

Raiber, Eva

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## Anticipated Children and Educational Investment: Evidence from the One-Child Policy in China

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# Anticipated Children and Educational Investment: Evidence from the One-Child Policy in China\*

Eva RAIBER

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## Abstract

Does the number of future anticipated children affect educational investment in parents-to-be? In theory, anticipated children can affect the returns to education, the resources available for family consumption, and the incentives for pre-marital investment. Changes in the eligibility criteria for second-child permits during the one-child policy in China provide province-, time- and group-specific variation in the cost of having a second child. I first show that second-child permits have a strong positive effect on the likelihood of having a second child. I then investigate changes in the eligibility rules when individuals are about the finish middle school. I find that fulfilling an eligibility criterion at secondary school age increases the likelihood of enrolling in senior middle school. The effect is concentrated among those planning with only one child when not eligible, indicating that anticipating another child increases educational investment. The estimates are more precise for men who do not seem to suffer from a child penalty in the labor market and usually have a higher income than their wives, suggesting that the high costs of raising children can be a reason for increased educational investment.

**Keywords:** Fertility, Schooling Investment, Family Planning, China

**JEL codes:** I25, I26, J13.

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# 1 Introduction

Educational and fertility choices are major life decisions that are deeply interconnected. The microeconomics literature has largely focused on the effect of parental education on fertility (e.g., McCrary and Royer, 2011; Osili and Long, 2008; Duflo et al., 2015; Lavy and Zablotsky, 2015). But the reverse question has rarely been addressed. Do individuals who anticipate having more children receive more or less educational investment than those who anticipate none or few? Answering this question is challenging because the number of children an individual plans to have is generally unobserved. Even if fertility prospects are stated, they are correlated with other variables that affect the demand for education, such as socioeconomic characteristics and family background.

Theory suggests that raising children affects the income available for other family members' consumption and potentially parental labor supply. The desire to have children can also strengthen the incentives to find a marriage partner. Therefore, the anticipated number of children can have an effect on the returns to education and the marginal utility of income. The sign of the overall effect is ambiguous, yet policy-relevant. Faced with aging societies, policy-makers in many high- and medium-income countries are eager to encourage childbearing. Child benefits, free childcare, and paid parental leave are policies implemented or discussed in most low fertility countries. They incentivize higher fertility by reducing the costs associated with having children. How do such reforms influence educational investment? Do they have the side effect of decreasing educational investment in parents-to-be?

In this paper, I use variation in the strictness of the one-child policy in China to investigate the effect of anticipated fertility on educational investment. Although one child per family was the norm, having another child could be allowed with a "second-child permit." The eligibility criteria for these permits were set at the provincial level. Policy changes in the 1990s and 2000s provide plausibly exogenous variation in the cost of having a second child when conditioned on the province, time, and individual characteristics that determine eligibility. Several eligibility criteria were based on observable characteristics that are time-invariant. These include ethnic minorities, rural households, and only children. This allowed school-age individuals and their families to predict whether they would be eligible in the future. Given that second-child permits have a strong effect on fertility outcomes, fulfilling an eligibility criterion can change the anticipated number of children. The policy data are matched with individual information on socioeconomic characteristics, educational attainment and fertility from the 2010 China Family Panel Study.

The criteria for second-child permits varied over time and between provinces, and are not directly related to provincial educational policies, motivating the use of a triple-differences

approach. I compare individuals in a sub-population within a province before and after a policy change with individuals within the same sub-population in different provinces that do not change their policies in the same period. I calculate whether individuals fulfill a second-child permit criterion at the age of 15, when the choice to enroll in senior middle school is made. I find that fulfilling a second-child permit criterion increases schooling investment on average in the 1990s and 2000s. Eligible individuals were more likely to enroll in senior middle school. The effect is qualitatively similar for men and women, yet significant only for men.

To affect anticipated fertility, permits need to have an actual impact on fertility outcomes. For an older sample, I calculate the eligibility status at the average age when individuals have a second child based on the same eligibility criteria. I confirm that eligibility significantly increases the likelihood of having a second child by around 14 percentage points.

On average, individuals who fulfill an eligibility criterion at the age of 15 are around 10 percentage points more likely to enroll in senior middle school. The estimation controls for province-specific and group-specific time fixed effects and thus allows for differential trends for ethnic minorities, rural households, and only children. While the baseline specification already controls for province-level changes, I also find that the results are robust to controlling for the local fertility rate and sex ratio – the main variables that motivate policy changes. They are robust to excluding ethnic minorities, who might also be targeted by favorable educational policies. Furthermore, I find no effect of becoming eligible at the age of 17 or 18 on senior middle school enrollment. Policy changes after the enrollment decision has been taken therefore do not have any effect on educational investment. This falsification test mitigates the concerns that the results are driven by differential educational trends between treatment and control.

The enrollment effect is driven by enrollment into regular senior middle school. Part of the change in senior middle school enrollment might be due to an increase in junior middle school completion. Exploratory heterogeneity analysis suggests that the effect is driven by those who would only have one child if they were not eligible for a second-child permit. The effect, thus, appears concentrated in the subset of those not planning with a second child when not eligible. Also, eligibility criteria that allow for a second child independent of the characteristics of the spouse do not seem to have the same effect on enrollment as criteria that rely on the spouse to fulfill the same characteristics.

Schooling decisions are typically made before having children. However, individuals, together with their own parents, might take into account how many children they plan to have in the future. Children can be an important cost factor that decreases the financial resources available for other family members' consumption. To prepare for the additional

cost in the future, families can use educational investment to smooth consumption over time (intertemporal consumption-smoothing channel). This channel is particularly important when individuals have to financially support their own parents at the same time as raising their own children. Indeed, raising children is considered costly in China, and families spend a significant proportion of their income on their children's education investment. This may explain the positive effect on educational investment.

Children can also affect the time their parents spend in the labor market. The income loss due to reduced working time increases with the parent's educational level and has an effect on lifetime returns to education. The less time the parent can spend in the labor market, the lower are the pay-offs from education (labor supply channel). In China, women who have children earn less on average than men and experience a short-term child penalty for the second child. Yet, positive assortative marriages, as observed in China, can mitigate this channel.

Finally, individuals who want to have children have a stronger incentive to find a marriage partner. If the sex ratio is skewed to more men than women, men must compete for partners. They can use education to increase their chances (marriage market channel). However, this depends on how eligibility itself is valued in the marriage market. The marriage market channel can also explain the positive effect on men, but not on women.

This paper looks at the effect of anticipated fertility on schooling investment in a low fertility setting. The findings suggest that higher anticipated fertility can increase educational investment. Thus, policies that encourage childbearing can have positive side effects on education. However, labor market conditions are important. In theory, wanting several children does not have a negative effect on education if parents can quickly return to the labor market after childbirth. It is important that they do not have to fear lower returns to education than their childless co-workers.

## 1.1 Links with the Literature

Theoretical growth models and country-level empirical work usually connect low fertility rates and high human capital investment (Becker et al., 1990; Rosenzweig, 1990; Kalemli-Ozcan, 2003). Within a given setting, having many children is often correlated with lower levels of parental education. Several papers focus on identifying the causal effect of education on fertility outcome. They usually use shocks to the supply of education to address the issue of unobserved variables being correlated with both fertility and education and the decisions about them being taken simultaneously (e.g., Duflo et al., 2017; Osili and Long, 2008; Fort et al., 2016). In this paper, I use a shock to the cost of children to look at the reverse

question.

Female education is often associated with lower fertility rates (Osili and Long, 2008; Lam and Duryea, 1999; Schultz, 1997; Duflo et al., 2015, 2017; Lavy and Zablotsky, 2015). The main economic argument is that the opportunity costs of having a child for an educated woman are higher than for a noneducated woman (Becker, 1981). Education can also increase knowledge of contraception methods (Rosenzweig and Schultz, 1989) and the bargaining power of women who want fewer children than men (Manser and Brown, 1980). By raising women's income, education can shift the fertility choice toward fewer children of higher quality (Becker, 1960; Becker and Lewis, 1973; Willis, 1973). This result, however, does not necessarily hold for developed countries (Fort et al., 2016; McCrary and Royer, 2011; Monstad et al., 2008).

This paper complements dynamic life-cycle models of labor supply and fertility decisions. For example, Sheran (2007) and Keane and Wolpin (2010) estimate dynamic models where women make decisions about education, labor supply, marriage, and fertility. Adda et al. (2017) incorporate occupation-specific earning profiles and skill atrophy to study occupational choice and anticipated fertility.

An important share of papers in the fertility and education literature focuses on the quality/quantity trade-off. In the theoretical framework based on Becker and Lewis (1973), parents trade off between the number of children they have and how much they invest in each child. The one-child policy in China has been used to evaluate this trade-off empirically (Qin et al., 2016; Li and Zhang, 2016; Rosenzweig and Zhang, 2009; Qian, 2009). The present paper goes one step further. Given the number of children, parents take into account the number of anticipated grandchildren when they make investment decisions.<sup>1</sup>

Recent work by Huang et al. (2020) is the most closely related; they use provincial variation in monetary fines and a shorter time span. In using province-level variation only, they are restricted in the way they can address the potential endogeneity between monetary fines and other variables, such as economic development or policy exemptions. They find that monetary fines during childhood are positively correlated with higher investment in education. This result is not necessarily contradictory to the results of this paper, as they look at the intensive margin of higher fines and not at the extensive margin of having to pay any fines and being subject to non-monetary penalties.

The exemptions for ethnic minorities have been used to study inter-ethnic marriages

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<sup>1</sup>I assume that individuals can plan their fertility outcome and the timing of their pregnancies. This is an appropriate assumption for many high- and middle-income countries, including China. A distinct but connected strand of literature looks at fertility uncertainty. Contraceptive methods give women certainty over the pregnancy consequences of sex and thus decrease the risk of tertiary schooling investment (Goldin and Katz, 2002; Ananat and Hungerman, 2012; Miller, 2010).

(Huang and Zhou, 2015) and ethnic identity (Jia and Persson, 2020). This implies that on top of having fertility consequences, the one-child policy has shaped many other socioeconomic decisions. The present paper strengthens this conclusion.

## 2 Context

### 2.1 Family Planning in China

Family planning has been of particular importance to the Chinese government for decades. After the Great Famine (1959–1961), the central government promoted ambitious family-planning policies. These include the “Later, Longer, Fewer” campaign from 1971 to 1979, the one-child policy from 1979 to 2015, and the recent two-child policy. During the “Later, Longer, Fewer” campaign, the government promoted later marriage, longer intervals between births, and overall fewer children. One child per family was optimal, but two were acceptable for urban couples and three for rural couples. Penalties were introduced for those who did not comply (Whyte et al., 2015). Birth control and abortion were promoted. The campaign also included a strong element of coercion. Women, mainly in rural areas, were pressured to abort out-of-quota children and to get sterilized after the birth of the third child (Whyte et al., 2015). Fertility rates in China fell sharply during this period, although there is no consensus about how much of the fall was due to measures specifically targeting fertility.

Between 1978 and 1980, the central government introduced the goal of one child per family. Provinces were to implement this goal by setting fines for the birth of a second child and by providing birth control measures. Between 1978 and 1980, the policy was rolled out on a county-to-county basis (Qian, 2009; Almond et al., 2019). However, in rural areas where the one-child limit met significant resistance, implementation was delayed (Baochang et al., 2007). In 1983, the one-child policy precipitated a large wave of abortions and sterilizations (Whyte et al., 2015; Greenhalgh, 1986).<sup>2</sup> Reports of female infanticide also became widespread, which led the central government to respond with guidelines that gave local governments the flexibility to adapt their policies to local circumstances (Greenhalgh, 1986).

Between 1982 and 1984, provincial governments started to issue guidelines on the conditions under which married or remarried couples could apply for a second-child permit. Thus, they relaxed the one-child-per-family limit significantly (Scharping, 2013). Between 1986 and 1991, provincial governments produced official family-planning regulations that laid out in

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<sup>2</sup>Some 14.4 million abortions, 20.7 million sterilizations, and 17.8 million intrauterine device insertions (Whyte et al., 2015).

detail the different criteria. Most of these were revised at least once in the 1990s and again after 2001. While transparency about family policies increased, the use of coercive measures such as forced abortion and sterilization dropped substantially (Whyte et al., 2015).

In November 2013, the central government announced that all couples in which one spouse was an only child would be allowed to have a second child (Feng et al., 2016). Until then, in most provinces, both spouses needed to be an only child to apply for a second-child permit. Finally, in October 2015, the government stated that all couples would be allowed to have a second child from January 2016 onward, ending the transition from the one-child policy to the two-child policy.

## 2.2 Child Permits

During the one-child policy, couples who wanted to have a child had to apply for a permit, and only married couples were allowed to apply. Couples who had a second child without a second-child permit had to pay fines, set according to the couple's income (Scharping, 2013). Couples with higher income thus had to pay higher fines in absolute terms. Additionally, parents potentially faced nonmonetary penalties, including losing their job or having their career opportunities restricted. There are no accessible data on the enforcement of fines or the frequency of other social penalties. Couples officially had to obtain the second-child permit before having the second child. However, this posed a significant burden to local rural governments. Second-child permits were presumably given out after the birth if the couple fell into an exemption category (Scharping, 2013).

Eligibility criteria for second-child permits varied at the provincial level and between rural and urban areas. The household registration status (*hukou*) was an important determinant for eligibility. It is either agriculture/rural or nonagricultural/urban. Couples could apply for a child permit only at their place of household registration. This restricted strategic between-province and urban-rural migration. Most exemptions also required that the applicant respected late childbirth (birth of the first child after age 24 for women) and an acceptable birth interval (between 4 and 7 years).

Provinces introduced several different exemptions over time for different reasons. The best-known exemption is the policy that allowed couples in rural areas whose firstborn was a girl to have a second child. In five provinces, couples living in rural areas were always allowed to have two children (Baochang et al., 2007).<sup>3</sup> These exemptions were introduced to appease the rural population and to combat a skewed sex ratio. Some provinces allowed couples living in sparsely settled areas or border areas to have two children.

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<sup>3</sup>The provinces were Hainan, Yunnan, Qinghai, Ningxia, and Xinjiang (Scharping, 2013).



Couples from ethnic minorities were often allowed to have two children or were even completely exempted from the policy. However, this depended on the province, whether the couple lived in a rural or specific minority area, and sometimes on the size of the minority population. There is also variation if both spouses had to belong to a national minority or only one spouse. The fertility policies for ethnic minorities were related to the strategy the province used toward those minorities. Autonomous regions generally had more lenient fertility constraints for minority couples.

Following a statement from the central government, all provinces at some point introduced the criterion that if one or both spouses were an only child, they were eligible for a second-child permit. This policy was motivated by the idea that the one-child-per-family policy should hold for only one generation. Provinces implemented this criterion over the course of the 1990s to early 2000s. In urban areas, both spouses usually needed to be an only child, while in rural areas, one spouse was often sufficient.

There also existed specific exemptions for certain occupational groups such as fishermen and mine workers, as well as for military veterans. Most provinces also had rules for couples who had already adopted a child, remarried couples, or those who had their first child overseas. The category of couples with “real difficulties” is the vaguest and potentially most flexible one. An evaluation of these specific policies is difficult without governmental application and acceptance data.

