on other characteristics. The income effect would be easy to check if I had data on individual income and the amount of money transferred back to parents. In any case, singletons have shown a different fertility preference from non-singletons. This finding is remarkable. It shows that the endogenous fertility preference has changed, in the sense that the singleton generations, by themselves, prefer fewer children, compared to the contemporary non-singletons. Thus, although the OCP was relaxed in October 2015, and all families are now allowed to have two children, the number of children may not grow as quickly as hoped.

5 Conclusion

In this study, I found that reduction in family size has a significant positive effect on the education of girls, and it has intergenerational externality on singleton girls' fertility decisions. I developed a model to explain why girls with fewer siblings would obtain more resources and investment than those with more siblings, and thus attain better education outcomes. Then in the empirical part I employed a difference-in-difference-in-difference strategy to compare the education outcome between boys and girls during the pre- and post- OCP period for *Agricultural* and *Non-Agricultural Hukou* holders. The result shows that the OCP has a significant positive effect on girls' education after controlling for the common time trend, sex ratio, and government education investment.

In the second part, I found that the singletons generations, as a product of the OCP, now by themselves, prefer fewer children, compared to the contemporary non-singletons. I then used an overlapping generation model to illustrate the possible chanels that may involve, such as singleton's less gender preference and tighter budget constraint.

Overall, the main result is a strong positive impact of the family planning policy on the improvement of girls' education. The findings have significant policy implications for countries that are considering family planning policies, especially societies that have high fertility rates and sex discrimination.

Reference

[1] Afridi, Farzana, Sherry Xin Li, and Yufei Ren. "Social identity and inequality: The impact of China's hukou system." Journal of Public Economics 123 (2015): 17-29.

[2] Angrist, Josh. "How do sex ratios affect marriage and labor markets? Evidence from America's second generation." Quarterly Journal of Economics (2002): 997-1038.

[3] Anukriti, S. "Financial Incentives and the Fertility-Sex Ratio Trade-off." (2014).

[4] Becker, Gary S. "Altruism, egoism, and genetic fitness: Economics and sociobiology." Journal of economic Literature (1976): 817-826.

[5] Becker, Gary S., and Robert J. Barro. "Altruism and the economic theory of fertility." Population and Development Review (1986): 69-76.

[6] Banerjee, Abhijit, Esther Duflo, and Nancy Qian. On the road: Access to transportation infrastructure and economic growth in China. No. w17897. National Bureau of Economic Research, 2012.

[7] Cavalcanti, Tiago, and JosTavares. "The Output Cost of Gender Discrimination: A ModelBased Macroeconomics Estimate." The Economic Journal (2015).

[8] Chan, Kam Wing, and Li Zhang. "The hukou system and rural-urban migration in China: Processes and changes." The China Quarterly 160 (1999): 818-855.

[9] Coeurdacier, Nicolas, Stphane Guibaud, and Keyu Jin. "Fertility Policies and Social Security Reforms in China." IMF Economic Review 62.3 (2014): 371-408.

[10] Choukhmane, Taha, Nicholas Coeurdacier, and Keyu Jin. "The One-Child policy and household savings." (2013).

[11] Dollar, David, and Roberta Gatti. "Gender inequality, income, and growth: are good times good for women?". Vol. 1. Washington, DC: Development Research Group, The World Bank, 1999.

[12] Hanushek, Eric A. "The trade-off between child quantity and quality." Journal of political economy (1992): 84-117.

[13] Horton, Susan. "Child nutrition and family size in the Philippines." Journal of Development economics 23.1 (1986): 161-176.

[14] Hsieh, Chang-Tai, Erik Hurst, Charles I. Jones, and Peter J. Klenow. "The allocation of talent and us economic growth". No. w18693. National Bureau of Economic Research, 2013.

[15] Klasen, S. (2002). "Low schooling for girls, slower growth for all? Crosscountry evidence on the effect of gender inequality in education on economic development". The World Bank Economic Review, 16(3), 345-373.

[16] Klasen, Stephan, and Francesca Lamanna. "The impact of gender inequality in education and employment on economic growth: new evidence for a panel of countries." Feminist economics 15, no. 3 (2009): 91-132.

[17] Li, Lixing, and Xiaoyu Wu. "Gender of children, bargaining power, and intrahousehold resource allocation in China." Journal of Human Resources 46.2 (2011): 295-316.

[18] Liao, Pei-Ju. "The one-child policy: A macroeconomic analysis." Journal of Development Economics 101 (2013): 49-62.

[19] Lundberg, Shelly, and Robert A. Pollak. "Separate spheres bargaining and the marriage market." Journal of political Economy (1993): 988-1010.

