Fertility Change and Household Savings in China: Evidence from a General Equilibrium Model and Micro Data*

(Preliminary)

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Abstract

This study investigates the relationship between fertility and household savings in partial and general equilibrium using data from urban China. First, we document that parents rely on children for support when old and that an increase in fertility causes a reduction in household savings. Second, we construct an OLG model with partial equilibrium results that match the findings. Then, we show that under standard assumptions, GE forces can be offsetting such that partial equilibrium analysis is likely to overstate the effect of a change in aggregate fertility on aggregate households savings.

Keywords: Savings, Demographic Structure, Fertility

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1 Introduction

One of the most striking macroeconomic facts have been the very high savings rates in China. It has been a key factor in China's remarkable growth story, but has also been blamed by some for destabilizing the global economy. Several recent studies have attempted to explain why personal savings rates in particular have been so high. A major strand of this literature is motivated from the observation that high savings rates emerged during a period of major fertility transition that were largely a result of draconian government policies. These studies then provide explanations of how an exogenous reduction in fertility can increase household savings rates. The simplest version of the argument is as follows: in China, people rely on their children to take care of them in old age, and when, as result of the One Child Policy, they could not be sure that they would have enough support in old age, they started to save more. Choukhmane, Coeurdacier and Jin (2013), Ge, Yang and Zhang (2012) and finally, Banerjee, Meng and Qian (2011), which this paper builds on and supersedes, all use natural experiments from China to estimate the effect of an exogenous change in fertility on household savings rate and find a strong and significant negative effect of more children on savings. This is also the conclusion of Curtis, Lugauer and Mark (2011), which calibrates a partial equilibrium OLG model with transfers from children to parents using Chinese demographic and economic data and demonstrate that they can explain all of the changes in saving rates through the fertility transition.

The point of departure of this paper is the observation that this evidence, while important in showing that fertility decisions are indeed closely tied to savings decisions, as suggested for example by Becker (1981), Boldrin and Jones (2002), is incomplete because it does not take into account the effect of the aggregate fertility shift on the time path of wages and prices, which in turn feeds back on savings.Indeed, Curtis et al. (2011) explicitly rules out this source of influence, while the three micro empirical papers cited above all look at the effects of relatively small shifts from an overall trend which can be reasonably assumed to have no price effects.[1] The primary aim of this paper is to ask whether this assumption makes a significant difference to the conclusions we draw.

To get at this, the paper starts by showing that the micro data strongly supports a causal connection between fertility and savings. Using data from a natural experiment that exploits the first introduction of strict family planning policies in urban China (from the early 1970s), we show that families that had one extra child for exogenous reasons, end up, in late middle age, having average savings that is 14,122 RMB lower on a base of 112,253 RMB.[2] The difference is highly significant. The fact this is the effect of reduced old age support is confirmed by a two other pieces of evidence. In addition, we find that those who have one more child are more likely to be retired after controlling for age and age-squared. People who have fewer children seem to be working longer to compensate and therefore earn more.

As we will discuss in greater detail below, there was no sex-selection in our context. Thus, we can treat the gender of the child as exogenous and study its effect on the savings of the parents. We find that the number of children matters essentially only when the eldest is a girl. For example, if the first child is a daughter, having one more child reduces savings by 18,570 RMB on average. In contrast, when the eldest is a boy, having an additional child reduces savings by only 7,518 RMB and the estimate is statistically indistinguishable from zero. This is consistent with both sociological studies of China that emphasize the role of the oldest male child in taking care of parents and survey evidence that disproportionate amounts of care for older parents are delivered by sons.

Motivated by these facts, we construct a parsimonious Diamond-style OLG model with two additional features: parents anticipate transfers from children when making savings decisions and fertility depends on anticipated future transfers from children. In our model,

[1] To be clear, the one-child policy was a massive shift, but the identification of its effects in quasi-experimental studies come from local variation in its implementation. Similarly, Choukhmane et al. (2013) uses variation across households in the occurrence of twins to empirical identify the effect of family size on savings.

[2] The base is the constant estimated from equation (1). It is not reported in the tables.

fertility affects savings through two channels: the consumption/expenditure channel and the transfer channel. In partial equilibrium, increased fertility increases consumption and increases anticipated transfers, both of which will cause parents to reduce savings. In general equilibrium, the consumption channel effects are similar, but the transfer channel differs in that an increased in aggregate fertility will increase the labor-capital ratio in the economy, which will increase interest rates, reduce the value of future transfers, and therefore, increase savings today. In motivating the interest rate channel, we note that while bank interest rates are low and change little over time, but the prices of housing, which is the most significant portion of urban household wealth today is presumably housing, vary significantly with market conditions. We discuss this more later in the paper.

The results of our simple model show that in partial equilibrium, increased fertility unambiguously reduces savings rates, but in general equilibrium, the effect depends on the relative strength of the forces of the consumption and transfer channels. The empirical findings imply that transfers are important and the consumption channel is unlikely to be only driving force in our context. Thus, to investigate the quantitative importance of the GE forces, we conduct a simple calibration exercise where we pick the parameters (on transfers etc.) to mimic the point estimates from our regression estimates. The calibrated model shows that the GE forces approximately offset the partial equilibrium effects by two-thirds. Thus, allowing for price effects can significantly change our interpretation of the relationship between fertility and savings rates for the Chinese economy as a whole.

We provide several additional results. First, we demonstrate that our results are not sensitive to changes in wage growth. Thus, our findings are not specific to the high wage growth experienced by urban Chinese cohorts that we study. Second, we show that our results are robust to accounting for endogenous human capital investment. Third, we show that our results are robust to endogenizing transfer rates.

We acknowledge that the quantitative magnitudes we report are specific to our data and the functional forms we chose for our parsimonious model; and the empirical estimates should be seen as illustrative due to the data limitations that we describe in the paper. Nevertheless, the insight that GE forces can potentially offset much of the partial equilibrium effects of fertility on savings is generalizable to many contexts. For policy makers, our results imply that the effects of a change in aggregate fertility on household savings could be much smaller than what has been suggested by past studies. For China, this means that relaxing the One Child Policy may lead to quite a quite modest fall in savings.

Our study complements recent attempts to explain Chinese savings rates using a range of other models. Modigliani and Cao (2004) emphasizes the effect of the falling dependency ratio and increasing wage growth rate on savings in a standard life-cycle model. Song and Yang (2010) elaborates on this line of argument and shows compelling evidence that link the spike in aggregate savings, the growth rate and the flattening of experience profiles over time. On the other hand, Chamon and Prasad (2010) argues that financial under-development and the precautionary motive are important contributors to savings. Finally, Wei and Zhang (2011) provides careful empirical evidence showing that savings rates for middle age parents today are partly driven by the anticipation of the need to save to pay "bride prices" for sons in a future where there are many more men than women on the marriage market. As noted earlier, there are a number of recent studies that carefully explore the same fertility-savings channels that we emphasize. These studies use other empirical approaches, but also find evidence for a strong partial equilibrium causal effect of reducing fertility on increasing household savings.

Finally, at a methodological level, we are motivated by the concern expressed by Browning, Hansen and Heckman (1999) that there is often a "discordance between the macro models used in policy evaluation and the microeconomic models used to generate the empirical evidence". The approach of our study embodies the view taken by Banerjee and Duflo (2005) that growth models should build up from well-identified parameters estimated using experimental and quasi-experimental data.

This paper is organized as follows. Section 2 documents transfers from children to elderly retired parents. Section 3 documents the relationship between fertility change and savings. Section 4 presents the model. Section 6 offers concluding remarks.

2 Background: Children as old age security

Children are arguably the most important savings vehicle in China. In urban China, households have historically had few other instruments for savings. Money could be deposited in banks or credit cooperatives or it could be held as cash but these institutions offer very low interest rates. During the 1980s, annual real interest rates for savings deposit ranged from 0.7 to 1%. In the late 1990s, housing became a savings vehicle with the privatization of the urban housing stock. More recently, reforms of financial markets have allowed a small number of urban households to invest in stocks but despite this, in 2007, almost all household savings (other than housing) in urban areas were in bank deposits (He and Cao, 2007).[3]

It is therefore no surprise that the norm in Confucian Chinese society is for parents to invest in children (or specifically in their sons, and in particular the eldest son) with the expectation that they will be taken care of by their children (again mainly sons) in old age. Indeed there is a proverb in China that tells parents to "raise children for old age as one would store up grain against famine" (Delehanty, Ginzler and Pipher, 2008: p. 17).

