# DISCUSSION PAPER SERIES

DP17550

## ANTICIPATED CHILDREN AND EDUCATIONAL INVESTMENT: EVIDENCE FROM THE ONE-CHILD POLICY IN CHINA

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**DEVELOPMENT ECONOMICS**

ISSN 0265-8003

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Discussion Paper DP17550
Published 29 September 2022
Submitted 29 September 2022

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www.cepr.org

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## Abstract

Children can be costly both in terms of finances and time. Those who want children and their families may take this into account when making educational decisions earlier in life. Does the number of future anticipated children affect educational investment in parents-to-be? During the one-child policy in China, second-child permits allowed specific groups to have a second child without paying a fine. Changes in the eligibility criteria for this permit provide geographic and temporal variation in the cost of having a second child. I first show that second-child permits indeed had an effect on the number of children: They strongly increased the likelihood of having a second child in the 1990s and 2000s. I then investigate changes in the eligibility rules when individuals are about to finish mandatory education. I compare the educational attainment of those that fulfilled an eligibility criterion for a second-child permit at secondary school age with those that did not. I find that eligibility at secondary school age increases the likelihood to continue education. Anticipating another child seems to increase educational investment as the effect is concentrated among those predicted to have only one child when not eligible. This effect, clearer for men than for women, can be explained by the high costs of raising children in China.

JEL Classification: I25, I26, J13

Keywords: Fertility, Education, China, Family planning

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Acknowledgements
I am grateful to Paul Seabright, Chris Udry, Emmanuelle Auriol, Silvain Chabé-Ferret, Mathias Reynaert, Sylvie Démurger, Thierry Magnac, Matteo Bobba, Tilman Brück, Nancy Qian, Matthias Doepke, Paula Gobbi, Sylvie Lambert, Eliana La Ferrara, seminar participants from ISDC Berlin, Toulouse, ECARES Brussels, Northwestern, Warwick, Bocconi, Nottingham, Amsterdam, Aix-Marseille and Cologne, and participants at the CSAE 2018, and the 2018 EEA-ESEM in Cologne for their comments and suggestions. I thank Wanying Zhao for excellent research assistance. Funding from the French National Research Agency (ANR) under the Investments for the Future (Investissements d'Avenir) program, grants ANR-17-EURE-0010 and ANR-17-EURE-0020, is gratefully acknowledged.

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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). Yet, in many contexts, children are costly both in terms of financial resources as well as in time. Thus, the *anticipated* number of children might be a factor that influences educational investment. Parents-to-be and their families might plan with the child-related expenditure and take into account that they will have to cut back on their working hours. The first channel can motivate them to invest in education to ensure sufficient financial resources. The second channel of reduced labor supply can demotivate educational investment. The overall effect is ambiguous.

This paper asks if anticipating children increases or decreases educational investment in parents-to-be. The number of children someone 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. Yet, the answer is policy-relevant. Faced with aging societies, policy-makers in many 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 temporal and geographic variation in the strictness of the one-child policy in China to investigate the effect of anticipated children on education. Although one child per family was the norm, having another child was 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. Several eligibility criteria were based on observable individual characteristics, including 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. Fulfilling such an eligibility criterion can then increase the anticipated number of children.

The criteria for second-child permits varied between groups, over time, and between provinces.

This motivates the use of a triple-differences approach. I combine provincial policy information with individual data from the 2010 China Family Panel Study. I determine whether individuals fulfilled a second-child permit criterion at the age of 15. At this point, they are about to finish junior high school and have to decide to enroll in senior middle school - a decision relevant for nearly all parts of the population.[1] The cohorts that are not eligible or become eligible at a later stage are untreated. I thus compare individuals that were still in school when their eligibility status changed with those that were older or did not experience a change. As criteria vary between groups within a province, the estimation controls for province trends. As criteria vary between provinces and over time, it also controls for group-specific time trends and differences between the groups within a given province.

To change the anticipated number of children, permits need to have an actual impact on family size. To check this prerequisite, I determine the eligibility status at the average age when people have a second child for an older cohort. I find that second-child permits indeed increase the number of children: Eligibility significantly increases the likelihood of having a second child by around 14 percentage points. These results are in line with recent findings from the introduction of the two-children policy in 2015 (e.g., Wu (2022)).[2]

Looking at educational investment, I find that on average fulfilling a second-child permit criterion increases the likelihood to enroll in senior middle school. The effect is qualitatively similar for men and women, yet significant only for men. The results are robust to controlling for the local fertility rate and sex ratio – the main variables that motivate policy changes. They are also unchanged when excluding ethnic minorities and when controlling for parents' characteristics. In 1986, the Law on Nine-Year Compulsory Education took effect. Its goal was to guarantee at least nine years of schooling which might confound the results. However, restricting the analysis to those who turn 15 after 1995 finds similar results.

Importantly, I find no effect of becoming eligible at the age of 18 on senior middle school enrollment. Thus, policy changes after the enrollment decision do not have any effect on educational investment. This placebo test mitigates the concerns that the results are driven by differential

[1] University enrollment, on the other hand, is only relevant for a small part of the population and thus not investigated here.

[2] Wang et al. (2017) reports that by mid of 2015, about 16.8% of couples who became eligible for having a second child had applied for a second child permit.

educational trends between the treatment and control groups. Investigating pre-trends in an event study design, I find that while the individual estimates are noisy there is no overall trend before the policy change.

The heterogeneity analysis tries to isolate the effect of anticipated children. Is the effect indeed driven by those that adapt their fertility plans to being allowed to have two children? I use individual and local variables to predict the number of children one would have without being eligible for a second-child permit. I then look separately at those predicted to have one child and those predicted to have two children without a second-child permit. The results suggest that the positive effect on education is driven by those who would have only one child if they were not eligible. Thus, the effect appears concentrated among those having only one child when not eligible but anticipating a second child once eligible.

These results contrast with the recent finding from Huang et al. (2020) who find that monetary fines during youth are positively correlated with investment in education. However, official fines might be a very imperfect measure of the real cost that parents face when not abiding by the child limit. They might lose their job, might not get promoted, and face extra child-care costs. While both this paper and Huang et al. (2020) rely on within province variation for identification, I employ a sharp cut-off at the age threshold. This allows me to run a strong placebo test where I assign treatment at the age of 18 and do not find any effect. Huang et al. (2020) also rely on variation during an earlier period of the one-child policy. I focus on a later period when the second child criteria are transparent and predictive of the future policy environment.[3]

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 family consumption. To prepare for this 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 parents at the same time. Indeed, raising children is considered costly in China, and families spend a significant proportion of their income on their children. This can explain the positive effect on educational investment.

[3]While Huang et al. (2020) account for differences according to household registration and minority status, they do not control for the exemption for only children.

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 education and has an effect on lifetime returns to education. The less time the parent can spend in the labor market, the lower 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. Men do not seem to suffer any child penalty which can explain their robust positive effects, while the effect for women seems to be noisier.

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, as the theory highlights, labor market conditions are important. 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.

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. 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).[4]

In this paper, I use a shock to the cost of children to look at the reverse question. Indeed, I show theoretically, that while an increase in education investment can decrease the number of children, an increase in the *anticipated* number of children can also increase investment in education. This analysis can only speak to the effect of anticipating a second child, but not to the difference between having children and not having any children. Furthermore, it aggregates different groups in the empirical analysis (only children, ethnic minorities, and rural households). Each group is too small to investigate separately, thus, potentially covering interesting heterogeneity. However, the question

[4]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).[5] This result, however, does not necessarily hold for developed countries (Fort et al., 2016; McCrary and Royer, 2011; Monstad et al., 2008).

of how many children to have is pertinent in many contexts and the illustrated mechanisms are applicable in most circumstances.

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.[6]

The exemptions for ethnic minorities have been used to study inter-ethnic marriages (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. Relaxations and changes in the one-child policy have also been used to estimate the effect of fertility on maternal labor supply that I discuss in section 6 (Wu, 2022; Cao, 2019).

The remainder of the paper is structured as followed: The next section described the policy context. Section 3 summarizes the theoretical mechanisms. Section 4 describes the policy and individual data, as well as the empirical strategy. Section 5 summarizes the main results. Section 6 discusses the results in light of the Chinese context. Finally, section 7 concludes.

[6] 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).

# 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 (1971-1979), the one-child policy (1979-2015), and the recent two-child policy which has now been relaxed further. During the "Later, Longer, Fewer" campaign, the government promoted later marriage, longer intervals between births, and 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 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).[7] 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 with the details of the criteria. Most

[7] Some 14.4 million abortions, 20.7 million sterilizations, and 17.8 million intrauterine device insertions (Whyte et al., 2015).

of these were revised at least once in the 1990s and again after 2001. Thus, transparency about family policies increased. At the same time, 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.

## 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 a 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 a 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 when 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).[8] 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.

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.

Pushed by the central government, all provinces at some point introduced the eligibility criterion for couples with one or both spouses being an only child. 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 the 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 impossible 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 pri-

[8] The provinces were Hainan, Yunnan, Qinghai, Ningxia, and Xinjiang (Scharping, 2013).