[20] Manser, Marilyn, and Murray Brown. "Marriage and household decision-making: A bargaining analysis." International economic review (1980): 31-44.

[21] McElroy, Marjorie B., and Mary Jean Horney. "Nash-bargained household decisions: Toward a generalization of the theory of demand." International economic review (1981): 333-349.

[22] Pop-Eleches, Cristian. "The supply of birth control methods, education, and fertility evidence from romania." Journal of Human Resources 45.4 (2010): 971-997.

[23] Qian, Nancy. "Quantity-quality and the one child policy: The only-child disadvantage in school enrollment in rural China". No. w14973. National Bureau of Economic Research, 2009.

[24] Qian, Nancy. "Missing women and the price of tea in China: The effect of sex-specific earnings on sex imbalance." (2006). Rosenzweig, Mark R., and Kenneth I. Wolpin. "Testing the Quantity-quality Fertility Model: The Use of Twins as a Natural Experiment". Econometrica 48.1 (1980): 227—240

[25] Rosenzweig, Mark R., and Zhang, Junsen. "Do population control policies induce more human capital investment? Twins, birth weight and China's 'one-child' policy." The Review of Economic Studies 76.3 (2009): 1149-1174.

[26] Rosenzweig, Mark R., and Junsen Zhang. "Economic growth, comparative advantage, and gender differences in schooling outcomes: Evidence from the birthweight differences of Chinese twins." Journal of Development Economics 104 (2013): 245-260.

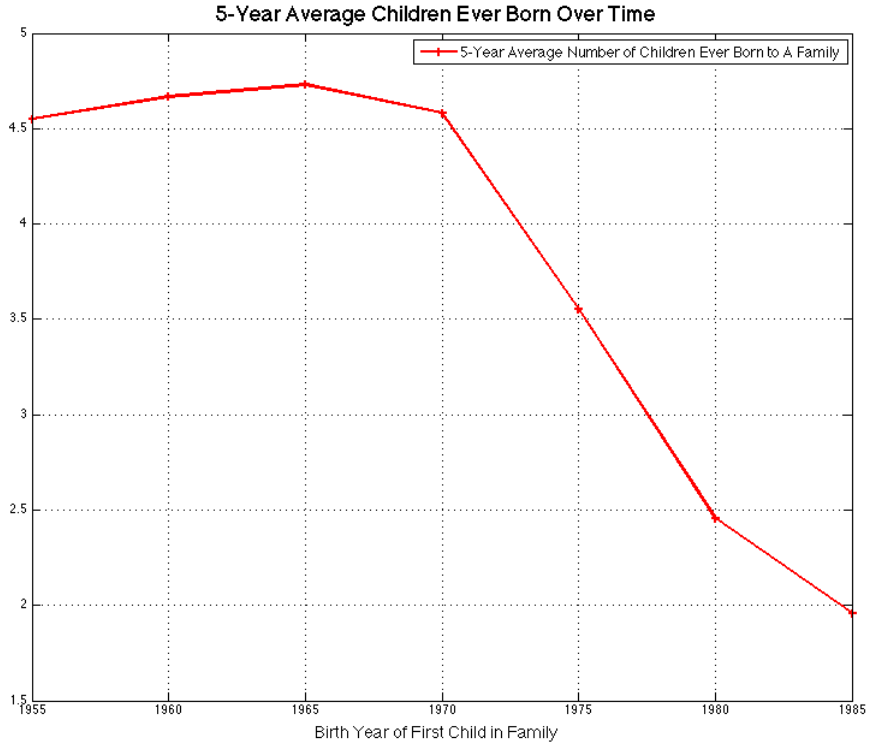
[27] Schuler, Sidney Ruth, Syed Mesbahuddin Hashemi, and Ann P. Riley. "The influence of women's changing roles and status in Bangladesh's fertility transition: evidence from a study of credit programs and contraceptive use." World Development 25.4 (1997): 563-575.

[28] Sousan Abadian, "Women's autonomy and its impact on fertility", World Development, Volume 24, Issue 12, December 1996, Pages 1793-1809, ISSN 0305-750X

[29] Tarozzi, Alessandro, and Aprajit Mahajan. "Child nutrition in India in the nineties." Economic Development and Cultural Change 55.3 (2007): 441-486.