## 2.3 Educational system

In 1986, the Law on Nine-Year Compulsory Education took effect. Its goal was to guarantee at least nine years of schooling: six years of primary school and three years of junior middle school. Children usually enter primary school at the age of 6 or 7 and stay up to the age of 12. They then continue with junior middle school for three years until the age of 15. Mandatory schooling is generally free, albeit with some small fees. After mandatory schooling, students can decide to continue with high school (senior middle school). There are different types of senior middle schools, ranging from prestigious “academic” high schools to vocational schools.

Previous educational reforms and investment in primary schooling had already increased primary school enrollment to 95% in the mid-1980s (Zhang and Minxia, 2006). In 1986, around 70% of children transitioned from primary school to junior middle school. In 1995, transitions had risen to around 90% (Wu, 2010). The planning committee envisioned that in 1990, junior middle school should be universal in one-fourth of the population, and in 1994, for another half of the population. After 1995, several programs targeted the last quarter

of the population in poor and isolated areas (Zhang and Minxia, 2006). For the empirical analysis, I use individuals that turn 15 between 1991 and 2008 in the first sample. In the second sample, I include those who turned 15 between 1995 and 2008. The second sample starts after nine years of compulsory schooling has been extended to the majority of the population. At this time, more individuals are faced with the decision of whether or not to continue with senior middle school, and more senior middle school slots might have been available.

Figure 1 illustrates the rates of primary school completion, junior middle school completion, and senior middle school enrollment using the 2010 China Family Panel Study. For all three schooling levels, there is a wide gap between individuals with an agricultural household status and a nonagricultural household status. The gap is closing for primary school and junior middle school, but persists for senior middle school. Of those who turned 15 between 1991 and 2008 and who indicate the type of senior middle school they attended, 67% went to a regular senior middle school. The other 33% went to either a specialized senior middle school (15%), a vocational senior middle school (10%), a technical school (5%), or an adult middle school (3%).

### 3 Theoretical Mechanisms

A theoretical model formalizes the different mechanisms of how the anticipated number of children can affect educational decisions. The model is developed in Online Appendix B, section 10; here, I summarize the setup and the intuition.

#### 3.1 Setup: Education and Fertility Decisions

The decision of interest is whether or not to continue schooling at senior middle school after junior middle school. The individual concerned by this decision is around 15 years old. Therefore, the main decision makers are most likely the parents of this individual. At this stage (period 1), parents trade off current family consumption and investment in education. They take into account that in the future (period 2), the individual will be grown up, will marry, work, and also have children. The parents want their child to be well off in the future, either because they are altruistic or because they rely on their financial support. I model this as parents receiving a share of their child's available income. In the second period, the individual is grown up and married and must decide how many children to have.

The fertility decision depends on whether the individual is eligible for a second-child permit. If the individual is not eligible, they have to pay a fine for the second child according

to their income. This reflects that official fines are a multiple of the household income, so that these and other penalties such as job loss and waived promotions are more expensive for educated individuals.

Raising children is assumed to be expensive. This assumption is discussed later in Section 6.1. There is not only a direct cost of raising children, but also, potentially, an indirect cost due to children affecting parental labor supply. I model this cost as a loss in working time, although it could also come from the loss in work-specific skills (such as argued in Adda et al. (2017)). This is the case if the individual has to stay at home for some time due to childbirth and raising children. It also applies if the individual's working hours decrease with the number of children, for example, if one parent can work only part-time because of childcare responsibilities.

Finally, the individual has a preference for having children, and the individual's parents, who are the decision makers in period 1, have a preference for grandchildren. The individual has to decide how many children to have, weighing the benefits of having children and the direct and indirect costs.

### 3.2 The Effect of Eligibility on Fertility Decisions

Being eligible for a second-child permit allows the couple to have a second child without having to pay the income-dependent fines. Eligibility thus implies a potentially big decrease in the cost of having a second child. The model can also be generalized as the effect of a shock on the cost of having another child.

This decrease in cost has a heterogeneous effect depending on the fertility preferences of the eligible couples. Those who have low preferences for having children, who want to have no children or at most one, are not affected. Those with very high preferences for children anticipated having at least two children. They experience an income effect because they do not have to pay the fines. This also has an indirect effect because the fines are income dependent. Finally, those with intermediate preferences for children planned on one child, but thanks to being eligible, now plan on two children. These *increasers* or *compliers* are the most interesting and are expected to have the strongest reaction as they change their anticipated fertility behavior.

### 3.3 The Effect of Anticipating Another Child on Education

Anticipating another child has two potential effects on education in the baseline setting.

***Intertemporal consumption-smoothing channel:*** Income available for family consumption and for supporting grandparents decreases with the number of children. For an

individual, anticipating two children instead of one increases child-related expenditure. If children affect parental labor supply, having another child also has an indirect cost due to the loss of working hours. This implies that the marginal utility of additional earning increases. Forward-looking parents use educational investment to shift consumption from period 1 to period 2, anticipating the higher costs due to having two children. Education is thus a way to smooth consumption intertemporally.<sup>4</sup>

The intertemporal consumption-smoothing channel is positive. Because children are costly, those who anticipate more receive more educational investment.

**Labor supply channel:** If having another child implies that the individual has to cut productive work hours, this decreases the returns to education. Intuitively, if the individual has to stay at home to care for the children, where the returns to education are lower than in the labor market, the payoffs from education are lower. Forward-looking parents invest less in their child's education if they expect them to spend less time in the labor market due to childcare obligations.

The labor supply channel is negative. Because children decrease working time, those who anticipate more receive less educational investment.

**Overall effect and sex differences:** The overall effect is positive if the intertemporal consumption-smoothing effect is stronger than the labor supply effect. If labor supply is not affected, the overall effect is positive. This can be argued for men in the context of China. Female labor supply is more likely to vary with the number of children. The overall effect on women can thus be expected to be smaller or even negative. In Online Appendix B Section 10.2.1, I show with an example income function that under constant absolute risk aversion, the higher the loss in working time due to the second child, the lower the overall effect of anticipating another child on educational investment.

These baseline results do not take into account that the spouse's education can be positively correlated with the individual's education. Indeed, positive assortative matching mitigates the sex differences in the overall effect. If marriages are perfectly positively assortative and the educational attainments of men and women are the same, the men's labor-market returns to education correspond to the women's marriage-market returns to education. Conversely, the women's labor-market returns to education correspond to the men's marriage-market returns to education. The men's marriage-market returns to education decrease with

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<sup>4</sup>The intertemporal consumption-smoothing channel relies on families being credit constrained between periods. In period 1, they are not able to borrow against the future income of their children. They can still borrow within periods, such as taking a loan to pay for tuition fees in period 1. Furthermore, educational investment needs to be at least as profitable as other intertemporal consumption-smoothing tools such as savings. Because in practice, returns to education are heterogeneous, some families may use education for consumption smoothing, while others may opt for other investment tools.

the anticipated number of children if women's labor supply is affected.

Finally, there can also be sex differences in how much the parents rely on the financial support of their child during old age. This is reflected in the share of available income transferred to their own parents. If women are not expected to financially support their parents, this mitigates the overall effect of anticipated fertility on education and pushes it toward zero. If men are expected to take care of their parents financially, this enforces the consumption-smoothing aspect of educational investment.

### 3.4 Effects Through the Marriage Market

China has experienced a skewed sex ratio at birth since the introduction of the one-child policy, resulting in more marriageable men than women. As only married couples are officially allowed to have children, marriage is essential for the vast majority. I therefore introduce the possibility for the individual to be single in the second period. I assume that the marriage surplus, defined as the utility of being married minus the utility of staying single, is positive independent of the individual's and spouse's educational level and the number of children. This results in all women marrying, but some men staying single due to the skewed sex ratio. Furthermore, I assume that the likelihood of finding a spouse increases with the man's educational level.

***Marriage channel:*** On becoming eligible for a second-child permit, the utility of being married weakly increases. Those who plan on one child independent of eligibility are not affected. Those who want to have two children once eligible are at least as well off. They either benefit from not having to pay the fines or because having two children gives them a higher utility than having just one. As the payoff of marriage increases, so do the incentives to invest in education, which increases the chance of marrying. The marriage channel is thus positive: being eligible for a second-child permit increases the incentives to invest in education.

***Spouse-independent eligibility:*** Some criteria for second-child permits are dependent on the spouse fulfilling the same criteria, while others are spouse independent. If the criterion is spouse independent, this increases the value of those eligible for a second-child permit in the marriage market. Those who are not eligible, but would be better off being eligible (those increasing their fertility with eligibility and those always planning on two children), would prefer to marry someone with spouse-independent eligibility. They might be willing to do so even if the candidate is less educated. Spouse independence thus potentially mitigates the positive effect for men.

## 4 Data and Empirical Strategy

### 4.1 Policy Data

The information about province-level policies is compiled from official family-planning regulation document and cross-validated with [Scharping \(2013\)](#) and [Baochang et al. \(2007\)](#). The family-planning documents were accessed online in Mandarin and translated into English. I identify exemptions that are based on observable characteristics and that are time invariant for individuals who are 15 years old. These include their household registration status, the province they live in, whether they are an only child, and their ethnicity.

I use three broad groups of exemptions. The first group consists of those who are an only child. There is between- and within-province variation if one or both spouses need to be an only child, if they need to have an agricultural household status, or if the first child needs to be a girl to apply for a second-child permit. Between 1990 and 2008, five provinces changed this policy (Beijing, Hubei, Chongqing, Henan, and Gansu). The second group consists of ethnic minorities. There is variation if one or both spouses need to have minority status, if they have to live in a rural area, if their first child is a girl and if their ethnic group has fewer than 10 million people. Some provinces list the ethnic groups that are eligible. There are 5 provinces that changed their policy in this time frame (Hubei, Chongqing, Hebei, Guangdong, and Shaanxi). Finally, in rural areas, families are eligible if their first child is a girl. I define these as “half-eligible” in expectations. There was policy variation in 7 provinces (Shaanxi, Chongqing, Guizhou, Jiangsu, Zhejiang, Guangdong, and Hunan). In some areas, rural couples are allowed to have two children. Of those, only Yunnan and Hainan are present in the individual data set.

Based on this information, I calculate whether in the year the individual turns 15 they fulfill a second-child permit criterion. The year they turn 15 is supposedly the year they make the decision to continue schooling with senior middle school. At this time, students are about to complete junior middle school on average and must decide whether to continue with senior general or vocational high school.

For the main analysis, I use those who turned 15 between 1991 and 2008. This is for several reasons. First, only after 1990 did all Chinese citizens have official legal documents that they could rely on. Before then, conditions for second-child permits were presented as only guidelines. It is debatable whether implementation and knowledge of exemptions were comparable between provinces. Also, in this time span, there were several reforms in different provinces, but not at the same time. Nevertheless, the policy framework is sufficiently stable so that fertility anticipations can be formed based on the current policy situation. However, because the second phase of secondary school expansion lasted until

1994, I also use a restricted sample of those who turned 15 between 1995 and 2008. To assure that I do not merely capture a delay in school enrollment, I set the upper cutoff two years before the survey was collected.

## 4.2 Individual Data

For the individual-level data, I use survey data from the 2010 China Family Panel Study (CFPS). This was designed by a Peking University research team, supported by funding from Peking University Project 985, and carried out by the Institute of Social Science Survey of Peking University. The data set is available online in English and Chinese. Not all provinces are represented in the sample. In particular, the sample does not cover the autonomous regions of China, except for Guangxi Zhuang. The main population is sampled from Gansu (12%), Henan (11%), Guangdong (9%), Shanghai (8.5%), and Liaoning (8.4%). Overall, the data include observations from 24 provinces or regions.

In the first sample, I use individuals who turned 15 between 1991 and 2008, resulting in a sample of 8,217 observations. Summary statistics are displayed in Online Appendix A Table 9, Panel A. In the second sample, I use those who turned 15 between 1995 and 2008 (6,405 observations). Summary statistics for these are displayed in Panel B. The samples are predominantly rural. Around 70% hold an agricultural household status and 30% hold a nonagricultural household status. Around 10% of the samples are ethnic minorities and around 21–23% are an only child. The main ethnic minorities in the sample are Miao (2.1%), Yi (2.3%), and Man (1.5%). On average, individuals stayed in school for around 9.3 years (9.5 for the 1995–2008 sample). Some 75–77% finished junior middle school and 36–37% enrolled in senior high school. Tertiary enrollment lies at around 14%. Thus, secondary school enrollment is the decision with the highest variation.

As the share of individuals who are ethnic minorities or an only child is low, the main variation in eligibility for a second-child permit stems from the agricultural population. Between 1991 and 2008, several provinces updated their criteria catalogs (see Section 4.1). However, overall policies are relatively constant. This allowed families to form expectations about future eligibility based on current eligibility.

Those in the main sample were too young to have finished their reproductive stage at the time of the survey. To study fertility decisions, I use individuals in an older sample who were at the stage of deciding whether to have a second child between 1991 and 2008, and had their first child before 2003. The upper limits are to ensure that couples have sufficient time to have a second child. Summary statistics for the older sample are displayed in Table 9, Panel C. Educational levels and senior middle school enrollment rates are lower in the

older sample than in the main samples. There are slightly more individuals with a household registration status and fewer ethnic minorities.

### 4.3 Empirical Strategy

The goal of the empirical part is to estimate the effect of eligibility for a second-child permit on educational investment. As eligibility criteria vary between provinces, between groups within a province, and over time, I use a triple-differences approach. In the difference-in-differences approach, the treatment and control groups are assumed to follow the same trend. This would imply, for example, that ethnic minorities and Han Chinese have the same educational trends. Since I have treatment and control groups in several different provinces, I can control for province-level time fixed effects. This captures different trends in different provinces. Since the same subpopulation, such as ethnic minorities, are treated in different provinces, some earlier and some later, and stay in the control group in other provinces, I can control for subpopulation-specific time trends. The difference-in-differences common trend assumption is then modified. I assume that, conditional on varying province-level time fixed effects and population-specific time fixed effects, the treatment and control groups follow the same trend.

I denote  $\tilde{Z}_{ipt}$  the “eligibility status” of a 15-year-old teenager  $i$  in province  $p$ , turning 15 in year  $t$ . This captures whether, in the year they turn 15, they fulfill a criterion for eligibility for a second-child permit.  $X_i$  denotes time-invariant individual characteristics that are used to determine eligibility. These include household registration status, ethnicity, and being an only child. I also add gender as a control variable. I then regress enrollment in senior middle school on the eligibility status, individual characteristics, as well as province-specific time fixed effects ( $\kappa_{pt}$ ) and subgroup time fixed ( $\gamma_{it}$ ) effects.

$$enrolled_{i \text{ in } 2010} = \beta \tilde{Z}_{ipt} + X_i + \gamma_{it} + \kappa_{pt} + \epsilon_{ipt} \quad (1)$$

where  $\beta$  is the coefficient of interest and  $\epsilon_{ipt}$  the unobserved error term. The identifying variation comes from observing individuals, within one province, in a subpopulation before a policy change and after the policy change (first difference). This is compared with individuals in the same province that do not experience a policy change (second difference). Finally, this difference in differences is compared with the same difference in differences in a different province where the subpopulation did not experience a policy change (third difference).

I investigate enrollment behavior up to two years before the survey was collected to include the maximum number of observations and policy changes. This implies that I do not



observe actual fertility behavior. To verify that eligibility indeed changes fertility behavior, I investigate the effect of eligibility on fertility. For this, I run the same triple-differences specification with an indicator for having a second child as the outcome variable, using an older sample. The eligibility status is adjusted to the sex of the first child, which is then included in the control variables.