In this section, we document the continuing relevance of this norm. To document the dependence on children of retired individuals, we use data from the 2008 pilot wave of the *China Health and Retirement Longitudinal Survey* (CHARLS). This is a household-level survey of the elderly.[4] The CHARLS data reports whether these elderly parents cohabit with adult children and for non-cohabitating households, it reports transfers in and out. From the latter, we calculate the total amount of net transfers.

Table 1 Panel A reports the financial support that elderly parents (e.g. the household head is 65 or older) receive from children. It shows that parents with more children receive

[3] According to the 2002 round of the China Household Income Project (CHIP), average urban households hold approximately 10% of their total savings in stocks and bonds.

[4] We cannot restrict it to urban households due to the small sample size.

higher amounts of net regular transfers and net total transfers. The probability of any transfer in is also higher when parents have more children. When we divide households according to whether the first child is a son or daughter, we see that parents receive much more when their first child is a sons.

In Panel B, we examine support from the perspective of adult children under the age of 65. This provides additional information since the CHARLS surveys household heads such that parents and adult children of the same household are rarely both in the survey. We find that sons given much more than daughters. When we only examine the oldest child in Panel C, we find that the difference between sons and daughters in how much they give their parents is even bigger for this group.

Table 2 examines cohabitation patterns. Panel A shows that for households where the household head is age 65 or older, the probability of living with an adult child increases from 40% for household with one child to 54% or 53% for households with two or more children. In Panel B, we examine cohabitation from the perspective of adult children age 40-64. A striking pattern emerges. 22% of adult sons live with elderly parents, while only 3% of adult daughters live with elderly parents. The difference is similar when we restrict the sample to the oldest child in Panel C. Note that that higher cohabitation rates for parents in Panel A than for children in Panels B and C is due to the fact that each parent has several children.

We investigate with the possibility that cohabitation is not children supporting parents but the other way around, we examine the correlations between the probability of cohabitation and the parents' health status. Parents that report to be in poor health cohabitate more often with their children: 58% of parents in poor health[5] live with and adult son, as compared to 48% of parents who are in fair or good health. Sinceillness presumably reduces elderly parents' ability to provide financial transfers to children or provide them with childcare help, cohabit in our context is likely to reflect transfers from children to parents.

In summary, the descriptive statistics from the CHARLS data are consistent with con-

[5]Approximately one third of the household respond that their health status is poor.

ventional wisdom that children are important for old-age support in China, and in particular, sons are important.

3 The Effects of Family Planning

3.1 Historical background

Between 1949 and 1971, China implemented a pro-fertility policy with the encouragement of Mao Zedong who believed that China's main economic and military resources was labor.[6] This changed drastically in 1971, when Mao Zedong, following Zhou Enlai, announced that "population must be controlled", which signaled a turning point in family planning policy practice in China.[7] Efforts began in earnest in 1972. On January 17, 1972, provincial leaders attended a meeting organized by the Ministry of Public Health where the central government demanded that local governments publicize and enforce Mao's instructions on family planning, and instructed all levels of government to establish or reinforce their bureaucracies for organizing or implementing family planning related tasks. In May of that year, the Ministry of Public Health organized a national workshop on family planning measures where all provinces had to participate. These measures stated and clarified the shift in family planning policy and energized the bureaucracy. In another mandatory meeting for all provincial leaders on November 1, 1972, it was agreed that family planning should be introduced across urban areas within that year, 23 provinces had established the necessary bureaucracies for implementing family planning related policies.[8] Initially, family planning policies encouraged

[6] For example, contraceptives were not available to parents who had fewer than four children during this period.

[7] On Feb. 15th, 1971, Zhou Enlai re-emphasized the importance of family planning when meeting with the provincial representatives at the National Planning Conference in Beijing: "It's important to control population growth. Government should advocate late marriages and birth control, and vigorously publicize these policies from now on. On July 8th, the State Council published "the Report on Doing Well in Family Planning". The written instruction by the State Council on the document pointed out that "Family planning is an important issue that Chairman Mao has advocated for years. All levels of officially must treat the issue seriously."

[8] The details of family planning policy history public information and documented (in Chinese) by the China Population Information Network (POPIN), a branch of the China Population Development and Re-

birth spacing of three to four years. However, in 1980 (1979 in Shanghai), the government, took the unanticipated and unprecedented move of implementing a strict One Child Policy in urban areas.[9] Many parents who had one child and were waiting to have more children found that they could not do that.

For our empirical analysis, it is important to note that the introduction of family planning policies to restrict fertility was unanticipated. While there were discussions amongst the highest ranking leadership about whether the government should encourage or discourage fertility, the public policy until 1971 was always to encourage fertility. It is thus highly unlikely that those outside of these circles anticipated the policy shift in 1971.

3.2 Estimating the Effect of Fertility on Life Cycle Outcomes

We aim to estimate the causal effect of fertility on life cycle outcomes. This will follow from two reduced form relationships: i) family planning reduced fertility; ii) family planning increased savings. The two sets of estimates will allows us to approximate the structural parameter for the effect of an exogenous chance in fertility on savings.

Since parents traditionally rely on sons more than daughters, "fertility" from the perspective of parents thinking about future transfers is some weighted sum of children, where daughters receive less weight than sons. As we do not know how to assign to these weights, we simply treat daughter and sons separately. Thus, we estimate the following reduced-form equation

$$y_{ij} = \delta p_{ij} + \alpha m_{ij} + \zeta(p_{ij} \times m_{ij}) + \Delta X_{ij} + \theta_j + \varepsilon_{ij}. \qquad (1)$$

search Center (CPDRC or CPIRC). See http://www.cpirc.org.cn/yjwx/yjwx_detail.asp?id=308.

[9] For example, one of the first programs that was implemented was the "late, thin and few" policy. Couples were encouraged to have children later in life, have only one child (or at most two children), and have at least three or four years in between births. A more stringent version of family planning, known as the One Child Policy (OCP), was introduced in 1979/80. This punished households that had more than one child with fines, job loss, and the loss of access to public goods, and rewarded those with only one child with bonuses. Family planning polices also became better defined over time. For example, in 1978, the state defined details on things such as what counted as late marriages and the bonuses and subsidies for workers and farmers if they go through sterilizing operations, etc. See "The Report on the State Councils Family Planning Groups First Meeting"(1978). Also see Qian (2008) for a summary of family planning policies.

y_{ij}, for household i living in region j that had their first child in year t, represents outcomes like the total number of children, savings, income etc. We specify that it is a function of: a dummy variable for whether the first child was born after 1972, p_{ij}; a dummy for whether the first child is male, m_{ij}; the interaction term between p_{ij} and m_{ij}; a vector of household-level controls, X_{ijt}; region fixed effects, γ_i; and a household-specific error term, ε_{ij}. We estimate robust standard errors for all of our results. δ is the effect of having a first child in 1972 or afterwards for households that have a daughter for the first child. $\delta + \zeta$ is the effect of having a first child in 1972 or afterwards for households that have a son for the first child.

The hypotheses we are testing are standard, given the idea that children, especially the male first child, play a key role in providing old age support to parents. The claim that having one's first child during or after 1972 decreased total fertility both when the first child is female and when he is male, translates into a test for whether both $\hat{\delta} < 0$ and $\widehat{\delta + \zeta} < 0$. Similarly, the claim that parents rely more on sons than daughters for old-age support, and therefore parents who gave birth after 1972 and had the first male child need to save less and can retire earlier compared to parents who gave birth after 1972 and have a daughter as a first child would imply $\hat{\zeta} < 0$ in the savings and retirement equations. The vector X_i includes household-specific controls that we will discuss and motivate later as they become relevant.

To assess the implied magnitudes of the relationship between fertility and savings, we estimate an instrumental variables specification.

$$y_{ij} = \delta n_{ij} + \alpha m_{ij} + \zeta(n_{ij} \times m_{ij}) + \Delta X_{ij} + \theta_j + \varepsilon_{ij}. \tag{2}$$

Here $n_{ij}$is the number of children the family eventually had. It is instrumented by whether the first child is born after 1972, .p_{ij}. The interaction of the number of children and whether the first child is male is instrumented with the interaction of whether the first child is born after 1972 and whether he is male, $p_{ij} \times m_{ij}$. Under the assumption that the only thing that changed in 1972 for this population was the number of children they could have, the second stage estimate of $\hat{\delta}$ is the effect of having an additional child on savings if the first child is a daughter, and $\widehat{\delta+\zeta}$ is the effect if the first child is a son.[10]

There are several important facts to keep in mind for our empirical analysis. First, the policies for population control gradually tightened over time. This means that the effect of family planning policies on total fertility is not uniform across households that have their first child after 1972; the later they have their first child, the fewer children they will have. This does not affect the validity of our strategy, but is important for keeping in mind when interpreting the magnitude of the estimates as the average post-reform effect. Second, family planning policy is relatively uniform across urban areas (e.g., Ebenstein, 2010; Qian, 2009) and there are relatively few ethnic minority households (who are subject to different rules in most Chinese cities). In any case, variation across cities does not affect the validity of our empirical strategy, which estimates the average change after 1972.

