Anticipated Fertility and Educational Investment: Evidence from the One-Child Policy in China *

Eva Raiber
Toulouse School of Economics, University of Toulouse, France
Institute for Advanced Study in Toulouse, France

Work in progress: Latest version

July 24, 2018

Abstract

How does future anticipated fertility affect current educational investment? The number of children planned is usually unobserved and affected by variables that are correlated with the demand for education. Theory, however, suggests that anticipated fertility can impact returns to education, the resources available for family consumption and the incentives to find a partner.

Using policy data about varying eligibility criteria for second child permits during the One-Child Policy in China, I investigate the effect of eligibility status on fertility and education. The subset of second child permits that are conditional on individual characteristics constant over time have a strong positive effect on the likelihood of having a second child between 1990 and 2005. Fulfilling an eligibility criterion at secondary school age increases the time invested in education and the likelihood to continue schooling after middle school. The effect is likely concentrated in the subset of individuals who increase their anticipated number of children as a response to eligibility. This positive effect which is stronger for men can be explained by the high cost of raising children, by the second child having only a short-term effect on parental labour supply and by a skewed sex ratio.

Keywords: Fertility, Schooling Investment, Family Planning, China

JEL Classification Numbers: I25, I26, J13, J24, O15.

*I thank Paul Seabright, Chris Udry, Silvain Chabé-Ferret, Mathias Reynaert, Sylvie Démurger, Thierry Magnac, Matteo Bobba, Tilman Brück, Nancy Qian, Matthias Doepke, Paula Gobbi, Florence Nimoh, participants and discussants at the Ruhr Graduate School Doctoral Conference 2017, the ENTER Jamboree at University College of London 2017, the EUDN PhD workshop 2017, the 2017 Lindau Nobel Laureates Meeting, the CSAE 2018, seminar participants at ISDC Berlin, Toulouse School of Economics, ECARES Brussels and Northwestern University for valuable feedback and comments. I am grateful to Wanying Zhao for excellent research assistance. Funding from the ANR - Labex IAST is gratefully acknowledged. Contact: eva.raiber@tse-fr.eu.
1 Introduction

Educational and fertility decisions are major life-time decisions that are deeply interconnected: they affect each other and many factors influence both, such as parental income, socio-economics status and labour market opportunities. The microeconomic literature has focused on the effect of parental education on the number of children, using exogenous variation in the cost of or the returns to education for identification. The question how anticipated fertility outcomes affect the demand for education has largely been unanswered: Do men and women who anticipate to have several children in the future choose to pursue a lower or higher level of education than those who expect none or few? Children can impact labour supply, income available for parental consumption, and the wish to have children can strengthen the incentives to find a partner. Therefore, the anticipated number of children can have an effect on the returns to education and the marginal utility of additional income, thus affecting educational investment decisions.

Answering this question is challenging: The number of children one plans to have in the future is usually unobserved. Surveys asking for the ideal number of children probe at fertility preferences which are only part of the calculation for anticipated or targeted fertility. When observed, it is highly correlated with other variables that affect the demand or cost of education. China’s One-Child Policy provides a unique opportunity to address this challenge. While one child per family was the norm, having a second child was allowed with a “second child permit” and the eligibility criteria for these permits were set on the provincial level. This transparent and predictable variation in the opportunity to have a second child without having to pay fines provides quasi-exogenous individual variation in the cost of the second child. Second child permits had a strong effect on fertility outcome and can therefore be expected to have an economically significant effect on anticipated fertility.

The consequences of an ageing society are debated in many countries and policy makers, faced with low fertility rates, are eager to encourage child bearing. Child benefits, free child care or paid parental leave are tools implemented or at least discussed in most low fertility countries. How do reforms that affect fertility influence educational investment? Do they have the side effect of keeping future parents from investing in education? This paper provides one of the first sets of evidence for these questions: First, it finds that second child permits that are based on characteristics constant
over time on average increase investment in education. Second, it argues that the effect is driven by those that anticipate a second child once they are eligible, but not before. Higher anticipated fertility can therefore increase educational investment. Context is as always important: theory, treatment effect heterogeneity and descriptive statistics are used to put the results into context.

Basic educational decisions are typically taken before individuals have children, however, individuals and their families might take into account how many children they plan to have in the future. First, depending on the context, children can be an important cost factor that decreases the monetary resources available for consumption of other family members, or are expected to add to the household income relatively quickly. In order to prepare for the cost of having children, families can use educational investment to smooth consumption over time (intertemporal consumption smoothing effect). This channel is particularly important when parents have to financially support their own parents at the same time. Second, children can affect the time their parents spend working in the labour market. The income loss increases in the parents’ educational level and thus affects lifetime returns to education: the less time the parent can spend in the labour market, the lower are the pay-offs from education (labour supply effect). Third, individuals who want to have children in the future might have a higher incentive to find a partner. If the sex ratio is skewed, individuals of the abundant sex compete for partners and can use education to increase their chances (marriage market effect). In section 3, I use a simple model to demonstrate these channels and highlight the assumptions needed.

During the One-Child Policy in China, provincial regulations dictated the number of children an individual is allowed to have. Monetary fines, disciplinary measures and social penalties were employed to discourage having more than one child, but some couples had the possibility to apply for a permit allowing them to have a second child. The different criteria for these second child permits were introduced for diverse reasons that are not directly related with provincial educational policies. Fulfilling a second child permit criterion can increase anticipated fertility from one to two children. It can, however, also relieve an individual planning on having two children in the future regardless of the penalties from having to pay income-dependent fines. Making use of temporal and provincial variation in the eligibility criteria, I calculate if at the age of 16, when individuals finish mandatory middle school and must decide to continue with voluntary general or vocational senior high school, they fulfils a current 2nd child permit criterion and can therefore anticipate to be eligible for a
2nd child permit later. In the difference-in-differences (DID) specification, I compare individuals in a population before and after a reform where they become eligible with individuals in the same province who do not experience a change in their eligibility status. In the double DID (or triple differences) specification, I compare this DID with the same DID in another province that did not have a reform for this population in the same period. Thanks to the double DID approach, I can control for population-specific time trends, thus relaxing the common trend assumption.

Individuals that turned 16 between 1990 and 2005 have not finished their reproductive stage by 2010, the year of the survey used, but have finished their basic education. I find that fulfilling a 2nd child permit criterion at the age of 16 increases significantly the years of education undertaken by around 0.9 years on average and the likelihood of enrolment into higher secondary school by nearly 10 percentage points. The effect is driven by men; the effect for women is positive but insignificant at around 0.6 years of education.

Furthermore, eligibility for a second child permit at the age of 27/28 due to the same observable criteria increases the likelihood of having a second child by around 14 percentage points in an older cohort that has finished their main productive stage in 2010. I make use of this older cohort to determine how different groups are affected: some individuals might plan to have one child or two children independent of eligibility for second child permits. The sub-sample of those in the older cohort that are not eligible is used as the training sample for a random forest estimation to predict if individuals would have a second child even when they are not eligible for a second child permits. I find that those who are predicted to have a second child absent of permits have a significantly lower effect of eligibility on the likelihood of enrolment into higher secondary school. This suggests that the overall positive effect on schooling investment is driven by those for whom the permit constraint is binding, meaning those who increase their anticipated fertility from one child to two as a response to being eligible for a second child permit. I do not find evidence that the official amount of monetary fines propagated by the provincial government has an effect on fertility outcome and educational levels. Further treatment heterogeneity analysis suggests that men in provinces with a skewed sex ratio, who anticipate a second child once eligible, are the most affected.

This paper looks at the effect of anticipated fertility on schooling investment in a low fertility setting and presents the case that wanting a family in the future does not necessarily hold one back
from education. However, labour market conditions are important. If parents can quickly return to the labour market after childbirth and do not have to fear lower returns to education than their childless co-workers, wanting children should not have a negative effect on educational decisions. In the theoretical section I show that the likelihood of an overall positive effect is (i) increasing the in the costs of raising the child and (ii) decreasing in the loss of working time due to a second child. It is not difficult to claim that raising children is seen as costly in China. For one, an important share of family income is spend on the children’s education. For example, for a family with two children, the second child being a teenage, educational expenditure accounts for roughly 20% of family income. Furthermore, parental labour supply and income is not affected in the long-run by having a second child: Women with a second child work less than women with only one child for around 4 years and then catch up. Guo et al. [2017] and He and Zhu [2016] also find no or little evidence on the negative effects of fertility on parental labour supply.

It is important to note that this paper looks at the intensive margin of anticipated fertility (having one more child) and not at the extensive margin (having the first child). As such, the results are in line with studies that find that having one more children has no or only a weak effect on the mother’s earnings in the long-run (Angrist and Evans [1996], Jacobsen et al. [1999], Lundborg et al. [2017]).

1.1 Links with the literature

This paper adds to the vast literature on schooling investment and fertility. 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]). On an individual level, female education in particular is usually associated with lower fertility rates (Osili and Long [2008], Lam and Duryea [1999], Schultz [1997], Duflo et al. [2015], Duflo et al. [2017] among others). This result however does not necessarily hold for developed countries (Fort et al. [2016]). The main economic argument is that the opportunity costs of having a child for an educated woman are higher than for a non-educated woman (based on Becker [1981]). Educated individuals on average have higher earnings that they might have to forgo when childbearing. Other explanations are that education increases the knowledge of contraception methods (Rosenzweig and Schultz [1989]) and increases the bargaining power of women who might want to have fewer children than men (Manser
and Brown [1980]).

A distinct but connected strand of literature looks at the effect of contraception on the educational investment choices of women (Goldin and Katz [2002], Ananat and Hungerman [2012], Miller [2010]). The idea is that contraceptive methods give women certainty over the pregnancy consequences of sex and thus decrease the risk of tertiary schooling investment. This paper assumes, however, that individuals can plan their fertility outcome as well as the timing of their pregnancies, an appropriate assumption for many high and middle income countries, including China.

This paper also adds to the literature on the One-Child Policy (OCP) in China and has implications for the effect of the current changes in fertility policies allowing two children. There is an ongoing discussion about how effectively fines and campaigns decreased fertility rates during the OCP (McElroy and Yang [2000], Li [1995]). Data related to the OCP has been used to investigate the relationship between education and fertility outcome, mostly addressing the quality-quantity trade-off that parents face when they decide how many children they want to have and how much they want to invest in each child (Qin et al. [2016], Li and Zhang [2016], Rosenzweig and Zhang [2009], Qian [2009]). The exemption from the strict OCP for some ethnic minorities has been used to study inter-ethnic marriages (Huang and Zhou [2015]) and ethnic identity (Jia and Persson [2017]). To the best of my knowledge, the only paper discussing a similar idea and using variation in the enforcement in the OCP as an identification mechanism is the recent work by Huang et al. [2016]. However, they only use the regional variation in monetary fines that, in the data set I use, has no effect on either schooling investment or on fertility choice. Furthermore, they assume that an increase in monetary fines decreases anticipated fertility without discussing that it might also increase the cost of having a second child while keeping anticipated fertility constant.

2 Context: The One-Child Policy, second child permits and education in China

Empirical identification relies on exogenous variation in the cost of having another child, which in turn leads to individuals changing their anticipated fertility. The OCP in China between 1979 and 2015 was based on the goal of one child per family, setting out fines and penalties for the birth of a second child. At the same time, provincial governments could issue permits for the second
Family planning has been of particular importance to the Chinese government for the past decades. The experience of the Great Famine during 1959-1961 is said to be a trigger for the ambitious family planning policies that followed, including the “Later, Longer, Fewer” campaign from 1971-1979, the OCP from 1979-2015 and the recent two-children policy. During the “Later, Longer, Fewer” campaign later marriage, longer birth intervals and fewer children were promoted. One child per family was stated to be optimal, two was acceptable for urban couples and three for rural couples. Already during this time, penalties were introduced for those who did not comply (Whyte et al. [2015]). Birth control and abortion were promoted, but 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]). These measures had a substantial effect on fertility rates (see figure 1, Whyte et al. [2015]).