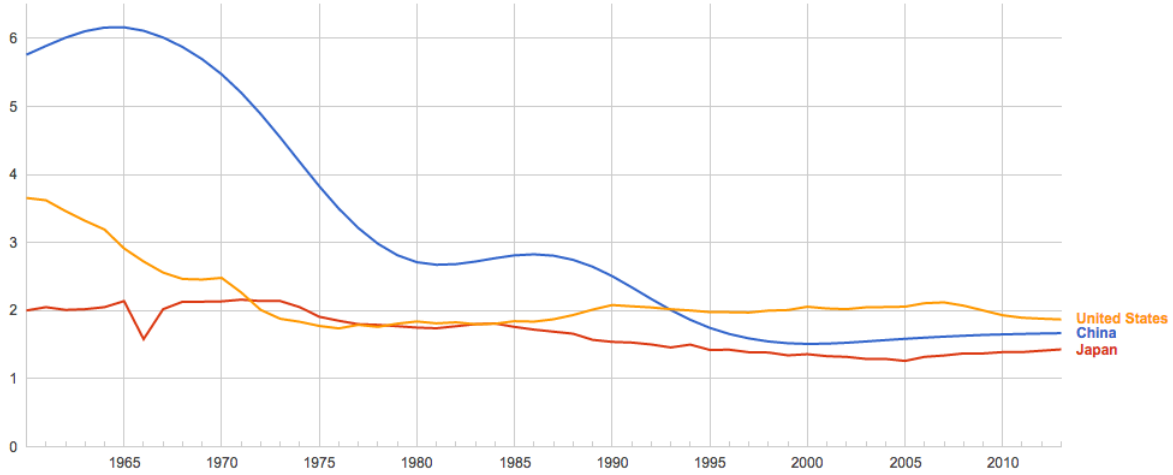
[30] Zhu, Wei Xing, Li Lu, and Therese Hesketh. "China' s excess males, sex selective abortion, and one child policy: analysis of data from 2005 national intercensus survey." BMJ 338 (2009): b1211.

Figure 1: 5-Year Average Number of Children Ever Born in a Family



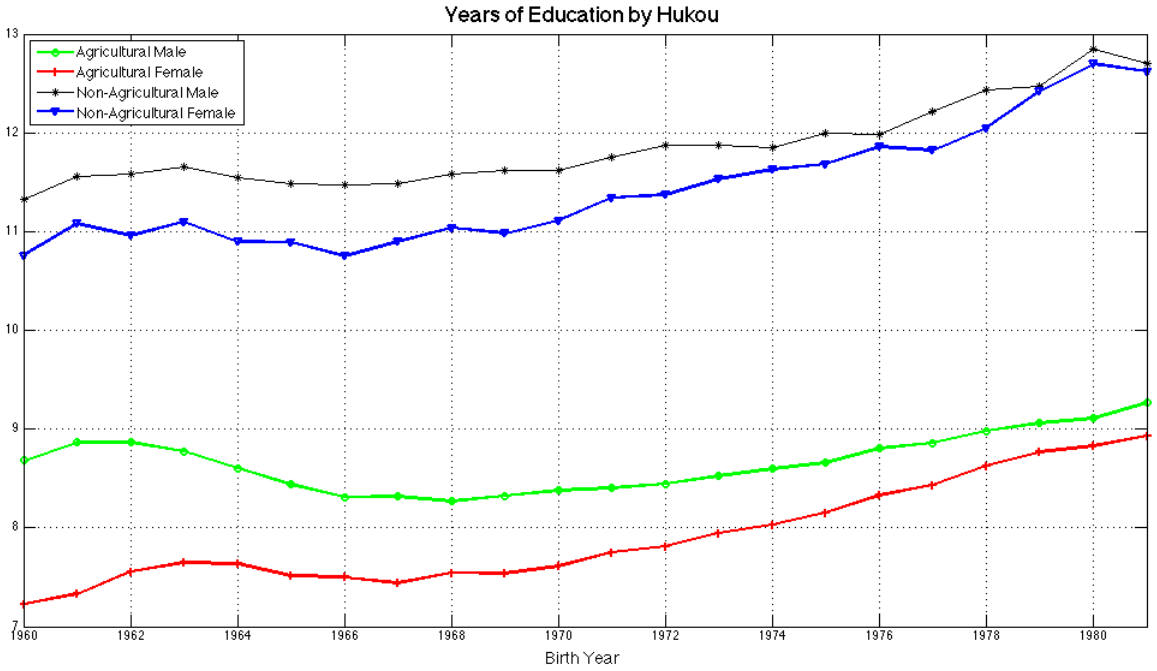
Notes: This figure depicts 5-year average number of children ever born in a family. Population growth reached a peak after the end of 1959-1962 The Three Years of Great Chinese Famine. With family planning policy implemented in 1972, a significant drop in the population followed right after. It implies that the One Child Policy effectively reduced the family size.