Finally, note that there is little female infanticide in urban China at this time: the ability to conduct pre-natal sex-selection only became prevalent in the 1980s with the introduction of Ultrasound B machines. To avoid the confounding influences of sex-selection, we restrict our sample to households that had their first child during the late 1960s and 1970s, before sex-selective abortion was available. For this reason, we also avoid examining the influences of the second child, some of which were born after sex-selection technologies became available. It is important to note that in our data, there is no evidence of sex-selection. 49.8% of all children are male. Thus, we interpret the sex of children born in the 1970s as exogenous. Note that we do not interpret the sex of higher parity births as exogenous since some of them are born in the 1980s, when sex selection technology became widely available.

There are two important caveats to our strategy. First, households in the control group (e.g., those that have their first child prior to 1972) will on average be older than those in the treatment group (e.g., those that have their first child after 1972), which can affect savings

[10] We interpret the 2SLS estimates as merely illustrative. It is possible, for example, that even if the actual number of children were unaffected, the option of having another child later in life might have independent effects.

patterns if parents of the two groups are at different parts in their life cycle. One way to address this is to control for the age of the household head. However, while this controls for age, it can introduce selection bias if parents choose fertility timing based on factors that are correlated with savings later in life. This leads to the second difficulty. For example, parents that have children later in life may be more risk adverse, which will, in turn, cause them to save more. To investigate this possibility, we directly examine the correlation between age at first birth and savings, controlling for the same baseline controls. We find no correlation. We will discuss this in further when we interpret the results.

Another potential and related concern is that parents anticipated the policy shift in 1971 and those who desired more children chose to have children prior to 1971, and the preference for more children is correlated with low savings through channels other than fertility. We believe that this is highly unlikely. As we discussed earlier, the Chinese government aggressively pursued a pro-fertility policy until 1971, despite a secular decline in the demand for children (in urban areas especially). Thus is it is highly unlikely that parents anticipated the shift. At the same time, the same concern motivates us to exploit the variation in family size caused by the first shift in policy, and use the introduction of the more stringent One Child Policy in 1979/80 (it is more likely to have been anticipated).

3.3 Data

For this analysis, we use the urban household portion of the a larger unique survey called the 2008 *Rural-Urban Migration in China* (RUMiC). The main advantage of our survey over other data is that it allows us to measure both the total number of children ever born and savings rate for a sufficient number of households for empirical analysis. Until very recently, this was the only data that contained such information.[11] In this paper, we only

[11] There are several household level surveys from China. The UHIES (1988 -) surveys contain high quality income and expenditure data, but do not report total fertility. The China Health and Nutritional Surveys (CHNS) urban sample is small. The China Household Income Project (CHIP) does not report complete fertility and has a very small urban sample. The CHARLS survey contains similar information to our survey and in addition, report transfers. We use the pilot survey from 2008 for our descriptive statistics. However,

use the urban data because family planning policies and access to savings instruments were relatively uniform in urban areas, and equally importantly, because there was little sex-selection. RUMiC asks respondents detailed questions about all of the children ever born to the household. The income and expenditure data in RUMiC are recorded directly from the *Annual Urban Household Income and Expenditure Survey* (UHIES), which is conducted by the National Bureau of Statistics. See the Data Appendix for more details about the RUMiC survey and the UHS.

In our data, total household income is the sum of wage income, business income, property income, transfer income from pension and retirement allowances, social welfare benefits. Total expenditure is the sum of consumption expenditure (e.g. food; clothing; housing; family equipment; service; health; transpirations and communication; education; cultural and entertainment; other commodity and services), business expenditure, property expenditure, transfer expenditure and social security expenditure (e.g. individually paid pension fund, individually paid public housing fund individually paid health care fund, individually paid unemployment fund, and other social security).[12]

Our main outcomes of interest are measures of savings, which we measure in the standard manner as the difference between total income and total expenditure, $Y - E$, and savings rates which is savings divided by total income, $\frac{Y-E}{Y}$. We will also look at the impact on income.

The data is organized as a household-level birth cohort panel according to the birth year of the first child. The empirical analysis focuses on households that had their first child five years before or after the policy shift in 1972, i.e., 1967-77. This restriction excludes households that have no children. This makes little difference to our data as almost all couples in the comparable age range are married and have at least one child. The length of

the larger sample from the first full wave is still being cleaned and is not ready for use. The sample size for our analysis (once we restrict the sample to urban households that had their first child close before or after the initial family planning policy) is similar to what it would be if we were to use the full CHARLS sample.

[12]Food expenditure is the sum of expenditure on the following categories: grain, wheat, and rice coarse grains; dried vegetables pork, beef, and mutton; edible vegetable oil, fresh vegetables, dried vegetables, poultry, meat, eggs, fish; sugar, cigarettes, liquor, fruit, wine, beer, fresh melons and fruits cake; and milk.

the window is arbitrarily chosen to be symmetric around the year of the reform.Our sample is restricted to individuals age 50 to 65 in 2008. We choose this age range because we are interested in the period in which households save for retirement based on the expectation of future transfers. Thus, they should not be so old that they are already relying on transfers. We choose a narrow age band so that the individuals are likely to be on the same part of the life-cycle and therefore comparable to each other. For example, much younger parents will have children at home and high expenditures that partly reflect investments in children's future earnings.

Note that this differs from the sample we use in the previous section to document transfers from adult children to elderly retired parents who are *age 65 or older*. The final sample contains 475 households in eighteen cities. We discuss the means as they become relevant.

3.4 Results

The Effects of Family Planning on Fertility Table 3 presents the estimated effects of the introduction family planning on fertility. Column (1) shows a specification that only controls for city fixed effects. The estimates show that parents that gave birth to their first child in 1972 or afterwards had 0.6 fewer children on average. This is consistent with our priors, which we discussed in Section 3. In column (2), we control for whether the first child is a son. It shows that parents have a son as the first child has on average 0.2 children fewer than those that have a daughter as the first child. This is consistent with the fact that parents have son preference such that they are more likely to have additional children if the first is a daughter – i.e., the "stopping rule". In columns (3)-(5), we add controls that we motivate later when we examine savings.[13]

For the examination of fertility, the added controls make little difference though the estimated effect under our preferred specification in column (4) is slightly larger (-0.812). We discuss why this is our preferred specification when we present the results on savings.

[13] In our data, on average, boys come from households with 1.7 children, while girls come from households with two children.

The fact that the average number of children for the sample is 1.88 (shown at the top of the table) and that the reform reduced the number by approximately 0.6 to 0.8 is consistent with the fact that the initial family planning policy reduced the number of total children from slightly more than two to slightly less than two.

In column (6), we estimate equation (1) where we add controls for whether the first child is a son and the interaction of that term with whether the first child was born after 1972. The coefficient for whether a child was born after 1972 reflects the effect on households that have daughters for a first child. The sum of this coefficient and the interaction of whether the first child is a son reflects the effect on households that have a son as a first child. This sum and its p-value are shown at the bottom of the table. We begin by only controlling for city fixed effects. Then in columns (7)-(9), we add the same controls as in columns (3)-(5). We focus our discussion on our preferred specification in column (8).

In column (8), the estimate for the uninteracted post-1972 term shows that parents who had their first daughter after 1972 had approximately 0.75 less child. The sum of the uninteracted post-1972 term and its interaction with the first child being a son is also negative, but it is smaller in magnitude than the uninteracted term (-0.338). This means that parents who had their first son after 1972 were also likely to have had fewer children but the reduction in the number of children was smaller in magnitude than for parents that had a first daughter. This is driven by the fact that when they had a choice, i.e before 1972, many parents stopped having children once they have a son with the result that males have on average fewer siblings than females. As before, this can be seen from the negative coefficient for the uninteracted dummy variable for whether the first child is a son. All of the coefficients discussed here are statistically significant at the 1% level. The results in Table 3 are confirm that the introduction of family planning reduced total fertility and that there is a prejudice in favor of sons.