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. However, particularly in rural areas where the one-child limit met significant resistance, implementation was delayed (Baochang et al. [2007]). In 1983, the OCP precipitated a huge wave of abortions and sterilizations (Whyte et al. [2015])\(^1\). Between 1982 and

---

\(^1\)14.4 million abortions, 20.7 million sterilizations and 17.8 million IUD insertions (Whyte et al. [2015])
1984, provincial governments started to issue more or less formal guidelines under which married or remarried couples could apply for a second child permit, thereby relaxing the one child per family limit significantly mainly in rural areas (Scharping [2013]). Between 1986 and 1991, provincial governments produced official family planning regulations outlying in detail different criteria for second child permits. Most of them were revised at least once in the 1990s and again after 2001. While transparency about family policies increased, coercive measures such as forced abortion and sterilization dropped substantially (Whyte et al. [2015]).

The 1980s therefore represent the time of introduction and adjustment of the policy, whereas the 1990s and 2000s represent a time of stability from a family policy perspective. Transparency of the policy measures is important to form adequate fertility expectations. This motivates using the time frame of 1990 to 2005 for the empirical evaluation. Furthermore, the 1980s coincide with the implementation of the Law on Nine-Year Compulsory Education. The law was introduced to attain universal education for nine years: six years at primary school (from age 6/7 to 12/13) and three years at junior high school (from age 12/13 to 15/16). After junior high school, students can voluntarily continue with general or vocational senior high school. Therefore, the first and most relevant educational investment decision is taken when the child is around 16 years old: the child has finished lower secondary education and must decide to continue with higher secondary education.

During the OCP, couples that wanted to have a child had to apply for a permit allowing them to do so and only married couples were able to apply. Couples that had a second child without a second child permit were officially subject to monetary fines which were set as a function of the couple’s income (Scharping [2013]). Couples with higher income thus had to pay higher fines in absolute terms. Additionally, parents potentially faced non-monetary penalties such as losing their job or having their career opportunities restricted. There is no accessible data on the enforcement of monetary fine and how frequent other social penalties were, making evaluation difficult. Couples had to obtain the second child permit before having the second child, however, this posed a significant financial burden to local governments particularly in rural areas, such that second child permits were presumably given out after birth if the couple fell into a specific exemption category (Scharping [2013]).

Eligibility criteria for second child permits varied on the provincial level and between rural
and urban areas. The household registration status (hukou), which is either agriculture/rural or non-agricultural/urban, determined whether and under what conditions a married couple was able to apply. Couples could only apply for a child permit at their place of household registration, restricting strategic between-province and urban-rural migration. Most exemptions from the strict one child policy also required that the applying couple had to respect late child birth (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 most known is the policy that allowed couples in rural areas whose first-born 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])\(^2\). These exemptions were introduced to appease the rural population and to ensure sufficient labour in the agricultural sector.

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, if the couple lived in a rural or specific minority area and sometimes even on the size of the minority population. Specifically autonomous regions\(^3\) had more lenient fertility constraints for minority couples. The fertility policies for ethnic minorities depended on the overall strategy the province uses toward those minorities.

Furthermore, following a statement from the central government, all provinces introduced at some point the criterion stipulating that if one or both spouses are an only child they are eligible for a second child permit. This policy was motivated by the idea that the one-child-per-family policy should only hold for one generation. Provinces implemented this criterion over the course of the 1990s to early 2000.

There were also specific exemptions for certain occupational groups such as fishermen and mine workers, as well as for veterans, couples who already adopted a child or that had their first child oversees. These policies are not taken into account here because they are not observable or can be anticipated at the age of 16. The category of couples with “real difficulties” is the most vague and potentially flexible one, making it impossible to evaluate without having governmental application and acceptance data.

To summarize, I use the following criteria for the empirical analysis:

\(^2\)The provinces are: Hainan, Yunnan, Qinghai, Ningxia and Xinjiang. In the province of Guangdong, couples with rural household status were also allowed to have two children until 1998 (Scharping [2013]).

\(^3\)Tibet, Inner Mongolia, Ninxia, Xinjiang and Guanxi
1. In five provinces, couples in rural areas were allowed to have two children. In the province of Quangdong, second child permits were given to couples in rural areas until 1998.

2. Couples living in rural areas whose first child is a girl can anticipate to be eligible in with a likelihood of approximately 50%.

3. Couples in which one or both spouses belong to a national minority (either in the whole province or living in rural or specific areas) can have two children.

4. Couples in which one or both spouses are an only child can have two children.

Empirical identification of the effect of the reform changes relies on geographical and temporal variation in the eligibility criteria. Figure 2 illustrates the share of individuals that fulfilled an eligibility criteria at the age of 16 and could therefore anticipate to be allowed to have another child. I differentiate between two categories: those that fulfil a criterion to have another child, and those that fulfil the criterion to have a second child if the first child is a girl (i.e. being eligible with a likelihood of approximately 50%). There was high variation at the beginning of the OCP between 1982 and 1990 and some changes around 1997 and 2001, when provinces revised their family planning regulations.

---

4 Specific exemptions I also use: In Jiangsu province, men can have a second child if the first born is a girl and they do not have a brother. In Jilin province, in rural areas, if one spouse is an only child and the first born is a girl, the can have a second child.

50% is an approximation. However, there are no reports of couples falling into that exemption that tried to avoid having a son as the first child. The main simplification is that I ignore sex differences in the costs-benefit analysis of parents.
3 Model

The motivation of the theoretical part is two-fold: First, it illustrates different channels through which anticipated fertility can affect educational investment in the most traceable form. Second, the model shows how different types of individuals react differently to a change in the cost of another child: some anticipate to have another child, some do not change the number of children planned but are relieved from paying the fine. This is used to guide the empirical investigation which aims at isolating group-specific effects. These two goals are achieved with a simple two stage model, that can be extended for additional questions.

3.1 Set-up

In the model, a representative family consisting of two parents and one focus child must decide how much to invest in the education of the focus child in the present (period 1). In the future (period 2), the focus child is grown up, married, earns income together with his/her spouse and the newly formed couple can have children themselves. Couples have to pay a fine for the second child which depends on the educational level of the now grown-up focus child if they are not eligible for
a second child permit.

Modelling both educational decision and fertility decision as made by the family is a simplifying assumption for which there are some arguments: For one, the focus child can influence educational investment by making more or less effort and persuading the parents of their school choice. Parents can influence the focus child’s fertility decision by passing on their own fertility preferences and by offering their help raising the grand-children. This channel is particularly persuasive in China where the family is still the most important social unit for many individuals. Also, grand-parents draw important benefits from having grand-children since they are invested in the continuation of their family line besides other biological, social and altruistic motivations. However, they may see having grand-children as being particularly costly because their focus child has to invest in raising them and thus may have fewer resources to allocate to the grand-parents when they are retired and have financial and care needs.

In the model the educational investment stage and the reproductive stage do not overlap. This is realistic with regard to primary and secondary education in China which is usually finished before starting the reproductive stage. In China, the minimum age for marriage is 20 for women and 22 for men and individuals are strongly discouraged from having children without being married.

**Period 1 “the present”**

In period 1, the family consumes $c^1$. The income $Y$ of the family is given exogenously which is used for consumption, investment in education $I$ or saving $s$. Utility in period 1 is given by

$$u(c^1) = u(Y - \eta I - s)$$  \hspace{1cm} (1)

where $u(.)$ is the utility of consumption, assumed to be strictly increasing and concave, $\eta > 0$ the constant cost of education, $Y$ the exogenous income, $I$ the educational level of the focus child and $s$ the level of savings. Families are assumed to be credit constraint such that $s \geq 0$.

**Period 2 “the future”**

In period 2, the focus child is grown up and married. The income earned is consumed by the family
and spend on the \( n \) children the newly formed couple has. The family gets utility from having (grand-) children assumed to be additively separable from the utility of consumption.

Utility in period 2 is given by:

\[
u(c^2) + \alpha_i h(n) = u(y(I, J, n) + Rs - p(I, n, Z) - f(n)) + \alpha h(n)\]

(2)

where \( p(I, n, Z) \) indicates the fine that the family has to pay with \( Z \in \{0, 1\} \) indicating eligibility status. The fine is dependent on the educational level of the focus child \( I \), reflecting the fact that monetary fines are dependent on the household income and that couples might have to pay non-monetary fines such as losing their job or not being promoted. The fine is 0 for the first child and only has to be paid when the family is not eligible for a second child permit (i.e \( Z = 0 \)):

\[
p(I, n, Z) = \begin{cases} 
0 & \text{if } n = 1 \\
0 & \text{if } n = 2 \& Z = 1 \\
\rho(I)(n - 1) & \text{if } n \geq 2 \& Z = 0 \\
\rho(I)(n - 2) & \text{if } n \geq 2 \& Z = 1 
\end{cases}
\]

(3)

\( f(n) \) is the cost of raising \( n \) (grand-) children (strictly increasing and concave), \( \alpha h(n) \) represents the utility of having (grand-) children (strictly increasing and concave), with \( \alpha \) being an individual fertility preference parameter drawn from a given distribution. \( y(I, J, n) \) is the household income, assumed to be strictly increasing and concave in the educational level \( I \), the spouse’s educational level \( J \) and decreasing in the number of children \( n \). For now, we assume that the educational level of the spouse \( J \) is exogenous; \( J \) is endogenized in section 3.4. An example is an income generation function that remunerates individuals for each hour worked multiplied by their productivity which is a concave function of education: \( y(I, n) = (T - \mu n)P(I) \) where \( T \) is the maximum time an individual can work, working hours decrease \( \mu \) for each child, and \( P(I) \) is the productivity of the individual. One could also interpret \( T \) as the number of years an individual works in his/her life and the number of children potentially decreases the years of working.
Given their fertility preferences and eligibility status, family $i$ solves:

$$\max_{I,s,n} u(Y - \eta I - s) + \delta[u(y(I, J, n) + Rs - p(I, n, Z) - f(n)) + \alpha h(n)]$$  \hspace{1cm} (4)$$

with $\delta$ as the discount factor. The model disregards any level of uncertainty and assumes full information. These are clearly unrealistic assumptions: one is never sure about future income, costs of raising a child, finding a partner and having a child at the desired time. However, to illustrate the basic mechanisms, this model suffices.

### 3.2 Optimal educational level and optimal number of children

Maximising with respect to education gives the optimal level of education as a function of the number of (grand-) children $n$:

$$u'(c^2) \left[ \frac{\partial y(I^*, J, n)}{\partial I^*} - \frac{\partial p(I, n, Z)}{\partial I^*} \right] = \frac{\eta}{\delta} u'(c^1) \hspace{1cm} (5)$$

The number of (grand-) children affects educational investment by decreasing family consumption in the second period, by affecting the returns to education directly through $\frac{\partial y(I^*, J, n)}{\partial I^*}$ and indirectly through $\frac{\partial p(I, n, Z)}{\partial I^*}$ when the number of (grand-) children is higher than 1.

Maximising utility with respect to $n$ gives us the optimal number of children as a function of education:

$$u'(c^2) \left[ \frac{\partial p(I, n, Z)}{\partial n} + \frac{\partial f(n^*)}{\partial n^*} - \frac{\partial y(I, J, n^*)}{\partial n^*} \right] = \alpha \frac{\partial h(n^*)}{\partial n^*} \hspace{1cm} (6)$$

On the left hand side is the marginal (opportunity) cost of having $n^*$ (grand-) children which 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 (grand-) child, and a decrease in income due to shorter working hours. On the right hand side is the marginal benefits of having $n^*$ (grand-) children. The effect of education on the optimal number of children reflects standard results: Education increases income and thus makes having (grand-) children less costly. However, education also increases the opportunity cost of having (grand-) children through $\frac{\partial y(I, J, n^*)}{\partial n}$. Higher education also implies having to pay a higher fine for the second (grand-) child, increasing the cost of having another one.
Maximising with respect to savings adds the following constraint:

\[ R = \frac{u'(c^1)}{\delta u'(c^2)} \]  

(7)

### 3.3 Effect of 2nd child permits

I focus my attention to the choice set for children being either one or two \((n \in [1, 2])\) which encompasses the choice set of the majority of Chinese (the theoretical discussion easily extends to an unrestricted choice set). Since the number of (grand-) children is a discrete variable and since there is no fine for the first one, eligibility does not necessarily change the optimal number of (grand-) children given by equation 6. The effect of the exemption depends on if eligibility changes anticipated fertility or not. There are three cases (with the standard policy evaluation names in brackets):

1. **Always one child (never-takers)**: \(n^*(Z = 0) = 1\) and \(n^*(Z = 1) = 1\)

   The optimal number of (grand-) children with eligibility or without is the same. The family is unaffected by the exemption.