Identification still relies on the assumption that treatment groups are following the same trend as the control group, conditional on province-specific and group-specific year fixed effects. A violation of the identifying assumption would be if the policy change was correlated with a differential trend in the targeted province-specific subpopulation. This would be the case, for instance, if provinces that allow second-child permits for ethnic minorities combine these measures with an increase in the educational budget for ethnic minority areas. I thus need provincial family-planning policies to be independent of educational measures that target the same group. So far, I have not encountered evidence in the literature for such policy behavior. As this channel is the most salient for ethnic minorities, I include the results without ethnic minorities in my main tables.<sup>5</sup>

Finally, standard errors are two-way clustered on the province and the year, as educational and fertility policies are set at the province level. Since cluster sizes vary, I use the wild bootstrap algorithm proposed by [Roodman et al. \(2019\)](#). I also provide p-values on the basis of clustering at the subgroup within-province level, as this is the level at which the policies are applied. This means that one cluster is a subgroup in one specific province, for example, ethnic minorities in Yunnan. As the latter gives me generally more conservative p-values, these are also used for the exploratory heterogeneity analysis.

## 5 Results

### 5.1 Effect of Eligibility on Fertility

First, I verify that being eligible for a second-child permit after the birth of the first child has an effect on the likelihood of having a second child. The results are displayed in [Table 1](#). I look at the pooled sample with men and women (column 1) and then women and men separately (columns 2 and 3). Finally, I exclude ethnic minorities as a robustness check (column 4). I find that on average, individuals who are eligible for a second-child

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<sup>5</sup>We might also be concerned about potential spillover through migration. However, the Chinese household registration system restricts the possibility to migrate between provinces and between urban and rural areas. Applications for a second-child permit can be submitted only at the place of registration. Moving the place of registration is difficult. Within the 1991–2008 sample, only 1.2% indicated a different provincial code as the place of residence at the age of 12 to that when they were born. Some 5.4% indicated a different county or district code (within-province migration). Recent reforms are intended to loosen these restrictions.

permit after the birth of a first child, at the age of 27 (women) or 28 (men), are significantly more likely to have a second child (p-value = 0.013/0.048). The point estimate lies at 0.14. Individuals who are eligible for a second-child permit are 14 percentage points more likely to have a second child than those who are not eligible. The point estimates are smaller for women than for men, but not significantly so. The results are robust to the exclusion of minorities.

I therefore find that the official number of children allowed at age 27/28 influences real fertility decisions. However, an increase of approximately 14 percentage points implies that there is a share of the population that does not significantly change their fertility outcomes due to the policy. This might be because they want only one child or because they were planning to have two children and to pay the fine.

The coefficient measures the impact of eligibility only on the basis of criteria that are observable at the age of 27/28. There are several criteria that are based on unobservable and (for the econometrician) unpredictable characteristics. These include the first child being disabled and the family being in “poor economic conditions.” Furthermore, eligibility is measured only at age 27/28, which is the year before the average age of the birth of a second child. This implies that individuals who become eligible at the age of 28/29 fall into the control group. The same applies to those who become ineligible at age 27/28 but might already have a second child or had acquired a second-child permit before the change. Also, the measure does not take into account the eligibility status of the spouse. Thus, the coefficient does not measure the complete impact of second-child permits and probably underestimates even the effect of the criteria that are included.

## 5.2 Effect of Second-Child Permits on Education

Table 2 displays the main results. Enrollment into senior middle school is regressed on eligibility at the age of 15. Eligibility measures whether the individual fulfills at least one criterion for a second-child-permit in the year they turn 15. It uses the triple-differences approach and thus includes province-specific year fixed effects as well as group-specific year fixed effects. The p-values indicated are calculated based on the bases of (i) wild-bootstrapped two-way clustered (province and year) standard errors, and (ii) wild-bootstrapped clustered standard errors on the sub-population at the within-province level.

I find that on average, fulfilling a criterion at the age of 15 increases the likelihood of enrollment into senior high school (column 1, Panels A and B). Eligible individuals are 10.8 percentage points more likely to enroll in senior high school in the 1991-2008 sample (p-values 0.029 and 0.013) and 12.8 percentage points in the 1995-2008 sample (p-values 0.006

and 0.006). The results stay constant when restricting the samples to those who finished primary school (column 2). The point estimates decrease to around 7 percentage points when restricting the sample to those who have completed junior middle school and are no longer significant at the 5 percent level (column 3, p-values between 0.078 and 0.129). This suggests that part of the effect is not only enrollment into senior middle school, but also completing junior middle school. In both samples, the results are robust to excluding ethnic minorities (column 4). The results for different year cut-offs are shown in Online Appendix A Table 10.

I further investigate the type of senior middle school into which eligible individuals enroll. In Online Appendix A Table 11, I look at enrollment rates into regular senior middle school and other types of senior middle school. The latter include vocational, technical, specialized regular, and adult middle school. In the 1991–2008 sample, 23% enroll in regular school and 12.4% in another, specialized senior middle school. I find that eligibility on average increases the likelihood of enrolling only into regular senior middle school, but not in other types. The average effect on enrollment into other types of senior middle school is close to zero.

However, these results can be explained by different shifts in enrollment. It is possible that eligibility motivates 10% of students who would otherwise not continue schooling to enroll in regular senior middle school. Nevertheless, it might also be possible that eligibility pushes some who would otherwise enroll in a specialized school to attend a regular school. At the same time, some who would not have attended any senior middle school enroll in a specialized school. If those amounts are similar, the net effect on enrollment in a specialized school would also be zero. I cannot distinguish between those two possibilities.

Finally, I verify whether eligibility has an effect on the completion of junior middle school. Officially, junior middle school is compulsory. However, at the beginning of the 1990s, only half of the rural population graduated with a junior middle school degree. Eligibility could motivate an individual to complete their degree or their parents to push their child to complete the degree. In Table 3, I regress junior middle school completion on eligibility at age 15 and at age 14 (one year before the average student finishes junior middle school). I find that eligibility does not have an effect on completion rates in the 1991–2008 sample. In the 1995–2008 sample, the coefficient is positive, although not significant. This may explain the larger point estimates on senior middle school enrollment in the 1995–2008 sample. Becoming eligible might have a weak effect on junior middle school completion and a weak effect on senior middle school enrollment once the junior middle school degree has been obtained. Combined, this leads to a large effect of eligibility on senior middle school enrollment.

### 5.3 Differential Effects for Men and Women

Theory suggests that men and women may be differentially affected by eligibility for a second-child permit. Men’s labor supply is supposedly unaffected by number of children. Furthermore, due to sex imbalances, men are under pressure to find a spouse. The effect of eligibility on men is thus expected to be positive. The prediction for women is less clear, as women’s labor supply and their returns to education might depend on their number of children. However, marriage market returns can mitigate the sex differences. In Table 4, the sample is split between men and women.

I find that the effect of fulfilling an eligibility criteria is positive and significant for men (column 1 and 2). In the 1991-2008 sample, men who fulfill an eligibility criterion at the age of 15 have a point estimate of around 11 percentage points (p-values between 0.053 and 0.081). In the 1995-2008 sample, the point estimate is even larger at around 17 percentage points (p-values between 0.024 and 0.04). The point estimates for women are also positive and around 10 percentage point. Yet, standard errors are higher and the coefficients not significant (p-values between 0.117 and 0.351). The coefficients are not significantly different from each other. The noisier estimates for women can hide heterogeneous responses to changes in anticipated fertility. These could depend on expectations about the labor supply effects of children and the importance of women’s income for family resources.

### 5.4 Robustness

The identification strategy relies on the decision being taken around the age of 15 to continue with education. Those that are older should have already made their decision and should not be affected. As a falsification test, I look at the effect of becoming eligible at the age of 18 on senior middle school enrollment. At this point, even those who postpone their enrollment should have decided. The effect of eligibility should then be close to zero. This also corresponds to the pre-trend analysis. If future treated subpopulations within a province had a differential educational trend than subpopulations in other provinces with unchanged treatment status, this leads to an effect on those becoming eligible at a later age. However, it should be noted that there is the possibility to enter certain types of senior middle school after the age of 16.

I also investigate the effect of becoming eligible at an earlier stage, the age of 12. Those who become eligible at the age of 13, 14, or 15 then fall into the control group. This should reduce the effect. Table 6 illustrates the results. Indeed, I find that eligibility at the age of 12 has a positive effect, but it is not significant, and the point estimates are lower (Panels A and B). In particular, the point estimates for those who have finished junior middle school

are close to zero (column 3). More importantly, I find that eligibility at the age of 18 has no effect on senior middle school enrollment (Panels C and D). The coefficients are close to zero and not significant.

Figure 2 illustrates the coefficients for the different cut-offs for the 1991-2008 sample, including all individuals (Panel A) and only those who finished junior middle school (Panel B). There is a clear drop in the treatment effect once individuals become eligible after the year they turn 15. If the treatment is assigned earlier, at the age of 13 or 14, there is a treatment effect but it is smaller than at the age of 15. This is more so when only looking at those who complete junior high school. Again, this suggests that there might be a weak effect on junior middle school completion. The identification strategy assumes that policy changes are exogenous to education policies. For example, fertility policies targeting ethnic minorities that come into effect simultaneously with policies that favor their educational attainment would threaten the identifying assumption. As ethnic minorities are a small part of the population, they can be excluded without changing the results. Family policies can also be responses to the sex ratio and the fertility rate. The province fixed effects already capture variables that change on the province level. In Table 5, I control for district-level fertility rates and the cohort sex ratio. The annual district-level fertility rate is calculated as the average number of children of individuals between the ages of 30 and 35 years. It is then matched with the year the individual turns 15. The cohort sex ratio is defined as the sex ratio of those born from two years before to two years after the individual, within the same district.

In both samples, the results are robust to including the district cohort sex ratio (columns 1 to 4). Controlling for the district fertility ratio decreases the point estimates slightly, particularly in the 1995-2008 sample. However, the coefficients are still significant in the majority of specifications.

Finally, Online Appendix A Table 12 shows that the results are robust to excluding the six provinces with the lowest number of observations (corresponding to roughly 25% of the provinces or regions).

## 5.5 Exploratory Heterogeneity Analysis

In this section, I investigate heterogeneity in the treatment effect beyond sex differences. Though the analysis is theory-driven, it is exploratory as it investigates mechanisms. P-values are not adjusted for multiple hypothesis testing and therefore all results are suggestive. Furthermore, introducing interactions substantially decreases statistical power. For the heterogeneity analysis, I use variables that are either related to the individual's fertil-

ity response or to one of the potential channels. Because the empirical approach includes province-level year fixed effects, only variables that vary on the geographical and time level or on the individual level can be used.

### 5.5.1 Predicted Fertility Behavior

First, I investigate heterogeneity according to the individual’s predicted fertility response. Some of those who become eligible for a second-child permit might have planned on two children all along. I use the subsample of individuals who are not eligible at age 27/28 in the older sample as a training set for a random forest estimation to predict their fertility behavior.<sup>6</sup> The aim is to predict who has a second child, even when not eligible for a second-child permit. As potential predictors, I use a variety of individual- and district-level variables. I use a random forest as it deals well with nonlinearities and it includes an automatic selection of predictors.

Online Appendix A Figure 4 lists all of the variables used to predict fertility behavior and how “important” they are in the final prediction algorithm.<sup>7</sup> This includes most of the control variables (province, ethnicity, household status), but with a linear trend instead of year fixed effects, as well as additional potential predictors.<sup>8</sup> The most important predictors are province, local fertility rate, local cohort sex ratio, living in an urban area in 2010, trend, number of siblings, and agricultural household status.

In the following, I use the algorithm to predict who has a second child, independent of eligibility, for the older sample and the main sample. In the older sample, 45% are predicted to have two children even when not eligible, and around 36% in both the 1991–2008 and 1995–2008 samples. I then interact eligibility with the predicted fertility behavior. Table 1 displays the result. Figure 3 illustrates the corresponding predicted likelihood of having a second child for the older 1991–2008 sample (Panel A), as well as the predicted likelihood of enrolling in senior middle school for the 1991–2008 and 1995–2008 samples (Panels B and C). The likelihoods are according to predicted fertility behavior and eligibility status.

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<sup>6</sup>I use only those who turn 27/28 between 1991 and 2004, to assure there is no overlap between the training sample and the main sample.

<sup>7</sup>The random forest grows 1,000 classification trees. For each tree, three predictors are used, which are randomly selected from all predictors. The number of predictors minimizes the out-of-bag error rate. Prediction is based on the average of those trees. An observation is predicted to have two children if more than half of the observation that fall into the same category have a second child (majority rule). Importance is measured as how much the predictor decreases node impurity (measured by the node Gini).

<sup>8</sup>Number of siblings (which also incorporates being an only child), mother finished primary school, mother finished junior middle school, mother having an occupation (coded in the International Standard Classification of Occupations (ISCO) 88 groups 1 to 5: managers, professionals, technicians, clerical support, and service and sales), district fertility rate, district sex ratio, living in an urban area in 2010, and within-province migration during childhood.

Those who are not eligible in the older sample are part of the training sample. Thus, their predicted likelihood of having a second child in panel A measures the accuracy of the prediction algorithm. The likelihood of those not eligible and predicted to have two children is 0.86 and for those predicted to have one child 0.14, corresponding to a 14% error rate. Those not eligible are not part of the training sample and their prediction is out-of-sample. Those eligible and predicted to have a second child in any case have a 84% predicted likelihood of having a second child; the same as those not eligible. Those who are predicted to have one child and are eligible have a predicted likelihood of 48% of having a second child. Thus, the effect of eligibility among those predicted to have one child (34 percentage points) is clearly higher than the average effect (14 percentage points, see table 1). This suggests that in the group of individuals predicted to have only one child, there are more individuals that increase the number of children as a response to being eligible than in the average population.

In Figure 3, Panels B and C, the fertility prediction is out of sample for all observations. For those who are predicted to have only one child, eligibility for a second-child permit has a significant positive effect on senior middle school enrollment. For those predicted to have two children in any case, eligibility does not have a significant effect on enrollment. The difference in the effect between the two groups, captured in the interaction effect, is consistently negative, although only significant on average in the 1991-2008 sample (p-value 0.041, see Table 7). This suggests that the overall effect is driven by those who are predicted to have one child when not eligible and change their anticipated fertility behavior in a response to becoming eligible.

### 5.5.2 Spouse-Dependent Eligibility and Cohort Sex Ratio

Table 8 includes interactions related to the marriage channel. If the sex ratio is skewed to more men than women, men must compete to find a spouse with whom they can subsequently form a family. They can use education to improve their chances in the marriage market. Eligibility for a second-child permit increases the marriage surplus and thus the motivation to invest in education. This effect should be stronger in areas in which the sex ratio is biased. I find that the interaction between eligibility and the district sex ratio is not significant overall, nor is it significant for men or women (columns 1 to 3).

The effect of eligibility on educational investment to improve marriage outcomes depends on whether the spouse also needs to fulfill the eligibility criteria. If this is the case, the pressure to find a spouse might increase. Conversely, if a criterion is spouse independent, eligibility might increase the chance of finding a spouse independent of education. I thus include an indicator if the criteria is spouse independent which is interpreted as an interaction

in columns 4 to 6. Eligibility at 15, based on criteria that are spouse dependent, has a significant positive effect on enrollment rates. The coefficient is negative for the criteria being spouse independent, yet only significant in the 1995-2008 sample and on average (p-value 0.035). It should also be noted that most exemptions are spouse dependent, and those that are not are mainly based on ethnicity.