The Effect of Family Planning on Savings Next, we examine the effect of the introduction of family planning on savings. We estimate the same regressions as before, except that we replace the dependent variable with household savings rates. Table 4 shows the reduced form results. Columns (1)-(4) examine the effect of having the first child after 1972. We begin by having only city fixed effects as controls in column (1), and then add controls for the education of the household head and its squared term, which can influence savings behavior (as well as income levels or consumption behavior). In column (3), we introduce controls for the age of the household head and its squared term to control for the fact that savings behavior differs across ages in a non-linear way. This is our "baseline" set of controls. We discuss the additional controls in column (4) later.

The estimates in column (1) show that, on average, parents that had their first child after 1972 save 6,175 RMB more. This is a third of the average household savings in our sample, which is 17,162 RMB (shown at the top of the table). In columns (2)-(3), the estimates are very similar. All of the estimates are statistically significant at the 1% level.

In columns (5)-(8), we introduce controls for the sex of the first child and its interaction with whether the first child is born after 1972 and estimate equation (1). As before, we begin with only city fixed effects as controls and gradually add controls for the educational attainment and age of the household head. Column (7) is the baseline equation. We will discuss the estimates in column (8) later. The estimates are similar across specifications. We focus our discussion on our preferred specification in column (7). The uninteracted coefficient for post-1972 shows that the effect of stricter family size restrictions comes almost entirely from households whose first child was female. The estimated effect is 14,361 RMB and is statistically significant at the 1% level. The post-1972 effect is almost entirely canceled by the interaction of the post-1972 effect and a dummy for the first child is male, suggesting that as long as the family has a male oldest child, it does not matter very much how many other children it has. This conforms with the stereotype that in Chinese families the eldest male child is responsible for the parents.

One caveat to the causal interpretation of these results is that parents who chose to have their first child prior to 1972 may save less than parents that chose to have their first child after 1972 for reasons other than the reduction in fertility. This concern is partially mitigated by the fact that our sample comprise of individuals within a relatively narrow age band (age 50 to 65), who are likely to have been similarly affected by economic growth, and the estimates are robust to controlling for so individual characteristics such as education, age and the city of residence.

However, controlling for the age of the household head also introduces a specific type of selection: it raises the question of whether parents that chose to have children at an earlier time in life will save less than parents that chose to have children later in life for reasons other than the difference in total fertility. To address this, we drop the two controls for the age of the household head. Columns (6) and (7) shows that the estimates change little and statistically similar between the two specifications. So it is unlikely that are estimates are driven by selection.

One may also be concerned about omitted variables. In particular, we are concerned about factors that could be correlated to whether a child is born after 1972 and savings behavior. To address this, we control for additional variable that we believe to be the most likely to cause concern in our context: We control for whether the head of the household age is under 55 years of age addresses the possibility that being over the "mandatory" retirement age increases unemployment probabilities and savings behavior. We control for the age of the youngest child addresses the possibility that having a young child will increase consumption and affect savings. We also control for the dummy variable for whether the youngest child is under 22 years of age to address this point. Finally, we control for whether the mother is the household head in case this variable reflects intrahousehold bargaining power and thereby, savings behavior. Columns (4) and (8) show that adding this set of controls does not change our estimates.

In addition to the results presented here, we also conduct a placebo experiment where we directly examine the effect of the age at first birth on savings rates and/or the age at first birth interacted with whether the first child is a son on savings rates. We find no effect. These estimates are available on an Online Appendix.

The Implied Effect of Fertility on Savings The results in Tables (3) and (4) show that the introduction of family planning reduced fertility and increased savings. Together, this is consistent with a reduction in fertility increasing savings rates. To estimate the effect of fertility on savings, we need to assume that the entire effect of the policy goes through the total number of children (rather than the probability of their being at least one male child, for example). In Table 5, we report the instrumental variables estimates. As expected, the instrumented estimates are roughly similar in magnitude to the reduced form estimate. Column (1) shows that an additional child reduces savings rates by approximately 14,122 on average. Given that average household savings is approximately 17,162 MRB, this is economically significant. Column (2) controls for whether the first child is a male.

In column (3), we estimate equation 2. The uninteracted estimate of the number of children shows that for households that have a daughter, an additional child reduces savings by approximately 18,570 RMB. This is statistically significant at the 1% level. The sum of the uninteracted coefficient and the interaction coefficient with whether the first child is a male is presented at the bottome of the table. It is negative in sign, but small in magnitude (-7,518 RMB) and statistically insignificant. As before, this shows that the effects of fertility on savings is mostly driven by those that had daughters as their first child.

The Effect of Fertility on Earnings Table 6 reports the instrumented second stage effect of fertility on earnings. This is the same as equation 2, except that the dependent variable is income. Column (1) shows that an additional child reduces income by 11,238 RMB for households with first daughters. It is statistically significant at the 1% level. The sum of the interaction effect with whether the first child is a son and the uninteracted effect at the bottom of the table is negative, but small in magnitude and statistically insignificant, which shows that this is mostly driven by those with first daughters. In column (2), we examine only wage income and show that the negative effect of fertility on income for those with first-born daughters is driven by a reduction in wage income (it is almost statistically significant). In column (8), we examine a dummy for whether the household head earns any labor income. The uninteracted term is negative, but statistically insignificant. The interaction term with whether the first child is male is negative and statistically significant at the 1% level. These estimates show that parents with more children are more likely to have retired, especially if they have a son as the first child. Together with the results on income, they imply that parents with more children earn less because they are less likely to work, which is also consistent with the theory that they look to their children for old age support.

The Effect of Fertility on the Savings Rate While we recognize that fertility affects many aspects of people's lives for the purpose of calibrating our model it is convenient to have one variable that summarizes (no doubt imperfectly) the effect. For this purpose, we focus on the savings rate. Since we wish to compare these results with a model where what changes is the number of children, we focus on the instrumental variables estimate. These are reported in Table 6. They are less precisely estimated than the results on savings and should be interpreted cautiously as illustrative. Column (4) suggests that each child reduces savings rate by eleven percentage-points on average. (Note that in the model that we present later, parents will base savings on future transfers, which is a function of the weighted sum of children, where sons receive higher weights than daughters. Thus, we focus on the effect of fertility on savings rates average across all households).

Additional Results In inferring the stock of savings from the savings rate in one year, we must assume that the two are positively correlated. For example, our interpretation would be misleading if parents that had their first child prior to 1972 accumulated more assets than parents that had their first child after 1972 and therefore had stopped saving. We do not have data on savings deposits, but can investigate this possibility imperfectly by examining several other variables. First, we can examine interest earnings, which presumably increases with total bank savings and asset ownership. Similarly, we can observe rental income (from real estate). This could be significant since almost 85% of urban household wealth in China today is in real estate. Table 6 column (5) shows that fertility is unrelated to interest income. In our data, we also observe households own durables such as refrigerators, motorcycles, and cars; and the imputed value of housing. We find no relationship between assets and fertility. Theses results are available upon request.In addition, we can examine age-savings profiles across cohorts using the UHIES urban household survey data to see if the profiles varied across cohorts that were likely to be having children during 1967-77. Using data from 19 cities for the periods of 1988 to 2005, we find little change in the profiles across cohorts. Thus, we conclude that our results are unlikely to be driven by the differential life-cycle patterns in savings across cohorts.

In addition to the results presented in the paper, we also conduct a placebo experiment to show that our results are not driven by age. When we compare savings rates of households whose household head is between fifty and sixty years of age to those that are between sixty and 65 years of age, we find no difference. Similarly, we show that our estimates are robust to controlling for the sex ratio of the city, which Wei and Zhang (2009) find to be important for determining savings. These results are available on an Online Appendix.

4 Model

4.1 Partial Equilibrium

The empirical findings that parents receive large amounts of transfers from children and that the policy-driven reduction in fertility increases household savings are consistent with parents anticipating more transfers when they have more children. This is also consistent with observation that the probability of elderly individuals living alone when ill is decreasing with the number of children. Thus, an OLG model where parents anticipate transfers from children is a natural way to characterize households savings decisions. We consider a version of the standard Diamond model with two additional features: (i) children transfer a fraction τ of their income to parents, (ii) population growth rate is endogenous to the extent that parents decide to bear children (n_{t+1} children for each individual), paying a linear cost, $\theta A_t w_t$, in time t, in expectations of transfers in time $t+1$. We also introduce a pay-as-you-go social security that is financed through a tax, $\psi A_t w_t$, in time t and pays back $\psi n_{t+1} A_t w_t$ in time $t+1$. We model the one-child policy as a constraint $n \leq 1$.[14] The usual notation applies. We assume log utility, Cobb-Douglas production function, and full depreciation. The household solves the following

$$\max_{c_t^Y, c_{t+1}^O, n_{t+1}} log\left(c_t^Y\right) + \beta log\left(c_{t+1}^O\right)$$

$$s.t.$$

$$c_t^Y + \frac{c_{t+1}^O}{1+r_{t+1}} \leq A_t w_t \left(1 - \tau\left(\tilde{n}_t\right) - \psi - \theta\left(n_{t+1}\right) n_{t+1}\right) + \frac{A_{t+1} w_{t+1}}{1+r_{t+1}} \left(\tau\left(n_{t+1}\right) n_{t+1} + \psi \tilde{n}_{t+1}\right)$$

$$n_{t+1} \leq \chi,$$

where $\chi = 1$ when the one-child policy is effective and $\chi = \infty$ when we relax the one-child policy. $\tilde{n}_{t+1}$ is aggregate fertility, which is taken as given from the perspective of the household.