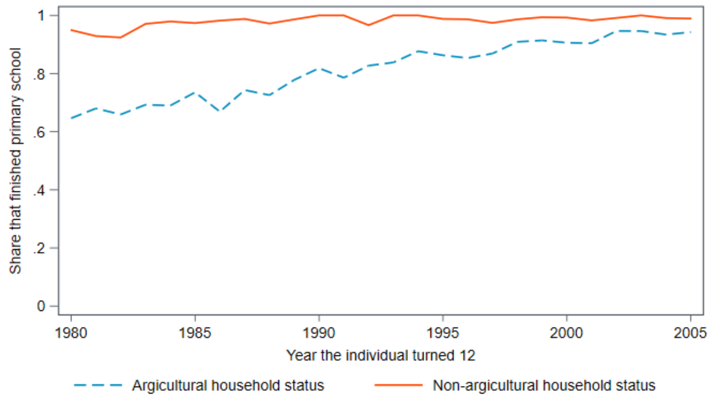
mary school enrollment to 95% in the mid-1980s (Zhang and Minxia, 2006). In 1986, around 70% of children transitioned from primary school to junior middle school. In 1995, transitions had risen to around 90% (Wu, 2010). The planning committee envisioned that in 1990, junior middle school should be universal 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 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.[9]

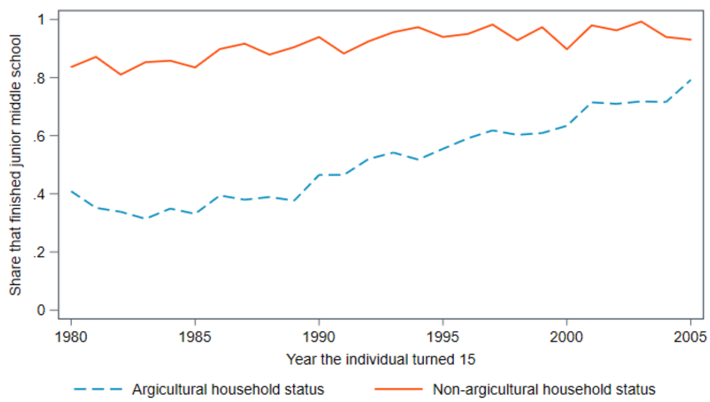
Figure 2 displays the share of children that are attending junior high school at a given age in 2010. Children usually enter junior high school after they turn 12. Most 14 and 15-year old were enrolled in junior high school in 2010. They then continually graduate with only a few still being enrolled at age 17 or 18.

[9]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%).

(a) Primary school completion




(b) Junior middle school completion




(c) Senior middle school enrollment

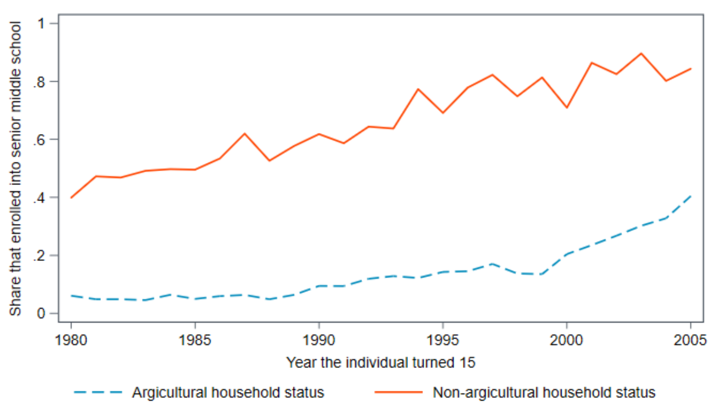



Figure 1: Share of the population completing the different schooling stages between 1980 and 2005 according to their household registration status. *Note:* Average completion or enrolment rates according to the year the individual turned 12 (for primary school completion) or 15 (for junior middle school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

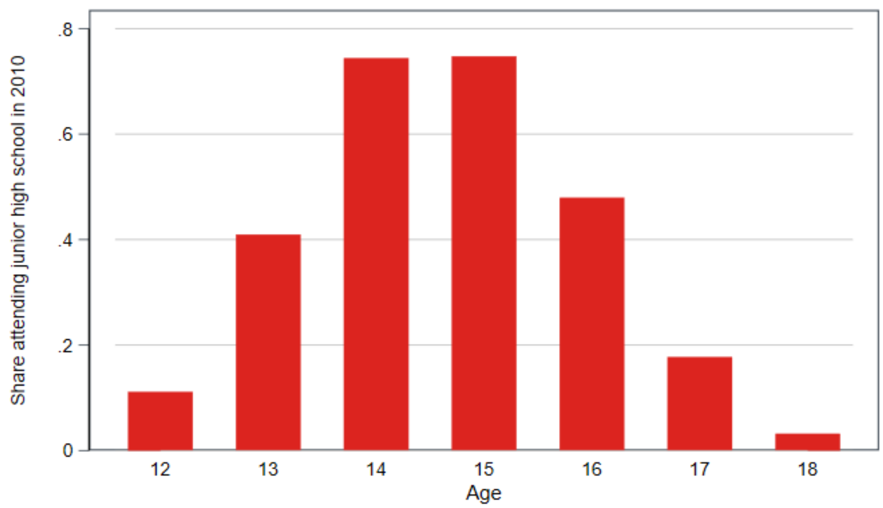



Figure 2: Share attending in junior high school according to their age in 2010. *Data:* CFPS 2010.

## 3 Theoretical Mechanisms

Why would the number of *anticipated* children have an effect on educational investment? To illustrate the mechanisms I use a theoretical model which is developed in Appendix B, section 9. 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 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. This can be thought of 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 in period 2 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. 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 anticipat 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 families 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.

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 families invest less in the individual'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 Appendix B Section 9.2.1, 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. I also discuss the effect of positive assortative marriages and the possibility that sons might be expected to financially support their parents during old-age more than daughters.[10]

[10] 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 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

***Constraints on and effects of borrowing and saving:*** 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, this baseline model does not include other means of intertemporal consumption-smoothing, such as saving, but can easily be extended to do so. Indeed, the simple model predicts that an increase in anticipated children leads to an increase in savings. For education to be used as an intertemporal consumption-smoothing channel, educational investment needs to be at least as profitable 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.

### 3.4 Other potential channels

This subsection consider other channels by which anticipated children can affect educational investment. This list is not exhaustive. For example, being allowed to have a second child in a society where children are highly values can have positive psychological effect that can spill-over to educational attainment. Such more subtle channels are not modeled here but should be taken into account.

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

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.

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 documents 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.

The analysis uses three broad groups. 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, 5 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 always 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, after 1990, 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). It 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 Table 1, 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.

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 limit is set to ensure that couples have sufficient time to have a second child. Summary statistics for the older sample are displayed in Table 1, 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: Eligibility status is based on the birth year, province of residence, and belonging to a specific group. Treatment and control groups are observed in several different provinces allowing to control for province-level time fixed effects which capture different trends in different provinces. The same sub-population, such as ethnic minorities, are treated in different provinces at different times and stay in the control group in other provinces, such that sub-population-specific time trends can be included. The identification assumption thus implies that, conditional on varying province-level time fixed effects and population-specific time fixed effects, the treatment and control groups follow the same trend.

Denote $\tilde{Z}_{ipgt}$ the "eligibility status" of an individual $i$ in province $p$, part of group $g$, who turned

Table 1: Summary statistics

| Variable | Mean | Std. Dev. | Min. | Max. | N |
|---|---|---|---|---|---|
| *Panel A: 1991 - 2008 Sample* | | | | | |
| 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 |
| *Panel B: 1995-2008 Sample* | | | | | |
| 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 |
| *Panel C: Older 1991-2008 Sample* | | | | | |
| 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

15 in year $t$. This captures whether, in the year they turn 15, they fulfill a criterion for eligibility for a second-child permit. The groups are based time-invariant individual characteristics that are

used to determine eligibility. These include household registration status, ethnicity, and being an only child. I then regress if in at the time when data was collected 2010 that they had enrolled at some point into senior middle school on the eligibility status, province-specific group fixed effects ($\mu_{gp}$ province indicator interacted with group indicators), province-specific year fixed effects ($\kappa_{pt}$, province indicator interacted with birth year indicator) and group-specific year fixed effects ($\gamma_{gt}$, group indicator interacted with birth year indicator).

$$enrolled_{igpt\ in\ 2010} = \beta \tilde{Z}_{ipgt} + \gamma_{gt} + \mu_{gp} + \kappa_{pt} + X_i + \epsilon_{ipgt} \quad (1)$$

where $\beta$ is the coefficient of interest and $\epsilon_{ipgt}$ the unobserved error term. The identifying variation comes from observing individuals, within one province, in a group before a policy change and after the policy change (first difference). Individuals in the same province that do not experience a policy change help to control for province-specific trends (second difference). Individuals in a different province where this group did not experience a policy change help control for group-specific trends (third difference). Additional individual controls $X_i$ include gender, not having brothers and being classified as a minority that has a population of less than one million in 1990 and 2010. These are variables that influence eligibility status in one province each (without policy variation).

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 within this sample actual fertility behavior is not observed. To verify that eligibility indeed changes fertility behavior, I run the same triple-differences specification with 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 relies on the assumption that treatment groups follow 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 sub-population. 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. Thus, provincial family-planning policies need 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.[11]

Finally, standard errors are two-way clustered on the sub-population-with-a-province level which is the level at which the policies are implemented. Since cluster sizes vary, I use the wild bootstrap algorithm proposed by Roodman et al. (2019).