Figure 2: Total Fertility Rate



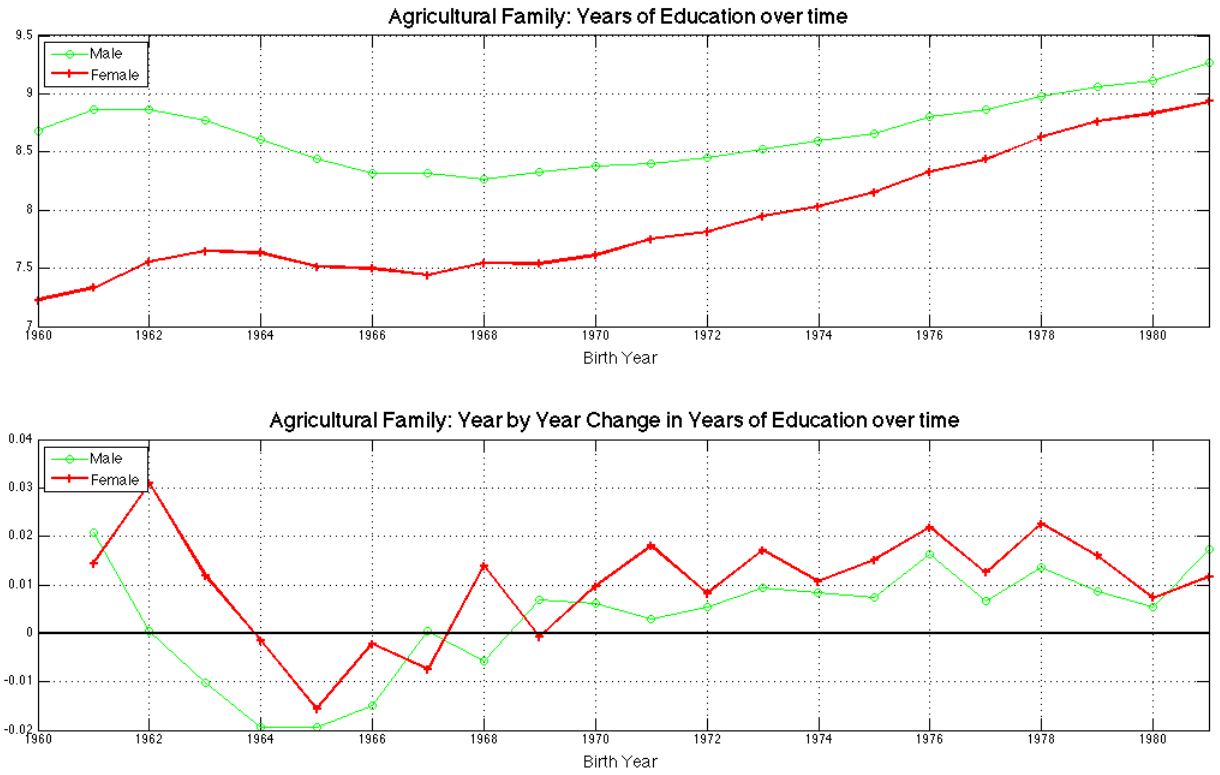
Notes: This figure shows the Total Fertility Rate from World Bank. It provides a comparison with contemporary U.S. and Japan. China shows the same pattern as in Figure 1. The numbers are more dramatic, because Total Fertility Rate is the number of children who would be born per woman if she/they were to pass through the childbearing years bearing children, while in Figure 1 I use the actual children ever born in a family.