The first order conditions of the model are

$$c_t^Y = \frac{1}{1+\beta} W_t, \quad (3)$$

$$c_{t+1}^O = \frac{\beta\left(1+r_{t+1}\right)}{1+\beta} W_t, \quad (4)$$

[14]Note that technically the one-child policy imposes the constraint $n \leq 0.5$, since it allows 1 child per household, not 1 child per individual. However we use $n \leq 1$ for simplicity, without any loss of generality.

$$(1+r_{t+1})\left(\theta(n_{t+1})+\frac{\partial\theta(n_{t+1})}{\partial n_{t+1}}n_{t+1}\right)=\frac{A_{t+1}w_{t+1}}{A_t w_t}\left(\tau(n_{t+1})+\frac{\partial\tau(n_{t+1})}{\partial n_{t+1}}n_{t+1}\right)-\lambda, \quad (5)$$

where we have defined net wealth as $W_t = A_t w_t (1-\tau-\psi-\theta n_{t+1}) + \frac{A_{t+1}w_{t+1}(\tau n_{t+1}+\psi\tilde{n}_{t+1})}{1+r_{t+1}}$, and λ is a rescaled multiplier on the constraint $n_{t+1}\leq\chi$, which we assume is binding when the one-child is enforced ($\chi=1$), so that $\lambda>0$. We can then calculate the saving rate of the a young household defined as $s_t \equiv \frac{A_t w_t(1-\tau-\psi-\theta n_{t+1})-c_t^Y}{A_t w_t}$, with n_{t+1} children:

$$s_t=\left(\frac{\beta}{1+\beta}\right)\left[(1-\tau(\tilde{n}_t)-\psi-\theta(n_{t+1})n_{t+1})-\frac{(\tau(n_{t+1})n_{t+1}+\psi\tilde{n}_{t+1})}{\beta(1+r_{t+1})}\left(\frac{A_{t+1}w_{t+1}}{A_t w_t}\right)\right]. \quad (6)$$

This equation has two features. First, if we assume that the transfer rate, direct cost of children and social security are all zero, then the savings rate is identical to the Diamond model, $\left(\frac{\beta}{1+\beta}\right)$, and does not depend on the interest rate. This is due to the fact that, with log utility, substitution and income effects perfectly offset each other[15]. Second, the effect of total transfers from children, $\tau(n_{t+1})n_{t+1}$, on the saving rate is discounted by the interest rate. The interest rate does not directly affect the saving rate, due to the assumption of log utility, but does change the value of transfers from children: a high interest rate increases the relative returns of alternative savings vehicles and makes children relatively less valuable assets.

We can then calculate the effect of an additional child on the saving rate. This is given by

$$\frac{\partial s_t}{\partial n_{t+1}}=-\left(\frac{\beta}{1+\beta}\right)\left(\left(\theta(n_{t+1})+\frac{\partial\theta(n_{t+1})}{\partial n_{t+1}}n_{t+1}\right)+\left(\frac{\tau(n_{t+1})+\frac{\partial\tau(n_{t+1})}{\partial n_{t+1}}n_{t+1}}{\beta(1+r_{t+1})}\right)\left(\frac{A_{t+1}w_{t+1}}{A_t w_t}\right)\right). \quad (7)$$

This derivative is what we estimated in the data. It is the effect of an exogenously given extra child for the saving rate of a household that faces otherwise identical economic conditions. It is therefore the partial equilibrium effect of an extra child on saving rate.

[15] We use log utility in order to abstract from any direct effect of the interest rate on savings, and isolate the role that the interest rate has through transfers from children.

We assume that if you have more children, you receive more transfer $\frac{\partial(\tau(n_{t+1})n_{t+1})}{\partial n_{t+1}} > 0$. From 7 we can notice that an additional child decreases savings through two channels: (i) an *expenditure channel*; and (ii) a *transfer channel*. The expenditure channel is given by $-\left(\frac{\beta}{1+\beta}\right)\left(\theta\left(n_{t+1}\right)+\frac{\partial\theta(n_{t+1})}{\partial n_{t+1}}n_{t+1}\right)$: an additional child reduces savings because it increases consumption needs in the first period. Young agents thus must save less, since they have to spend more to support children in the first period, as long as $\theta\left(n_{t+1}\right) > \frac{\partial\theta(n_{t+1})}{\partial n_{t+1}}n_{t+1}$, which we assume to be always the case. The transfer channel is given by $-\left(\frac{\beta}{1+\beta}\right)\left(\frac{\tau(n_{t+1})+\frac{\partial\tau(n_{t+1})}{\partial n_{t+1}}n_{t+1}}{\beta(1+r_{t+1})}\right)\left(\frac{A_{t+1}w_{t+1}}{A_t w_t}\right)$: an additional child reduces savings because it increases the transfers received in the second period. Young agents thus wish to save less, since they will be supported more by children in the second period.

It is important to distinguish between the two channels for several reasons. First, the expenditure channel does not depend on interest rates because expenses are paid upfront. As such, the partial and general equilibrium effects of fertility on savings are identical. In contrast, the forces of the transfer channel differ between partial and general equilibrium because transfers are received later in life, which causes the true value of transfers to depend on the interest rate. Second, an additional child decreases the net wealth, W_t, through the expenditure channel, while she increases the net wealth through the transfer channel. In order to understand if an additional child induces a positive or negative wealth shock, we need to estimate which one of the two effects dominates. In section 4.3.1, we use the empirical estimates to impose some discipline on the relative importance of the expenditure and transfer channels. Before doing so, we first consider the effect of an aggregate change in fertility. Hence, we need to take into account general equilibrium effects.

4.2 General Equilibrium

We now solve the model to understand its general equilibrium properties. The law of motion of capital, as in any OLG model, is given by

$$k_{t+1} = (1-\alpha)\frac{s_t\left(\tilde{n}_t, \tilde{n}_{t+1}, 1+g\right)}{(1+g)\,\tilde{n}_{t+1}}k_t^{\alpha}, \tag{8}$$

where $\tilde{s}_t$ is aggregate saving rate, we have, as usual, defined $k_t = \frac{K_t}{A_t L_t}$, and used the fact that $L_{t+1} = \tilde{n}_{t+1} L_t$ and $A_{t+1} = (1+g)\,A_t$. We first focus on steady state properties. Using the fact that markets are competitive and there is full depreciation, so that $1+r_t = \alpha k_t^{\alpha-1} + 1 - \delta = \alpha k_t^{\alpha-1}$ and $w_t = (1-\alpha)\,k_t^{\alpha}$, the steady state interest rate is given by:

$$1+r = \frac{\alpha\,(1+g)\,\tilde{n}}{(1-\alpha)\,\tilde{s}}. \tag{9}$$

We can then replace the interest rate into equation 6 to get

$$s = \left(\frac{\beta}{1+\beta}\right)\left[(1-\tau\left(\tilde{n}\right)-\psi-\theta\left(n\right)n) - \left(\frac{\tau\left(n\right)n}{\tilde{n}}+\psi\right)\left(\frac{\tilde{s}\,(1-\alpha)}{\alpha\beta}\right)\right],$$

which shows that the saving rate of a household with n children depends on the ratio between total expected transfer, $\tau\left(n\right)n$, and aggregate fertility, $\tilde{n}$. Thus as long as every household has the same number of children n equilibrium , such that $n = \tilde{n}$ and $s = \tilde{s}$, only the transfer rate, $\tau\left(\tilde{n}\right)$ (rather than the total transfer amount) is relevant for saving. In fact, solving for the saving rate from the previous expression we get

$$\tilde{s} = \frac{\alpha\beta\left(1-\tau\left(\tilde{n}\right)-\psi-\theta\left(\tilde{n}\right)\tilde{n}\right)}{\alpha\,(1+\beta)+\left(\tau\left(\tilde{n}\right)+\psi\right)(1-\alpha)}. \tag{10}$$