### 5.5.3 Mother's Education and Occupation

For women, there might be heterogeneity in their reaction to eligibility, according to their beliefs about how much children will affect their labor supply. This belief might be influenced by the mother's behavior: her education and occupation. However, these variables can also affect anticipated fertility and how much parents rely on their child for old-age support.

Online Appendix A Table 13 interacts eligibility with the mother having completed at least primary school (columns 1 to 3) and with the mother having an occupation not in agriculture or as an unskilled worker (columns 4 to 6). In the 1991–2008 sample, 52% of mothers finished primary school (31% finished junior middle school). Unfortunately, for the mother's main occupation, 31% have a missing observation. Of those with available information, 90% have an agriculture-related occupation. Only around 4% fall into the ISCO 88 occupation groups 1 to 5 (managers, professionals, technicians, clerical support, and service and sales). Although both variables have a significant effect on school enrollment rates for both men and women, the interactions with eligibility for a second-child permit are not significant.

## 5.6 Effect of Eligibility on Age at Marriage and Age at the Birth of the First Child

The previous sections describe how eligibility for a second-child permit affects fertility and educational decisions. I now investigate whether eligibility affects family decisions in between, namely, the age at marriage and the age at the birth of the first child. For the age at marriage, I use eligibility at age 19 and adjust the sample to those who turn 19 between 1991 and 2005. For the age at first birth, I use eligibility at age 20 and adjust the sample respectively. Becoming eligible at age 19 or 20 does not influence educational investment, but can influence subsequent decisions.

The expected sign of the effect of eligibility on those two decisions is not clear a priori. On the one hand, those who anticipate having more children might want to marry and have their first child earlier. Eligibility might also increase their value in the marriage market and make it easier to find a spouse. On the other hand, family-planning documents stress that



late marriage and late childbirth is important. Those who plan to apply for a second-child permit might be more motivated to stick to the presented age limits.

Indeed, the legal age limits for marriage, 20 for women and 22 for men, seem to be binding for an important subset of the population. Around 7.5% of married women who turned 19 between 1991 and 2005 married at the age of 18 or 19 (3% marry before 18), and 12% married the year they turned 20. The average age at marriage is 22.5 and the median age is 22.0. Similarly, for men, around 12% marry at the age of 20 or 21 (5% beforehand), and 13% the year they turn 22. The average age at marriage is 24 and the median age is 23. Late childbirth was usually defined as the woman being 24 years or older. The average age at first birth for women who turned 19 between 1991 and 2001 is 24, which corresponds to the median. For men, the average age is 25.5 and the median is 25.0. .

Online Appendix A Table 14 displays the results for age at marriage. I find a negative coefficient of eligibility at age 19 on the age at marriage, which is not significant. When including an indicator that the eligibility criterion is spouse-independent, its coefficient is positive for women and negative for men. Again, the coefficients are not significant.

Online Appendix A Table 15 displays the results for age at the birth of the first child. The coefficient of eligibility at age 20 on the age at first birth is negative (p-values 0.128 and 0.067). It seems to be driven by men being younger with a point estimate of  $-1.4$  (p-values 0.134 and 0.048). When looking at men and women separately, the coefficients are negative for both but not significant. Including an indicator for spouse-independence does not change the coefficients for eligibility or affect their p-values. The coefficient on spouse independence is not statistically significant.

## 6 Discussion: Why Would Those Who Anticipate Having More Children Educate More?

The theoretical model provides different mechanisms of how anticipated fertility can affect educational investment. It can have an effect on family consumption, labor supply, and incentives to find a partner. In this section, I provide descriptive statistics to discuss the intertemporal consumption smoothing, labor supply channels, and the marriage market mechanism.

## 6.1 The Cost of Raising Children and the Double Burden of Parents

The fertility literature in developing countries generally treats children as an investment for parents that pays off quickly because children are productive from an early stage. In developed countries, however, children are often seen as expensive. Children have to be financially supported until the end of the educational stage. Furthermore, retirement schemes and health insurance mitigate the need to rely on children during sickness or old age. In China, education is mandatory until age 16, and children are not allowed to work. Indeed, gross enrollment rates for primary school have constantly been above 100% for the past few years and have increased at the secondary school level. Moreover, child labor is not prevalent.<sup>9</sup>

Expenditure on the education of their children is an important budget item for parents in many countries. Appendix A Figure 5 illustrates the average expenditure on education as a share of family income for families with one child in China in 2010. Educational expenditure, which includes tuition, tutoring, and extracurricular activities, is low in the first years. However, after the fourth year, families spend over 5% and up to 25% of their available income on education-related items. A recent report estimates that Chinese parents overall pay around US\$43,000 for their child's education (HSBC, 2017), which is less than in the United States, but higher than in the United Kingdom, Canada, and France. Furthermore, out of the countries surveyed, China had the highest rate of parents (around 55%), indicating that they are able to fund their child's education through savings or investment. This suggests that parents are aware of the high costs of educating children.

The cost of raising children is particularly important when parents have to financially support their own parents at the same time. Indeed, children are still an important source of old-age support in China. According to the China Family Panel Study, in 2010, 45% of individuals over the age of 60 live with at least one of their children, 69% of those with a son, and 31% with a daughter. For families with an agricultural household status and at least one person older than 60, social security and pensions transfers accumulate to, on average, 2,068 yuan (approximately €218),<sup>10</sup> making up less than 10% of family income. For families with a nonagricultural household status, these accumulate to, on average, 20,353 yuan (€2,137), around 47% of family income. Additionally, 33% of individuals over 60 say that they had received financial transfers from at least one of their children.

Parents thus face financial pressure from two sides. On the one side, they are expected

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<sup>9</sup>Tang et al. (2016) estimate that in 2010, only about 7.74% of children age 10 to 15 were working. Most of them combined education with their economic activity.

<sup>10</sup>Based on the conversion rate of 0.105, the approximate average exchange rate at the beginning of 2010.

to invest in their children’s education. On the other side, their own retired parents may rely on their financial support. It is therefore conceivable that parents invest in their children’s education to improve their financial situation once they have grand-children.

## 6.2 Parental Labor Supply and Earnings

The labor-market returns to education depend on the number of children if the parents adjust their labor supply according to the number of children they have. Do parents work more or less when they have a second child? Appendix A Figure 6, Panel A, displays the average log working hours of men and women as a function of years since the birth of the second child. It compares parents who have exactly two children with a matched control group of parents with one child. Matching is based on the household registration status, education, age, and age at the birth of the first child. For men, there is no significant pattern; they work the same amount whether they have one or two children. Women, however, work less in the first four years following the birth of the second child. They then work around the same hours from year 4 onward. Panel B displays parents’ monthly income. In line with the previous results, there is no consistent pattern between the number of children and paternal earnings. Women’s earnings are less in the first four years after the birth of the second child. Although the comparison controls for some characteristics, the graphs are only descriptive, and endogeneity remains an issue.

Guo et al. (2018) and He and Zhu (2016) address the endogeneity between childbirth and labor market conditions by using twinning as a natural experiment. They compare maternal labor supply dependent on whether the mother has twins or just one child. Guo et al. (2018) do not find evidence on the negative effects of fertility on parental labor supply. He and Zhu (2016) find a small negative effect on women’s labor force participation in the 1990s and an insignificant effect in the 2000s.

Overall, in the Chinese context, paternal labor supply seems unaffected by the birth of a second child. Maternal labor supply might be negatively associated with the birth of a second child, but only in the short run. This may explain the noisier and insignificant results for women.

## 6.3 Marriage in China

Marriage is still nearly universal in China. In 2010, 95% of individuals between the age of 40 and 50 were married, and only 1.3% had never married. Marriage is also positively assortative on education. The correlation between the years of education between spouses is 0.64 for couples who married between 2005 and 2010. Raiber et al. (2020) show that educa-

tional level is a valuable characteristic in the marriage market for both men and women. It, therefore, is plausible that while women anticipating two children have lower labor market returns to education, they have higher marriage market returns to education. Positive assortativity on education can thus mitigate the sex differences. At the same time, it is plausible that educational investment is used to improve men’s marriage prospects when faced with a scarcity of women.

The cohort of individuals who turned 15 between 1991 and 2008 and were born between 1976 and 1993 experience a skewed sex ratio. According to the 2000 census, 50.2% of newborns in 1976 were female, but only 46.6% in 1993. Of the 1976-1993 cohort, 47.9% are women. Thus, for every 100 women, there are 108.8 men on average. Marriage is seen as fundamental in China, but because of a skewed sex ratio, not all men who want to marry are able to find a spouse.

At the same time, eligibility for a second-child permit might be a valuable characteristic in the marriage market, especially when eligibility is spouse independent. [Huang and Zhou \(2015\)](#) find that a higher fine—the financial penalty for having a second child when not eligible—increases the likelihood of marriage between a Han and an ethnic minority spouse in provinces where the eligibility of ethnic minorities for a second-child permit is spouse independent. Spouse-independent eligibility should have a similar effect on marriage prospects to an increase in wealth that is equivalent to paying the fine for having a second child. However, this effect changes incentives to invest in education only if at least part of the competition and part of the other sex is not eligible.

## 7 Conclusion

This paper uses the one-child policy in China and the policy changes in the eligibility criteria of second-child permits for a subset of individuals. Identification relies on a setting with an exogenous, predictable, and important variation in the cost of a child. I find that on average, fulfilling an eligibility criterion at secondary school age increases the likelihood to continue with schooling. Treatment heterogeneity analysis suggests that the effect is driven by those who update their anticipated fertility once they become eligible for a second-child permit.

In section 3, I sketch the economic channels through which anticipated fertility can positively influence educational investment. Because children are expensive, families want to ensure sufficient income in the future. Children are particularly costly when parents have to financially support their own parents at the same time. Improvement in social security and the pension system can decrease the burden of parents.

The positive effect also depends on the relationship between lifetime returns to education and fertility outcomes. If men and women can stay in or re-enter the labor market without loss of their skills, higher anticipated fertility does not have a negative effect on educational investment. The policy implication is thus to ensure the availability of flexible childcare, to fight potential discrimination of parents in the labor market, and to support parents who want to re-enter the labor market.

The importance of marriage in China, combined with a skewed sex ratio at birth, may also explain the observed patterns. Decreases in marriage rates among educated women might reinforce competition between men in the marriage market. This channel is not necessarily relevant to every country. However, it might be important for several populous Asian countries where marriage competition among men is strong.

There are other channels through which anticipated fertility can affect education that are not modeled. For example, individuals who plan on having more than one child might invest in education to prepare for important childcare tasks. There is also a potential psychological effect. For instance, being allowed to have two children in a society where children are essential can lead to a more positive attitude about the future and greater motivation at school.

Similarly, there are many other variables on which anticipated fertility could have an effect. Do men and women who anticipate having several children choose certain types of jobs or avoid certain sectors? Do saving patterns change? Do they look for different types of partners? These questions are important to ensure that individuals have the same opportunities independent of their desire to have children. They can also help to understand saving, investment, and marriage patterns.

China is one specific social and economic environment that has been influenced by strict policies. Comparing individuals who plan on having two children instead of one (intensive margin) is not the same as comparing individuals who do not plan on having any children with those who do (extensive margin). Studies from developed countries find that having one more child has, at most, a weak effect on the mother in the long run ([Angrist and Evans, 1996](#); [Jacobsen et al., 1999](#); [Lundborg et al., 2017](#)). However, the first child has a significant effect. This suggests that the effect on education of having a child compared with not having any may also be different.

In 2015, China announced a two-child policy, which allows everyone to apply for a second-child permit. There is an ongoing discussion about the effect of the one-child policy on fertility rates and thus the effect of the new policy. The results of eligibility for a second-child permit on fertility behavior suggest that the two-child policy has an effect on fertility, but it is expected to be small. The policy is also predicted to increase educational investment.

The findings of this paper are a result of the Chinese social and economic environment. However, low fertility is a concern in many medium- and high-income countries. The findings are therefore a positive sign for policy makers who want to promote fertility and education simultaneously.

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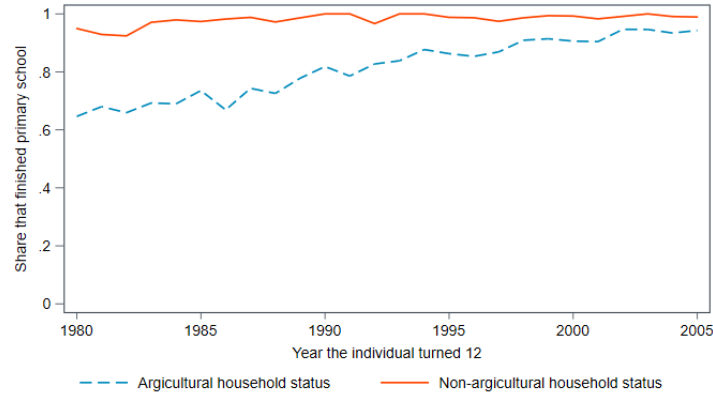
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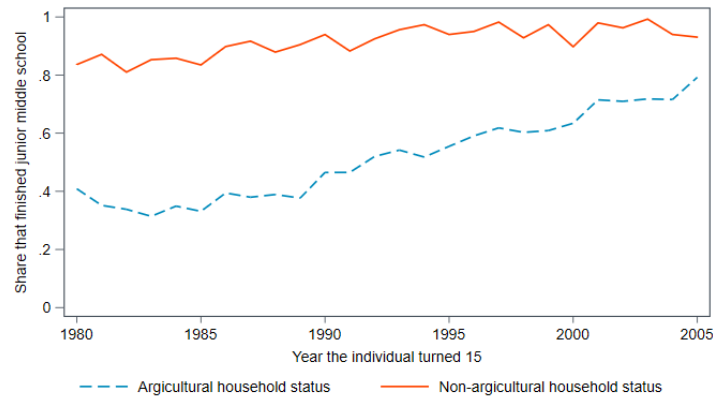
## 8 Appendix: Figures and Tables

### 8.1 Figures

(a) Primary school completion



(b) Junior middle school completion



(c) Senior middle school enrollment

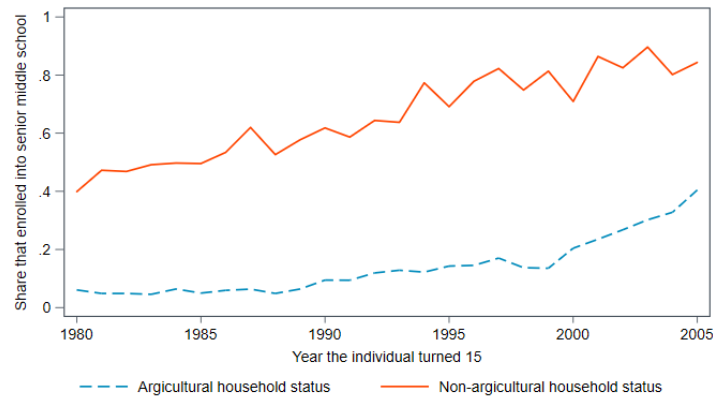


Figure 1: Share of the population completing the different schooling stages between 1980 and 2005 according to their household registration status. *Note:* Average completion or enrolment rates according to the year the individual turned 12 (for primary school completion) or 15 (for junior middle school completion or senior middle school enrollment). *Data:* CFPS 2010.