2. **Always two children (always-takers)**: \(n^*(Z = 0) = 2\) and \(n^*(Z = 1) = 2\)

   The fertility decision is not altered by the eligibility status since the family always wanted two (grand-) children, but the family benefits from not having to pay the fine for the second (grand-) child.

3. **Increasers (compliers)**: \(n^*(Z = 0) = 1\) and \(n^*(Z = 1) = 2\)

   Becoming eligible, the optimal number of (grand-) children increases by one child.

The exemption policy affects educational investment of *Increasers* and *Always-2-children* as followed:

**Always 2 children**:

Optimal education with \(Z = 0\):

\[
u'(y(I^*, J, 2) + Rs - \rho(I^*) - f(2)) \left[ \frac{\partial y(I^*, J, 2)}{\partial I^*} - \frac{\partial \rho(I^*)}{\partial I^*} \right] = \frac{\eta}{\delta} u'(Y - \eta I^* - s) \]  

(8)
Optimal education with $Z = 1$:

$$u'(Y(I^*, J, 2) + Rs - f(2)) \left[ \frac{\partial y(I^*, J, 2)}{\partial I^*} \right] = \frac{\eta}{\delta} u'(Y - \eta I^* - s) \quad (9)$$

Being eligible has two opposing effects:

**Intertemporal consumption smoothing:** Eligibility decreases the marginal utility of consumption in period 2 ($u'(c^2)$) because the fine $\rho(I)$ does not have to be paid any more. This decreases education because the family responds with higher consumption and lower educational investment in period 1.

**Returns to education:** Eligibility increases the returns to education by $\frac{\partial \rho(I^*)}{\partial I^*}$ because the fine is dependent on income which increases in education. Since there are two potential opposing effects, the total effect can be negative or positive.

**Increasers:**

Optimal education with $Z = 0$:

$$u'(y(I^*, J, 1) + Rs - f(1)) \left[ \frac{\partial y(I^*, J, 1)}{\partial I^*} \right] = \frac{\eta}{\delta} u'(Y - \eta I^* - s) \quad (10)$$

Optimal education with $Z = 1$:

$$u'(y(I^*, J, 2) + Rs - f(2)) \left[ \frac{\partial y(I^*, J, 2)}{\partial I^*} \right] = \frac{s}{\delta} u'(Y - \eta I^* - s) \quad (11)$$

Again, eligibility has two effects:

**Intertemporal consumption smoothing:** Eligibility increases the marginal utility of consumption in period 2 ($u'(c^2)$) by increasing spending on (grand-) children by $f2 - f1$. Also, the grown-up child earns less due to having to care for two (grand-) children (when $y(I^*, J, 1) > y(I^*, J, 2)$). Marginal utility of additional earning in the future increases and the family uses education (and saving) as a way to shift consumption from period 1 to period 2 such that equation 5 holds.

**Labour supply and returns to education:** Eligibility decreases the returns to education if the grown-up child has to cut productive working hours ($\frac{\partial y(I^*, J, 2)}{\partial I^*} < \frac{\partial y(I^*, J, 1)}{\partial I^*}$). This decreases returns to education and thus decreases the incentives to invest in education.
The sign of the overall effect is discussed in the appendix using as an example the income generation function \( y(I, n) = (T - \mu n)P(I) \) where \( \mu \) is the time the parents cannot work due to having another child. The overall effect of having another child is positive if the intertemporal consumption smoothing effect is stronger than the labour supply effect\(^5\). This depends on the income of the individual: The higher the income, the more likely the intertemporal substitution effect outweighs the labour supply effect. Also, the smaller \( \mu \) the more likely the overall effect is positive (assuming constant absolute risk aversion). Furthermore, the more costly children are to raise \((f'(n))\) the more likely the overall effect is positive. These factors are summarized in the following proposition:

**Proposition 1** The likelihood that higher anticipated fertility has a positive effect on educational investment:

- increases in the cost of raising a child,
- decreases in the loss of working time due to child care.

The individual effect of the policy depends also on if the family is behaving as an *always-2*, *always-1*, or *increaser*. Here, this depends on the exogenous parameters \( \alpha \) and gives the following comparative statics: For given cost and fine levels, families with a low fertility preference \( \alpha \) are *always-1*, those with a medium \( \alpha \) are *increasers* and those with a high \( \alpha \) are *always-2*. This is illustrated in figure 4 in the appendix: Until the threshold \( \alpha \) the family has 1 (grand-) child independent of eligibility. Between \( \alpha \) and \( \bar{\alpha} \), the family has one (grand-) child if not eligible and two (grand-) children if eligible. Above \( \bar{\alpha} \), the family has two (grand-) children in any case. \( \alpha \) and \( \bar{\alpha} \) are defined by equation 6.

**Proposition 2** The likelihood of the family being *always-2*

- increases in fertility preferences \( \alpha \),
- decreases in cost of raising a child \( f(\cdot) \),
- decreases in fines \( \rho(\cdot) \).

\(^5\)Note that if children are not costly but seen as productive, both effects decrease education.
Second child permits should not have any effect on the always-1, but a positive or negative overall effect can be driven by families that are benefiters, or always-2, or both of them. Proposition 2 helps to empirically disentangle the overall effect of second child permits on schooling investment, differentiating between the effect it has on individuals that are increasers and always-2.

### 3.3.1 Effect on saving

In this model, saving and educational investment are both tools to smooth consumption. Denote $E_I$ the net returns to education $\frac{1}{\eta} \left[ \frac{\partial y(I^*, J, n)}{\partial I^*} - \frac{\partial p(I, n, Z)}{\partial I^*} \right]$, such that the first order condition 5 can be rewritten as:

$$E_{I^*} = \frac{u'(c^1)}{\delta u'(c^2)}$$

The family uses only education if at $I = I^*$ given by equation 5 $E_{I^*} > R$ (case i), it uses only savings if at $s = s^*$ given by equation 7 $E_{I^*} < R$ (case ii), and it uses both if at $I = I^*$ and $s = s^* E_{I^*} = R$ (case iii).

**Intertemporal consumption smoothing:** If with anticipated fertility the need for intertemporal consumption smoothing increases, in case i, the family uses educational investment for smoothing until either $E_{I^*} = \frac{u'(c^1)}{\delta u'(c^2)}$ or $E_{I^*} = R$. In case ii and iii, because the returns to savings are linear and the returns to education are decreasing, the family only uses savings to smooth. However, under certain assumptions, family increases both investment in education and savings as a reaction to increased anticipated fertility. For example, when educational investment is considered safe and savings are considered risky (or the other way around).

**Labour supply effect:** When increased anticipated fertility decreases the expected labour supply and thus the returns to education, this can tilt the favour towards using savings rather than educational investment for consumption smoothing.

### 3.4 Gender differences and marriage

In this section, I distinguished between families with male or female focus child and include a simplified version of a marriage market in the analysis. First, I assume that spouses match positive-assortatively on educational level: The spouse’s educational level $J$ is a function of own
education $I$: $J(I) = \sigma I$ with $0 < \sigma \leq 1$ capturing the correlation between the educational levels. Furthermore, I assume that only women reduce their working hours when they have a child and that the spouses’ incomes enter additively. Both assumptions are in line with descriptive statistics (see section 7).

The maximisation problem of a family with a daughter is:

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

(13)

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

(14)

Families with a daughter who anticipates a reduction in working hours when having a second child 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 intertemporal 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.

However, for men, there might be another factor, relevant in this context. So far, I assume that everyone marries. I now introduce the possibility of staying single. If a person stays single in period 2, he/she earns income and does not have children: $u(c^2_s) = \tilde{y}(I)$. Denote $c^2_m$ the consumption in period 1 when being married, $c^2_s$ the consumption when staying single, $\omega$ the probability of marrying in period 2 and $\tau$ 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 the educational level of the individual and the potential spouse and the number of children: $u(y(I) + y(J(I),n) + Rs - p(I,n,Z) - f(n)) + \alpha h(n)) - u(\tilde{y}(I)) > 0, \forall I,n$. As a consequence, if there are as many men as women, then 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: $\omega(I, \tau)$.

We focus on the situation where there are more men than women, the relevant case for China: $\tau > 1$. The utility of a man is then given by (FOC in the appendix):

$$\max_{I,s,n} u(Y - \eta I - s) + \delta[\omega(I, \tau) u(y(I)) + \delta(y(I), n) + Rs - p(I, n, Z) - f(n)) + \alpha h(n)] + (1 - \omega(I, \tau)) u(\bar{y}(I))$$

(15)

**Marriage market effect:** An increase in the number of anticipated children implies a (weak) increase in the marriage surplus as it increases the utility of being married but not the utility of being single. It therefore increases the incentives to invest in education to increase the odds of finding a spouse in order to make the now more beneficial situation more likely.

Furthermore, a reduction in the cost of the second child due to second child permits, keeping the number of anticipated children constant, also increases the marriage surplus and thus the incentives to invest in education in order to increase the likelihood of finding a spouse. The marriage market effect would thus be positive for *increasers* and always-2 alike.

**Proposition 3** An increase in anticipated fertility increases the incentives to invest in education to improve the odds of finding a spouse, given that the sex ratio is skewed.

As in the previous sections, the general equilibrium effects are not taken into account. 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.

### 3.5 The effect of fines on education

How does the amount of fines change the incentives to educate? Second child permits can be interpreted as a reduction in the cost of having a second child, and the size of the cost reduction depends on $p(I)$. The effect of these monetary fines is again different for different types of individuals: For *increasers*, defined as those that anticipate a second child only if they are eligible for a...
second child permit, the size of the fine does (by definition) not matter. However, as mentioned in proposition 2, how many *increasers* there are in the population depends on the amount of fines. The higher the monetary fines, the higher the cost reduction due to 2nd child permits, thus the more people react to it.

On top of changing the composition in the population between *increaser* and *always-2*, the amount of the fines change the incentives to educate for *always-2*. Higher fines, as a function of household income, increase the need to smooth consumption intertemporally, but also have a stronger negative effect on education. Higher fines also strengthen the marriage market effect: not having to pay high fines increases the marriage surplus more than not having to pay low fines.

4 Data

4.1 Individual Data

For the empirical analysis I use individual survey data from the 2010 China Family Panel Study (CFPS). It was designed by a Peking University research team, supported by Peking University 985 funds and carried out by the Institute of Social Science Survey of the Peking University. The data set in English and Chinese is available online.

For the main cohort, I use individuals that turned 16 between 1990 and 2005 which leads to a sample with 7840 observations of which 53% are female. Summary statistics are displayed in table 5 in the appendix. The sample is predominantly rural: 70% hold agricultural household status and 30% hold non-agricultural household status. 89% of the sample indicate that they are of Han ethnicity. The other main minorities in the sample are Miao (2.1%), Yi (2.3%) and Man (1.5%)7. On average, individuals stayed in school for 7.6 years (women: 7.1, men: 8.2). Those with a non-agricultural household status spend nearly twice as many years at school as those with agricultural household status (11.4 compared to 6.1).

Those in the main cohort are too young to have finished their reproductive stage at the time of the survey in 2010. I am thus not able to use the number of children allowed at age 16 as instrument

---
7Not all provinces are represented in the sample. In particular, the sample does not cover the autonomous regions of China (Inner Mongolia, Tibet, Xinjiang and Ninxia) with the exception of Guangxi Zhuang autonomous region. The main population is sampled from Gansu (12%), Henan (11%), Guangdong (9%), Shanghai (8.5%) and Liaoning (8.4%).
for the actual number of children. To fill the need for an older cohort that has already finished the reproductive stage at the time of the survey, I use individuals that turned 16 between 1980 and 1995. I use this older cohort to establish the effect of second child permits on the likelihood of having a second child and to find predictors for fertility outcome. Summary statistics for the older cohort are also displayed in table 5. As expected, educational levels are lower but other characteristics are the same (sex, ethnicity). There are more individuals with an agricultural household registration status.

4.2 Policy exemptions

Data about province level policies are taken from Scharping [2013] and supplemented by Baochang et al. [2007] and official family planning regulation documents accessed on-line in Mandarin Chinese and translated into English. An excerpt of the data is displayed in table 4 in the appendix. Based on this information, the number of children one is officially allowed to have is calculated at the time of the educational decision-making, which is assumed to be 16. At this time students on average must decide to continue with senior general or vocational high school after completing compulsory junior high school. The official exemption policy within the province should influence this decision.