This expression relates aggregate fertility to aggregate savings in general equilibrium and shows the difference between the partial and general equilibrium effects of a change in fertility. Let us first consider the transfer channel. In partial equilibrium, a change in fertility affects the saving rate through total transfers, $\tau(n)\, n$; in general equilibrium, the effects comes only through the transfer rate, $\tau(n)$. This difference is driven by the effect of fertility on the interest rate. As shown in equation (9), an increase in fertility increases the interest rate for any given saving rate: a higher number of children per household increases the labor/capital ratio, making capital scarcer and thus pushing up its price, the interest rate. The increase in interest rate makes transfers next period less valuable from the perspective of a young household, and thus increases savings. Intuitively, if only one household has an additional child, it will expect higher transfers next period and thus will reduce savings today, but if *all* households have more children, capital tomorrow will become scarce, which will increase the interest rate such that transfers are effectively less valuable. Now, consider the expenditure channel. It is easy to see that to the extent that the number of children affects savings through the total expenditure required to raise them, $\theta(n)\, n$, this effect is the same both in partial and general equilibrium

Equation 10 is derived from the F.O.C. for savings. Aggregate savings and fertility are also linked by the F.O.C. for fertility through the following relationship:

$$\tilde{n} = \left(\tau(\tilde{n}) + \tau'(\tilde{n})\,\tilde{n} - \frac{\lambda}{1+g}\right)\left(\frac{1}{\theta(\tilde{n}) + \theta'(\tilde{n})\,\tilde{n}}\right)\left(\frac{1-\alpha}{\alpha}\right)s. \tag{11}$$

It is interesting to consider one specific case to build up intuition. Let's consider the following functional forms

$$\tau(n) = \tau + \frac{\varphi}{n}, \;\; n > 0$$

$$\theta(n) = \theta.$$

These are consistent with the data (see section 4.3.1) and are useful because they keep the F.O.C. for fertility linear from the point of view of a single household.[16] This means that any single household is indifferent between investing in children or savings, but at the aggregate

[16] Notice that $\tau(n)$ is not defined for $n = 0$. This is due to the fact that the chosen functional form gives $\tau(0) = \infty$, which clearly cannot be the case. However this should not a problem, to the extent that there are no households with 0 children in the data.

level, there is a unique level of aggregate fertility that is consistent with the equilibrium, since fertility enters through the interest rate. Specifically, with these two simplifying assumptions, equation (11) becomes

$$\tilde{n} = \left(\frac{\tau}{\theta} - \frac{\lambda}{(1+g)\,\theta}\right)\left(\frac{1-\alpha}{\alpha}\right)s,$$

from which we observe the following two results: (i) consider the case in which the constraint is not binding, so that $\lambda = 0$. For fixed parameters, savings and fertility co-move. This is intuitive: if households wish to save more for reasons that do not directly influence the costs or returns of children, then they wish to save more both in assets and in children. Thus, the two must co-move. (ii) When the one-child policy is binding, so that $\lambda > 0$, the level of fertility is too low with respect to savings. Absent the constraint, households would want to invest more in children.

Equations (10) and (11) are sufficient to characterize the equilibrium.[17]

4.2.1 Transitional Dynamics

So far we have focused on steady states. However the previous results, and in particular, the important role that general equilibrium forces have on the relationship between fertility, transfers and savings, hold as well on the transition from one steady state to another. In order to understand why general equilibrium forces are equally strong on the transition path is useful to describe a thought experiment. Let's consider the effect on the interest rate of an exogenous increase in fertility, as for example the one that may derive from relaxing the one-child policy. In the short run, the interest rate will not immediately react to the increase in fertility, and as such, we could argue that the partial and general equilibrium results are more similar on the transition path. However, until the new steady state is reached, wages adjust each period. In particular, as long as aggregate capital per efficiency unit is decreasing towards the new steady state, wages will be decreasing as well. So that absent the role of

[17] Uniqueness of the equilibrium can be shown for simple functional forms of $\tau(n)$ and $\theta(n)$. In particular when $\tau(n)$ and $\theta(n)$ do not depend on n. However, for arbitrary functional forms, the equilibrium may not be unique.

TFP growth, children will earn less than parents and therefore, parents will save more today.

In the case with log utility and full depreciation this additional general equilibrium effect, which is limited to transitional dynamics, exactly offset the fact that the interest rate is less elastic to fertility in the short run. The effect of a change on fertility on saving rate is thus identical in steady state and on the transition path.

Let's now make this intuition formal. Substituting the equilibrium expression for interest rate and wage in the formula for saving rate, 6, we get:

$$s_t = \left(\frac{\beta}{1+\beta}\right)\left[\left(1-\tau\left(\tilde{n}_t\right)-\psi-\theta\left(n_{t+1}\right)n_{t+1}\right)-\frac{\left(\tau\left(n_{t+1}\right)n_{t+1}+\psi\tilde{n}_{t+1}\right)}{\alpha\beta}\left(1+g\right)\frac{k_{t+1}}{k_t^{\alpha}}\right].$$

We can then further manipulate this expression, substituting the law of motion of capital, 8, which must hold even out of steady state, assuming as previously that in equilibrium $s_t = \tilde{s}_t$ and $n_t = \tilde{n}_t$, and solving for the saving rate. The aggregate saving rate on the transition path is then given by

$$\tilde{s}_t = \frac{\alpha\beta\left(1-\tau\left(\tilde{n}_t\right)-\psi-\theta\left(\tilde{n}_{t+1}\right)\tilde{n}_{t+1}\right)}{\alpha\left(1+\beta\right)+\left(\tau\left(\tilde{n}_{t+1}\right)+\psi\right)\left(1-\alpha\right)}.$$

This formula exactly mirrors the steady state formula reported in 10.

4.3 Relaxing the One Child Policy

Now, we consider the effect of the removal of the One Child Policy on household savings. Assuming that the one-child policy is binding, we can simply consider the effect on saving rate of an exogenous change in n. Hence we want to calculate the derivative of s with respect to $\tilde{n}$, with s defined as in equation (10). This derivative is negative if and only if

$$\theta\left(\tilde{n}\right)+\theta'\left(\tilde{n}\right)\tilde{n} > -\frac{\tau'\left(\tilde{n}\right)\left(1+\alpha\beta-\left(1-\alpha\right)\theta\left(\tilde{n}\right)\tilde{n}\right)}{\alpha\left(1+\beta\right)+\left(\tau\left(\tilde{n}\right)+\psi\right)\left(1-\alpha\right)}. \tag{12}$$

If $\tau\left(n\right) = \tau$, such that the transfer rate does not depend from the number of siblings, then the removal of the one-child policy would decrease the aggregate savings rate.

Now, consider the difference between the effects in partial and general equilibrium. In partial equilibrium, a higher number of children reduces the saving rate through both the expenditure channel and the transfer channels, while in general equilibrium, only the expenditure channel goes in that direction. The transfer channel affects the savings rate in the opposite direction. As long as the transfer rate is a decreasing function of number of children (which we find in the data), the removal of the one-child policy would decrease the transfer rate and *increase* savings.

In order to sign the net effect of the removal of the One Child Policy on savings, we must discipline the functions $\theta(n)$ and $\tau(n)$. We do this in the next section.

4.3.1 Transfer vs. Consumption Channel

For simplicity, let's assume that households can have only one or two children. We take into account that the amount of transfers differs between sons and daughters. Allowing both the average transfer rate per child, $\tau(n)$, and the average consumption expenditure per child, $\theta(n)$, to vary by the gender of the child, the timing and the number of children, results in twelve parameters to be estimated: τ_m, τ_f, τ_{mm}, τ_{mf}, τ_{fm}, τ_{ff}, θ_m, θ_f, θ_{mm}, θ_{mf}, θ_{fm}, θ_{ff}. Where, for example, τ_f is the transfer rate of a household that has only one daughter and τ_{mf} is the average transfer rate per child of a household whose first born is a male and second-born is a female. The empirical estimates provide us with only three linear restrictions. Thus, to identify all the parameters of interest, we must make a series of identifying assumptions, which are motivated from the data.

Assumption 1 Transfers from males are four times as much as from females.[18]

$$\tau_m = 4\tau_f$$

[18]See CHARLS 2008 Pilot Survey .

Assumption 2 A male first-born crowds out transfers from siblings.[19]

$$\tau_{fm} = \frac{\tau_f + \tau_m}{2} \quad \tau_{mm} = \tau_{fm} - \rho_m,$$

where ρ_m is the negative effect on average transfer that is given by the first born being a male.