# 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 2. Column 1 includes both men and women, column 2 only women, and column 3 only men. On average, individuals who are eligible for a second-child 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. Individuals who are eligible for a second-child permit are around 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 (column 4) and to controlling for parental characteristics (column 5).

The official number of children allowed at age 27/28 therefore 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

[11] 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.

Table 2: Effect of eligibility for second-child permits on the likelihood of having a second child

| | (1) All | (2) Women | (3) Men | (4) w/o Minorities | (5) All |
|---|---|---|---|---|---|
| Eligibility at age 27/28 | 0.144** | 0.129* | 0.156** | 0.147** | 0.153** |
| | (0.063) | (0.070) | (0.075) | (0.066) | (0.063) |
| Province X Group FE | Yes | Yes | Yes | Yes | Yes |
| Province X Year FE | Yes | Yes | Yes | Yes | Yes |
| Group X Year FE | Yes | Yes | Yes | Yes | Yes |
| Parental Controls | No | No | No | No | Yes |
| Observations | 7168 | 3782 | 3386 | 6594 | 6635 |
| P-Value (Sub-population Level) | 0.042 | 0.082 | 0.044 | 0.035 | 0.033 |

**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 and the province indicators. Parental controls include: Mother's education and age; indicators for mother's and father's type of work (manual, non-manual, none). Standard errors in parenthesis and p-values are based on wold bootstrapping, clustered on the sub-population within-the-province level. Eligibility indicates if the individual fulfills an eligibility criterion for a second child permit. * p< 0.01, ** p< 0.05, *** p< 0.01

at the age of 27/28. There are several criteria that are based on unobservable and (for the econometrician) unpredictable characteristics. 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. Also, the measure does not take into account the eligibility status of the spouse. Thus, the coefficient does not measure the full effect of all 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 3 displays the regression of eligibility at the age of 15 on enrollment into senior middle school. Eligibility measures whether the individual fulfills at least one criterion for a second-child permit in the year they turn 15. On average, fulfilling a criterion at the age of 15 increases the likelihood of enrollment into senior high school. Eligible individuals are around 11 percentage points more likely to enroll in senior high school in the 1991-2008 sample, and similarly in the 1995-2008 sample. The results stay the same 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. In both samples, the results are robust to excluding ethnic minorities (column 4) and controlling for parental characteristics (column

5). The results are also robust to using different year cut-offs as shown in Appendix A Table 8.

Table 3: Effect of eligibility for second-child permits on enrollment into senior middle school

| | (1) All | (2) w/ Primary | (3) w/ JMS | (4) w/o Minorities | (5) All |
|---|---|---|---|---|---|
| ***Panel A: Sample 1991-2008*** | | | | | |
| Eligibility at age 15 | 0.114** | 0.107** | 0.075* | 0.149** | 0.102** |
| | (0.039) | (0.040) | (0.039) | (0.042) | (0.037) |
| Province X Year FE | Yes | Yes | Yes | Yes | Yes |
| Group X Year FE | Yes | Yes | Yes | Yes | Yes |
| Parental Controls | No | No | No | No | Yes |
| Observations | 8217 | 7530 | 6146 | 7347 | 7862 |
| P-Value (Sub-population Level) | 0.012 | 0.020 | 0.075 | 0.010 | 0.018 |
| ***Panel B: Sample 1995-2008*** | | | | | |
| Eligibility at age 15 | 0.135*** | 0.123** | 0.068 | 0.151** | 0.101** |
| | (0.042) | (0.042) | (0.040) | (0.050) | (0.038) |
| Province X Year FE | Yes | Yes | Yes | Yes | Yes |
| Group X Year FE | Yes | Yes | Yes | Yes | Yes |
| Parental Controls | No | No | No | No | Yes |
| Observations | 6405 | 5935 | 4918 | 5757 | 6160 |
| P-Value (Sub-population Level) | 0.005 | 0.010 | 0.119 | 0.017 | 0.017 |

**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 effect and the province indicators. Parental controls include: Mother's education and age; indicators for mother's and father's type of work (manual, non-manual, none). Standard errors in parenthesis and p-values 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. * p< 0.1, ** p< 0.05, *** p< 0.01

In which type of senior middle school do eligible individuals enroll? In Appendix A Table 9, I investigate 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. 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.[12]

Finally, I explore whether eligibility has an effect on the completion of junior middle school.

[12] 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.

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 4, 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. Overall, this suggest that eligibility motivates those that would have completed junior high school in any case to continue schooling.

Table 4: Effect of eligibility for second-child permits on junior middle school completion

| | (1)<br>All | (2)<br>w/ Primary | (3)<br>All | (4)<br>w/ Primary |
|---|---|---|---|---|
| ***Panel A: Sample 1991-2008*** | | | | |
| Eligibility at age 15 | 0.021 | 0.002 | | |
| | (0.041) | (0.037) | | |
| Eligibility at age 14 | | | 0.025 | -0.003 |
| | | | (0.039) | (0.032) |
| Province X Group FE | Yes | Yes | Yes | Yes |
| Province X Year FE | Yes | Yes | Yes | Yes |
| Group X Year FE | Yes | Yes | Yes | Yes |
| Observations | 8217 | 7530 | 8210 | 7586 |
| P-Value (Sub-population Level) | 0.680 | 0.983 | 0.573 | 0.907 |
| ***Panel B: Sample 1995-2008*** | | | | |
| Eligibility at age 15 | 0.081 | 0.055 | | |
| | (0.047) | (0.039) | | |
| Eligibility at age 14 | | | 0.059 | 0.027 |
| | | | (0.045) | (0.037) |
| Province X Group FE | Yes | Yes | Yes | Yes |
| Province X Year FE | Yes | Yes | Yes | Yes |
| Group X Year FE | Yes | Yes | Yes | Yes |
| Observations | 6405 | 5935 | 6486 | 6046 |
| P-Value (Sub-population Level) | 0.155 | 0.240 | 0.272 | 0.540 |

**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 and the province indicators. Standard errors in parenthesis and p-values based on wild bootstrapped standard errors, clustered on the sub-population within-the-province level. Eligibility indicated of the individual fulfills an eligibility criterion for a second child permit. * p< 0.1, ** p< 0.05, *** p< 0.01

### 5.3 Robustness

**Pre-trends**: The check for differences in the pre-trend, I apply an event study approach. The baseline estimation used until now groups all treated independent on the timing of the policy change: Those that become eligible at age 13 are treated, the same as those that become treated at age 14 or 15. In the event study design, a treatment effect is estimated separately for those that turn 15 the year of the policy change ($t = 0$), those that turn 15 the year after ($t = 1$), and so forth. This allows to calculate also the effect on those that turn 15 the year before the policy change ($t = -1$), those that turn 15 two years before the policy change ($t = -2$). Each coefficient is thus estimated on a much smaller sample of treated individuals: In the years after the policy change there around 100 individuals in each year in the treatment group (up to 10 years after the change). In the years before the policy change, there are around 60 individuals in each year until 5 years before the policy change. The control group is much more numerous.

This design also groups all policy changes and defines those that see a difference in their eligibility status as treated. Thus, those whose eligibility change changes from 0 to 0.5 (because they can have a second child if the first child is a girl) are treated that same as those whose eligibility changes from 0 to 1. The coefficients are therefore not directly comparable. For the estimation, I use the *eventdd* command from Clarke and Tapia-Schythe (2021).

Figure 3 illustrates the result of the event study. Coefficients are noisy as they are based on a smaller sample of treated for each year. After the policy change, most coefficients are positive and significant with the exception of 2 years. There is no obvious trend in the treatment effect strengthening nor weakening over time. Most pre-trend coefficients are not significant at 5 percent and close to 0 with the major exception of the cohort 5 years before the policy change. Overall, there is no apparent pre-trend observable from this exercise.

**Heterogeneous treatment effects:** Recent literature (e.g., De Chaisemartin and d'Haultfoeuille (2020), Goodman-Bacon (2021)) points out that the difference-in-differences estimator is not consistent when treatment effects are heterogeneous across groups or across times. Both are plausible in this case: Rural individual might well respond different to a change in eligibility status than only children. Within the same group, as fertility preferences and educational attainment changes over time, policies that come at an earlier stage can have a different effect than policies at a later

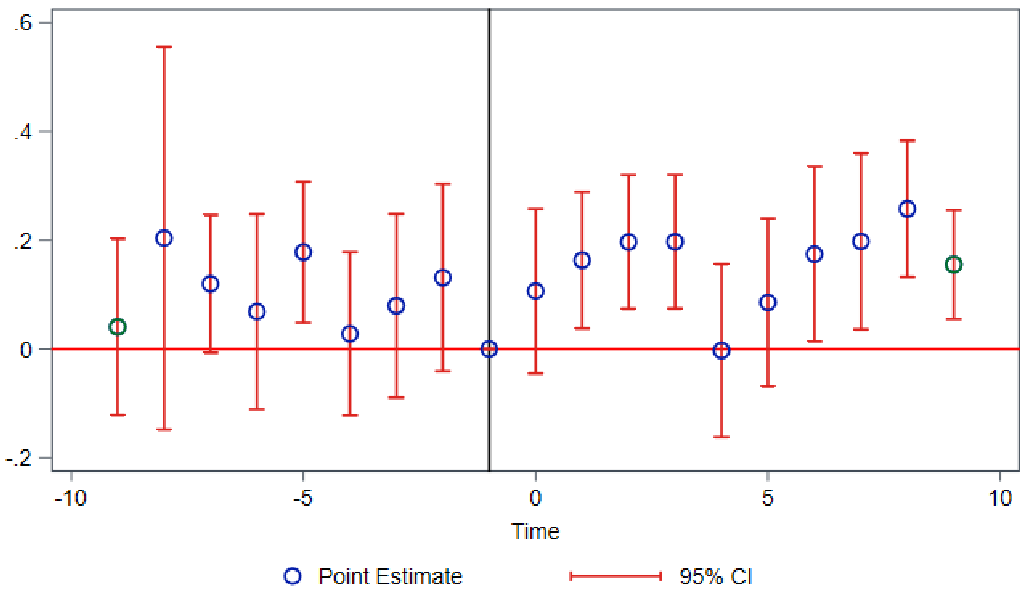



Figure 3: Effect of a policy change affecting eligibility for a second child permit according to the timing of the policy in an event study design. Time $t = 0$ measures the effect on those that observe a policy change in the year their turn 15, $t = 1$ measures the effect on those that observe a policy change in the year their turn 14, and so forth. Estimates before the polcy change test if there are difference in the trends before the policy. The first and the last point estimate (in green) accumulate all the previous and following estimates.

stage. While heterogeneity in time can be accounted for in the panel event study design mentioned before, heterogeneity across treatment groups still poses a problem.