(a) Effect of eligibility for second-child permit on enrollment into senior middle school:  
All



(b) Effect of eligibility for second-child permit on enrollment into senior middle school:  
Only those with junior middle school degree

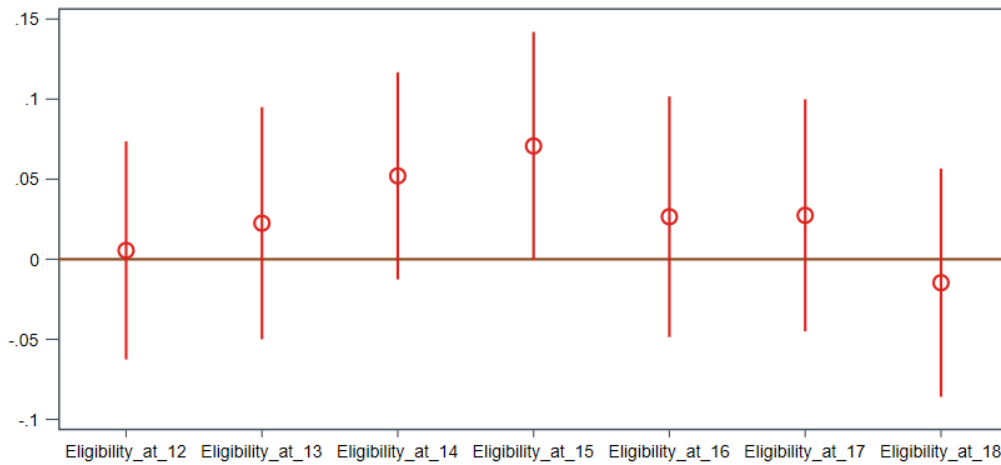
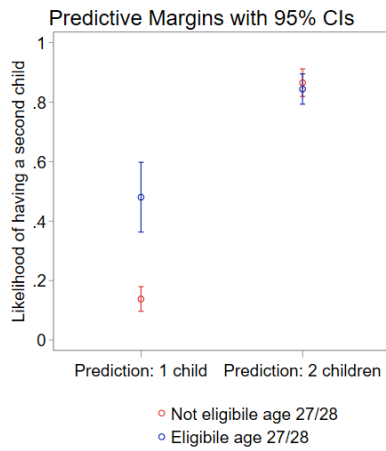
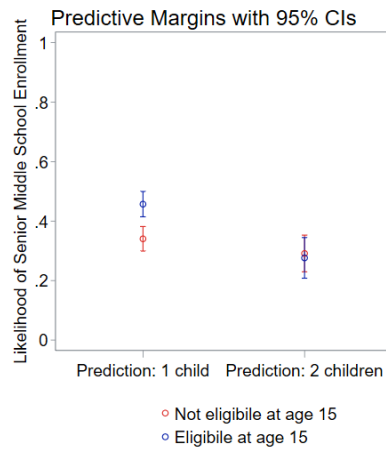


Figure 2: Coefficients of eligibility for second-child permit on enrollment into senior middle school at different age thresholds with 95% confidence intervals. Based on the 1991–2008 sample. Confidence intervals based on subpopulation within-province clustered standard errors. *Data:* China Family Panel Study 2010.

(a) Older sample 1991–2005



(b) Sample 1991–2008



(c) Sample 1994–2008

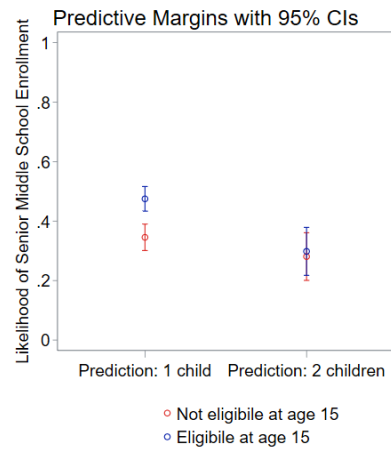


Figure 3: Predicted likelihood of having a second child (Panel A) and senior middle school enrollment (Panels B and C) according to eligibility status and predicted fertility behavior. Confidence intervals based on subpopulation within-province clustered standard errors. *Data:* China Family Panel Study 2010.

## 8.2 Tables

Table 1: Effect of eligibility for second-child permits on the likelihood of having a second child

<b>Dependent variable: Having a second child</b>				
	(1)	(2)	(3)	(4)
	All	Women	Men	w/o Minorities
Eligibility at age 27/28	0.142 (0.057)	0.128 (0.069)	0.155 (0.069)	0.147 (0.064)
Observations	7168	3782	3386	6594
P-Value (Two-way clustered)	0.013	0.049	0.024	0.030
P-Value (Sub-population Level)	0.048	0.086	0.042	0.035

**Note:** Restricted to married couples with at least one child before 2004 and no more than 2 children. Includes province fixed effected interacted with year-fixed effects and group indicators for minority, rural household status, and being an only child interacted with year-fixed effects. Standard errors in parenthesis are based on two-way-fixed effect (province and year) wild bootstrapping. P-Value (Two-way clustered) is based on wild bootstrapped standard errors, two-way clustered (province and year). P-Value (Sub-population Level) is based on wild bootstrapped standard errors, clustered on the sub-population within-the-province level. Eligibility indicates if the individual fulfills an eligibility criterion for a second child permit in the year they turn 27 (women) or 28 (men).

Table 2: Effect of eligibility for second-child permits on enrollment into senior middle school

<b>Dependent variable: Senior Middle School Enrollment</b>				
	(1)	(2)	(3)	(4)
	All	w/ Primary	w/ JMS	w/o Minorities
<b><i>Panel A: Sample 1991-2008</i></b>				
Eligibility at age 15	0.108 (0.048)	0.102 (0.047)	0.071 (0.045)	0.150 (0.050)
Observations	8217	7530	6146	7347
P-Value (Two-way clustered)	0.029	0.036	0.124	0.009
P-Value (Sub-population Level)	0.013	0.018	0.078	0.009
<b><i>Panel B: Sample 1995-2008</i></b>				
Eligibility at age 15	0.128 (0.046)	0.120 (0.047)	0.067 (0.043)	0.152 (0.050)
Observations	6405	5935	4918	5757
P-Value (Two-way clustered)	0.006	0.009	0.129	0.006
P-Value (Sub-population Level)	0.006	0.010	0.110	0.015

**Note:** w/ Primary: Only those with Primary School Degree. w/ JMS: Only those with Junior Middle School degree. Includes province fixed effected interacted with year-fixed effects and group indicators for minority, rural household status, and being an only child interacted with year-fixed effects. Standard errors in parenthesis are based on two-way-fixed effect (province and year) wild bootstrapping. P-Value (Two-way clustered) is based on wild bootstrapped standard errors, two-way clustered (province and year). P-Value (Sub-population Level) is based on wild bootstrapped standard errors, clustered on the sub-population within-the-province level. Eligibility indicates if the individual fulfills an eligibility criterion for a second child permit in the year they turn 15.

Table 3: Effect of eligibility for second-child permits on junior middle school completion

<b>Dependent variable: Junior Middle School Completion</b>				
	(1)	(2)	(3)	(4)
	All	w/ Primary	All	w/ Primary
<b><i>Panel A: Sample 1991-2008</i></b>				
Eligibility at age 15	0.013 (0.053)	0.001 (0.048)		
Eligibility at age 14			0.021 (0.047)	-0.001 (0.037)
Observations	8217	7530	8210	7586
P-Value (Two-way clustered)	0.804	0.977	0.636	0.984
P-Value (Sub-population Level)	0.814	0.985	0.649	0.986
<b><i>Panel B: Sample 1995-2008</i></b>				
Eligibility at age 15	0.066 (0.047)	0.048 (0.042)		
Eligibility at age 14			0.040 (0.048)	0.013 (0.038)
Observations	6405	5935	6486	6046
P-Value (Two-way clustered)	0.158	0.247	0.378	0.719
P-Value (Sub-population Level)	0.244	0.298	0.430	0.734

**Note:** w/ Primary: Only those with Primary School degree. Includes province fixed effected interacted with year-fixed effects and group indicators for minority, rural household status, and being an only child interacted with year-fixed effects. Standard errors in parenthesis are based on two-way-fixed effect (province and year) wild bootstrapping. P-Value (Two-way clustered) is based on wild bootstrapped standard errors, two-way clustered (province and year). P-Value (Sub-population Level) is based on wild bootstrapped standard errors, clustered on the sub-population within-the-province level. Eligibility indicates if the individual fulfills an eligibility criterion for a second child permit in the year they turn 14 or 15.

Table 4: Effect of eligibility for second-child permits on enrollment into senior middle school: Men and women separately

<b>Dependent variable: Senior Middle School Enrollment</b>				
	(1)	(2)	(3)	(4)
	Men	Men w/ Primary	Women	Women w/ Primary
<b><i>Panel A: Sample 1991-2008</i></b>				
Eligibility at age 15	0.109 (0.063)	0.119 (0.066)	0.091 (0.094)	0.090 (0.097)
Observations	3902	3652	4315	3878
P-Value (Two-way clustered)	0.069	0.057	0.326	0.351
P-Value (Sub-population Level)	0.081	0.053	0.236	0.318
<b><i>Panel B: Sample 1995-2008</i></b>				
Eligibility at age 15	0.168 (0.082)	0.175 (0.089)	0.112 (0.068)	0.104 (0.074)
Observations	3046	2876	3359	3059
P-Value (Two-way clustered)	0.035	0.040	0.171	0.145
P-Value (Sub-population Level)	0.027	0.024	0.117	0.140

**Note:** w/ Primary: Only those with Primary School degree. Includes province fixed effects interacted with year-fixed effects and group indicators for minority, rural household status, and being an only child interacted with year-fixed effects. Standard errors in parenthesis are based on two-way-fixed effect (province and year) wild bootstrapping. P-Value (Two-way clustered) is based on wild bootstrapped standard errors, two-way clustered (province and year). P-Value (Sub-population Level) is based on wild bootstrapped standard errors, clustered on the sub-population within-the-province level. Eligibility indicates if the individual fulfills an eligibility criterion for a second child permit in the year they turn 15.



Table 5: Effect of eligibility for second-child permits on enrollment into senior high school: Controlling for district level sex ratio and fertility rate

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All	w/ Primary	w/ JMS	w/o Minorities	All	w/ Primary	w/ JMS	w/o Minorities
<b><i>Panel A: Sample 1991-2008</i></b>								
Eligibility at age 15	0.109 (0.037)	0.103 (0.037)	0.072 (0.036)	0.150 (0.041)	0.098 (0.035)	0.094 (0.036)	0.067 (0.035)	0.130 (0.038)
District Cohort sex ratio	0.010 (0.013)	0.008 (0.013)	0.012 (0.013)	0.009 (0.014)				
Disctrict Fertility Rate					-0.128 (0.021)	-0.124 (0.022)	-0.109 (0.022)	-0.128 (0.022)
Observations	8155	7472	6092	7288	8103	7419	6056	7239
PValue_WB_Twoway	0.027	0.032	0.110	0.008	0.040	0.047	0.127	0.022
PValue_WB_Group_Clusters	0.013	0.017	0.073	0.009	0.014	0.021	0.101	0.013
<b><i>Panel B: Sample 1995-2008</i></b>								
Eligibility at age 15	0.129 (0.040)	0.121 (0.040)	0.068 (0.038)	0.153 (0.049)	0.103 (0.037)	0.097 (0.037)	0.049 (0.036)	0.124 (0.043)
District Cohort sex ratio	0.003 (0.017)	0.002 (0.017)	0.005 (0.016)	0.003 (0.018)				
Disctrict Fertility Rate					-0.129 (0.023)	-0.123 (0.024)	-0.108 (0.023)	-0.128 (0.024)
Observations	6352	5882	4867	5704	6354	5884	4880	5711
PValue_WB_Twoway	0.007	0.010	0.115	0.003	0.024	0.032	0.247	0.016
PValue_WB_Group_Clusters	0.009	0.013	0.108	0.018	0.021	0.027	0.209	0.027

**Note:** w/ Primary: Only those with Primary School Degree. w/ JMS: Only those with Junior Middle School degree. Includes province fixed effected interacted with year-fixed effects and group indicators for minority, rural household status, and being an only child interacted with year-fixed effects. Standard errors in parenthesis are based on two-way-fixed effect (province and year) wild bootstrapping. P-Value (Two-way clustered) is based on wild bootstrapped standard errors, two-way clustered (province and year). P-Value (Sub-population Level) is based on wild bootstrapped standard errors, clustered on the sub-population within-the-province level. Eligibility indicates if the individual fulfills an eligibility criterion for a second child permit in the year they turn 15.

Table 6: Effect of eligibility for second-child permits on enrollment into senior high school: three years before and after 15

<b>Dependent variable: Senior Middle School Enrollment</b>				
	(1)	(2)	(3)	(4)
	All	w/ Primary	w/ JMS	w/o Minorities
<b><i>Panel A: Sample 1991-2008</i></b>				
Eligibility at age 12	0.056 (0.038)	0.051 (0.035)	0.006 (0.034)	0.070 (0.046)
Observations	7215	6710	5428	6470
P-Value (Two-way clustered)	0.146	0.157	0.879	0.135
P-Value (Sub-population Level)	0.190	0.187	0.879	0.191
<b><i>Panel B: Sample 1995-2008</i></b>				
Eligibility at age 12	0.047 (0.049)	0.032 (0.046)	-0.011 (0.041)	0.053 (0.055)
Observations	5544	5195	4212	5010
P-Value (Two-way clustered)	0.365	0.520	0.798	0.287
P-Value (Sub-population Level)	0.444	0.543	0.824	0.383
<b><i>Panel C: Sample 1991-2008</i></b>				
Eligibility at age 18	0.004 (0.037)	0.001 (0.036)	-0.015 (0.036)	0.025 (0.040)
Observations	8627	7672	6061	7693
P-Value (Two-way clustered)	0.942	0.978	0.746	0.646
P-Value (Sub-population Level)	0.926	0.983	0.740	0.583
<b><i>Panel D: Sample 1995-2008</i></b>				
Eligibility at age 18	0.045 (0.042)	0.043 (0.040)	0.007 (0.039)	0.065 (0.049)
Observations	6528	5933	4820	5833
P-Value (Two-way clustered)	0.450	0.427	0.895	0.337
P-Value (Sub-population Level)	0.380	0.346	0.882	0.268

**Note:** Sample is adjusted to those who turned 12 between 1991 - 2008 (Panel A) and 1995 - 2008 (Panel B), and to those who turned 18 between 1991 - 2008 (Panel C) and 1995 - 2008 (Panel D). w/ Primary: Only those with Primary School Degree. w/ JMS: Only those with Junior Middle School degree. Includes province fixed effects interacted with year-fixed effects and group indicators for minority, rural household status, and being an only child interacted with year-fixed effects. Standard errors in parenthesis are based on two-way-fixed effect (province and year) wild bootstrapping. P-Value (Two-way clustered) is based on wild bootstrapped standard errors, two-way clustered (province and year). P-Value (Sub-population Level) is based on wild bootstrapped standard errors, clustered on the sub-population within-the-province level. Eligibility indicates if the individual fulfills an eligibility criterion for a second child permit in the year they turn 15.