Figure 3: Years of Education by *Hukou*



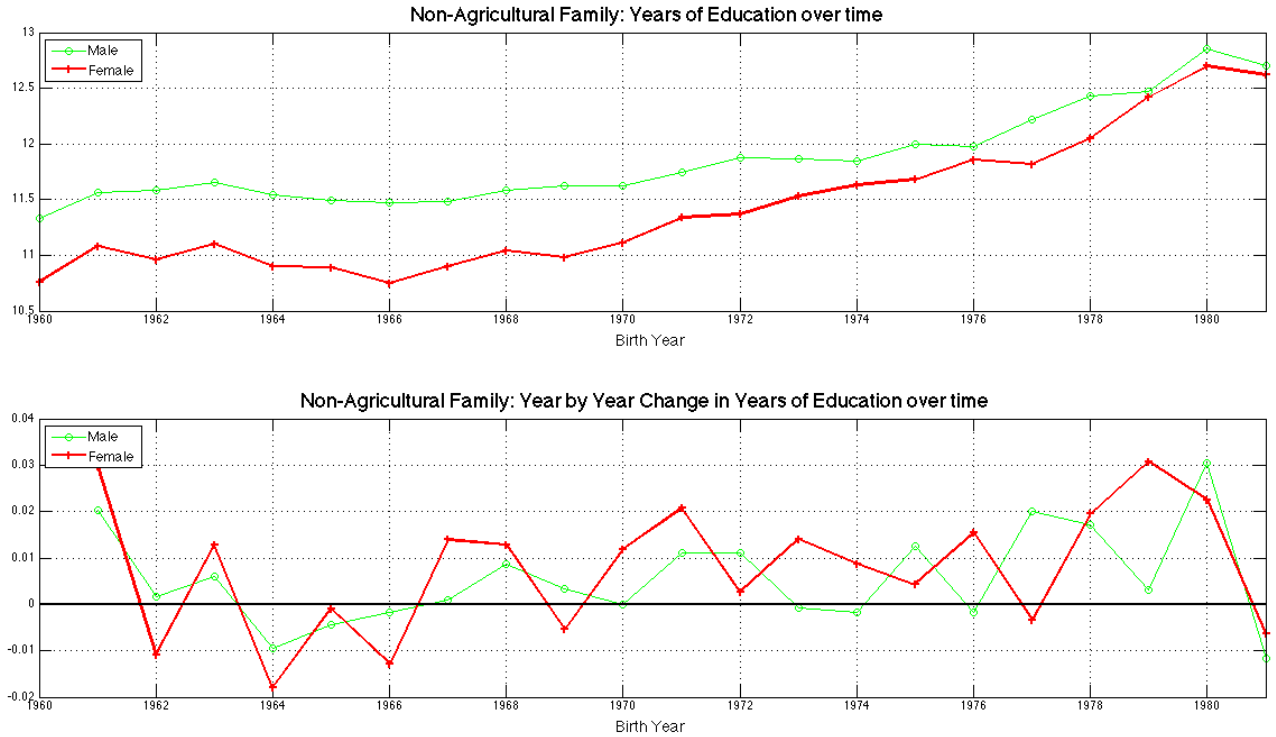
Notes: This figure shows the education development for boys and girls, classified by *Agricultural* and *Non-Agricultural* based on their *Hukou*. Notice that *Non-Agricultural* generally overrides *Agricultural*. The education gap by gender narrowed in the 1970s, and the education of girls growed faster than boys in both *Hukou* groups.

Figure 4: Years of Education and Year by Year Change: *Agricultural*



Notes: This figure shows the education of *Agricultural* and its yearly growth. In the 1970s, the yearly growth of girls started to accelarate, and overrided boys ever since.

Figure 5: Years of Education and Year by Year Change: *Non-Agricultural*



Notes: This figure shows the education of *Non-Agricultural* and its yearly growth. It experienced a low period from 1964 to 1969, then the education of *Non-Agricultural* girls started to rise in 1970 and reached the same level as in 1963; it keeps a positive growth every year since then.

Table I: Education Attainment for *Han* Ethnicity

Dependent Variable: Schooling years	(1)	(2)	(3)	(4)	(5)
Post	0.376***	0.870***	0.608***	1.193***	0.473***
	(0.013)	(0.036)	(0.020)	(0.034)	(0.041)
Girl	-0.917***	-0.898***	-0.587***	-0.586***	-0.609***
	(0.012)	(0.012)	(0.019)	(0.019)	(0.028)
Post × Girl	0.483***	0.474***	0.298***	0.305***	0.318***
	(0.018)	(0.018)	(0.029)	(0.028)	(0.032)
Agricultural			-3.047***	-2.972***	-2.947***
			(0.016)	(0.016)	(0.018)
Post × Agricultural			-0.358***	-0.340***	-0.361***
			(0.024)	(0.023)	(0.025)
Girl × Agricultural			-0.386***	-0.374***	-0.428***
			(0.023)	(0.022)	(0.025)
Post × Girl × Agricultural			0.202***	0.176***	0.233***
			(0.034)	(0.033)	(0.036)
Additional Controls	No	No	No	No	Yes
Living Place FE	No	Yes	No	Yes	Yes
Birth Year FE	No	Yes	No	Yes	Yes
Observations	354509	354509	353233	353233	290076
Adjusted R^2	0.030	0.109	0.331	0.367	0.370