For the main analysis, I use those turning 16 between 1990 and 2005. This has several reasons: First, only after 1990 Chinese citizens had official legal documents that they could rely on. Before, conditions for second child permits were only presented as guidelines and it is debatable if implementation and knowledge of exemptions was comparable between provinces. Second, I do not want to mix up the effects of the policy with the implementation time of the 1986 compulsory secondary school reform. The upper cut-off of 2005 is chosen in order to assure that in the year of the survey (2010), basic educational investment is finished. Also, as previously mentioned, in this time span, there are some reforms in the different provinces, but the policy framework is sufficiently stable so that fertility anticipations can be form on the current policy situation.

---

8 This collection of policy information in English was collected by Wanying Zhao and is available upon request.
5 Empirical methodology

The goal of this study is to isolate the effect of anticipated fertility on education. I denote $I$ the educational outcome and $\tilde{N}$ anticipated fertility. Furthermore, denote with $P$ the cost of an out-of-quota child. Ideally, one would want to estimate:

$$I_i = \theta_1 \tilde{N}_i + \theta_2 P_i + \mu_i$$

(16)

using anticipated eligibility $\tilde{Z} \in \{0, 0.5, 1\}$ as an instrument for $\tilde{N}$. The first stage would take the following form:

$$\tilde{N}_i = \beta \tilde{Z}_i + X_i + \epsilon_i$$

(17)

where $X$ indicated individual level characteristics that determine eligibility status, province fixed effects and time fixed effects. Conditioned on $X$, eligibility status $Z$ is assumed to be uncorrelated with the error term $\epsilon$.

5.1 Effect of eligibility on education

However, $\tilde{N}$ and $P$ are unobserved. instead, only the actual fertility outcome $N$ is observed in the older cohort for which the actual eligibility status $Z \in \{0, 1\}$ is know after the birth of the first child. So what can be identified? Denote $I(\tilde{Z})|X$ the educational level dependent on anticipated eligibility at the age of 16 given characteristics $X$. I can identify the intention-to-treat effect $E(I(1)|X) - E(I(0)|X)$ which compares the educational level of individuals that are eligible with those that are not, with the following regression:

$$I_i = \tilde{\theta} \tilde{Z}_i + X_i + \tilde{\mu}$$

(18)

The intention-to-treat effect $\tilde{\theta}$ is a policy relevant parameter and is estimated in section ??.

It indicates how the policy overall affects the outcome and is thus a parameter of interest. From theory we know that the intention-to-treat effect is a weighted average of the effect of the policy on the three different groups always-1, increasers and always-2, which correspond to never-takers, compliers and always-takers in the Angrist framework (Angrist et al. [1996]). In order to interpret
the coefficient as the effect of the policy on compliers, one has to assume that the behaviour of the other groups are unaffected (exclusion restriction). In this context, it is easy to do for the group of always-1, but it is restrictive in the case of always-2 since, as we have seen in the theory section, they benefit from not having to pay income-dependent fines.

The intention-to-treat effect can be decomposed into the effect on *increasers* which goes through anticipated fertility $\tilde{N}$ and on always-2 whose effect goes through the fine for an out-of-quota child. By definition, *increasers* are those that change anticipated fertility from 1 to 2 as a response to eligibility, thus $\beta$ is the share of *increasers* in the population. Denote $\pi$ the share of always-2 in the population and $\rho$ the average amount of fines. The average effect of eligibility on out-of-quota fines then defines as: $E(P(1)|X) - E(P(0)|X) = \pi \rho$. Thus, the intention-to-treat effect can be decomposed into:

$$E(I(1)|X) - E(I(0)|X) = \theta_1[E(\tilde{N}(1)|X) - E(\tilde{N}(0)|X)] + \theta_2[E(P(1)|X) - E(P(0)|X)]$$  \hspace{1cm} (19)

$$= \beta \theta_1 + \pi \rho \theta_2 \hspace{1cm} (20)$$

In the standard Angrist LATE case, the exclusion restriction implies that $\pi \rho \theta_2 = 0$: either there are no always-takers or always-takers are unaffected by the instrument $Z$. Furthermore, if anticipated fertility $\tilde{N}$ was observed, one can estimate $\beta$, the “take-up rate”. Even if the take-up rate is unobserved, by assuming a non-negative effect of the instrument on take-up together with the exclusion restriction, one is able to identify the sign of the effect.

### 5.2 Effect of eligibility on fertility outcome

Since anticipated fertility is unobserved, $\beta$ cannot be estimated. However, it is reasonable to assume that the anticipated eligibility status can only affect anticipated fertility when eligibility affects the fertility outcome. Fertility outcome $N$ is observed in the older cohort, as is eligibility status $Z \in \{0, 1\}$ after the birth of the first child, so that we can estimate:

$$N = \tilde{\beta} Z + X + \epsilon$$ \hspace{1cm} (21)

This regression provides an estimator of the take-up rate of the 2nd child permit categories
included in $Z$. Results are discussed in section 6.2. One should keep in mind that there are criteria for 2nd child permits that are not included in $Z$ because they are not observable or because they rely on the realization of the first birth or occupational choice. $\tilde{\beta}$ therefore is not the take-up rate of all 2nd child permits criteria. However, $\tilde{\beta}$ measures the effect of categories important for forming fertility anticipations.

5.3 Isolating the effect on increasers

In the older cohort, we observe individuals that have a second child without being eligible. Keeping in mind the caveat that some of those were eligible for different 2nd child permits, we can nonetheless use information gained from this cohort to decompose the overall intention-to-treat effect, under some assumptions, guided by the theoretical model.

In the theoretical model, fertility preferences determine if the individual is an always-1, increaser, or always-2. The share of always-2 is denoted with $\pi$. I use the fertility proxies $W$ to predict if an individual in the main cohort will be a always-2 or not. For this, those not eligible in the older cohort are used to estimate the effect of $W$ on the likelihood of having a second child:

$$Prob(N_i = 2 | Z_i = 0, X) = f(\alpha W_i | Z_i = 0, X)$$

(22)

The purpose of this exercise is prediction and not inference, thus, the values of $\alpha$ are not of interest and only capture correlation, not necessarily causality. To get the highest predictive power and to account for potential non-linearities, I use a classification random forest with 500 trees, where the prediction is determined by majority rule at the respective node. The number of predictors used for each tree is determined by minimising the out-of-bag error rate.

The effect of the fertility predictors, based on the training set of those in the older cohort who are not eligible, is then extrapolated to the whole older cohort and the main cohort. Denote the prediction status of an observation $L$ which can be either 0 (not predicted to be an always-2) or 1 (predicted to be an always-2). Regressions 27 and 18 are then run with $L$ as an interaction term. We therefore observe the coefficients $\tilde{\theta}(L) = E(Y(1) - Y(0)|L)$.

Denote the share of always-2 in the sample of those predicted to be always-2 $\overline{\pi}$ and the share in the sample of those predicted to not be always-2 $\overline{\pi}$. If the prediction is informative about the
underlying distribution of always-2, then $\bar{\pi} > \pi > \bar{\pi}$. Under the assumption that the prediction is informative, the decomposition allows to make statements about the signs of the coefficients $\theta_1$ and $\theta_2$.

It is again useful to draw comparisons to the standard case in which $\tilde{N}$ is observed. In this case, we could estimate the share of always-2 ($\pi$) and increasers ($\beta$). Once they are known this decomposition allows to estimate $\theta_1$ and $\theta_2$ separately (as shown in Hull [2015]).

5.4 Effect of fines on education

What can be observe with a (noisy) measure on $P$ that is measured at the province level? Once the full set of controls $X$ is included, the effect of $P$ is captured in the province times year fixed effects. However, we can look at the differential effect of fines for those that are eligible. Eligibility for a second child permit means an anticipated cost reduction in the monetary cost of the second child, and this cost reduction is a function of the fines. The cost reduction is essentially an interaction between eligibility and the monetary fine levels:

$$I_i = \delta \tilde{Z}_i P_i + X_i + \tilde{\mu}$$  \hspace{1cm} (23)

Monetary fines can also be used to test predictions derived from the theoretical model: First, monetary fines should change the distribution of always-2 in the population. For this, I first check if eligibility has a higher effect on fertility outcome when fines are high. I also verify if monetary fines are important making predictions in the prediction status $L$ (see previous subsection). Second, monetary fines do not have an effect for those that are either increasers and always-1. Third, monetary fines potentially have an effect on always-2, though it is unclear in which direction.

6 Results

6.1 Effect of second child permits on education

The first and most relevant educational choice for most families is made when the focus child is 16 years old, which is point in time when anticipated eligibility is calculated. Educational attainment is first measured in years of education ($I_{ip\text{ in }2010}$) and then replaced by a dummy
variable indicating enrolment into senior high school and college or university. In order to be as thorough as possible, I estimate 3 specifications. Each specification relaxes an assumption but also includes more control variables and thus puts more burden on the model. Specification 1 is a DID estimation that assumes a national trend (equation 22). It includes province fixed effects (now denoted $\gamma$) and province-specific effects (denoted $\kappa$), characteristics defining potential eligibility groups and additional controls ($X$), but assumes that annual effects are the same for each province and each population.

$$I_{ip \text{ in } 2010} = \tilde{\theta}Z_{ip \text{ age}(16)} + X_i'\kappa_p + \gamma_t + \kappa_p + \epsilon_{ipt} \quad (24)$$

Specification 2 is a DID estimation with province-specific trends (equation 25). It relaxed the assumption that the annual effects are the same for each province. It still assumes that the annual effects are the same for each population within the province.

$$I_{ip \text{ in } 2010} = \tilde{\theta}Z_{ip \text{ age}(16)} + X_i'\kappa_p + \gamma_t'\kappa_p + \epsilon_{ipt} \quad (25)$$

The third specification is a Differences-in-Differences-in-Differences (Double DID or Triple Differences approach, equation 26). It relaxes the assumption that the potentially eligible populations and the general population have the same trend.

$$I_{ip \text{ in } 2010} = \tilde{\theta}Z_{ip \text{ age}(16)} + X_i'\kappa_p + X_i'\kappa_p\gamma_t' + \gamma_t'\kappa_p + \epsilon_{ipt} \quad (26)$$

In specification 1 and 2, the difference between those that were not eligible and those that are eligible for a second child permit at age 16 (after policy reform) within the same population in a province are compared with a population were no change in eligibility occurs. In specification 3, I compare this difference-in-difference with the same comparison in another province where in the same time span no reform change for these populations happened.

Identification comes from the geographical and time variation of the introduction and scope of exemptions from the OCP. The double DID approach allows to control for population-specific time
trends, thus relaxing the common trend assumption. The exclusion restriction is that, conditioned on province trends, the sub-groups that become eligible have the same educational trend as the sub-groups in other provinces that do not change eligibility status. In order to support this identifying assumption, I run a pre-OCP placebo test. Identification also implies that provincial family planning policies targeting a specific sub-population are independent of educational measures that target the same group. For instance, if provinces that allow second child permits for ethnic minorities couple these measures with an increase in the educational budget for ethnic minorities areas, the policy measure captures both. So far, I have not encountered evidence in the literature for such behaviour. Additional robustness checks are run to verify that the overall results are not driven by a specific easily targeted group.

One might be concerned about potential spill-over through migration. However, the Chinese household registration system restricts the possibility to migrate, particularly between provinces. Applications for the second child permit can only be submitted at the place of registration and moving the place of registration is difficult. Recent reforms are set to loosen these restrictions.

The results for the effect of second child permits on schooling investment are shown in table 1 with the specification 1, 2 and 3 in column 1, 2 and 3 respectively. Fulfilling a second child permit criterion at the age of 16 and thus anticipating to be eligible for a second child permit increases the years of education by around 0.9 years on average. The coefficient does not change significantly between the three specifications (but standard errors increase). The effect is higher for men but not significantly so (see column 5). The coefficient for women alone lies at 0.6 years of education and is not significant. This empirical result is evidence that men and to a smaller extend women who expect to be allowed to have two child without react by increasing educational investment.

At which stage of the educational career does eligibility play a role? Instead of year of education I now use indicator variables for finishing junior high school and enrolment into senior high school, technical college and university as outcomes. Results are displayed in table 6 in the appendix and graphically shown in figure 3. First, there is no effect of eligibility on junior high school completion (column 1 and 2). This is expected and can be regarded as a falsification test. At the age of 16, individuals have completed or are about to complete their mandatory junior high school degree.