A common approach is to only use never-treated as a control group. In this setting, never-treated are those that are never eligible between 1991 and 2007. While overall there is an important share of never-treated in the sample, there are few within the rural and minority population (and all only children are treated from 2013 on). Indeed, a big share of the control group that allows including the different levels of fixed effect are individuals that are already treated before the start of the sample. To investigate if the results are robust to accommodating for heterogeneous treatment effect, I use the estimator proposed by Sant'Anna and Zhao (2020). I include not-yet-treated in the control group. Still, this does not allow me to include the same fixed-effects structure as in the baseline estimation and the event study design. I thus aggregate all groups in a simple difference-in-difference design where all those that experience a policy change at some point are defined as belonging to the treatment group and do not control for differential province- or group-fixed effects.

Table 10 in Appendix A summarizes the results. The treatment effect is qualitatively the same when aggregated across all periods and all groups. However, the standard errors are higher and thus the effect is not significant. The treatment effect can also be estimated for each "group". The average of these treatment effects is positive and significant. Yet, when the treatment effect is estimated separately by year, the average is smaller and not significant. Reassuringly, the average of the pre-period estimates are insignificant and close to 0 in each specification. In the light of these results, I investigate heterogeneity in the next subsection.

**Eligibility after finishing junior middle school**: The identification strategy relies on the decision to continue with education being taken around the age of 15. Those that are older should have already made their decision and thus not be affected. As a placebo 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 postponed their enrollment should have decided. Those that become eligible at the age of 16, 17 or 18 are then defined as treated. If eligibility at a later stage indeed does not have an effect on senior school enrollment, this should decrease the treatment effect. However, if future treated groups within a province had a different educational trend than groups in other provinces with unchanged treatment status, this could show up as a significant effect on those becoming eligible at a later age. Table 11 displays the results. Reassuringly, eligibility at the age of 18 has no significant effect on senior middle school enrollment (Panels A and B).

Figure 4 illustrates the coefficients for being eligible at different age cut-offs for the 1991-2008 sample. Eligibility at age 15 illustrates our baseline treatment effect. Eligibility at age 18 illustrates the placebo test coefficient. There is a clear drop in the treatment effect once individuals become eligible after the year they turn 15, which then is close to 0 at age 18.[13]

**Controlling for local fertility rate and sex ratio:** 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 12 in Appendix A, I control for district-level fertility rates and the cohort

[13] Eligibility at age 14 is also positive and significant. In this estimation, those that become eligible at age 15 move to the control group. This can explain the slightly smaller treatment effect.

Table 5: Effect of eligibility for second-child permits at age 18 on enrollment into senior high school

| | (1) All | (2) w/ Primary | (3) w/ JMS | (4) w/o Minorities | (5) All |
|---|---|---|---|---|---|
| ***Panel A: Sample 1991-2008*** | | | | | |
| Eligibility at age 18 | 0.007 | 0.001 | -0.015 | 0.024 | -0.001 |
| | (0.039) | (0.058) | (0.039) | (0.074) | (0.038) |
| Province X Group FE | Yes | Yes | Yes | Yes | Yes |
| Province X Year FE | Yes | Yes | Yes | Yes | Yes |
| Group X Year FE | Yes | Yes | Yes | Yes | Yes |
| Parental Controls | No | No | No | No | Yes |
| Observations | 8627 | 7672 | 6061 | 7693 | 8173 |
| P-Value (Sub-population Level) | 0.886 | 0.972 | 0.744 | 0.593 | 0.989 |
| ***Panel B: Sample 1995-2008*** | | | | | |
| Eligibility at age 18 | 0.052 | 0.048 | 0.010 | 0.064 | 0.053 |
| | (0.046) | (0.058) | (0.042) | (0.074) | (0.044) |
| Province X Year FE | Yes | Yes | Yes | Yes | Yes |
| Group X Year FE | Yes | Yes | Yes | Yes | Yes |
| Parental Controls | No | No | No | No | Yes |
| Observations | 6528 | 5933 | 4820 | 5833 | 6216 |
| P-Value (Sub-population Level) | 0.329 | 0.318 | 0.820 | 0.273 | 0.294 |

**Note:** Sample is adjusted to those who turned 18 between 1991 - 2008 (Panel A) and 1995 - 2008 (Panel B). 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 and the province indicators. Parental controls include: Mother's education and age; indicators for mother's and father's type of work (manual, non-manual, none). Standard errors in parenthesis and p-values are based on wold bootstrapping, clustered on the sub-population within-the-province level. Eligibility indicated of the individual fulfills an eligibility criterion for a second child permit. * $p< 0.1$, ** $p< 0.05$, *** $p< 0.01$

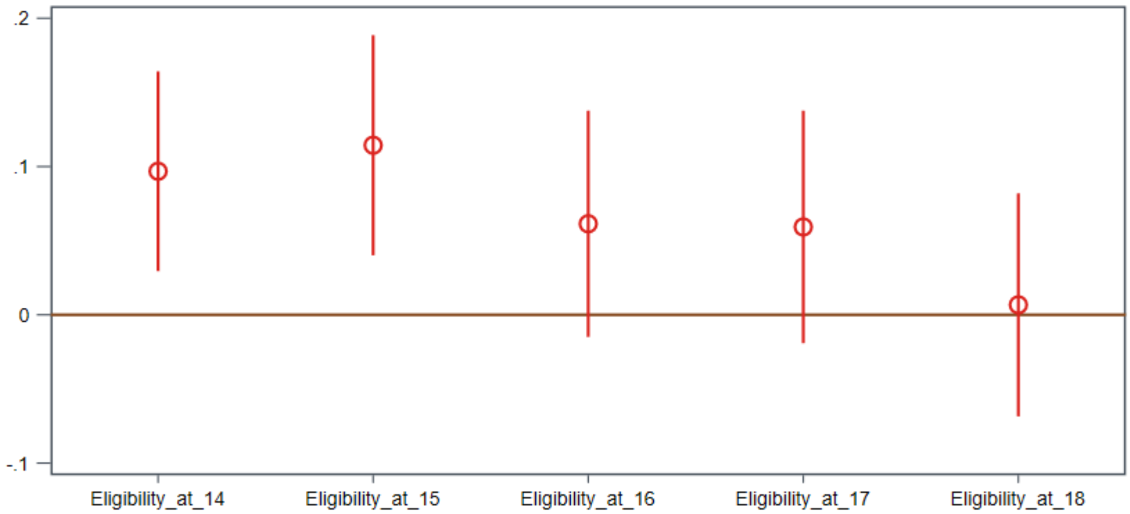



Figure 4: Effect of eligibility for second-child permit on enrollment into senior middle school. Based on the 1991–2008 sample. Confidence intervals (95%) based on sub-population within-province clustered standard errors. *Data:* China Family Panel Study 2010.

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 and the district fertility ratio.

**Excluding small provinces:** Finally, Appendix A Table 13 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).

## 5.4 Heterogeneity Analysis

### 5.4.1 Differential Effects for Men and Women

Theory suggests that men and women may be differently affected by a change in their anticipated family size: Men's labor supply might be unaffected by the number of children. Furthermore, due to sex imbalances, men might be 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 the number of children. In Table 6, the sample is split between men and women.

Table 6: Effect of eligibility for second-child permits on enrollment into senior middle school: Men and women separately

| | (1) Men | (2) Men w/ Primary | (3) Women | (4) Women w/ Primary |
|---|---|---|---|---|
| ***Panel A: Sample 1991-2008*** | | | | |
| Eligibility at age 15 | 0.110* | 0.120* | 0.097 | 0.095 |
| | (0.056) | (0.058) | (0.070) | (0.074) |
| Province X Group FE | Yes | Yes | Yes | Yes |
| Province X Year FE | Yes | Yes | Yes | Yes |
| Group X Year FE | Yes | Yes | Yes | Yes |
| Observations | 3902 | 3652 | 4315 | 3878 |
| P-Value (Sub-population Level) | 0.078 | 0.058 | 0.213 | 0.293 |
| ***Panel B: Sample 1995-2008*** | | | | |
| Eligibility at age 15 | 0.172** | 0.177** | 0.118 | 0.109 |
| | (0.065) | (0.066) | (0.067) | (0.070) |
| Province X Group FE | Yes | Yes | Yes | Yes |
| Province X Year FE | Yes | Yes | Yes | Yes |
| Group X Year FE | Yes | Yes | Yes | Yes |
| Observations | 3046 | 2876 | 3359 | 3059 |
| P-Value (Sub-population Level) | 0.019 | 0.018 | 0.100 | 0.116 |

**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 and the province indicators. Standard errors in parenthesis and p-values based on wild bootstrapped standard errors, clustered on the sub-population within-the-province level. Eligibility indicated of the individual fulfills an eligibility criterion for a second child permit.