Assumption 3 The costs for raising male and female children are similar. [20]

$$\theta_m = \theta_f = \theta.$$

Assumption 4 The costs of children is linear in the number of children.[21]

$$\theta_{mm} = \theta_{mf} = \theta_{ff} = \theta_{fm} = 2\theta.$$

Parameters We assume a time period of 25 years, which is the average age of mothers at birth of the first child. We also assume a discount rate equal to return on risk free bonds of 1%. TFP growth rate of China in the last 25 years are thus

$$\beta = 0.99^{25} = 0.78$$

$$1 + r = \frac{1}{\beta} = 1.28$$

$$1 + g = 1.04^{25} = 2.67.$$

We assume steady state wage such that $w_{t+1} = w_t$.

[19] See CHARLS 2008 Pilot Survey.

[20] This is motivated by the observation in the UHS data that educational attainment for men and women for cohorts born in the 1960s and 1970s are very similar and that schooling, housing, etc., for this cohort was mostly provided by the state at prices that did not vary by the sex of the children. It is also consistent with our finding no sex-differential result on income. See Tables 6 and **??**.

[21] This is a simplifying assumption. In the *China Health and Nutritional Survey*, Qian (2009) documents that the marginal cost of an additional child decreases with the number of children. Thus, the costs are in practice concave. This would cause the results to go further in the direction that we predict.

In the data, we have estimates of $s_f - s_m = 0.084$, $s_{fn} - s_f = 0.112$, and $s_{mn} - s_m = 0.035$, where the previous notation applies and s_{mn} is the average saving rate of households with two children, of whom the oldest is male.

We can identify τ_f using the difference in savings between households with only one daughter and households with only one son. Using equation (6) and the previous assumptions, it follows that

$$s_f - s_m = \left(\frac{\beta}{1+\beta}\right)\left[(\tau_m - \tau_f)\left(\frac{1+g}{\beta(1+r)}\right)\right] = 3.51\tau_f.$$

In the data, we estimate that $s_f - s_m = 0.084$ so that $\tau_f = 0.024$, which implies that $\tau_m = 0.092$.

We can identify ρ_m using the difference in savings between the effect of an additional child conditional on the first one being a female and the effect of an additional child conditional on the first one being a male. Using our assumptions, we can rewrite

$$(s_{fn} - s_f) - (s_{mn} - s_m) = \left(\frac{\beta}{1+\beta}\right)\left[(2\rho_m)\left(\frac{1+g}{\beta(1+r)}\right)\right].$$

In our context, there is no selective abortion. Therefore, we can assume $s_{mn} \equiv \frac{s_{mm}+s_{mf}}{2}$. The previous equality thus gives $\rho_m = 0.033$.[22]

We can identify θ using the difference in savings between households with two children and households with only one child.[23]

$$s_{fn} - s_f = \left(\frac{\beta}{1+\beta}\right)\left[\theta + \left(\frac{\tau_f+\tau_m}{2}\right)\left(\frac{1+g}{\beta(1+r)}\right)\right]$$

We get $\theta = 0.095$: one child cost approximately 10% of parents income. We summarize the average transfer rate and savings rate Table 7. We report both the savings rate and transfer

[22]Note that this coefficient has one controversial implication: households with one male and one female receive less transfers than household with only one male.

[23]We can alternatively use $s_{fn} - s_f$ or $s_{mn} - s_m$: they provide, by construction, the same coefficient for θ.

rate for each "type" of household, and the average savings and transfer rates for households with one child and two children. Lastly, we report the averages.

The model is stylized, but we can nonetheless discuss the plausibility of the estimated parameters. First, note that the average saving rate in the model is 26%, which is close to the 31% saving rate we observe in the data, despite the fact that we have not directly targeted savings rate. Second, the average transfer rate implied by the model is 5.2%. Assessing the plausibility of the transfer rate is difficult because of our inability to accurately measure transfer rates. To the best of our knowledge, there is no reliable data on transfers to parents at the individual level. Moreover, cohabitation during old age is likely to be very valuable to parents and is difficult to monetarize. We do the best we can by using the UHIES data, which report total transfer expenditures. We document that transfer expenditure is approximately 8% of total household income for the average household with a household head between 25 to forty years of age. If two-thirds of these expenditures go to elderly parents, then the transfer rate would be similar to the implied transfer rate of the model, $\frac{2}{3}8\% \simeq 5.2\%$. Third, the model implies that every child costs approximately 10% of household income. This is consistent with the data reported by the *China Health and Nutritional Survey*, which shows that an urban household in 1989 spends approximately 8% of total income on food, clothing and schooling for children. This is similar to the 9.5% direct costs implied by the model.

4.3.2 Quantitative Results

The estimated parameters can be used to discuss the effect of the removal of the one-child policy on savings. In order to match the empirical evidence, we need to have a transfer function that is decreasing in the number of children. We know from the previous analysis that the reduction in savings due to the expenditure channel will be attenuated, and even possibly completely offset, by the decrease in the transfer rate. Assuming that the removal of the one-child policy would change the average number of children from one to two, we can use equation (10) and our estimated parameters to compute the effect of the One-Child Policy on savings: $\frac{s(2)-s(1)}{s(1)} = -7.69\%$, where $s(2)$ is the average saving rate of the counterfactual in which every household has two children. We find that this increase in fertility would decrease the average savings rates 7.69%, which is equal to 2.67 percentage-points. The general equilibrium effect on savings is thus very small. We can additionally decompose this effect by the fraction due to consumption and transfer: if we assume that the average transfer rate stays constant, then the reduction in savings rates would be 11.24%, which equals a 3.90 percentage-points reduction. Thus effectively the consumption expenditure alone would cause a 3.90 percentage-points reduction, but the fact that transfer rate is decreasing in the number of children reduces the total effect to 2.67 percentage-points. The moderate general equilibrium effects of the removal of the one-child policy on savings contrasts with the large partial equilibrium effects we document in our empirical results. The corresponding values for partial equilibrium are in fact 24.01%, which is equal to 7.30 percentage-points: in general equilibrium the effect of one additional child on savings decreases by two thirds.

5 Additional Results

5.1 Wage Growth

Given that the amount of anticipated transfers largely depends on wage growth, we investigate the sensitivity of our results to the slowdown of growth, which is predicted to decline to 5% by 2030 (WorldBank, 2013). This will reduce the importance of transfers from children, which in partial equilibrium, will increase savings. However, in an OLG model, lower growth rate also reduce the interest rate, since capital tomorrow would be relatively abundant and thus its price must fall. In a log-utility setting with full depreciation, both the interest rate and total transfers from children are unit-elastic with respect to the growth rate. Thus, a change in growth rate has no effects on savings. This result is driven by the general equilibrium assumption: if the interest rate does not change as growth slows down, then transfers would be relatively smaller, which increases savings should increase. However, in general equilibrium, the interest rate moves in such a way to exactly offset the upward pressure on savings, so that the net effect is zero.

5.2 Endogenous Human Capital Investment

For parsimony, our model has thus far ignored human capital investment, which is obviously interesting and is center to the recent work of Choukhmane et al. (2013). In this section, we provide an intuitive discussion on the implications of endogenous human capital investment for our results. The main goal of this analysis is to discuss if the presence of endogenous human capital investment is able to change our results.The model is shown formally in the Appendix. Since in our model parents raise children in the anticipation of future transfers, we allow parents to make human capital investments for their children in order to increase children's future wages and therefore, anticipated transfers. Children's education is thus an investment that requires an upfront cost when children are young and pays a benefit in the form of transfers. We first assume that there is no quantity-quality trade-off in partial equilibrium, so that parents investment in their children human capital is independent from the number of children itself. We show that, despite the lack of a trade-off in partial equilibrium, a quantity-quality trade-off emerges in general equilibrium: increased aggregate fertility causes a reduction in human capital investment per child. This is because a higher interest rate reduces the value of transfers. Thus, when increases in aggregate fertility causes the interest rate to rise, the incentives for parents to invest in children's human capital declines. Next we assume the presence of a standard quantity-quality tradeoffs, which is consistent with our finding that reduced fertility increases education attainment for daughters. Thus even in partial equilibrium, having more children reduces the amount of human capital investment per child. We show that the interest rate does not depend form the level of human capital, so that the presence of a quantity-quality trade-off has no effect on the general equilibrium properties of the model. Those two results taken together, show that the introduction of endogenous human capital investment make the partial and general equilibrium results even more different than in the case without endogenous human capital investment. In fact, the general equilibrium quantity-quality trade-off generates a reduction in human capital investment, which reduces both consumption/expenditure and anticipated transfers. The consequence is an increase in savings. As such, allowing for endogenous human capital investment further mitigates the negative relationship between fertility and savings..