---

9Within the main cohort, only 1.2% indicated a different provincial code as place of residence at the age of 12 than at the age of 3 while 5.4% indicated a different county or district code (within-province migration).
### Table 1: Effect of the number of children allowed at age 16 on the years of education.

Dependent variable: Years of education

<table>
<thead>
<tr>
<th>DID national trend</th>
<th>DID province trends</th>
<th>Double DID</th>
<th>Double DID</th>
<th>Double DID</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
</tbody>
</table>

Expected eligibility at age 16  
0.829**  
(0.385)

Female X Expected eligibility  
-0.00592  
(0.414)

<table>
<thead>
<tr>
<th>Female Dummy</th>
<th>Eligibility Indicators</th>
<th>Province FE</th>
<th>Eligibility Controls x Province FE</th>
<th>Year FE</th>
<th>Eligibility Controls x Year FE</th>
<th>Year FE x Province FE</th>
<th>Female x Province FE; Female x Year FE</th>
<th>Observations</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>7840</td>
<td>0.432</td>
</tr>
<tr>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>7840</td>
<td>0.461</td>
</tr>
<tr>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>7840</td>
<td>0.467</td>
</tr>
<tr>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>7840</td>
<td>0.474</td>
</tr>
</tbody>
</table>

Note: Sample includes individuals that turned 16 between 1990 and 2005. Dependent variable is the years of education the individual completed. Standard OLS regression with standard errors clustered on provinces-times-urban-area levels in parenthesis. Significance levels: * 0.10; ** 0.05; *** 0.01. Data source: China Family Panel Survey 2010.
Note: 95% Confidence Intervals. Likelihoods are based on DID estimates with province specific trends (table 6)

Figure 3: Effect of anticipated eligibility on finishing junior high school, enrollment into senior high school and enrollment into college or university. Estimates for not eligible and eligible (0.5 - eligible category is omitted).

Second, enrollment into senior high school increases by around 9 percentage points (3 and 4). The effect carries on: enrollment into at least college (vocational or university studies - column 5 and 6) increases significantly by around the same size and enrollment into university increases by 6 percentage points (column 7 and 8).\(^\text{10}\)

Following, I run a placebo test to argue that the exclusion restriction is not violated (table 7 in the appendix). I map the eligibility status of those in my main cohort to those that turned 16 before the introduction of any second child exemptions. I find that the placebo variable does not have any effect on the educational level of those that turned 16 between 1972 and 1982\(^\text{11}\).

Furthermore, I investigate which group drives the results (see table 8 in the appendix). First, the coefficient for anticipating to be eligible with 50% likelihood (because of a 1.5 children rule) is lower than half of the coefficient of “full eligibility”, not significantly different from zero but positive and within the expected range (column 1). When including interaction terms for the different eligibility groups, the effect is the same for the minority and agricultural sub-groups (column 2 and 4) and only significantly different for those that are an only child (column 3). Indeed, it seems that anticipated

\(^{10}\)As another falsification test, I at the eligibility status at age 20. As expected enrolment in senior high school is not affected but enrolment into university slightly is.

\(^{11}\)Results do not change significantly if one year earlier or later is chosen for the mapping.
eligibility does not have a significant effect on an only child. This can have several reasons: For one, those that are an only child might have low fertility preferences and thus fall into the category of \emph{always-1}. Second, the policy to allow only children to have two children was announced by the central government and slowly implemented in all province regulations. It could thus be that only children that were not eligible when they were 16 anticipated to be eligible once they were older.

There are other variables that might have an effect on the impact of the policy. I check if individuals with a highly educated father have a different intensity of the effect, with the idea that the father’s education is a proxy for household income. However, I do not find any significant difference. This might be due to the fact that though individuals with a highly educated father are more likely to have the means to pay the fines, they are also more likely to have lower fertility preferences. As an interesting addition, I find that individuals whose father is a member of the Communist party are not significantly affected by the second child permit reforms. It is plausible that those have already internalized the party rule of one child per family and thus their fertility expectations are not affected by a change in eligibility rules.

### 6.2 Effect of eligibility on fertility outcome

Since the main cohort is too young to have finished their reproductive phase in 2010, I use the older cohort to estimate the effect of actual eligibility on fertility outcome. \( N_i \) is measured as having a second child in 2010 or not. The analysis is restricted to married individuals that already had one child before 2003, so they have enough time to have a second child while conforming with promoted birth intervals, and do not have more than two children. Eligibility is measured at the age of 27 for women and 28 for men which is the year before the average age of the birth of the second child.

In specification 1, the indicator variable of having a second child in 2010 or not is regressed on the eligibility status at the age of 27/28, controlling for individual characteristics that allow eligibility as well as birth year and province fixed effects, and the sex of the first child:

\[
N_{i \text{in } 2010} = \tilde{\beta}Z_{ip \text{age}(27/27)} + X_i + \gamma_t + \kappa_p + \epsilon_{ipt}
\]

Equation 27 can be estimated by a logit regression. However, the underlying assumptions such
that $E(\epsilon_i, Z_i | X_i) = 0$ are strong: The effect of the characteristics that make someone eligible such as belong to an ethnic minority or having an agricultural household status are assumed to be the same in each province. Also, year fixed effects are assumed to be the same for all provinces and for all population groups. In order to relax these assumptions, I also run a DID and double DID specification as in the previous section.

The results are displayed in table 2: Eligibility for a second child permit at the age of 27/28 has a highly significant effect in all specifications (columns 1 to 3). On average, being eligible increases the likelihood to have a second child by 14 percentage points, based on the DID specification. Effects are similar for men and women (columns 5 and 6).

The official number of children allowed at age 27/28 thus influences real fertility decisions. However, an increase of approximately 14 percentage points implies that there is an important 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 only the impact of eligibility based on criteria that are observable at the age of 16. There are a range of exemptions that are based on unobservable and (for the econometrician) non predictable characteristics such as the first child being disabled, the family being in “poor economic conditions” etc. Furthermore, eligibility is only measured at 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 as are those that become non-eligible at age 27/28 (but might have already had a second child or had gotten a second child permits before the change). The coefficient therefore does not measure the complete impact of 2nd child permits and probably underestimates even the effect of the criteria included.

6.3 Isolating the effect on increasers

In order to decompose the effect of eligibility on education, I want to split the sample into two groups: those that are expected to be always-2 and those that are not. I use the subsample of those in the older cohort that are not eligible for a second child permit as a training set for a random forest estimation that predicts if someone has a second child without being eligible. Only those that turn 16 before 1990 are included, so that the training sample and the sample for the main cohort do not overlap. Motivated by proposition 2 in the theory section, I include potential
Dependent variable: Having a second child

<table>
<thead>
<tr>
<th></th>
<th>OLS DID (1)</th>
<th>Logit (2)</th>
<th>OLS Double DID (3)</th>
<th>OLS Double DID (4)</th>
<th>OLS-DID Women (5)</th>
<th>OLS-DID Men (6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eligibility at age 27 (women)/28 (men)</td>
<td>0.143*** (0.0438)</td>
<td>0.110*** (0.0284)</td>
<td>0.152*** (0.0449)</td>
<td>0.144*** (0.0447)</td>
<td>0.153*** (0.0483)</td>
<td>0.139*** (0.0477)</td>
</tr>
<tr>
<td>Eligibility Controls</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Additional Controls</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Local Fertility Rate</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Province FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Elig. Controls x Province FE</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Province FE x Year FE</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Elig. Controls x Time FE</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

Observations: 8423, 8423, 8192, 8423, 4554, 3869

$R^2$: 0.420, 0.447, 0.434, 0.457, 0.442

Note: Sample includes individuals that turned 16 between 1977 and 1992, are married, had their first child before 2003 and have no more than two children. Logit or OLS regressions with standard errors in parenthesis. Standard errors are clustered on the province interacted with an urban dummy which indicated that in 2010, the area is defined as an urban area. It is not feasible to include Province FE x Eligibility controls in the logit regressions. Dependent variable = 1 if the individual had a second child. Coefficients are average marginal effects. Eligibility controls: Household status, only child status, minority status. Additional controls: sex, sex of first child. Data source: China Family Panel Survey 2010.

Table 2: Effect of eligibility status at age 27/28 on the likelihood of having a second child.
fertility proxies on top of eligibility characteristics, province indicators and a trend variable: The local, district-level fertility rate is calculated as the average number of children those aged between 30 and 35 have when the individual turns 16. Furthermore, I include the number of siblings, an indicator if the mother has finished at least junior high school, if the individual grew up in an urban area (independent of hukou status) and if the father is member of the Communist party.

The random forest grows 1000 classification trees with 3 predictors used for each tree which are randomly selected from all predictors. The number of predictors is chosen to minimize the out-of-bag error rate. Prediction is made based on the average of those trees and an observation is predicted to be an always-2 if more than half of the observation that fall into the same category have a second child (majority rule). Figure 5 shows the importance of the different predictors. Unsurprisingly, the province and the local fertility rate are the most important predictors. The trend, number of siblings, and the household registration status are important as well.

The random forest is used to predict if an individual in the older cohort and the main cohort would be an always-2. This variable is then interacted with the eligibility status. Results are displayed in table 3. The first two columns (1 and 2) show the effect of eligibility are age 27/28 on the indicator of having a second child: As expected, the take-up rate among those that are not predicted to be always-2 is significantly higher than those among predicted always-2, where second child permits have an effect close to zero.

We can see in columns 3 and 4 that the effect of anticipated eligibility at age 16 is still positive and significant for those that are not predicted to be always-2. The interaction has a negative sign but is not significant. Once we look at the effect of senior high school enrolment, the effect of eligibility is significantly higher for those that are not predicted to be always-2 (columns 5 and 6). These results suggest that the positive effect of eligibility on educational investment is driven by those that increase their anticipated fertility as a response to eligibility status, i.e. for those who the permit constraint is binding.
<table>
<thead>
<tr>
<th>Cohort</th>
<th>Dependent variable: Having a 2nd child</th>
<th>Years of Education</th>
<th>Enrollment into SHS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eligibility at age 27/28</td>
<td>0.180***</td>
<td>0.183***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0511)</td>
<td>(0.0512)</td>
<td></td>
</tr>
<tr>
<td>Eligibility at age 27/28 X Predicted Always-2</td>
<td>-0.125**</td>
<td>-0.129**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0535)</td>
<td>(0.0545)</td>
<td></td>
</tr>
<tr>
<td>(Anticip.) eligibility at age 16</td>
<td></td>
<td>1.048*</td>
<td>1.212***</td>
</tr>
<tr>
<td>Predicted Always-2</td>
<td></td>
<td>(0.347)</td>
<td>(0.440)</td>
</tr>
<tr>
<td>Predicted Always-2 X (Anticip.) eligibility at age 16</td>
<td></td>
<td>-0.511</td>
<td>-0.475</td>
</tr>
<tr>
<td>Predicted Always-2</td>
<td></td>
<td>(0.384)</td>
<td>(0.375)</td>
</tr>
<tr>
<td>Observations</td>
<td>8104</td>
<td>8104</td>
<td>7528</td>
</tr>
<tr>
<td>R²</td>
<td>0.631</td>
<td>0.633</td>
<td>0.472</td>
</tr>
</tbody>
</table>

Note: Includes eligibility characteristics, province and time fixed effects, province X time fixed effects, eligibility characteristics X province fixed effects, female dummy. Column 1 and 2 include sex of first child, column 2, 4 and 6 include eligibility characteristics X time fixed effects. Standard OLS regression with standard errors clustered on provinces-times-urban-area levels in parenthesis. Significance levels: * 0.10; ** 0.05; *** 0.01. Data source: China Family Panel Survey 2010.

Table 3: Decomposing the effect of eligibility
6.4 Effect of fines on education

In order to investigate the effect of fines on education, I use the fine data set from Ebenstein [2010] which is based on Scharping [2013] and includes the official monetary fines (as well as bonuses) that are set on the province level. Unfortunately, the fines are only available until 2000, so that only 2/3 of the main cohort can be used. The fines are set as a multiple of the previous year’s household annual income and ranged between 0.15 and 5 between 1990 and 2000. These official monetary fines measure the true costs of an out-of-quota child imperfectly: We do not know if these fines where actually implemented, and there were other penalties such as losing one's job that are important. Furthermore, there were several costly avoidance strategies whose employment probably correlated with the official fines.