The effect of fulfilling an eligibility criteria is positive and significant for men (column 1 and 2) with a point estimate between 11 and 17 percentage points. The point estimates for women are also positive and at around 10 percentage point. Yet, standard errors are higher and the coefficients not significant (p-values between 0.100 and 0.293). 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.

### 5.4.2 Predicted Fertility Behavior

Next, 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 with two children all along. I use the sub-sample of individuals who are not eligible at age 27/28 in the older sample as a training sample for a random forest estimation to predict their fertility behavior.[14] The aim is to predict who has a second child even when they are not eligible for a second-child permit. As potential predictors, I use a variety of individual- and district-level variables. The random forest predictor deals well with nonlinearities and includes an automatic selection of predictors.

Appendix A Figure 6 lists the variables used to predict fertility behavior and how "important" they are in the final prediction algorithm.[15] This includes most of the control variables (province, ethnicity, household status), a linear trend instead of year-fixed effects, as well as additional potential predictors.[16] The most important predictors are the province, the local fertility rate, the local cohort sex ratio, living in an urban area in 2010, the linear trend, the number of siblings, and agricultural household status.

The algorithm is then used to predict who has a second child, independent of eligibility. In the older sample, 45% are predicted to have two children even when not eligible, and around 36% in

[14] 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.

[15] 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 observations 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).

[16] 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.

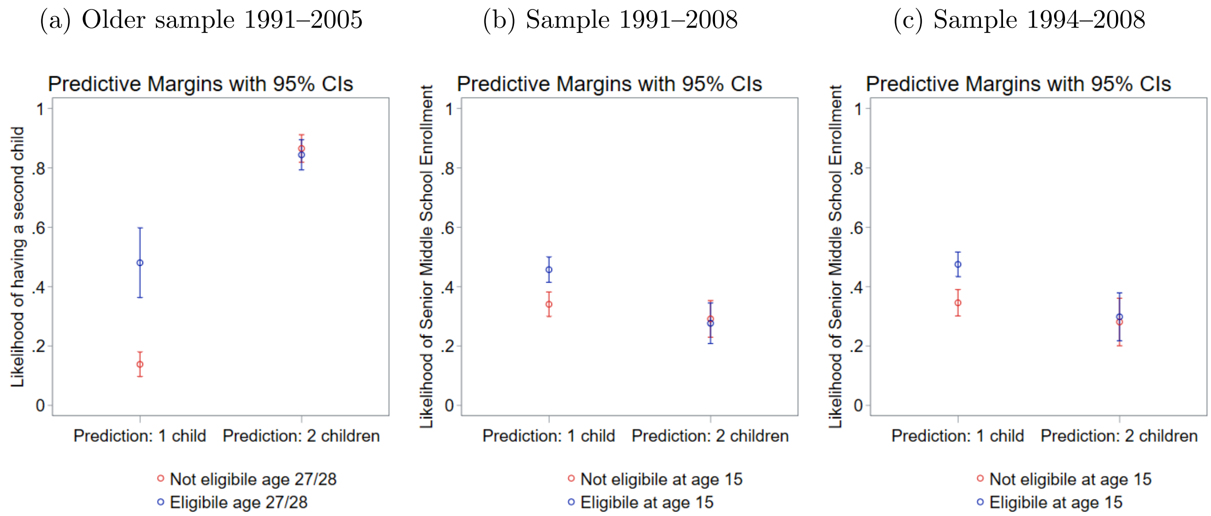



Figure 5: Predicted likelihood of having a second child (Panel a) and senior middle school enrollment (Panels b and c) according to eligibility status and predicted fertility behavior. Confidence intervals based on subpopulation within-province clustered standard errors. *Data:* China Family Panel Study 2010.

both the 1991–2008 and 1995–2008 samples. Eligibility is then interacted with the predicted fertility behavior. Table 7 displays the result. Figure 5 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).

Those who are not eligible in the older sample are part of the training sample. Thus, their likelihood of having a second child in panel A measures the accuracy of the Random forest algorithm. The likelihood of having a second child for those not eligible and predicted to have two children is 0.86. The likelihood of having a second child for those not eligible and predicted to have one child is 0.15, corresponding to an error rate of around 14%.

Those eligible and predicted to have a second child in any case have an 83% 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 likelihood of 48% of having a second child. Thus, the effect of eligibility among those predicted to have only one child is around 34 percentage points - clearly higher than the average effect of 14 percentage points (see table 2). This verifies that among those 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.

Returning to educational investment, I contrast the effect of eligibility for a second-child permit

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

| | (1) All | (2) Men | (3) Women |
|---|---|---|---|
| ***Panel A: Older Sample - Dependent variable: Having a second child*** | | | |
| Eligibility at age 27/28 | 0.352*** | 0.379*** | 0.350*** |
| | (0.076) | (0.091) | (0.082) |
| Eligibility at 27/28 X Predicted to have 2 children | -0.381*** | -0.401*** | -0.384*** |
| | (0.070) | (0.087) | (0.074) |
| Predicted to have 2 children | 0.709*** | 0.733*** | 0.685*** |
| | (0.026) | (0.040) | (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 |
| ***Panel B: Sample 1991-2008 - Dependent variable: Senior middle school Enrollment*** | | | |
| Eligibility at age 15 | 0.120*** | 0.110* | 0.108 |
| | (0.038) | (0.052) | (0.061) |
| Eligibility at 15 X Predicted to have 2 children | -0.103* | -0.105* | -0.064 |
| | (0.055) | (0.060) | (0.089) |
| Predicted to have 2 children | -0.061 | -0.026 | -0.110 |
| | (0.036) | (0.042) | (0.044) |
| Observations | 8023 | 3805 | 4218 |
| Eligibility: P-Value (Sub-population Level) | 0.004 | 0.076 | 0.137 |
| Interaction: P-Value (Sub-population Level) | 0.069 | 0.078 | 0.564 |
| Predicted 2 children: P-Value (Sub-population Level) | 0.231 | 0.556 | 0.107 |
| ***Panel C: Sample 1995-2008 - Dependent variable: Senior middle school Enrollment*** | | | |
| Eligibility at age 15 | 0.134*** | 0.172** | 0.115 |
| | (0.040) | (0.061) | (0.061) |
| Eligibility at 15 X Predicted to have 2 children | -0.100 | -0.113 | -0.030 |
| | (0.060) | (0.073) | (0.108) |
| Predicted to have 2 children | -0.070 | -0.031 | -0.133 |
| | (0.037) | (0.048) | (0.056) |
| Observations | 6296 | 2990 | 3306 |
| Eligibility: P-Value (Sub-population Level) | 0.006 | 0.025 | 0.100 |
| Interaction: P-Value (Sub-population Level) | 0.107 | 0.137 | 0.821 |
| Predicted 2 children: P-Value (Sub-population Level) | 0.171 | 0.532 | 0.089 |

**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 and the province indicators. Additional controls: female, not having brothers, being part of a minority with a population of less than 1 million in 1990 and 2000. Standard errors in parenthesis are clustered on the sub-population within-the-province level. P-values are 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. Predicted to have 2 children is an indicator based on a random forest prediction algorithm, indicating 1 if the individual is predicted to have a second child when not eligible.

between those predicted to have one or two children when not eligible. For those predicted to have only one child, eligibility has a significant positive effect on senior middle school enrollment (Table 7, Panel B and C). For those predicted to have two children, 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 at the 10% level in the 1991-2008 sample (p-value in the 1995–2008 sample: 0.107). The overall effect thus seems driven by those who are predicted to have one child when not eligible. This suggests that those who change their anticipated fertility behavior in response to becoming eligible explain the positive effect.

#### 5.4.3 Other exploratory heterogeneity analysis

**Spouse-Dependent Eligibility and Cohort Sex Ratio:** Appendix A Table 14 includes interactions related to the marriage channel. If the sex ratio is skewed towards 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. Yet, 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 0.045). It should also be noted that most exemptions are spouse dependent, and those that are not are mainly based on ethnicity.

**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.

Appendix A Table 15 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.

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

The theoretical model describes two main mechanisms of how anticipated family size can affect educational investment. It can have an effect on family consumption and labor supply. This section provides descriptive statistics to discuss the intertemporal consumption smoothing and labor supply channels.

**The Cost of Raising Children and the Double Burden of Parents:** In developed countries children are often seen as expensive. Children have to be financially supported until the end of the educational stage. 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.[17]

Raising children is considered expensive in China. Appendix A Figure 7 illustrates that families spend up to 25% of their available income on education-related items only. A recent report estimates that Chinese parents overall pay around US$43,000 for their child's education (HSBC, 2017), which

[17] 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.

is 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 raising and particularly 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 lived 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 retirement benefits make up less than 10% of family income.[18] 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 to raise their children and invest in their education. On the other side, their own retired parents may rely on their financial support. It is therefore conceivable that people invest in their children's education to improve their financial situation once they have grandchildren.