Table 7: Heterogeneity in the effect of eligibility for second-child permits on enrollment into senior high school according the predicted fertility behavior

	(1)	(2)	(3)
	All	Men	Women
<b><i>Panel A: Older Sample - Dependent variable: Having a second child</i></b>			
Eligibility at age 27/28	0.342 (0.076)	0.366 (0.090)	0.345 (0.081)
Eligibility at 27/28 X Predicted to have 2 children	-0.363 (0.071)	-0.384 (0.086)	-0.369 (0.074)
Predicted to have 2 children	0.727 (0.029)	0.731 (0.043)	0.724 (0.037)
Observations	5716	2615	3101
Eligibility: P-Value (Sub-population Level)	0.000	0.001	0.000
Interaction: P-Value (Sub-population Level)	0.000	0.000	0.000
Predicted 2 children: P-Value (Sub-population Level)	0.000	0.000	0.000
<b><i>Panel B: Sample 1991-2008 - Dependent variable: Senior middle school Enrollment</i></b>			
Eligibility at age 15	0.116 (0.039)	0.111 (0.052)	0.109 (0.064)
Eligibility at 15 X Predicted to have 2 children	-0.131 (0.055)	-0.093 (0.056)	-0.121 (0.084)
Predicted to have 2 children	-0.049 (0.030)	-0.030 (0.036)	-0.081 (0.046)
Observations	8023	3805	4218
Eligibility: P-Value (Sub-population Level)	0.012	0.071	0.151
Interaction: P-Value (Sub-population Level)	0.041	0.093	0.217
Predicted 2 children: P-Value (Sub-population Level)	0.139	0.393	0.072
<b><i>Panel C: Sample 1995-2008 - Dependent variable: Senior middle school Enrollment</i></b>			
Eligibility at age 15	0.129 (0.040)	0.169 (0.061)	0.115 (0.062)
Eligibility at 15 X Predicted to have 2 children	-0.118 (0.069)	-0.067 (0.065)	-0.083 (0.127)
Predicted to have 2 children	-0.064 (0.036)	-0.054 (0.042)	-0.102 (0.067)
Observations	6296	2990	3306
Eligibility: P-Value (Sub-population Level)	0.009	0.026	0.100
Interaction: P-Value (Sub-population Level)	0.139	0.269	0.598
Predicted 2 children: P-Value (Sub-population Level)	0.128	0.199	0.193

**Note:** Panel A: Restricted to married couples with at least one child before 2004 and no more than 2 children. Includes province fixed effected interacted with year-fixed effects and group indicators for minority, rural household status, and being an only child interacted with year-fixed effects. Standard errors in parenthesis are clustered on the sub-population within-the-province level. P values are based on wild bootstrapping, clustered on the sub-population within-the-province level. Eligibility indicates if the individual fulfills an eligibility criterion for a second child permit in the year they turn 15. Predicted to have 2 children is an indicator based on a random forest prediction algorithm.

Table 8: Effect of eligibility for second-child permits on enrollment into senior high school according to the cohort sex ratio and spouse dependence of the eligibility criterion

<b>Dependent variable: Senior Middle School Enrollment</b>						
	(1)	(2)	(3)	(4)	(5)	(6)
	All	Men	Women	All	Men	Women
<b><i>Panel A: Sample 1991-2008</i></b>						
Eligibility at age 15	0.109 (0.037)	0.111 (0.052)	0.090 (0.064)	0.116 (0.037)	0.114 (0.053)	0.098 (0.062)
Eligibility at 15 X District cohort sex ratio (std)	-0.012 (0.013)	-0.010 (0.022)	-0.008 (0.018)			
Criteria spouse independent				-0.079 (0.046)	-0.045 (0.090)	-0.077 (0.071)
Observations	8155	3875	4280	8217	3902	4315
Eligibility: P-Value (Sub-population Level)	0.013	0.073	0.238	0.010	0.069	0.185
Interaction: P-Value (Sub-population Level)	0.407	0.668	0.736	0.188	0.739	0.341
<b><i>Panel B: Sample 1995-2008</i></b>						
Eligibility at age 15	0.129 (0.040)	0.169 (0.061)	0.113 (0.064)	0.140 (0.040)	0.182 (0.062)	0.122 (0.061)
Eligibility at 15 X District cohort sex ratio (std)	-0.011 (0.017)	-0.009 (0.023)	-0.006 (0.025)			
Criteria spouse independent				-0.139 (0.050)	-0.145 (0.088)	-0.102 (0.087)
Observations	6352	3021	3331	6405	3046	3359
Eligibility: P-Value (Sub-population Level)	0.008	0.024	0.115	0.003	0.024	0.084
Interaction: P-Value (Sub-population Level)	0.571	0.707	0.831	0.035	0.299	0.355

**Note:** Includes province fixed effected interacted with year-fixed effects and group indicators for minority, rural household status, and being an only child interacted with year-fixed effects. Standard errors in parenthesis are clustered on the sub-population level. P-Values are based on on wild bootstrapped standard errors, clustered on the sub-population within-the-province level. Eligibility indicated of the individual fulfills an eligibility criterion. District cohort sex ratio is the standardized share of women in the same cohort (plus and minus 2 more year's than the individual). Eligibility indicates if the individual fulfills an eligibility criterion for a second child permit in the year they turn 15.

# 9 Online Appendix A: Additional Figures and Tables

## 9.1 Figures

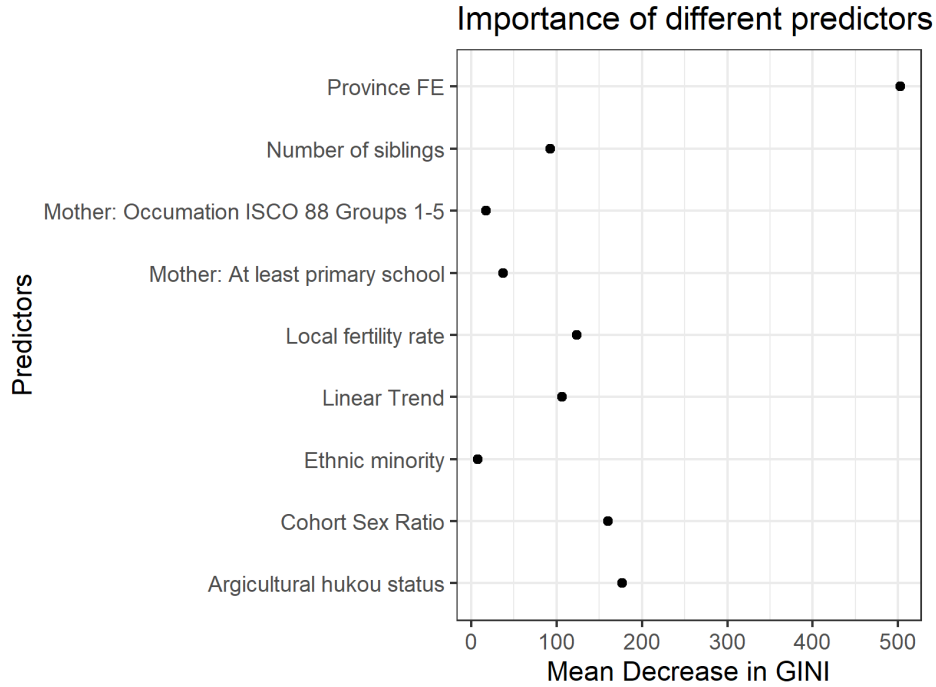


Figure 4: Importance of different predictors: Decrease in node impurity due to the predictor weighted by the probability of reaching that node averaged over all trees of the ensemble. Uses the randomForest R package.

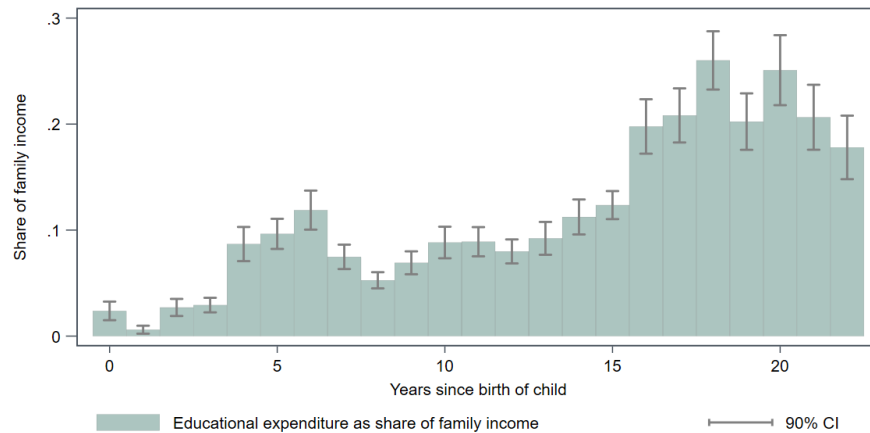
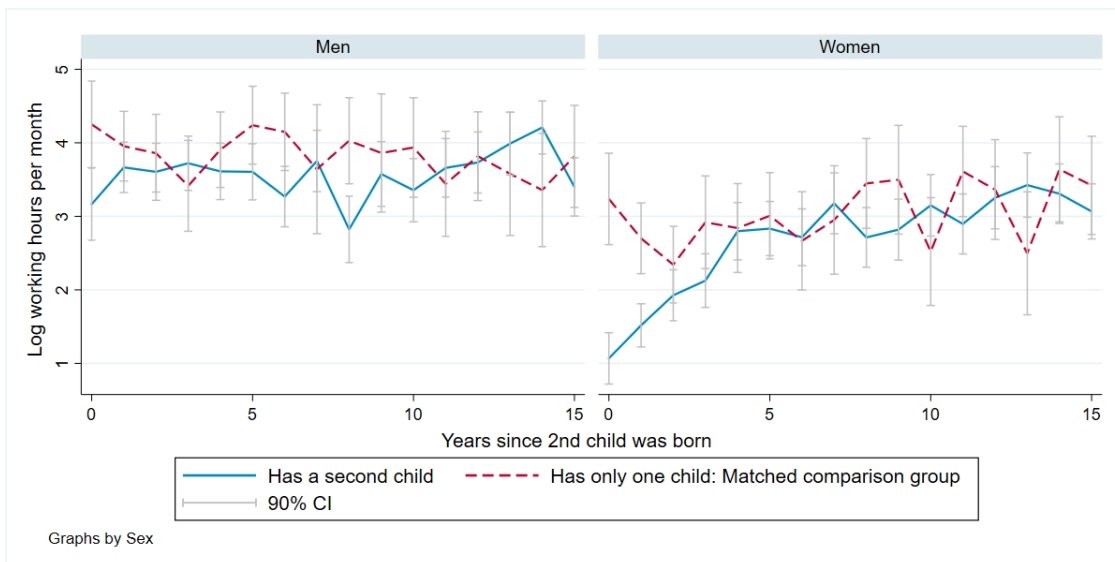


Figure 5: Educational expenditure as share of net family income, in 2010, for families with one child, according to the age of the child. *Data Source: CFPS 2010*

(a) Working Time



(b) Labor income

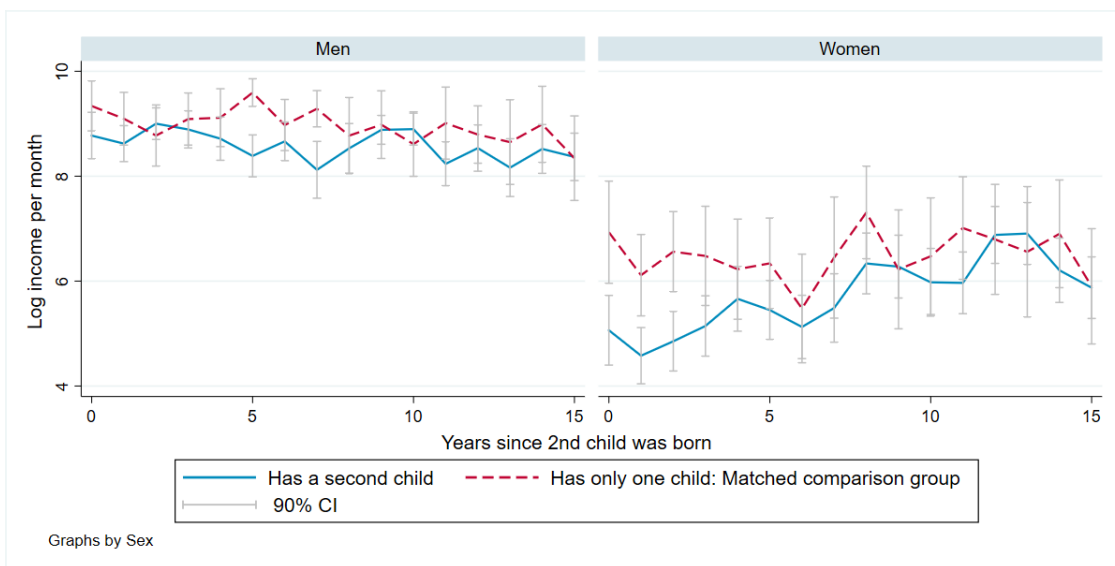


Figure 6: Log working hours and log income by sex and number of children. Compares individuals with two children with a matched group of individuals with one child. Individuals are matched 1 to 1 with their nearest neighbor with replacement. Matching function takes into account education, age, age at first birth and the household status. *Data*: CFPS 2010.

## 9.2 Tables

Table 9: Summary statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
<i>Panel A: 1991 - 2008 Sample</i>					
Years of education	9.254	4.203	0	22	8217
Finished junior high school	0.748	0.434	0	1	8217
Enrolled in senior high school	0.355	0.479	0	1	8217
Finished senior high school	0.344	0.475	0	1	8217
Enrolled in College or University	0.141	0.348	0	1	8217
Female	0.525	0.499	0	1	8217
Only Child	0.209	0.407	0	1	8217
Ethnic Minority	0.106	0.308	0	1	8217
Agricultural household status	0.699	0.459	0	1	8217
Age	25.393	5.18	17	34	8217
Eligible for 2nd child permit (at 15)	0.271	0.445	0	1	8217
Eligible if 1st child is a girl (at 15)	0.483	0.5	0	1	8217
<i>Panel B: 1995-2008 Sample</i>					
Years of education	9.502	4.098	0	22	6405
Finished junior high school	0.768	0.422	0	1	6405
Enrolled in senior high school	0.369	0.483	0	1	6405
Finished senior high school	0.356	0.479	0	1	6405
Enrolled in College or University	0.138	0.345	0	1	6405
Female	0.524	0.499	0	1	6405
Only Child	0.233	0.423	0	1	6405
Ethnic Minority	0.101	0.302	0	1	6405
Agricultural household status	0.712	0.453	0	1	6405
Age	23.375	3.949	17	30	6405
Eligible for 2nd child permit (at 15)	0.284	0.451	0	1	6405
Eligible if 1st child is a girl (at 15)	0.51	0.5	0	1	6405
<i>Panel C: Older 1991-2008 Sample</i>					
Years of education	6.895	4.444	0	22	7168
Finished junior high school	0.556	0.497	0	1	7168
Enrolled in senior high school	0.189	0.392	0	1	7168
Finished senior high school	0.183	0.387	0	1	7168
Enrolled in College or University	0.074	0.261	0	1	7168
Female	0.528	0.499	0	1	7168
Only Child	0.037	0.188	0	1	7168
Ethnic Minority	0.08	0.271	0	1	7168
Agricultural household status	0.723	0.448	0	1	7168
Age	40.353	4.011	32	47	7168
Eligible for 2nd child permit (at 27/28)	0.123	0.328	0	1	7168
Eligible if 1st child is a girl (at 27/28)	0.533	0.499	0	1	7168
Number of children	1.514	0.5	1	2	7168
First child is a girl	0.459	0.498	0	1	7168

**Note:** Panel A includes individuals who turned 15 between 1991 and 2008. Panel B includes individuals who turned 15 between 1995 to 2008. Panel C includes individuals who turned 27 (women) or 28 (men) between 1991 and 2008, who are married, where at least 18 when they married, had a first child before 2003 and have no more than two children in 2010. *Data source:* CFPS 2010

Table 10: Effect of eligibility for second-child permits on enrollment into senior middle school: Different panel cut-offs

	(1)	(2)	(3)	(4)
	All	w/ Primary	w/ JMS	w/o Minorities
<b><i>Panel A: Sample 1990-2008</i></b>				
Eligibility at age 15	0.086	0.085	0.060	0.131
	(0.047)	(0.048)	(0.049)	(0.047)
Observations	8698	7936	6455	7771
P-Value (Two-way clustered)	0.084	0.089	0.197	0.016
P-Value (Sub-population Level)	0.058	0.066	0.164	0.012
<b><i>Panel B: Sample 1992-2008</i></b>				
Eligibility at age 15	0.108	0.102	0.065	0.146
	(0.051)	(0.049)	(0.046)	(0.055)
Observations	7730	7121	5838	6919
P-Value (Two-way clustered)	0.039	0.044	0.168	0.015
P-Value (Sub-population Level)	0.009	0.018	0.109	0.011

**Note:** w/ Primary: Only those with Primary School Degree. w/ JMS: Only those with Junior Middle School degree. Includes province fixed effect interacted with year-fixed effects and group indicators for minority, rural household status, and being an only child interacted with year-fixed effects. Standard errors in parenthesis are based on two-way-fixed effect (province and year) wild bootstrapping. P-Value (Two-way clustered) is based on wild bootstrapped standard errors, two-way clustered (province and year). P-Value (Sub-population Level) is based on wild bootstrapped standard errors, clustered on the sub-population within-the-province level. Eligibility indicates if the individual fulfills an eligibility criterion for a second child permit in the year they turn 15.