The result that include monetary fines are displayed in table 9. Second child permits can be interpreted as a cost reduction which equals eligibility status times the fine amounts. This definition of cost reduction is included in column 1 and 3 and the coefficients are interpreted as followed: a cost reduction of one time the annual income increases the likelihood of having a second child by 9.4 percentage points but does note have a significantly positive effect on education. Differentiating between those predicted to be always-2 and those not (column 3), we find that those that are not predicted to be always-2 react positively to a cost reduction while those that are predicted to be always-2 do not. Here, the prediction process for always-2 includes the fine levels as a possible predictor.

However, the amount of monetary fines does not add explanatory power over just using an eligibility dummy (see column 2 and columns 5 to 8). Being eligible in a province with higher fines does not have a higher effect on the likelihood of having a second child than being in a province with lower fines. Fines are not important in predicting always-2(see figure 6). This is probably due to these official fines measuring the real cost of an out-of-quote child very noisily.

6.5 Effect of eligibility and the sex ratio

The theoretical model predicts that the effect should be stronger when the cost of raising children is high, when the family has to fear a loss in life-time returns to education due to reduction in the

---

12The previous results hold for this subsample.
labour supply, and, when there is a skewed sex ratio, for the abundant sex. Of those channels, I investigate the latter, as the cohort sex ratio is observable and plausibly exogenous on the individual level.\textsuperscript{13} I use the 2000 Census to calculate the share of women for each birth year.\textsuperscript{14}. For the 1977-1992 cohort, the average ratio is ..., for the 1990-2005 cohort the average ratio is

At first I check if the sex ratio has an effect on the take up rate of second child permits (see table 10, column 1). Though the interaction between eligibility and sex ratio is insignificant, I include the sex ratio in the prediction for always-2 and find that it is less important that the local fertility rate, province fixed effects or the household status, but as important as the number of siblings and the trend variable (see figure ??).

The sex ratio indeed has a significant effect on the impact of second child permits: The interaction term in table 10 column 2 is negative and significant. Thus, the less women compared to men in the cohort, the stronger the effect of second child permits. This is indeed driven by the abundant sex (men): in columns 3 and 4 where men and women are looked at separately, the coefficient is significant (and also larger in size) for men. If effect is driven by always-2 or not is verified in columns 5 to 7. Splitting up the sample further decreases power, however, the size of the coefficient for men that are not predicted always-2 stays the same (though it is not significant) in column 7 (p-value = 0.22).

6.6 Effect of second child permits on other variables

Anticipated fertility can also have an effect on other choices. For example, those that anticipate to have more children could get married earlier and have their first child earlier. However, it should be remembered that in order to apply for a second child permit, couples often have to respect certain criteria, one being ‘late birth’ of the first child. Late birth defined as the woman being at least 25 years old when having the first child. For those being born between 1970 and 1980, average age at first birth lies at 24.75 overall, 24 for women and 25.56 for men. Thus, this criterion might actually push those that plan to apply for a second child permit to wait until age 25 for having the first child.

Since the decisions are taken at a later stage in life, I use the eligibility status at age 22 for the

\textsuperscript{13}Expenditures for the second child are not observed and endogenous, as are labour market conditions.
\textsuperscript{14}The census, having more observations than the CFPS, gives a cleaner measure.
timing of marriage, and the eligibility status at age 25 for the timing of first birth. The sample is
adjusted accordingly. I also control of the years of education to correct for any effect that fertility
expectations could have through education. The result using the triple differences specification are
displayed in table 11 in the appendix. The coefficient of eligibility status at age 22 on the age of
marriage is significantly negative once it is interacted with the sex of the individual (column 2).
When female specific year and province fixed effects and an interaction between the female indicator
and education are included (column 3), eligibility significantly decreases the age at marriage only
for men.

We find the same results for the age at the birth of the first child: When female specific year,
province, and educational effects are included, eligibility at age 25 significantly decreases the age at
first birth only for men (column 6). A potential explanation is that eligible women are concerned
with the official guidelines about late marriage and late birth. It is also possible that for women
the legal limit for marriage is generally binging. At the same time, there are no thresholds for men
and the legal marriage age might not be binding for most men, so that they can adjust the age of
marriage and first birth to their anticipated fertility.

7 Discussion: Why would those that expect more children educate
more?

The theoretical model provides mechanism why an increase in anticipated fertility can have a
positive effect on education: by affecting family consumption, by affecting the labour supply and by
affecting the incentives to find a partner. In this section, I provide descriptive statistics to discuss
the intertemporal consumption smoothing and labour supply channels. The model is not able to
give us concrete thresholds, however, looking at expenditure data and parental labour supply helps
us to put the results into context.

The cost of raising children not only depends on how much money is spend on the need of
the children but also on the available income at that point in time. If during the time of raising
children, parents also have to financially support their own parents, it makes the cost of children
more relevant for parents but also for the grand-parents that have a strong say in the educational
decision making. Therefore, in the last subsection, I look at the financial and living situation of
7.1 Cost of raising children

The fertility literature in developing countries has treated children as an investment for parents that pays off quickly because children are productive from an early stage on. The idea of children as productive household members relies on children being able work from an early stage on. In developed countries however, children are often seen as expensive: children have to be financially supported until the end of the educational stage. Furthermore, retirement schemes and health insurance mitigate the need to rely on children during sickness or old-age.

In China, education is mandatory until age 16 and children are not allowed to work. If families abide to these rules, they have additional expenses for at least 16 years per child and no additional income. Indeed, gross enrolment rates for primary schools have been constantly above 100% for the past years for girls and boys, at the secondary school level they have increased from around 70% in 2007 to over 90% in 2015 and for tertiary education from 20% in 2007 to 45% in 2015 (UNICEF). Child labour can be a way how parents gain from their child from an early age on. However, Tang et al. [2016] estimate that in 2010, about 7.74% of children aged from 10 to 15 were working and most of them combined education with their economic activity. For most parents, expenditure for children is larger than monetary gains for at least 16 years.

Expenditure on the education of their children is an important cost for parents in many countries. Figure 8 in the appendix shows total expenditure on education as a share of family income for families with one child. Though educational expenditure is low in the first four years, 10 to 20% of family income is spend on education afterwards. Figure 9 shows the different expenditure items as share of family expenditure. The increase at the age of 5 is driven by tuition that families probably pay for pre-school. Tuition drops at age 6 or 7 when children start primary school, however, at the same time families spend more on extracurricular activities and home tutoring. Tuition becomes more important again at the age of 17 when students enter senior high school, then college or university.

Figure 10 in the appendix contrasts the educational expenditures of a family with two children with the expenditure of a family with only one child. For the control group, a nearest-neighbour
matching technique is used.\textsuperscript{15} Families with two children pay more for education measured as a share of family income than families with one child in the control group starting when the second child is around 5 years old. When the second child is around 15/16 years old, educational expenditure accounts for more than 20\% of family income. This descriptive results is replicated in a regression analysis displayed in table 12 in the appendix. Using standard OLS regression, we find that families with a second child spend twice as much on education than families with only one child. Due to the endogeneity problem, the indicator of having a second child is instrumented with the number of children allowed at age 30 adjusted for the sex of the first child in column 3 but the result stays the same. The IV approach is only suggestive since fertility expectations potentially affect other variables that influence educational expenditure that I cannot control for such as savings.

A recent report commissioned by HSBC estimates that Chinese parents pay around $42,892 for their child’s education (HSBC [2017]). Though this is less than in the USA ($58,464) where college attendance is higher, it is still more than in other countries such as the UK ($24,862), Canada ($22,602) or France ($16,708)(HSBC [2017]). Furthermore, the report revealed that 93\% of Chinese parents have paid for a private tutor. However, Chinese parents seemed to have expected these expenses since out of the countries that were surveyed, China had the highest rate of parents (around 55\%) indicating that they could fund their child’s education through savings or investment.

The suggestive evidence and the additional literature indicate that raising children in China is indeed costly at least for on average 20 years. In particular, families spend an important share of their income on the education of their children.

7.2 Old-age support and the double burden of parents

The effect of anticipated fertility also depends on the importance of children’s financial support to parents. However, while it might be true that parents have their financial and care needs in mind when deciding how many children to have and how much to invest in them, it might also make children more costly when investment in children and financial support toward the grand-parents

\textsuperscript{15}First the likelihood of having a second child is regressed on age, agricultural household status, educational level and age at the birth of the first child and the propensity score is predicted. Each individual is then matched with his/her nearest neighbour (of the same sex) without replacement based on the propensity score. The matched control individual “adopts” the birth year of the second child from his/her neighbour.
are paid at the same time. Children are still an important source for old age support in China. According to the CFPS, in 2010, 45% of individuals over 60 live with at least one of their children, of those 69% live with a son and 31% with a daughter. Respectively, in our main cohort, 34% of adults have at least one parent living with them. For families with an agricultural household status and at least one person older than 60, social security/pensions transfers accumulate to on average 2068 Yuan (approx. 218€)\(^{16}\), making up less than 10% of family income. For families with an non-agricultural household status, it accumulates to on average 20353 Yuan (2137€), making up around 47% of family income. 33% of those over 60 indicate having received economic support from at least one of their children.

Overall, families with both spouses born between 1964 and 1979 give 4% of their annual income to relatives. They increase family member support by 1 percentage point for each grandparent that does not live with them, as displayed in table 14 in the appendix. Using OLS regression, there is no significant difference on the amount given to relatives between families with one child and two children. However, once having a second child is instrumented (column 3), we find that families with one child give around 3 percentage point of family income to a grand-parent who does not live with them, while this is not the case for families with two children. It looks as if the expenses for the second child impact the ability to support the grand-parents.

### 7.3 Parental labour supply and earnings

Do parents work more or less when they have a second child? The CFPS includes data on how much the individual worked on average per month in 2010. Figure 11 in the appendix shows the average log working hours of men and women according to how many years have passed since the birth of the second child for parents that have exactly two children and a matched control group with one child. If at all, men work significantly less only at the year of birth of the second child but not afterwards.\(^{17}\) Women work significantly less in the first four years following the birth of the second child but then work the same hours or potentially even more from year 5 onward. Figure 12 in the appendix displays parent’s monthly income. In line with the previous results, men earn less in the year of birth and there is no evidence for a lasting effect. Women’s earnings are less in

\(^{16}\)Based on conversion rate of 0.105, approximate average exchange rate at the beginning of 2010.

\(^{17}\)There are other years where they work significantly less at 10% but the difference is not systematic.
the first four years after the birth of the second child. Long-run earning patterns are noisy: there is no clear trend for either higher or lower earnings.

Again, the descriptive results are replicated in a regression analysis, displayed in table 13 in the appendix. Using standard OLS regression, we find that having a second child is negatively associated with working hours for men and women in 2010 (columns 1, 2, 4 and 5). When eligibility status at age 30 is used as an instrument, the coefficient for women is no longer significant but still negative (column 3). The effect of having a second child for men is insignificant with a positive sign (column 6).

While the IV approach is only suggestive, Guo et al. [2017] and He and Zhu [2016] address the endogeneity between child birth and labour market conditions by using twinning as a natural experiment. Guo et al. [2017] do not find evidence on the negative effects of fertility on parental labour supply while He and Zhu [2016] find a small negative effect in 1990 of a twin birth on women’s labour force participation and an insignificant effect in 2000. Finally, Angrist and Evans [1996], Jacobsen et al. [1999] and Lundborg et al. [2017] show for other countries that having one more child has no or only a small effect on earnings of women.

Overall, the descriptive statistics, suggestive IV results and the related literature suggests that in the Chinese context, having a second child does not have a large long-run effect on parental labour supply and earnings. Since the loss in working time is very small for men and relatively small for women, the positive effect of an increase in anticipated fertility on education is not surprising.

8 Conclusion

In this paper, I use a novel empirical approach to address the question of how anticipated fertility affects educational decisions, a question which has not been in the focus of the fertility literature. For this, I use the One-Child Policy in China and the existence of second child permits for a subset of individuals. The empirical results show that individuals who are allowed to have a second child without having to pay a fine invest more in education. This perhaps surprising result a result of the Chinese social and economic environment; however, it can still be a positive sign for policy makers who want to promote fertility and education. Replicating this result in other countries will be difficult since identification relies on a setting in which fertility constraints are set
exogenously; however, it is important to verify the external validity of the results.

In theory section, I sketch economic channels of how fertility expectations can positively influence educational investment: Because children are expensive one might want to ensure to earn sufficient money in the future in order to be able to provide for children. The overall positive effect depends on the relationship between lifetime returns to education and fertility outcome. In so far, the policy implication is nothing novel as it stresses the importance of providing the opportunity for men and women to stay in or re-enter the labour market without loss of their skills.