Notes: The table reports the effects of the One Child Policy on the education of girls. The sample is restricted to *Han* ethnicity. The dependent variable is the number of years an individual attends school. *Girl*, *Post* and *Agrigultural* are binary variables for individual being a girl, born during the post-OCP period and holding an *Agrigultural Hukou*. Additional controls include *Sex Ratio* and *Teacher Number*. Sex Ratio is calculated as $\frac{NumberofMale}{Numberoffemale}$ at the Prefecture-Year level. It is then ordered and assigned into 4 quantiles. *Sex ratio Quantile 2, 3 and 4* are included. *Quantile 1*, is the reference group and is thus dropped from the regression. *Teacher Number* is the number of primary shcool teacher at the Prefecture-Year level. It is then ordered and assigned into 4 quantiles. *Teacher Number Quantile 2, 3 and 4* are included. *Quantile 1*, is the reference group and is thus dropped from the regression. Standard errors in parenthesis: * significant at 10%; ** significant at 5%; *** significant at 1%.

Table II: Robustness Check: Education Beyond 9th Grade

Binary dependent variable: $Y_{ic} = 1$ **if education is beyond 9th grade**	(1)	(2)	(3)	(4)	(5)
Post	0.055***	0.131***	0.014***	0.103***	0.017**
	(0.002)	(0.005)	(0.003)	(0.006)	(0.007)
Girl	-0.156***	-0.154***	-0.023***	-0.023***	-0.042***
	(0.002)	(0.002)	(0.003)	(0.003)	(0.005)
Post × Girl	0.079***	0.078***	0.019***	0.018***	0.018***
	(0.003)	(0.003)	(0.005)	(0.005)	(0.005)
Agricultural			-0.226***	-0.216***	-0.210***
			(0.003)	(0.003)	(0.003)
Post × Agricultural			0.057***	0.057***	0.060***
			(0.004)	(0.004)	(0.004)
Girl × Agricultural			-0.178***	-0.176***	-0.183***
			(0.004)	(0.004)	(0.004)
Post × Girl × Agricultural			0.077***	0.075***	0.081***
			(0.006)	(0.006)	(0.006)
Additional Controls	No	No	No	No	Yes
Living Place FE	No	Yes	No	Yes	Yes
Birth Year FE	No	Yes	No	Yes	Yes
Observations	354509	354509	353233	353233	290076
Adjusted R^2	0.035	0.093	0.127	0.171	0.168

Notes: The table reports the effects of the One Child Policy on the non-compulsory education attainment of girls. The sample is restricted to *Han* ethnicity. The dependent variable is equal to 1 if individual has education beyond the 9th grade. *Girl*, *Post* and *Agrigultural* are binary variables for individual being a girl, born during the post-OCP period and holding an *Agrigultural Hukou*. Additional controls include *Sex Ratio* and *Teacher Number*. Sex Ratio is calculated as $\frac{NumberofMale}{Numberoffemale}$ at the Prefecture-Year level. It is then ordered and assigned into 4 quantiles. *Sex ratio Quantile 2, 3 and 4* are included. *Quantile 1*, is the reference group and is thus dropped from the regression. *Teacher Number* is the number of primary shcool teacher at the Prefecture-Year level. It is then ordered and assigned into 4 quantiles. *Teacher Number Quantile 2, 3 and 4* are included. *Quantile 1*, is the reference group and is thus dropped from the regression. Standard errors in parenthesis: * significant at 10%; ** significant at 5%; *** significant at 1%.

Table III: Education Attainment for *Minorities*

Dependent Variable: Schooling years	(1)	(2)	(3)	(4)	(5)
Post	0.116**	0.221	0.250***	0.221	0.488***
	(0.057)	(0.153)	(0.093)	(0.157)	(0.177)
Girl	-0.868***	-0.888***	-0.507***	-0.530***	-0.480***
	(0.056)	(0.053)	(0.094)	(0.092)	(0.125)
Post × Girl	0.481***	0.551***	0.313**	0.419***	0.401***
	(0.081)	(0.076)	(0.134)	(0.130)	(0.141)
Agricultural			-3.559***	-3.409***	-3.370***
			(0.075)	(0.074)	(0.078)
Post × Agricultural			-0.237**	-0.144	-0.145
			(0.108)	(0.105)	(0.110)
Girl × Agricultural			-0.389***	-0.365***	-0.389***
			(0.108)	(0.105)	(0.111)
Post × Girl × Agricultural			0.134	0.046	0.146
			(0.154)	(0.150)	(0.156)
Additional Controls	No	No	No	No	Yes
Living Place FE	No	Yes	No	Yes	Yes
Birth Year FE	No	Yes	No	Yes	Yes
Observations	20165	20165	20075	20075	18136
Adjusted R^2	0.017	0.135	0.342	0.387	0.384