Table 11: Effect of eligibility for second-child permits on enrollment into different types of senior middle school

Dependent variable: Enrollment in	Regular Sen. Middle School	Specialised Sen. Middle School		
	(1)	(2)	(3)	(4)
	All	w/ JMS	All	w/ JMS
<b><i>Panel A: Sample 1991-2008</i></b>				
Eligibility at age 15	0.134 (0.075)	0.101 (0.091)	-0.026 (0.054)	-0.030 (0.065)
Observations	8217	6146	8217	6146
P-Value (Two-way clustered)	0.099	0.266	0.619	0.631
P-Value (Sub-population Level)	0.031	0.135	0.506	0.514
<b><i>Panel B: Sample 1995-2008</i></b>				
Eligibility at age 15	0.148 (0.070)	0.112 (0.081)	-0.020 (0.053)	-0.045 (0.063)
Observations	6405	4918	6405	4918
P-Value (Two-way clustered)	0.046	0.165	0.702	0.501
P-Value (Sub-population Level)	0.018	0.104	0.571	0.329

**Note:** w/ JMS: Only those with Junior Middle School degree. Includes province fixed effected interacted with year-fixed effects and group indicators for minority, rural household status, and being an only child interacted with year-fixed effects. Standard errors in parenthesis are based on two-way-fixed effect (province and year) wild bootstrapping. P-Value (Two-way clustered) is based on wild bootstrapped standard errors, two-way clustered (province and year). P-Value (Sub-population Level) is based on wild bootstrapped standard errors, clustered on the sub-population within-the-province level. Eligibility indicates if the individual fulfills an eligibility criterion for a second child permit in the year they turn 15. Regular Sen. Middle School: Regular Senior Middle School. Specialised Sen. Middle School includes vocational, technical, adult and other senior middle schools.

Table 12: Effect of eligibility for second-child permits on enrollment into senior high school: Excluding provinces with few observations

<b>Dependent variable: Senior Middle School Enrollment</b>				
	(1)	(2)	(3)	(4)
	All	w/ Primary	w/ JMS	w/o Minorities
<b><i>Panel A: Sample 1991-2008</i></b>				
Eligibility at age 15	0.111 (0.051)	0.106 (0.050)	0.078 (0.048)	0.153 (0.052)
Observations	7677	7014	5695	6819
P-Value (Two-way clustered)	0.037	0.043	0.121	0.012
P-Value (Sub-population Level)	0.017	0.022	0.066	0.005
<b><i>Panel B: Sample 1995-2008</i></b>				
Eligibility at age 15	0.141 (0.048)	0.134 (0.047)	0.085 (0.043)	0.166 (0.049)
Observations	5993	5537	4558	5355
P-Value (Two-way clustered)	0.005	0.005	0.062	0.002
P-Value (Sub-population Level)	0.004	0.004	0.049	0.009

**Note:** Excludes the five provinces with the least observations, corresponding to around 25% of provinces. w/ Primary: Only those with Primary School Degree. w/ JMS: Only those with Junior Middle School degree. Includes province fixed effect interacted with year-fixed effects and group indicators for minority, rural household status, and being an only child interacted with year-fixed effects. Standard errors in parenthesis are based on two-way-fixed effect (province and year) wild bootstrapping. P-Value (Two-way clustered) is based on wild bootstrapped standard errors, two-way clustered (province and year). P-Value (Sub-population Level) is based on wild bootstrapped standard errors, clustered on the sub-population within-the-province level. Eligibility indicates if the individual fulfills an eligibility criterion for a second child permit in the year they turn 15.

Table 13: Effect of eligibility for second-child permits on enrollment into senior high school according to the mother's education and occupation

<b>Dependent variable: Senior Middle School Enrollment</b>						
	(1)	(2)	(3)	(4)	(5)	(6)
	All	Men	Women	All	Men	Women
<b><i>Panel A: Sample 1991-2008</i></b>						
Eligibility at age 15	0.103 (0.042)	0.128 (0.060)	0.076 (0.069)	0.107 (0.039)	0.095 (0.055)	0.095 (0.066)
Eligibility at 15 X Mother: Primary school	-0.001 (0.031)	-0.024 (0.054)	0.018 (0.038)			
Mother: Primary school	0.130 (0.019)	0.119 (0.033)	0.135 (0.021)			
Eligibility at 15 X Mother: ISCO 88 Occupations Groups 1-5				-0.035 (0.044)	0.007 (0.059)	-0.072 (0.052)
Mother: ISCO 88 Occupations Groups 1-5				0.137 (0.027)	0.073 (0.034)	0.201 (0.033)
Observations	8217	3902	4315	8217	3902	4315
Eligibility: P-Value (SPL)	0.036	0.045	0.365	0.028	0.136	0.223
Interaction: P-Value (SPL)	0.986	0.669	0.640	0.497	0.898	0.264
Mother education: P-Value (SPL)	0.000	0.001	0.000			
Mother occupation: P-Value (SPL)				0.000	0.037	0.000
<b><i>Panel B: Sample 1995-2008</i></b>						
Eligibility at age 15	0.110 (0.046)	0.175 (0.079)	0.083 (0.069)	0.135 (0.043)	0.166 (0.064)	0.118 (0.067)
Eligibility at 15 X Mother: Primary school	0.013 (0.040)	-0.013 (0.077)	0.036 (0.045)			
Mother: Primary school	0.128 (0.026)	0.111 (0.052)	0.136 (0.027)			
Eligibility at 15 X Mother: ISCO 88 Occupations Groups 1-5				-0.078 (0.046)	-0.051 (0.057)	-0.080 (0.060)
Mother: ISCO 88 Occupations Groups 1-5				0.168 (0.028)	0.120 (0.034)	0.199 (0.041)
Observations	6405	3046	3359	6405	3046	3359
Eligibility: P-Value (SPL)	0.027	0.051	0.267	0.010	0.028	0.129
Interaction: P-Value (SPL)	0.750	0.878	0.400	0.149	0.411	0.280
Mother education: P-Value (SPL)	0.000	0.037	0.000			
Mother occupation: P-Value (SPL)				0.000	0.000	0.000

**Note:** Includes province fixed effects interacted with year-fixed effects and group indicators for minority, rural household status, and being an only child interacted with year-fixed effects. Standard errors in parenthesis are clustered on the sub-population within-the-province level. P values are based on wild bootstrapping, clustered on the sub-population within-the-province level. Eligibility indicates if the individual fulfills an eligibility criterion for a second child permit in the year they turn 15. Mother: Primary school indicates that the mother finished at least primary school. Mother: ISCO 88 Occupations Groups 1-5 indicated if the mother's main occupation is coded as ISCO 88 group 1 to 5.

Table 14: Effect of eligibility for second-child permits on age at marriage

<b>Dependent variable: Age at marriage</b>						
	(1)	(2)	(3)	(4)	(5)	(6)
	All	Women	Men	All	Women	Men
Eligibility at age 19	-0.533	0.317	-0.448	-0.525	0.122	-0.231
	(0.404)	(0.646)	(0.630)	(0.422)	(0.661)	(0.562)
Criteria spouse independent				-0.062	1.716	-1.569
				(0.686)	(1.231)	(0.755)
Observations	6183	2347	2724	6183	2347	2724
Eligibility: P-Value (TWC)	0.225	0.637	0.693	0.793	0.793	0.793
Eligibility: P-Value (SPL)	0.284	0.674	0.616	0.317	0.856	0.743
Spouse-indep.: P-Value (TWC)				0.408	0.408	0.408
Spouse-indep.: P-Value (SPL)				0.948	0.273	0.188

**Note:** Restricted to married couples who turned 19 between 1991 and 2008. Columns 4 to 6 include individuals who have at least one child and who were at least 18 years old when the first child was born. Includes province fixed effected interacted with year-fixed effects and group indicators for minority, rural household status, and being an only child interacted with year-fixed effects. Standard errors in parenthesis are based on two-way-fixed effect (province and year) wild bootstrapping. P-Value (TWC) is based on wild bootstrapped standard errors, two-way clustered (province and year). P-Value (SPL) is based on wild bootstrapped standard errors, clustered on the sub-population within-the-province level. Eligibility indicates if the individual fulfills an eligibility criterion for a second child permit in the year they turn 15.

Table 15: Effect of eligibility for second-child permits on age at first birth

<b>Dependent variable: Age at birth of first child</b>						
	(1)	(2)	(3)	(4)	(5)	(6)
	All	Women	Men	All	Women	Men
Eligibility at age 20	-1.019	-1.020	-0.731	-0.986	-1.009	-0.564
	(0.389)	(0.865)	(0.604)	(0.381)	(0.825)	(0.558)
Criteria spouse independent				-0.249	-0.079	-1.364
				(0.755)	(1.633)	(0.776)
Observations	6116	2224	2681	6116	2224	2681
Eligibility: P-Value (TWC)	0.134	0.394	0.432	0.110	0.324	0.450
Eligibility: P-Value (SPL)	0.048	0.322	0.342	0.046	0.302	0.417
Spouse-indep.: P-Value (TWC)				0.828	0.949	0.509
Spouse-indep.: P-Value (SPL)				0.778	0.967	0.287

**Note:** Restricted to married couples who turned 20 between 1991 and 2005. Columns 4 to 6 include individuals who have at least one child and who were at least 18 years old when the first child was born. Includes province fixed effected interacted with year-fixed effects and group indicators for minority, rural household status, and being an only child interacted with year-fixed effects. Standard errors in parenthesis are based on two-way-fixed effect (province and year) wild bootstrapping. P-Value (TWC) is based on wild bootstrapped standard errors, two-way clustered (province and year). P-Value (SPL) is based on wild bootstrapped standard errors, clustered on the sub-population within-the-province level. Eligibility indicates if the individual fulfills an eligibility criterion for a second child permit in the year they turn 20.

## 10 Online Appendix B: Theory

### 10.1 Set-up

A representative family consists of two parents and their child, the individual who is a teenager at the beginning. Parents must decide how much to invest in the education of the teenager in period 1. In period 2, the individual is grown up, married, earns income together with their spouse, and transfers part of the income to the parents. The share of the transfer is sex-specific, reflecting social norms. The newly formed couple decides how many children they have.<sup>11</sup> They have to pay a fine for the second child if they are not eligible for a second child permit. The fine depends on the income of the now grown-up individual which is a function of the educational level. The results are qualitatively the same when both education and fertility decisions are taken by the family together and when children take the educational decision themselves and then transfer money to their parents due to social norms or altruistic reasons.

**Period 1:** In period 1, the parents  $p$  consumes  $c_p^1$ . The income of the family is given exogenously and used for consumption and investment in education. Utility in period 1 is given by:

$$u_p(c_p^1) = u(Y - \eta I_s) \quad (2)$$

where  $u_p(\cdot)$  is the utility of consumption, assumed to be strictly increasing and concave.  $\eta > 0$  is the constant cost of education,  $Y$  the exogenous income, and  $I_s$  the educational level of the individual of sex  $s$ . I assume that families are credit constraint such that they cannot borrow against their child's future income (across periods).

**Period 2:** In period 2, the individual is grown up and married. From the income earned, the family pays the cost, including an eventual fine. A given share income available after the cost for raising children is deducted  $\tau_s$  is then transferred to the individual's parents, the rest is used for consumption. The family gets utility from having children which is additively separable from the utility of consumption.

The now grown-up individual's utility in period 2 is given by:

$$u_s(c^2) + \alpha h(n) = u_s[(1 - \tau_s)(y(I_s, J, n) - p(I_s, n, Z) - f(n))] + \alpha h(n) \quad (3)$$

where  $p(I, n, Z)$  indicates the fine that the family has to pay with depending on eligibility

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<sup>11</sup>The educational investment stage and the reproductive stage do not overlap. This assumption is realistic for primary and secondary education that are usually finished before having children. In China, the minimum age for marriage is 20 for women and 22 for men. Individuals are strongly discouraged from having children without being married.

status  $Z \in \{0, 1\}$ . The fine is dependent on the educational level  $I_s$ . This reflects the fact that monetary fines are dependent on the household income and that the family might have to pay non-monetary fines such as losing the job or not being promoted. The fine is 0 for the first child and  $P(I)$  for the second child when the individual is not eligible for a second child permit (i.e  $Z = 0$ ).  $f(n)$  is the cost of raising  $n$  children (strictly increasing and concave),  $\alpha h(n)$  represents the utility of having children (strictly increasing and concave), with  $\alpha$  being an individual fertility preference parameter.  $y_s(I_s, J, n)$  is the household income, assumed to be strictly increasing and concave in the educational level  $I_s$  and the spouse's educational level  $J$ . In the baseline setting, the educational level of the spouse  $J$  is exogenous.

The income also decreases in the number of children  $n$  but only for women  $s = w$ . An example is an income generation function that remunerates individuals for each hour worked multiplied by their productivity :  $y_w(I_w, n) = (T - \mu n)L(I_w)$ . Productivity  $L(I)$  is a concave function of education and  $T$  is the maximum time an individual can work. Working hours decrease  $\mu$  for each child. One can interpret  $T$  as the number of years an individual works in their life where the number of children decreases the years of working.  $\tau_s$  is the sex-specific share that individuals transfers to their parents.