There are other channels how fertility expectations can affect education that one can think of. For one, individuals who plan to have more than one child in the future might also plan to take over important childcare tasks and want to be well prepared for it. It can also increase the incentive to find a productive spouse to share the cost of raising a child and therefore affect marriage market returns to education. Also, one parent might want to increase her/his bargaining power when he/she counts on having to secure sufficient resources for more than one child. Since bargaining power within the household and education are often said to be positively correlated, increasing education can be seen as a way to increase bargaining power. In the Chinese context, one can also add that obtaining a second child permit might come with difficult bureaucratic hurdles for which the individual prepares by getting more educated. One could also point out a psychological effect: being allowed to have two children in a society where children are seen as essential can imply a more positive attitude towards the future and thus more motivation at school.

China is one specific social and economic environment that has been perturbed by strict policies. Comparing individuals who plan to have two children instead of one (intensive margin) is not the same as comparing individuals who do not plan to have any children with those that do (extensive margin). However, this is one of the first empirical papers that addresses the identification issue of the relationship between fertility expectations and educational investment and will hopefully lead to a discussion where case studies of different countries can be compared.

References

E. O. Ananat and D. M. Hungerman. The power of the pill for the next generation: oral contraception’s effects on fertility, abortion, and maternal and child characteristics. Review of Economics


P. Hull. Isolateing: Identifying counterfactual-specific treatment effects with cross-stratum comparisons. 2015.


9 Appendix

9.1 Figures
Figure 4: The effect of ferility preferences on the number of children.

Figure 5: Importance of predictors in random forest estimation measured as how much the variables decreases the GINI (measure of node purity)
Figure 6: Importance of predictors including fine levels

Figure 7: Importance of predictors cohort sex ratio (from 2000 census)
Note: Share of family income allocated to education for families that have an only child. Data is based on the family questionnaire and question of how much was spend on education last year. Source: CFPS 2010.

Figure 8: Total educational expenditure as share of family expenditure

Note: Share of family expenditure allocated to education for families that have an only child. Data is based on the child questionnaire until the age of 15 and the adult questionnaire from age 16 onward. Includes families with an only child where the child lives with at least one parent. Excludes families that do not pay all the educational cost (28 observations). The question is asked for each educational item. Source: CFPS 2010.

Figure 9: Different items of educational expenditure as share of family expenditure.
Note: Share of family expenditure allocated to education comparing those with two children with a matched comparison group. The comparison group is matched 1 to 1 based on the propensity scores taking into account age, education, household registration status and the age at the birth of the first child. Data is based on the family questionnaire of the CFPS 2010.

Figure 10: Expenditure on education for families with two children and a matched control group with one child

Figure 11: Log monthly working hours in 2010 according to the year of birth of the second child
Figure 12: Log monthly income in 2010 according to the year of birth of the second child
9.2 Tables

<table>
<thead>
<tr>
<th></th>
<th>Hebei</th>
<th>Chongqing</th>
<th>Hubei</th>
<th>Zhejiang</th>
<th>Jiangsu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family only has girl (rural area)</td>
<td>1989</td>
<td>1997</td>
<td>1987</td>
<td>1995</td>
<td>2002(^{18})</td>
</tr>
<tr>
<td>Ethnic minorities</td>
<td>1982</td>
<td>2002</td>
<td>2002</td>
<td>1990</td>
<td>-</td>
</tr>
<tr>
<td>Spouses are only child</td>
<td>1982</td>
<td>1997</td>
<td>2002</td>
<td>1989</td>
<td>1990</td>
</tr>
</tbody>
</table>

Note: Provinces have several other eligibility criteria such as for couples who had their first child outside of China, remarried couples, couples with a disabled first child etc. that I do not regard. Based on Scharping [2013] and family planning documents.

Table 4: Example of when provinces formalized eligibility criteria.

---

\(^{18}\)Only if husband does not have a brother.
\(^{19}\)Truncated at 7
\(^{20}\)Taking into account the sex of the first child.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Main Cohort (turning 16 between 1990 and 2005)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Years of education completed (in 2010)</td>
<td>8.681</td>
<td>4.631</td>
<td>0</td>
<td>22</td>
</tr>
<tr>
<td>Female</td>
<td>0.534</td>
<td>0.499</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Han ethnicity</td>
<td>0.893</td>
<td>0.309</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Rural/agricultural household registration status</td>
<td>0.689</td>
<td>0.463</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Nb children allowed: 2 (at age 16)</td>
<td>0.275</td>
<td>0.446</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Nb children allowed: 1.5 (at age 16)</td>
<td>0.376</td>
<td>0.484</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>N</td>
<td>7840</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Older cohort: (turning 16 between 1977 and 1992)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Years of education completed (in 2010)</td>
<td>6.527</td>
<td>4.664</td>
<td>0</td>
<td>22</td>
</tr>
<tr>
<td>Female</td>
<td>0.529</td>
<td>0.499</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Han ethnicity</td>
<td>0.915</td>
<td>0.278</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Rural/agricultural household registration status</td>
<td>0.732</td>
<td>0.443</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Year born</td>
<td>1968.208</td>
<td>4.346</td>
<td>1961</td>
<td>1976</td>
</tr>
<tr>
<td>Nb children allowed: 2 (at age 16)</td>
<td>0.137</td>
<td>0.343</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Nb children allowed: 1.5 (at age 16)</td>
<td>1.711</td>
<td>0.865</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Number of children¹⁹</td>
<td>1.673</td>
<td>0.821</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Allowed to have 2nd child²⁰</td>
<td>0.36</td>
<td>0.48</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>N</td>
<td>11626</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 6: The effect of the number of children allowed on the likelihood of completing a degree.

<table>
<thead>
<tr>
<th></th>
<th>Junior High School</th>
<th>Senior High School</th>
<th>College</th>
<th>Undergraduate Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DID (1)</td>
<td>Double DID (2)</td>
<td>DID (3)</td>
<td>Double DID (4)</td>
</tr>
<tr>
<td>Nb children allowed(16)</td>
<td>0.0272 (0.0368)</td>
<td>0.0254 (0.0376)</td>
<td>0.106*</td>
<td>0.0898+</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.0967**</td>
<td>0.0981**</td>
</tr>
<tr>
<td>Female dummy</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Eligibility controls</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Province FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Eligib. controls x Province FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FE x Province FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Eligibility controls x Year FE</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>7840</td>
<td>7840</td>
<td>7840</td>
<td>7840</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.312</td>
<td>0.318</td>
<td>0.418</td>
<td>0.424</td>
</tr>
</tbody>
</table>

Note: Sample includes individuals that turned 16 between 1990 and 2005. Dependent variable is the likelihood of completing junior high school (columns 1 and 2), enrolling into senior high school (columns 3 and 4) and finishing senior high school (columns 4 and 5). OLS regressions with standard errors in parenthesis. Standard errors are clustered on the province times urban level. Significance levels: * 0.10; ** 0.05; *** 0.01. Data source: China Family Panel Survey 2010.
<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent variable:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Years of Education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of children allowed (16)</td>
<td>-0.112</td>
<td>-0.791</td>
</tr>
<tr>
<td></td>
<td>(0.592)</td>
<td>(0.616)</td>
</tr>
<tr>
<td>Female dummy</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Eligibility controls</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Province FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Eligibility controls x Province FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FE x Province FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Eligibility controls x Year FE</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>6705</td>
<td>6903</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.332</td>
<td>0.321</td>
</tr>
</tbody>
</table>

Note: Sample includes individuals that turned 16 between 1970 and 1980. Dependent variable is the years of education the individual completed. Standard OLS regression with robust standard errors in parenthesis. Significance levels: * 0.10; ** 0.05; *** 0.01 Data source: China Family Panel Survey 2010.

Table 7: Placebo test.
<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eligibility at age 16 = 0.5</td>
<td>0.258</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.263)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eligibility at age 16 = 1</td>
<td>0.961**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.382)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eligibility at age 16</td>
<td>0.815**</td>
<td>1.110***</td>
<td>1.337*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.381)</td>
<td>(0.385)</td>
<td>(0.693)</td>
<td></td>
</tr>
<tr>
<td>Agri. household status X Eligibility at age 16</td>
<td>0.277</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.318)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Only Child X Eligibility at age 16</td>
<td>-1.469**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.723)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Han ethnicity X Eligibility at age 16</td>
<td>-0.545</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.690)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female dummy</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Eligibility controls</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Province FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Eligibility controls x Province FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FE x Province FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Eligibility controls x Year FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>7840</td>
<td>7840</td>
<td>7840</td>
<td>7840</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.467</td>
<td>0.467</td>
<td>0.468</td>
<td>0.467</td>
</tr>
</tbody>
</table>

Note: Sample includes individuals that turned 16 between 1990 and 2000. Dependent variable is the years of education the individual completed. Standard OLS regression with robust standard errors in parenthesis. Significance levels: * 0.10; ** 0.05; *** 0.01 Data source: China Family Panel Survey 2010.

Table 8: Effect of the number of children allowed at age 16 on the years of education - Robustness Checks.
| Cohort       | Having 2nd child | Enrollment in Senior High School |  |  |  |  |
|-------------|------------------|-------------------------------|  |  |  |  |
|             | (1)             | (2)                          | (3)      | (4)       | (5)       | (6)       |
| Cost reduction | 0.0941***       | 0.0182                        | 0.0276*  |           |           |           |
|             | (0.0249)        | (0.0129)                      | (0.0138) |           |           |           |
| Eligibility at age 27/28 | 0.148***       |                               |           |           |           |           |
|             | (0.0433)        |                               |           |           |           |           |
| Eligibility at age 27/28 X Monetary fine (std) | 0.0114         |                               |           |           |           |           |
|             | (0.0110)        |                               |           |           |           |           |
| Predicted Always-2 X cost reduction | -0.0249**      |                               |           |           |           |           |
|             | (0.0108)        |                               |           |           |           |           |
| (Anticip.) eligibility at age 16 |                  | 0.0929**                    | 0.129*** |           |           |           |
|             |                 | (0.0431)                      | (0.0397) |           |           |           |
| (Anticip.) eligibility at age 16 X Monetary fine (std) | -0.000107      | -0.00487                     |           |           |           |           |
|             |                 | (0.0239)                      | (0.0269) |           |           |           |
| Predicted Always-2 X (Anticip.) eligibility at age 16 | -0.0712        |                               |           |           |           |           |
|             |                 | (0.0429)                      |           |           |           |           |
| Predicted Always-2 X Monetary fine (std) | -0.0360        |                               |           |           |           |           |
|             |                 | (0.0464)                      |           |           |           |           |
| Predicted Always-2 X (Anticip.) eligibility at age 16 X Monetary fine (std) | 0.0227         |                               |           |           |           |           |
|             |                 | (0.0549)                      |           |           |           |           |
| Predicted Always-2 | -0.0703**       | -0.0706*                     |           |           |           |           |
|             |                 | (0.0275)                      | (0.0379) |           |           |           |
| Observations | 7607            | 7607                          | 5405     | 5187      | 5405      | 5187      |
| $R^2$       | 0.420           | 0.421                         | 0.445    | 0.455     | 0.446     | 0.456     |

Note: All regressions are OLS Difference-in-Difference specification with province level times fixed effects, control for eligibility characteristics times province fixed effects and gender. Column 1 and 2 control for sex of the first child, includes only those that are married and had their first child before 2003. Clustered standard errors on province X urban level in parenthesis. Column 7 includes only those that are predicted to not have a second child when not eligible based on the random forest specification, column 8 those that are predicted to have a second child when not eligible. Significance levels: * 0.10; ** 0.05; *** 0.01 Data source: China Family Panel Survey 2010.