Notes: The table reports the effects of the One Child Policy on the education of *Minority* girls. *Minority* is defined as all the ethnicities in China except the major ethnicity *Han*. The dependent variable is the number of years an individual attends school. *Girl*, *Post* and *Agrigultural* are binary variables for individual being a girl, born during the post-OCP period and holding an *Agrigultural Hukou*. Additional controls include *Sex Ratio* and *Teacher Number*. Sex Ratio is calculated as $\frac{NumberofMale}{Numberoffemale}$ at the Prefecture-Year level. It is then ordered and assigned into 4 quantiles. *Sex ratio Quantile 2, 3 and 4* are included. The lowest quantile, *Quantile 1* is the reference group and is thus dropped from the regression. *Teacher Number* is the number of primary shcool teacher at the Prefecture-Year level. It is then ordered and assigned into 4 quantiles. *Teacher Number Quantile 2, 3 and 4* are included. *Quantile 1* is the reference group and is thus dropped from the regression. Standard errors in parenthesis: * significant at 10%; ** significant at 5%; *** significant at 1%.

Table IV: Fertility Decision of the Singleton Generation

Binary dependent variable: $Y_i = 1$ **if more than one child**	(1)	(2)
Singleton	-0.275***	-0.129**
	(0.061)	(0.056)
First child being a girl	0.180***	0.184***
	(0.020)	(0.018)
Singleton × First child being a girl	-0.087	-0.155*
	(0.087)	(0.079)
Living Place FE	No	Yes
Birth Year FE	No	Yes
Observations	2475	2475
Adjusted R^2	0.051	0.228

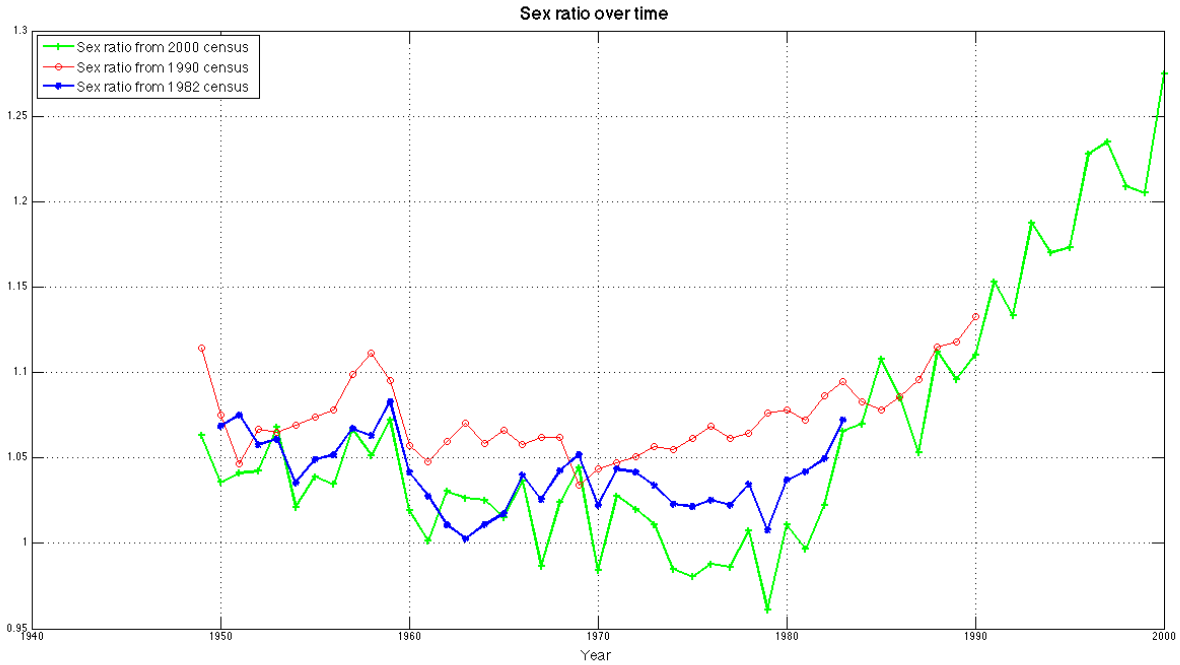
Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table reports the effects of being a singleton on her fertility decisions regarding a second child. The dependent variable is coded to 1 if an individual has more than one child, 0 otherwise. *Singleton* is equal to 1 if the individual is a singleton in her family. *First Child Being a Girl* is equal to 1 if the first child is girl, 0 otherwise. Standard errors in parenthesis: * significant at 10%; ** significant at 5%; *** significant at 1%.