**Parental Labor Supply and Earnings:** The labor-market returns to education depend on the number of children only if parents adjust their labor supply. Do parents work more or less when they have a second child? Appendix A Figure 8, 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 two children with a matched control group of parents with one child.[19] 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 lower 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.

The results are in line with recent literature on parental labor supply in China. Guo et al. (2018)

[18]For families with a non-agricultural household status, these accumulate to around 47% of family income.
[19]Matching is based on the household registration status, education, age, and age at the birth of the first child.

and He and Zhu (2016) address the endogeneity between childbirth and labor market conditions by using twinning as a natural experiment. Guo et al. (2018) do not find evidence for a negative effect 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. Wu (2022) uses the increase in fertility after the relaxation of the one-child policy in 2015 and finds a reduction in maternal labor supply. Cao (2019) finds that mothers in rural areas that were allowed to have a second child if their firstborn is female decreased female labor supply.

Overall, in the Chinese context, the 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.

# 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 number of children 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.

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.

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# 8 Appendix A: Additional Figures and Tables

## 8.1 Figures

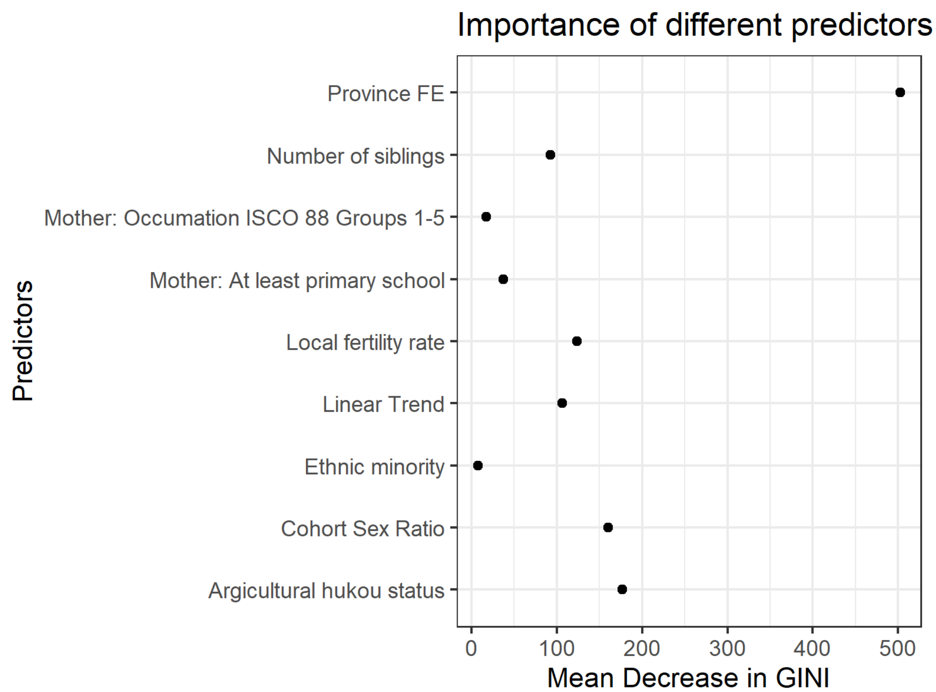



Figure 6: Importance of different predictors: Decrease in node impurity due to the predictor weighted by the probability of reaching that node averaged over all trees of the ensemble. Uses the randomForest R package.

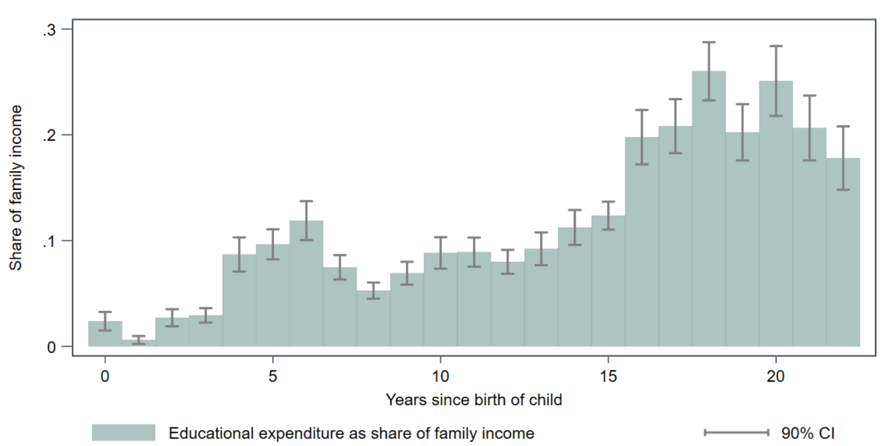
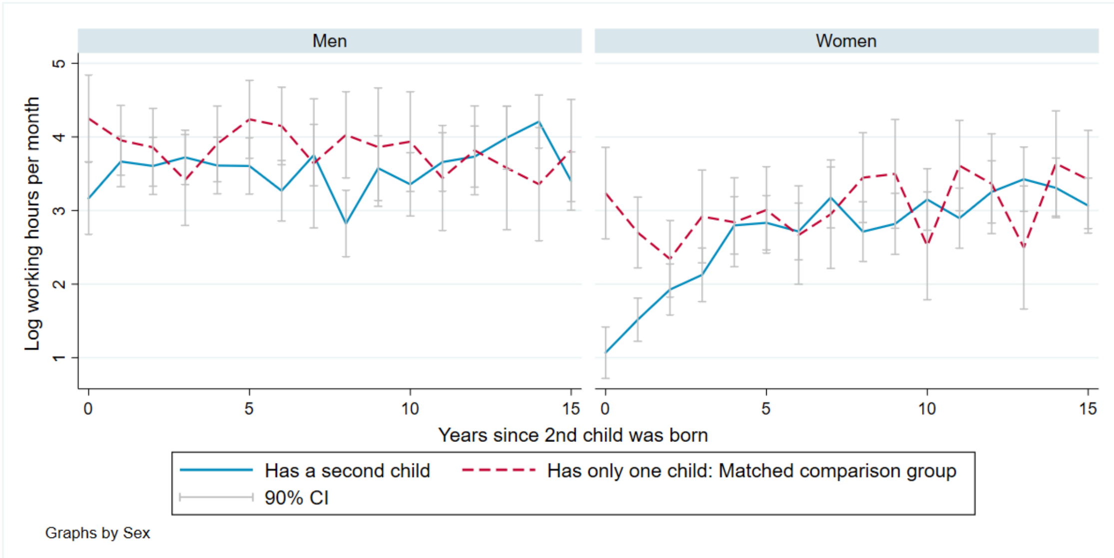



Figure 7: Educational expenditure as share of net family income, in 2010, for families with one child, according to the age of the child. *Data Source:* CFPS 2010

(a) Working Time




(b) Labor income

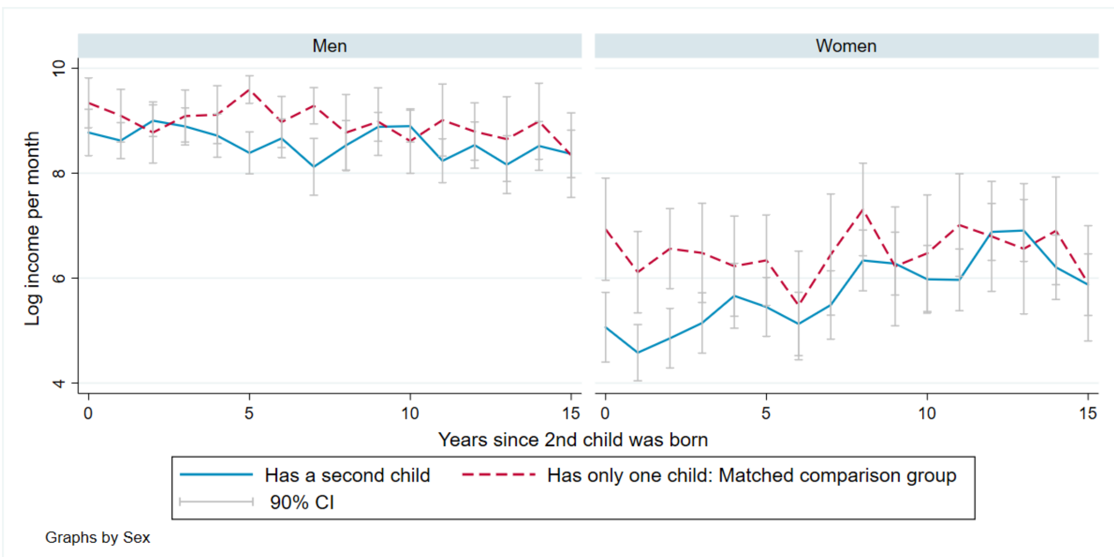



Figure 8: Log working hours and log income by sex and number of children. Compares individuals with two children with a matched group of individuals with one child. Individuals are matched 1 to 1 with their nearest neighbor with replacement. Matching function takes into account education, age, age at first birth and the household status. *Data:* CFPS 2010.