Table 9: Monetary fines and eligibility.
<table>
<thead>
<tr>
<th>Cohort</th>
<th>Having 2nd child</th>
<th>Dependent variable: Enrollment in Senior High School</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>all (1)</td>
<td>Women (2)</td>
</tr>
<tr>
<td>Eligibility at age 27/28</td>
<td>0.124***</td>
<td>0.127*</td>
</tr>
<tr>
<td></td>
<td>(0.0460)</td>
<td>(0.0699)</td>
</tr>
<tr>
<td>Eligibility at 27/28 X Sex ratio (std)</td>
<td>0.0369</td>
<td>0.0793</td>
</tr>
<tr>
<td></td>
<td>(0.0294)</td>
<td>(0.0176)</td>
</tr>
<tr>
<td>(Anticip.) eligibility at age 16</td>
<td>0.112*</td>
<td>0.0793</td>
</tr>
<tr>
<td></td>
<td>(0.0643)</td>
<td>(0.0776)</td>
</tr>
<tr>
<td>(Anticip.) eligibility at age 16 X Sex ratio (std)</td>
<td>-0.0219*</td>
<td>-0.0105</td>
</tr>
<tr>
<td></td>
<td>(0.0124)</td>
<td>(0.0176)</td>
</tr>
<tr>
<td>Predicted Always-2 X (Anticip.) eligibility at age 16</td>
<td>-0.0787*</td>
<td>-0.0755</td>
</tr>
<tr>
<td></td>
<td>(0.0395)</td>
<td>(0.0508)</td>
</tr>
<tr>
<td>Predicted Always-2 X Sex ratio (std)</td>
<td>-0.0142</td>
<td>0.00130</td>
</tr>
<tr>
<td></td>
<td>(0.0167)</td>
<td>(0.0262)</td>
</tr>
<tr>
<td>Predicted Always-2 X (Anticip.) eligibility at age 16 X Sex ratio (std)</td>
<td>0.00270</td>
<td>-0.0225</td>
</tr>
<tr>
<td></td>
<td>(0.0264)</td>
<td>(0.0366)</td>
</tr>
<tr>
<td>Predicted Always-2</td>
<td>-0.0750**</td>
<td>-0.0741***</td>
</tr>
<tr>
<td></td>
<td>(0.0300)</td>
<td>(0.0264)</td>
</tr>
</tbody>
</table>

Observations | 8423 | 7840 | 4184 | 3656 | 7528 | 4015 | 3513

R² | 0.421 | 0.419 | 0.480 | 0.428 | 0.424 | 0.485 | 0.435

Note: All regressions are OLS Difference-in-Difference specification with province level times fixed effects, control for eligibility characteristics times province fixed effects and gender. Column 1 and 2 control for sex of the first child, includes only those that are married and had their first child before 2003. Clustered standard errors on province X urban level in parenthesis. Column 7 includes only those that are predicted to not have a second child when not eligible based on the random forest specification, column 8 those that are predicted to have a second child when not eligible. Significance levels: * 0.10; ** 0.05; *** 0.01 Data source: China Family Panel Survey 2010.

Table 10: Sex ratio and eligibility.
Table 11: Effect of eligibility on age at marriage and age at first birth.

<table>
<thead>
<tr>
<th>Cohort (years they turned 16)</th>
<th>Age at marriage</th>
<th>Age at first birth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nb children allowed at age 22</td>
<td>-0.618 (0.397)</td>
<td>-0.732* (0.419)</td>
</tr>
<tr>
<td>Nb children allowed at age 25</td>
<td>0.212 (0.276)</td>
<td>0.635*** (0.236)</td>
</tr>
<tr>
<td>Female X Nb children allowed at age 22</td>
<td>0.212 (0.276)</td>
<td>0.635*** (0.236)</td>
</tr>
<tr>
<td>Female X Nb children allowed at age 25</td>
<td>0.314 (0.196)</td>
<td>0.602** (0.243)</td>
</tr>
<tr>
<td>Female dummy; Education</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Eligibility controls</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Province FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Eligibility controls x Province FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FE x Province FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Eligibility controls x Year FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Female x Year FE,Province FE &amp; Education</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Observations</td>
<td>8703</td>
<td>8703</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.237</td>
<td>0.237</td>
</tr>
</tbody>
</table>

Note: Sample includes individuals that turned 22 between 1990 and 2000 for columns 1 to 3 and individuals that turned 25 between 1990 and 2000 for columns 4 to 6. OLS regression with robust standard errors in parenthesis.

Data source: China Family Panel Survey 2010.
### Table 12: Effect of the second child policy on educational expenditure.

<table>
<thead>
<tr>
<th>Cohort (years they turn 16)</th>
<th>Dependent variable: Log(expenses on education)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indicator: Having a second child</td>
<td>1.020***</td>
</tr>
<tr>
<td></td>
<td>(0.0876)</td>
</tr>
</tbody>
</table>

Eligibility Controls: Yes
Additional Controls: Yes
Province FE: Yes
Year FE: Yes
Province FE x Eligibility controls: No
Province FE x Year FE: No
Year FE x Eligibility controls: No
Observations: 8471
R²: 0.112

Note: Sample includes individuals that turned 16 between 1980 and 1995. Robust standard errors in parenthesis. Additional controls: Sex, educational level, educational level of spouse, age at marriage, age at first birth, house ownership, number of adults in the household, if partner has a job, sex of the first child.

### Table 13: Effect of a second child on parental working hours.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Women: Log working hours</td>
<td>OLS (1)</td>
<td>OLS (2)</td>
<td>IV (3)</td>
<td>OLS (4)</td>
<td>OLS (5)</td>
<td>IV (6)</td>
</tr>
<tr>
<td>Men: Log working hours</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Eligibility Controls: Yes
Additional Controls: Yes
Province FE: Yes
Year FE: Yes
Province FE x Eligibility controls: No
Province FE x Year FE: No
Year FE x Eligibility controls: No
Observations: 8471
R²: 0.112

Note: Sample includes individuals that turned 16 between 1980 and 1995. Robust standard errors in parenthesis. Additional controls: Sex, educational level, educational level of spouse, age at marriage, age at first birth, house ownership, number of adults in the household, if partner has a job, sex of the first child.

Data source: China Family Panel Survey 2010.
### Table 14: Effect of the second child policy on household balance.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Indicator: Having 2nd child</td>
<td>-0.00313 (0.00636)</td>
<td>0.000427 (0.0240)</td>
<td>0.0218 (0.0221)</td>
</tr>
<tr>
<td>Nb of individual’s grandparents living somewhere else</td>
<td>0.0105*** (0.00353)</td>
<td>0.0113*** (0.00373)</td>
<td>0.0321*** (0.0116)</td>
</tr>
<tr>
<td>Indicator: Having 2nd child X</td>
<td>-0.000790 (0.00514)</td>
<td>-0.00209 (0.00497)</td>
<td>-0.0450** (0.0204)</td>
</tr>
<tr>
<td>Eligibility Controls</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Additional Controls</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Province FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Province FE X Eligibility controls</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Province FE x Year FE</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Year FE x Eligibility controls</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Observations</td>
<td>8104</td>
<td>8104</td>
<td>8104</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.028</td>
<td>0.076</td>
<td>0.021</td>
</tr>
</tbody>
</table>

Note: Sample includes the individuals that turned 16 between 1980 and 1995. Robust standard errors in parenthesis. Additional controls: Sex, educational level, educational level of spouse, age at marriage, age at first birth, house ownership, number of adults in the household, if partner has a job, sex of the first child. In column 3: First stage run by logit regression, 1. instrument: number of children allowed at age 30 adjusted for sex of first child, first stage run by logit regression: T-stat: 5.62; Chi2-stat: 31.64; 2.instrument: Nb of individual’s grandparents living somewhere else x nb of children allowed at age 30 adjusted for sex of first child), first stage run by OLS: T-stat: 8.42; F-stat: 70.91. Data source: China Family Panel Survey 2010.
9.3 Model appendix

9.3.1 The effect of another child on optimal education

Child care generally is time-intensive and parents might forgo earnings because they have to reduce working hours. Let us use the example income generation function from the model section:  
\[ Y(I, n) = (T - \delta n)P(I), \]
where \(T\) is the maximum working hours and for every child the parents has to spend \(\delta\) hours on child care. Each working hour is remunerated with \(P(I)\) which is a function of human capital. So parents that have one more child, have a reduction in income:

\[
\frac{\partial Y(I, n)}{n} = -\delta P(I) \tag{28}
\]

We can see that given the example income generation function, the cost of having to care for a child is a function of human capital. Looking at the optimal educational level (disregarding penalties for the second child):

\[
u'(Y(I^*, n) - \mu f(n)) \left[ \frac{\partial Y(I^*, n)}{\partial I^*} \right] = \frac{s}{\delta} u'(Y - sI^*) \tag{29}\]

We now look at how the optimal educational level changes with \(n\):

\[
u''[Y(I^*, n) - \mu f(n)] \left[ \frac{\partial Y(I^*, n)}{\partial n} \right] - \mu f'(n) \frac{\partial Y(I^*, n)}{\partial I^*} + u'(Y(I^*, n) - \mu f(n)) \frac{\partial^2 Y(I^*, n)}{\partial I^* \partial n} \tag{30}\]

We see that the first part is positive: \(u''()\) is negative; \(\frac{\partial Y(I^*, n)}{\partial n}\) is negative, as well as \(-\mu f'(n)\) while \(\frac{\partial Y(I^*, n)}{\partial I^*}\) is positive. This is the (negative) income effect: The cost of raising children directly though \(f(n)\) as well as indirectly through the forgone income \(\frac{\partial Y(I^*, n)}{\partial n}\) decrease income available for consumption and thereby increase the marginal utility of additional earning.

The sign of the second part depends on the sign of \(\frac{\partial^2 Y(I^*, n)}{\partial I^* \partial n}\). Using our income generation function from before:

\[
\frac{\partial^2 Y(I^*, n)}{\partial I^* \partial n} = -\delta P'(I) \tag{31}\]

Since hourly wage/productivity is increasing in human capital, returns to education decrease in the
number of children. The less time the individual can spend working, the less payoff the individual received from investment in education. This is the (negative) substitution effect: reducing working hours due to children decreases the payoffs of educational investment.

The overall effect is positive when the income effect is larger than the substitution effect:

$$u''(Y(I^*, n)) - \mu f(n) \left[ \frac{\partial Y(I^*, n)}{\partial n} - \mu f(n) \right] > -u'(Y(I^*, n)) - \mu f(n) \frac{\partial^2 Y(I^*, n)}{\partial I^* \partial n}$$  (32)

The likelihood of the overall effect being positive is increasing in the cost of raising children $f(n)$. In order to investigate the effect of working time reduction, we assume now that the forgone earnings are the only cost of having children (ignoring $f(n)$):

$$u''(Y(I^*, n)) \frac{\partial Y(I^*, n)}{\partial n} \frac{\partial Y(I^*, n)}{\partial I^*} > -u'(Y(I^*, n)) \frac{\partial^2 Y(I^*, n)}{\partial I^* \partial n}$$  (33)

Using our example income generation function:

$$u''(Y(I^*, n))(-\delta P(I^*))(-T - \delta n) > -u'(Y(I^*, n))(-\delta P'(I^*))$$  (34)

$$-u''(Y(I^*, n))P(I^*)(-T - \delta n) > u'(Y(I^*, n))$$  (35)

$$\frac{-u''(Y(I^*, n))}{u'(Y(I^*, n))} > \frac{1}{Y(I^*, n)}$$  (36)

On the left hand side we have the degree of risk aversion (or the concavity of the utility function). The likelihood that the overall effect is positive increases in the degree of risk aversion and in the individual’s income.

$$\frac{-u''((T - \delta n)P(I^*))}{u'((T - \delta n)P(I^*))} > \frac{1}{(T - \delta n)P(I^*)}$$  (37)
We use a CARA utility function with $a$ being the coefficient of constant absolute risk aversion:

$$a > \frac{1}{(T - \delta n)P(I)}$$  \hspace{1cm} (38)

$$a(T - \delta n)P(I) > 1$$  \hspace{1cm} (39)

$$\delta < \frac{T - 1/(P(I)a)}{n}$$  \hspace{1cm} (40)

The smaller the time loss due to children, the smaller the likelihood that the substitution effect will dominate the income effect and that the overall effect is negative.

### 9.4 Gender Difference and Marriage Markets

The first order condition for equation 22:

$$ \frac{\partial \omega(I^*, \tau)}{\partial I^*} \left( u'(c_m^2) \left[ \frac{\partial y(I^*)}{\partial I^*} + \frac{\partial y(J(I^*), n)}{\partial I^*} \sigma - \frac{\partial p(I, n, Z)}{\partial I^*} \right] + \alpha h(n) \right) + u'(c_s^2) \frac{\partial \tilde{y}(I^*)}{\partial I^*} \left( 1 - \frac{\partial \omega(I^*, \tau)}{\partial I^*} \right) \right) = \eta \frac{\delta}{\delta} u'(c^1) $$  \hspace{1cm} (41)