Appendix

Figure A1: Sex Ratio over Time



Notes: This figure depicts the sex ratio over time. It is calculated as $\frac{NumberofMale}{Numberoffemale}$. The data are from 1982, 1990 and 2000 censuses. All the three series show that the sex ratio remains between 1 and 1.07 before 1982. Given the natural rate of 1.06, it should not be interpreted as very aberrant. The sex ratio becomes more imbalanced with the introduction of ultrasonic fetal sex diagnosis in the late 1980s.

Proof

Utility Maximization Problem in equation(3)

Substituting Equation (4) into the three constriants,

$$c_{y,t} = w_{y,t} + \theta \frac{w_{m,t+1}}{R_{t+1}}$$
$$a_{m,t+1} = (1-\theta)w_{m,t+1} - c_{m,t+1} - T_{m,t+1}$$
$$c_{o,t+2} = R_{t+2}[(1-\theta)w_{m,t+1} - T_{m,t+1} - C_{m,t+1}] + T_{o,t+2} \tag{9}$$

The F.O.C with respect to $c_{m,t+1}$ gives the relationship between $c_{m,t+1}$ and $c_{o,t+2}$:

$$c_{o,t+2} = \beta R_{t+2} c_{m,t+1} \tag{10}$$

Equation (9) and (10) together can pin down the consumption at period t+1 and get the equation (7):

$$C_{m,t+1} = \frac{1}{1+\beta}[(1-\theta)w_{m,t+1} - T_{m,t+1} + \frac{T_{o,t+2}}{R_{t+2}}]$$

The F.O.C with respect to n gives:

$$vlog(\gamma)\frac{\partial q(n_t)}{\partial n} + \frac{\beta}{c_{m,t+1}}\frac{\partial c_{m,t+1}}{\partial n} + \frac{\beta^2}{c_{o,t+2}}\frac{\partial c_{o,t+2}}{\partial n} = 0$$

Where $\frac{\partial c_{m,t+1}}{\partial n} = \frac{1}{1+\beta}(-w_{m,t+1}\phi_{t+1})$, and $\frac{\partial c_{o,t+2}}{\partial n} = \psi_{t+2} w_{m,t+2}$. Substitute $c_{o,t+2}$ from quation (10) and rearrange to get equation (8)

$$vlog(\gamma)\frac{\partial q(n_t)}{\partial n_t} R_{t+2} c_{m,t+1} + \frac{\beta}{1+\beta} R_{t+2}(-w_{m,t+1}\phi_{t+1}) + \beta^2(\psi_{t+2} w_{m,t+2}) = 0$$

Proof of Proposition 2

To examine the relationship between a family's gender preference and the number of children to bear, take the first difference w.r.t γ on equation (8),

$$vR_{t+2}c_{m,t+1}[\frac{1}{\gamma}\frac{\partial q(n)}{\partial n} + log(\gamma)\frac{\partial^2 q(n)}{\partial n^2}\frac{\partial n}{\partial \gamma}] = 0$$

Then,

$$\frac{\partial n}{\partial \gamma} = -\frac{\frac{1}{\gamma}\frac{\partial q(n)}{\partial n}}{\frac{\partial^2 q(n)}{\partial n^2} log(\gamma)}$$

As aforementioned, $q(n)$ is an increasing concave function of n, thus $\frac{\partial q(n)}{\partial n} > 0$ and $\frac{\partial^2 q(n)}{\partial n^2} < 0$. Besides, a boy-preferred family will have $\gamma > 1$, and thus $log(\gamma) > 0$. Putting together,

$$\frac{\partial n}{\partial \gamma} > 0$$

Proof of Proposition 3

To examine the relationship between the fraction of labor income to transfer to parents and the number of children to bear, take the first difference w.r.t ψ_{t+1} on equation (8),

$$R_{t+2} v log(\gamma)[\frac{\partial^2 q(n)}{\partial n^2}\frac{\partial n}{\partial \psi_{t+1}} c_{m,t+1} + \frac{\partial q(n)}{\partial n}\frac{-w_{m,t+1}}{1+\beta}] = 0$$

So $\frac{\partial^2 q(n)}{\partial n^2}\frac{\partial n}{\partial \psi_{t+1}} c_{m,t+1} + \frac{\partial q(n)}{\partial n}\frac{-w_{m,t+1}}{1+\beta} = 0$, and thus

$$\frac{\partial n}{\partial \psi_{t+1}} = \frac{\frac{\partial q(n)}{\partial n} w_{m,t+1}}{\frac{\partial^2 q(n)}{\partial n^2}(1+\beta) c_{m,t+1}} < 0 \; because \; of \; the \; concavity \; of \; q(n)$$