## 8.2 Tables

Table 8: Effect of eligibility for second-child permits on enrollment into senior middle school: Different panel cut-offs

| | (1)<br>All | (2)<br>w/ Primary | (3)<br>w/ JMS | (4)<br>w/o Minorities | (5)<br>All |
|---|---|---|---|---|---|
| ***Panel A: Sample 1990-2008*** | | | | | |
| Eligibility at age 15 | 0.092** | 0.089** | 0.063 | 0.130*** | 0.084** |
| | (0.039) | (0.040) | (0.040) | (0.041) | (0.037) |
| Province X Group FE | Yes | Yes | Yes | Yes | Yes |
| Province X Year FE | Yes | Yes | Yes | Yes | Yes |
| Group X Year FE | Yes | Yes | Yes | Yes | Yes |
| Parental Controls | No | No | No | No | Yes |
| Observations | 8698 | 7936 | 6455 | 7771 | 8311 |
| P-Value (Sub-population Level) | 0.047 | 0.062 | 0.158 | 0.012 | 0.058 |
| ***Panel B: Sample 1992-2008*** | | | | | |
| Eligibility at age 15 | 0.115*** | 0.107** | 0.071* | 0.146** | 0.105*** |
| | (0.040) | (0.040) | (0.039) | (0.044) | (0.038) |
| Province X Group FE | Yes | Yes | Yes | Yes | Yes |
| Province X Year FE | Yes | Yes | Yes | Yes | Yes |
| Group X Year FE | Yes | Yes | Yes | Yes | Yes |
| Parental Controls | No | No | No | No | Yes |
| Observations | 7730 | 7121 | 5838 | 6919 | 7403 |
| P-Value (Sub-population Level) | 0.007 | 0.016 | 0.092 | 0.013 | 0.009 |

**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 and the province indicators. Standard errors in parenthesis and p-values 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. * $p< 0.05$, ** $p< 0.01$, *** $p< 0.001$

Table 9: Effect of eligibility for second-child permits on enrollment into different types of senior middle school

| *Dependent variable:* | Regular Senior Middle School | | Specialized Senior Middle School | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| | All | w/ JMS | All | w/ JMS |
| ***Panel A: Sample 1991-2008*** | | | | |
| Eligibility at age 15 | 0.135** | 0.102 | -0.021 | -0.026 |
| | (0.049) | (0.057) | (0.033) | (0.041) |
| Province X Group FE | Yes | Yes | Yes | Yes |
| Province X Year FE | Yes | Yes | Yes | Yes |
| Group X Year FE | Yes | Yes | Yes | Yes |
| Observations | 8217 | 6146 | 8217 | 6146 |
| P-Value (Sub-population Level) | 0.034 | 0.132 | 0.578 | 0.577 |
| ***Panel B: Sample 1995-2008*** | | | | |
| Eligibility at age 15 | 0.153** | 0.113 | -0.019 | -0.045 |
| | (0.050) | (0.057) | (0.035) | (0.041) |
| Province X Group FE | Yes | Yes | Yes | Yes |
| Province X Year FE | Yes | Yes | Yes | Yes |
| Group X Year FE | Yes | Yes | Yes | Yes |
| Observations | 6405 | 4918 | 6405 | 4918 |
| P-Value (Sub-population Level) | 0.015 | 0.107 | 0.612 | 0.336 |

**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 and the province indicators. Standard errors in parenthesis and p-values based on wild bootstrapped standard errors, clustered on the sub-population within-the-province level. Eligibility indicated of the individual fulfills an eligibility criterion for a second child permit. Specialised senior middle school includes vocational, technical, adult and other senior middle schools. * p< 0.1, ** p< 0.05, *** p< 0.01

Table 10: Average treatment effect on the treated using the Sant'Anna and Zhao (2020) estimator

| | (1) | (2) | (3) |
|---|---|---|---|
| ATT (all groups across all periods) | .125 | .103 | .119 |
| | (.141) | (.143) | (.117) |
| Average ATT by group | .150** | .135*** | .139*** |
| | (.061) | (.040) | (.041) |
| Average ATT by time | .072 | .012 | .032 |
| | (.120 ) | (.118) | (.097) |
| Average pre-trend | .007 | .004 | .007 |
| | (.0103) | (.012) | (.017) |
| Observations: | 3,212 | 3,212 | 3,212 |

**Note:** Average treatment effect on the treated (ATT) using the estimator of Sant'Anna and Zhao (2020) in the csdid command. Uses a difference-in-differences framework where all that experience any policy change are defined as treated. Does not include group- of province-fixed effects. Standard errors are clustered on the sub-population within- the-province level. Column 1 does not include any controls. Column 2 includes gender as control. Column 3 includes gender, having no bothers, and being an only child as control. * p< 0.1, ** p< 0.05, *** p< 0.01

Table 11: Effect of eligibility for second-child permits at age 18 on enrollment into senior high school

| | (1) All | (2) w/ Primary | (3) w/ JMS | (4) w/o Minorities | (5) All |
|---|---|---|---|---|---|
| ***Panel A: Sample 1991-2008*** | | | | | |
| Eligibility at age 18 | 0.007 | 0.001 | -0.015 | 0.024 | -0.001 |
| | (0.039) | (0.058) | (0.039) | (0.074) | (0.038) |
| Province X Group FE | Yes | Yes | Yes | Yes | Yes |
| Province X Year FE | Yes | Yes | Yes | Yes | Yes |
| Group X Year FE | Yes | Yes | Yes | Yes | Yes |
| Parental Controls | No | No | No | No | Yes |
| Observations | 8627 | 7672 | 6061 | 7693 | 8173 |
| P-Value (Sub-population Level) | 0.886 | 0.972 | 0.744 | 0.593 | 0.989 |
| ***Panel B: Sample 1995-2008*** | | | | | |
| Eligibility at age 18 | 0.052 | 0.048 | 0.010 | 0.064 | 0.053 |
| | (0.046) | (0.058) | (0.042) | (0.074) | (0.044) |
| Province X Year FE | Yes | Yes | Yes | Yes | Yes |
| Group X Year FE | Yes | Yes | Yes | Yes | Yes |
| Parental Controls | No | No | No | No | Yes |
| Observations | 6528 | 5933 | 4820 | 5833 | 6216 |
| P-Value (Sub-population Level) | 0.329 | 0.318 | 0.820 | 0.273 | 0.294 |

**Note:** Sample is adjusted to those who turned 18 between 1991 - 2008 (Panel A) and 1995 - 2008 (Panel B). 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 and the province indicators. Parental controls include: Mother's education and age; indicators for mother's and father's type of work (manual, non-manual, none). Standard errors in parenthesis and p-values are based on wold bootstrapping, clustered on the sub-population within-the-province level. Eligibility indicated of the individual fulfills an eligibility criterion for a second child permit. * p< 0.1, ** p< 0.05, *** p< 0.01

Table 12: Effect of eligibility for second-child permits on enrollment into senior high school: Controlling for district level sex ratio and fertility rate

| | (1) All | (2) w/ Primary | (3) w/ JMS | (4) w/o Minorities | (5) All | (6) w/ Primary | (7) w/ JMS | (8) w/o Minorities |
|---|---|---|---|---|---|---|---|---|
| ***Panel A: Sample 1991-2008*** | | | | | | | | |
| Eligibility at age 15 | 0.115** | 0.108** | 0.077* | 0.150** | 0.105*** | 0.100** | 0.073* | 0.129** |
| | (0.038) | (0.038) | (0.037) | (0.041) | (0.035) | (0.036) | (0.036) | (0.038) |
| District Cohort sex ratio | 0.010 | 0.008 | 0.012 | 0.009 | | | | |
| | (0.013) | (0.013) | (0.013) | (0.014) | | | | |
| District Fertility Rate | | | | | -0.128*** | -0.124*** | -0.109*** | -0.128*** |
| | | | | | (0.021) | (0.022) | (0.022) | (0.022) |
| Province X Group FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Province X Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Group X Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 8155 | 7472 | 6092 | 7288 | 8103 | 7419 | 6056 | 7239 |
| P-Value (Sub-population Level) | 0.012 | 0.018 | 0.070 | 0.010 | 0.006 | 0.013 | 0.076 | 0.013 |
| ***Panel B: Sample 1995-2008*** | | | | | | | | |
| Eligibility at age 15 | 0.136*** | 0.124** | 0.069 | 0.151** | 0.110** | 0.101** | 0.050 | 0.123** |
| | (0.041) | (0.041) | (0.039) | (0.049) | (0.037) | (0.038) | (0.036) | (0.043) |
| District Cohort sex ratio | 0.003 | 0.002 | 0.005 | 0.003 | | | | |
| | (0.017) | (0.017) | (0.016) | (0.018) | | | | |
| District Fertility Rate | | | | | -0.128*** | -0.123*** | -0.107*** | -0.127*** |
| | | | | | (0.023) | (0.024) | (0.023) | (0.024) |
| Province X Group FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Province X Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Group X Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 6352 | 5882 | 4867 | 5704 | 6354 | 5884 | 4880 | 5711 |
| P-Value (Sub-population Level) | 0.006 | 0.011 | 0.111 | 0.019 | 0.015 | 0.023 | 0.217 | 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 and the province indicators. Standard errors in parenthesis are clustered on the sub-population within-the-province level. P-values are based on wild bootstrapped standard errors, clustered on the sub-population within-the-province level. Eligibility indicated of the individual fulfills an eligibility criterion for a second child permit. * p< 0.1, ** p< 0.05, *** p< 0.01