Equivalently, the parent's utility in period 2 is:

$$u_p(c_p^2) + \alpha_p h(n) = u_p[\tau_s(y(I_s, J, n) - p(I_s, n, Z) - f(n))] + \alpha_p h(n) \quad (4)$$

with  $\alpha_p h(n)$  the utility of having grand-children.

Given their teenager's eligibility status  $Z$ , their fertility preferences and the number of children, parents  $i$  solve:

$$\max_{I_s} u_p(Y - \eta I) + \delta(u_p[\tau_s(y(I_s, J, n) - p(I_s, n, Z) - f(n))]) + \alpha_p h(n) \quad (5)$$

with  $\delta$  as the discount factor.

Given education, fertility preferences and eligibility status, individuals solve in period 2:

$$\max_n u_s(c_s^2) + \alpha h(n) = u_s((1 - \tau_s)(y(I_s, J, n) - p(I_s, n, Z) - f(n))) + \alpha h(n) \quad (6)$$

**Optimal number of children** (Maximising equation 6)

$$u'_s(c_s^2)(1 - \tau_s) \left[ \frac{\partial f(n^*)}{\partial n^*} + \frac{\partial p(I, n^*, Z)}{\partial n^*} - \frac{\partial y_s(I, J, n^*)}{\partial n^*} \right] = \alpha \frac{\partial h(n^*)}{\partial n^*} \quad (7)$$

The left-hand side reflects the marginal (opportunity) cost of having  $n^*$  children. It consists of the marginal cost of raising and educating  $n^*$  children ( $\frac{\partial f(n^*)}{\partial n^*}$ ), the fine if the

family has more than one child and a decrease in income due to raising children. For women, the decrease in income is negative:  $\frac{\partial y_s(I_s, J, n^*)}{\partial n^*} < 0$ . For men it is 0:  $\frac{\partial y_s(I_s, J, n^*)}{\partial n^*} = 0$ . On the right-hand side is the marginal benefit of having  $n^*$  children.

**Optimal amount of education** (Maximising equation 5)

$$\tau_s u'(c^2) \left[ \frac{\partial y(I^*, J, n)}{\partial I^*} - \frac{\partial p(I, n, Z)}{\partial I^*} \right] = \frac{\eta}{\delta} u'(c^1) \quad (8)$$

Parents use education to smooth consumption over time such that the discounted utility in period 2 equals the utility in period 1. Crucially, educational investment depends on the level of income (as this translates into the level of consumption  $c^2$ , the returns to education, the size of the transfers  $\tau_s$  and the existence of the fine.

## 10.2 Effect of 2nd child permits

I focus my attention to the choice set for the number of children being either one or two ( $n \in [1, 2]$ ). This encompasses the choice set of the majority of Chinese. Yet, the theoretical discussion easily extends to an unrestricted choice set. The model disregards any level of uncertainty and assumes full information for simplicity. The number of children is a discrete variable and there is no fine for the first one. Therefore, eligibility does not necessarily change the optimal number of children given by equation 7. The effect of the exemption depends on if eligibility changes anticipated fertility or not. There are three cases: those that always have only one child, those that always have two children, and those that increase the number of children they anticipate once they become eligible (*increasers* or *compliers*).<sup>12</sup> I investigate the reaction of those that change their anticipated fertility behavior with eligibility.

*Optimal education when non eligible ( $Z = 0$ ) and with one child:*

$$\tau_s u'(y(I_s^*, J, 1) - f(1)) \left[ \frac{\partial y(I_s^*, J, 1)}{\partial I_s^*} \right] = \frac{\eta}{\delta} u'(Y - \eta I_s^*) \quad (9)$$

*Optimal education when eligible ( $Z = 1$ ) and with two children:*

$$\tau_s u'(y(I_s^*, J, 2) - f(2)) \left[ \frac{\partial y(I_s^*, J, 2)}{\partial I_s^*} \right] = \frac{\eta}{\delta} u'(Y - \eta I_s^*) \quad (10)$$

**Inter-temporal consumption smoothing channel:** Eligibility increases the marginal

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<sup>12</sup>One could easily include for example uncertainty in the income gained in period 2 by adding a random shock to the income term. Given the distribution of this term, one knows the distribution in the type of family. For example, a family with a given  $\alpha$  could be an *increaser* with 80% likelihood and *always-2* with 20% likelihood.

utility of consumption in period 2 ( $u'(c^2)$ ) by increasing spending on children by  $f(2) - f(1)$ . Also, the couple earns less due to having to care for two children ( $y(I_s^*, J, 1) > y(I_s^*, J, 2)$ ). Marginal utility of additional earning in the future increases and the parents use education as a way to shift consumption from period 1 to period 2, such that equation 8 holds.

**Labour supply and returns to education:** Eligibility decreases the returns to education, for example if the individual has to cut productive working hours ( $\frac{\partial y(I_s^*, J, 2)}{\partial I_s^*} < \frac{\partial y(I_s^*, J, 1)}{\partial I_s^*}$ ). This decreases returns to education and thus decreases the incentives to invest in education. Intuitively, if the individual has to stay at home to care about the children, where the returns to education are lower than in the labor market, the payoffs from education are lower.

**Overall effect and sex differences:** The effect is positive if the inter-temporal consumption smoothing effect is stronger than the labour supply effect. For men, I assume that the labour supply effect is 0: their labor supply and income is unaffected by the second child. For women, the sign of the overall effect is discussed in section 10.2.1 using as an example the income generation function  $y(I_w, n) = (T - \mu n)L(I_w)$ . The effect size (in absolute terms) increases in  $\tau_s$ . Intuitively, if parents do not rely on the financial support of their child in period 2, the number of grand-children will not matter for their educational investment. However,  $\tau_s$  also captures altruistic motives and therefore is assumed to be positive. Thus, even if the overall effect is positive for both men and women, the assumption that  $\tau_w < \tau_m$  implies that the effect is smaller for women.

**Assortative marriages:** I assume that spouses match positive-assortatively on educational levels. The spouse's educational level  $J$  is a function of own education  $I_s$ :  $J(I_s) = \sigma I_s$  with  $0 < \sigma \leq 1$ . This captures the correlation between the educational levels. The maximization problem of a family with a daughter is:

$$\max_{I, s, n} u(Y - \eta I - s) + \delta[u(y(I, n) + y(J(I)) + Rs - p(I, n, Z) - f(n)) + \alpha h(n)] \quad (11)$$

$$u'(c^2) \left[ \frac{\partial y(I^*, n)}{\partial I^*} + \frac{\partial y(J(I^*))}{\partial J(I^*)} \sigma - \frac{\partial p(I, n, Z)}{\partial I^*} \right] = \frac{\eta}{\delta} u'(c^1) \quad (12)$$

Families with a daughter who anticipates a reduction in working hours expect to experience the labour supply effect. However, this effect gets mitigated by the returns to education in the marriage market  $\frac{\partial y(J(I^*))}{\partial J(I^*)} \sigma$ . While the labour market returns to education  $\frac{\partial y(I^*, n)}{\partial I^*}$  depend on the number of children, the marriage market returns do not. The stronger the correlation of educational levels, the better the daughter's educational investment can be used for inter-temporal consumption smoothing. For families with sons, it is the opposite. Though the marriage market returns to education are also positive, they decrease in the



anticipated number of children.

The marriage effects are described in section 10.2.2.

### 10.2.1 The overall effect of anticipated fertility when childcare affects labor supply

Assume that childcare is time-intensive and mothers forgo earnings because they have to reduce working hours. I use the example income-generation:  $y(I_w, n) = (T - \mu n)L(I_w)$ , where  $T$  is the maximum working hours and for every child the parents has to spend  $\mu$  hours on childcare. Each working hour is remunerated with  $\rho L(I_w)$  where  $L(I_w)$  is the productivity, which is a function of human capital, and  $\rho$  is a scaling parameter which can be interpreted as technology or labour market conditions. Mothers that have one more child, experience a reduction in income:

$$\frac{\partial y(I_w, n)}{\partial n} = -\delta \mu L(I_w) \quad (13)$$

In order to investigate the effect of a working time reduction, we assume for simplicity that  $f(n) = 0$  and disregard the spouse's income:

Optimal education when non eligible ( $Z = 0$ ) and with one child:

$$\tau_s u'(y(I_w^*, 1)) \left[ \frac{\partial y(I_w^*, 1)}{\partial I_w^*} \right] = \frac{\eta}{\delta} u'(Y - \eta I_w^*) \quad (14)$$

Optimal education when eligible ( $Z = 1$ ) and with two children:

$$\tau_s u'(y(I_w^*, 2)) \left[ \frac{\partial y(I_w^*, 2)}{\partial I_w^*} \right] = \frac{\eta}{\delta} u'(Y - \eta I_w^*) \quad (15)$$

Therefore, the overall effect depends on if incentives to invest in education are higher or lower for one child than for two children.

$$u'(y(I_w^*, 1)) \left[ \frac{\partial y(I_w^*, 1)}{\partial I_w^*} \right] - u'(y(I_w^*, 2)) \left[ \frac{\partial y(I_w^*, 2)}{\partial I_w^*} \right] \stackrel{?}{\geq} 0 \quad (16)$$

This condenses to if the following is increasing or decreasing in  $n$ :

$$u'(y(I_w^*, n)) \left[ \frac{\partial y(I_w^*, n)}{\partial I_w^*} \right] \quad (17)$$

Differentiating gives:

$$\underbrace{u''(y(I_w^*, n)) \frac{\partial y(I_w^*, n)}{\partial n} \frac{\partial y(I_w^*, n)}{\partial I_w^*}}_{\text{Income smoothing channel}} + \underbrace{u'(y(I_w^*, n)) \frac{\partial^2 y(I_w^*, n)}{\partial I_w^* \partial n}}_{\text{Labour supply channel}} \quad (18)$$

The overall effect is positive if the consumption smoothing effect is stronger than the labor supply effect, i.e.:

$$u''(y(I_w^*, n)) \left[ \frac{\partial y(I_w^*, n)}{\partial n} \right] \frac{\partial y(I_w^*, n)}{\partial I_w^*} > -u'[y(I_w^*, n)] \frac{\partial^2 y(I_w^*, n)}{\partial I_w^* \partial n} \quad (19)$$

If we assume constant absolute risk aversion (CARA) with  $a$  the coefficient of absolute risk aversion, we get:

$$a \frac{\partial y(I_w^*, n)}{\partial I_w^*} \left[ \frac{\partial y(I_w^*, n)}{\partial n} \right] > -\frac{\partial^2 y(I_w^*, n)}{\partial I_w^* \partial n} \quad (20)$$

**How does the overall effect vary with the loss in working time  $\mu$ ?** Losing income strengthens the labor supply channel, but may also strengthen the income smoothing channel. In the following, I show that under the assumption of constant relative risk aversion, the overall effect decreases in the loss in working time  $\mu$ . Using our example income generation function:

$$\underbrace{u''((T - \mu n)L(I_w^*))(-\delta L(I_w^*))(T - \mu n)L'(I_w^*)}_{\text{Income smoothing channel}} > \underbrace{u'((T - \mu n)L(I_w^*))(\mu L'(I_w^*))}_{\text{Labour supply channel}} \quad (21)$$

Taking total derivatives of the labor supply channel in terms of  $\mu$ :

$$u'(c^2)L'(I_w) + u''(c^2)\delta n L'(I_w)(-nL(I_w)) \quad (22)$$

of which both terms are positive. The labour supply effect is increasing in the loss of working time.

Taking total derivatives of the income smoothing channel in terms of  $\mu$ :

$$\underbrace{u''(c^2)}_{(-)} \underbrace{L(I_w)L'(I_w)}_{(+)} \underbrace{[2\mu n - T]}_{?} + \underbrace{u'''(c^2)}_{(+)} \underbrace{nL(I_w)\mu L(I_w)(T - \mu n)L'(I)}_{(+)} \quad (23)$$

While the second term is positive under the assumption of prudence, the sign of the first term depends on the sign of  $2\delta n - T$ . If  $T > 2\delta n$ , the loss in working hours increases the

income smoothing channel (while the reverse is not necessarily true).

We again use at the case of constant absolute risk aversion. Rewrite equation 20 without cost of raising a child and using the income generation function:

$$a(T - \mu n)L'(I_w)\mu L(I_w) > \mu L'(I_w) \quad (24)$$

which reduces to:

$$a(T - \mu n)L(I_w) > 1 \quad (25)$$

As an increase in  $\mu$  decreases the left hand side, it decreases the overall effect of anticipated fertility on education. Thus, under CARA, the overall effect of a second child on educational investment decreases with the loss in working time due to an additional child.

### 10.2.2 Marriage effects

I introduce the possibility of staying unmarried. If an individual stays unmarried in period 2, they earn income and do not have children:  $u(c_U^2) = \tilde{y}(I_s)$ . Denote  $\omega$  the probability of marrying in period 2 and  $\phi$  the ratio of men to women. I assume that the marriage surplus, defined as the utility of being married minus the utility of staying single, is positive independent of the educational level of the individual and the potential spouse and the number of children:  $u(y(I_s, J, n) + p(I_s, n, Z) - f(n)) + \alpha h(n) - u(\tilde{y}(I_s)) > 0, \forall I_s, n$ . As a consequence, if there are as many men as women, everyone gets married in period 2. If the sex ratio is skewed, all of those of the scarce sex get married and some of those of the abundant sex stay single. I assume that the likelihood of marriage for the abundant sex is a function of the sex ratio and the individual's education:  $\omega(I_m, \phi)$ .<sup>13</sup> We focus on the situation where there are more men than women, which is the relevant case for China:  $\phi > 1$ . The optimization problem for parents is then as followed:

$$\begin{aligned} & \max_{I_m} u(Y - \eta I_m) + \\ & \delta \tau_m [\underbrace{\omega(I_m, \phi) u(y(I_m, J, n) - p(I_m, n, Z) - f(n)) + \alpha h(n)}_{\text{married}} + (1 - \omega(I_m, \phi)) \underbrace{u(\tilde{y}(I_m))}_{\text{unmarried}}] \end{aligned} \quad (26)$$

**Marriage channel:** An increase in the number of anticipated children implies a (weak)

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<sup>13</sup>The assumptions is based on non-transferable utility. In the transferable utility case, families could compensate a lack of education with monetary transfers. By restricting monetary transfers, through transaction cost, limited commitment or simply social norms, families have to use premarital investment such as education in order to make their child attractive in the marriage market.

increase in the marriage surplus, because it increases the utility of being married but not the utility of being single. For those always anticipating two children, it increases the utility of marriage as it takes away the monetary fines. For those increasing fertility, it (weakly) increases the utility of being married as they choose to have two children over one child because it given them higher utility. It increases the incentives to invest in education to increase the odds of finding a spouse to make the now more beneficial situation more likely. The marriage market effect is thus be positive for both groups, but not necessarily of the same magnitude.

The general equilibrium effects are not taken into account (as in all the previous sections). The likelihood of finding a spouse is not only dependent on own education but also the distribution of educational levels within the same marriage market. If several individuals within the same marriage market become eligible, this can change the educational distribution of the abundant sex.

**Spouse-independent eligibility:** Eligibility  $Z$  could be a valuable characteristic in the marriage market, in particular, if eligibility does not rely on the spouse fulfilling the same criterion. The likelihood of finding a spouse could depend on the man's eligibility status  $\omega(I_m, \phi, Z)$ . If eligibility increases the chances to find a spouse, this decreases the incentives to invest in education with the goal to improve the man's marriage chances. This counteracts the marriage channel.