Table 13: Effect of eligibility for second-child permits on enrollment into senior high school: Excluding provinces with few observations

| | (1) All | (2) w/ Primary | (3) w/ JMS | (4) w/o Minorities |
|---|---|---|---|---|
| ***Panel A: Sample 1991-2008*** | | | | |
| Eligibility at age 15 | 0.118** | 0.112** | 0.083* | 0.153*** |
| | (0.040) | (0.041) | (0.040) | (0.044) |
| Province X Group FE | Yes | Yes | Yes | Yes |
| Province X Year FE | Yes | Yes | Yes | Yes |
| Group X Year FE | Yes | Yes | Yes | Yes |
| Observations | 7677 | 7014 | 5695 | 6819 |
| P-Value (Sub-population Level) | 0.014 | 0.019 | 0.061 | 0.006 |
| ***Panel B: Sample 1995-2008*** | | | | |
| Eligibility at age 15 | 0.149*** | 0.139*** | 0.087** | 0.165*** |
| | (0.043) | (0.043) | (0.041) | (0.052) |
| Province X Group FE | Yes | Yes | Yes | Yes |
| Province X Year FE | Yes | Yes | Yes | Yes |
| Group X Year FE | Yes | Yes | Yes | Yes |
| Observations | 5993 | 5537 | 4558 | 5355 |
| P-Value (Sub-population Level) | 0.006 | 0.003 | 0.044 | 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 effected interacted with year-fixed effects and group indicators for minority, rural household status, and being an only child interacted with year-fixed effects and the province indicators. Standard errors in parenthesis are clustered on the sub-population within-the-province level. P-values based on wild bootstrapped standard errors, based on standard errors clustered on the sub-population within-the-province level .

Table 14: 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

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | All | Men | Women | All | Men | Women |
| ***Panel A: Sample 1991-2008*** | | | | | | |
| Eligibility at age 15 | 0.115** | 0.112* | 0.097 | 0.121*** | 0.115* | 0.104 |
| | (0.038) | (0.053) | (0.065) | (0.037) | (0.053) | (0.063) |
| Eligibility at 15 X | -0.013 | -0.010 | -0.008 | | | |
| District cohort sex ratio (std) | (0.013) | (0.022) | (0.018) | | | |
| Criteria spouse independent | | | | -0.074 | -0.042 | -0.075 |
| | | | | (0.048) | (0.092) | (0.071) |
| Province X Group FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Province X Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Group X Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 8155 | 3875 | 4280 | 8217 | 3902 | 4315 |
| Eligibility: P-Value (SPL) | 0.011 | 0.075 | 0.211 | 0.007 | 0.064 | 0.179 |
| Interaction: P-Value (SPL) | 0.391 | 0.648 | 0.720 | | | |
| Criteria sp-dep.: P-Value (SPL) | | | | 0.227 | 0.769 | 0.364 |
| ***Panel B: Sample 1995-2008*** | | | | | | |
| Eligibility at age 15 | 0.135*** | 0.172** | 0.119* | 0.145*** | 0.185** | 0.127* |
| | (0.041) | (0.061) | (0.064) | (0.041) | (0.062) | (0.061) |
| Eligibility at 15 X | -0.011 | -0.010 | -0.006 | | | |
| District cohort sex ratio (std) | (0.016) | (0.023) | (0.025) | | | |
| Criteria spouse independent | | | | -0.134** | -0.145 | -0.100 |
| | | | | (0.051) | (0.089) | (0.086) |
| Province X Group FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Province X Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Group X Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 6352 | 3021 | 3331 | 6405 | 3046 | 3359 |
| Eligibility: P-Value (SPL) | 0.006 | 0.019 | 0.096 | 0.001 | 0.019 | 0.068 |
| Interaction: P-Value (SPL) | 0.536 | 0.681 | 0.831 | | | |
| Criteria sp-dep.: P-Value (SPL) | | | | 0.045 | 0.322 | 0.363 |

**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 and the province indicators. Standard errors in parenthesis are clustered on the sub-population within-the-province level. P-values 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. 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.

Table 15: Effect of eligibility for second-child permits on enrollment into senior high school according to the mother's education and occupation

| | (1) All | (2) Men | (3) Women | (4) All | (5) Men | (6) Women |
|---|---|---|---|---|---|---|
| ***Panel A: Sample 1991-2008*** | | | | | | |
| Eligibility at age 15 | 0.109** | 0.128* | 0.083 | 0.113** | 0.096 | 0.102 |
| | (0.042) | (0.061) | (0.070) | (0.040) | (0.055) | (0.067) |
| Eligibility at 15 X Mother: A | -0.000 | -0.023 | 0.018 | | | |
| At least primary school | (0.031) | (0.054) | (0.038) | | | |
| Mother: At least primary school | 0.130*** | 0.119*** | 0.136*** | | | |
| | (0.019) | (0.033) | (0.021) | | | |
| Eligibility at 15 X Mother: | | | | -0.035 | 0.008 | -0.073 |
| ISCO 88 Occupations Groups 1-5 | | | | (0.044) | (0.059) | (0.052) |
| Mother: ISCO 88 occupation Groups 1-55 | | | | 0.137*** | 0.072** | 0.201*** |
| | | | | (0.027) | (0.034) | (0.033) |
| Province X Group FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Province X Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Group X Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 8217 | 3902 | 4315 | 8217 | 3902 | 4315 |
| Eligibility: P-Value (SPL) | 0.021 | 0.050 | 0.308 | 0.024 | 0.132 | 0.210 |
| Interaction: P-Value (SPL) | 0.990 | 0.686 | 0.635 | 0.508 | 0.880 | 0.264 |
| Mother education: P-Value (SPL) | 0.000 | 0.001 | 0.000 | | | |
| Mother occupation: P-Value (SPL) | | | | 0.000 | 0.040 | 0.000 |
| ***Panel B: Sample 1995-2008*** | | | | | | |
| Eligibility at age 15 | 0.116** | 0.175* | 0.091 | 0.142*** | 0.169** | 0.124 |
| | (0.046) | (0.080) | (0.069) | (0.044) | (0.063) | (0.067) |
| Eligibility at 15 X Mother: | 0.014 | -0.011 | 0.037 | | | |
| At least primary school | (0.040) | (0.077) | (0.045) | | | |
| Mother: At least primary school | 0.128*** | 0.110** | 0.135*** | | | |
| | (0.026) | (0.053) | (0.027) | | | |
| Eligibility at 15 X Mother: | | | | -0.078 | -0.050 | -0.080 |
| ISCO 88 Occupations Groups 1-5 | | | | (0.046) | (0.057) | (0.060) |
| Mother: ISCO 88 occupation Groups 1-5 | | | | 0.168*** | 0.119*** | 0.199*** |
| | | | | (0.028) | (0.034) | (0.041) |
| Province X Group FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Province X Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Group X Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 6405 | 3046 | 3359 | 6405 | 3046 | 3359 |
| Eligibility: P-Value (SPL) | 0.023 | 0.053 | 0.214 | 0.008 | 0.022 | 0.110 |
| Interaction: P-Value (SPL) | 0.740 | 0.908 | 0.395 | 0.150 | 0.425 | 0.276 |
| Mother education: P-Value (SPL) | 0.000 | 0.040 | 0.000 | | | |
| Mother occupation: P-Value (SPL) | | | | 0.000 | 0.000 | 0.000 |

**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 and the province indicators. Standard errors in parenthesis are clustered on the sub-population within-the-province level. P-values are 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. 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. * p< 0.1, ** p< 0.05, *** p< 0.01

# 9 Appendix B: Theory

## 9.1 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.[20] 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:

$$u_p(c_p^1) = u(Y - \eta I_s) \tag{2}$$

where $u_p(.)$ 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.

[20]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.

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

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

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

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

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:

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

with $\delta$ as the discount factor.

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

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

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

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

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: $\frac{\partial y_s(I,J,n^*)}{\partial n^*} = 0$. On the right-hand side is the marginal benefit of having $n^*$ children.

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

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

Parents use education to smooth consumption over time such that the discounted utility in period 2 equally 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.

## 9.2 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*).[21] I investgate the reaction of those that change their anticipated fertility behavior with eligibility.

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

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

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

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

**Inter-temporal consumption smoothing channel:** Eligibility increases the marginal 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 9.2.1 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

[21] 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 an *increaser* with 80% likelihood and *always-2* with 20% likelihood.

therefore is assumed to the 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 maximisation problem of a family with a daughter is:

$$\underset{I_s,s,n}{max}\, u(Y - \eta I_s - s) + \delta[u(y(I_s, n) + y(J(I_s)) + p(I_s, n, Z) - f(n)) + \alpha h(n)] \tag{11}$$

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

Families with a daughter who anticipates a reduction in working hours expect to experience the labour supply effect. However, this effect gets mitigates 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 9.2.2.

### 9.2.1 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:

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

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:

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

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

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

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

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

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

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

Differentiating gives:

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

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

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

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

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

**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:

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

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

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

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 $\mu$:

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

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:

$$a(T-\mu n)L'(I_w)\mu L(I_w) > \mu L'(I_w) \tag{24}$$

which reduces to:

$$a(T-\mu n)L(I_w) > 1 \tag{25}$$

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.

### 9.2.2 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: $\omega(I_m, \phi)$.[22] 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:

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

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

[22] 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.

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.