5.3 Endogenous Transfers

Another assumption we make in the baseline model is that transfer rates are exogenous. However, the transfer rate from children may be endogenously determined. In the Appendix, we extend our model along the lines of Caldwell and Caldwell (1976) and Boldrin and Jones (2002), where children make transfers to parents because they care about their well-being. We show that, even when transfer rates are endogenous, general and partial equilibrium effects of fertility on saving rate are remarkably different: allowing for the transfer rate to be endogenously determined makes in fact partial and general equilibrium results even more different. When transfer rates are endogenous, increasing the number of children will reduce transfer rates. This occurs for three different reasons. First, more children decreases the incentive of each child to transfer to parents due to the strategic interactions among siblings. Second, more children imply that young parents must spend more on child rearing, and thus, they transfer less to their own parents. Third, an increase in aggregate fertility increases the interest rate, which reduces the value of transfers to parents, and thus reduces the incentives of altruistic children to make transfers. The first two reasons are present both in partial and general equilibrium, while the third one emerges due to the effect of fertility on the interest rate: hence in general equilibrium the negative relationship between the number of children and transfer rate is even stronger, which creates a further gap between partial and general equilibrium results. Finally, since the reduction in transfers will cause parents to increase savings, endogenizing transfer rates will weaken the negative relationship between fertility and savings shown in the empirical partial equilibrium results. Thus, endogenizing transfer rates will mitigate the negative effects of relaxing the One Child Policy on savings..

6 Conclusion

For understanding the relationship between fertility and household savings, recent studies have paid a significant amount of attention to providing well-identified estimates using natural experiments and cross-sectional data. In our paper, we argue that while such approaches provide valuable evidence on partial equilibrium effects, the results can be misleading for understanding the effects of changing aggregate fertility. As an example, we use a simple model to illustrate that general equilibrium effects can partly offset the partial equilibrium effects under standard assumptions.

For urban China, the calibrated model shows that the positive general equilibrium effects of fertility on savings offset the negative partial equilibrium effects by approximately two-thirds. Thus, the increase in fertility that will follow the relaxation of the One Child Policy on savings rates will likely be more moderate than what is implied by recent studies of partial equilibrium effects. In interpreting the results, it is important to note that the quantitative magnitudes of our results are specific to the context of our study and the modeling choices we have made. Similarly, there are potentially other channels through which fertility can affect savings.

The main point of the paper is simply that it is extremely important to take general equilibrium effects into account for policy analysis. This is not a new or particularly sophisticated insight. But by contextualizing it in an important and concrete example, we reinforce its importance for future research.

It is interesting to note that family relationships are changing in China. In particular, many observe that similar to the historical experience of the rich countries of today, parents' reliance on children is declining. Part of this may be due to cultural change. But part of it, must be due to social security, which citeasnounSongetal2013 show to be rapidly increasing in urban China. Understanding the effects of simultaneously changing fertility and the introduction of social security is an interesting avenue for future research.

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Table 1: Financial Support for the Elderly

	Net Regular Transfer	Net Total (regular + irregular + gift) Transfer	Probability Receive Transfer	Probability Give Transfer
	(1)	(2)	(3)	(4)
	A. Support Received by Elderly Parents (Household Head 65+ Age)			
# Kids				
1	59	158	0.19	0.16
2	206	1020	0.49	0.2
3+	842	2823	0.62	0.25
Sex of the Oldest Child				
Male	1010	2815	0.57	0.24
Female	428	2052	0.58	0.24
	B. Support Given to Elderly Parents by All Children (Household head <65 Age)			
Male	258	754		
Female	95	509		
	C. Support Given to Elderly Parents by First-Born Children (Household head <65 Age)			
Male	631	1218		
Female	45	463		

Source: CHARLS Pilot Survey (2008).

Table 2: Cohabitation with the Elderly

# Kids	A. Fraction of Parents 65+ Living with 1+ Child
1	0.4
2	0.54
3+	0.53
	B. Fraction of All Children Age 40-64 Living with Parents
Male	0.22
Female	0.03
	C. Fraction of Oldest Children Age 40-64 Living with Parents
Male	0.21
Female	0.03

Source: CHARLS Pilot Survey (2008).

Table 3: The Effect of Family Planning on Fertility

	Dependent Variable: # Kids								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8) Baseline	(9)
Dep. Var Mean	**1.88**	**1.88**	**1.88**	**1.88**	**1.88**	**1.88**	**1.88**	**1.88**	**1.88**
1st Born 1972+	-0.589	-0.592	-0.583	-0.812	-0.713	-0.822	-0.812	-0.754	-0.913
	(0.064)	(0.063)	(0.063)	(0.078)	(0.083)	(0.100)	(0.101)	(0.109)	(0.106)
1st Born 1972+ x 1st is a son						0.417	0.413	0.416	0.375
						(0.127)	(0.127)	(0.127)	(0.118)
1st is a Son		-0.222	-0.223	-0.193	-0.187	-0.455	-0.454	-0.454	-0.398
		(0.064)	(0.064)	(0.058)	(0.057)	(0.103)	(0.102)	(0.103)	(0.093)
Controls									
HH Head Age	N	N	N	Y	Y	N	N	Y	Y
HH Head Age Squared	N	N	N	Y	Y	N	N	Y	Y
HH Head Years of Edu	N	N	Y	Y	Y	N	Y	Y	Y
HH Head Years of Edu Squares	N	N	Y	Y	Y	N	Y	Y	Y
HH Head Age >55	N	N	N	N	Y	N	N	N	Y
Age of Youngest Child	N	N	N	N	Y	N	N	N	Y
Youngest Child Age < 22	N	N	N	N	Y	N	N	N	Y
Mother is HH Head		N	N	N	Y	N	N	N	Y
	N								
Observations	475	475	475	475	475	475	475	475	475
R-squared	0.265	0.284	0.290	0.387	0.403	0.302	0.307	0.313	0.417
Joint: 1st Born 1972+ 1st Born 1972 x 1st is a Son						-0.405	-0.398	-0.338	-0.539
p-value						0.000	0.000	0.000	0.000

Notes: All estimates control for city fixed effects. Robust standard errors are presented in parentheses. The sample uses households that have their first child during 1967-77, and where the age of the household head is 50-65. Source: RUMiC (2008).

Table 4: The Effect of Family Planning on Savings

	Dependent Variables: Savings							
	(1)	(2)	(3)	(4)	(5)	(6)	(7) Baseline	(8)
Dep. Var Mean	**17162.28**	**17162.28**	**17162.28**	**17162.28**	**17162.28**	**17162.28**	**17162.28**	**17162.28**
1st Born 1972+	6,175.455	5,673.021	7,355.226	6,523.363	13,452.626	12,730.379	14,361.154	13,466.261
	(2,402.994)	(2,366.350)	(2,714.480)	(2,977.212)	(3,782.381)	(3,718.996)	(4,003.795)	(4,058.891)
1st Born 1972+ x 1st is a son					-13,104.226	-12,692.440	-12,613.217	-12,979.041
					(4,656.364)	(4,590.075)	(4,585.115)	(4,667.702)
1st is a Son					11,097.453	10,981.485	10,989.328	11,795.381
					(3,331.267)	(3,311.620)	(3,303.155)	(3,473.908)
Controls								
HH Head Age	N	N	Y	Y	N	N	Y	Y
HH Head Age Squared	N	N	Y	Y	N	N	Y	Y
HH Head Years of Edu	N	Y	Y	Y	N	Y	Y	Y
HH Head Years of Edu Squares	N	Y	Y	Y	N	Y	Y	Y
HH Head Age >55	N	N	N	Y	N	N	N	Y
Age of Youngest Child	N	N	N	Y	N	N	N	Y
Youngest Child Age < 22	N	N	N	Y	N	N	N	Y
Mother is HH Head	N	N	N	Y	N	N	N	Y
Observations	475	475	475	475	475	475	475	475
R-squared	0.106	0.125	0.129	0.137	0.125	0.144	0.147	0.158
Joint: 1st Born 1972+ 1st Born 1972 x 1st is a Son					348.4	37.94	1748	487.2
p-value					0.904	0.989	0.569	0.889

Notes: All estimates control for city fixed effects. Robust standard errors are presented in parentheses. The sample uses households that have their first child during 1967-77, and where the age of the household head is 50-65. Source: RUMiC (2008).

Table 5: The Instrumented Effect of Fertility on Savings

	Dependent Variables					
	(1)	(2)	(3)	(4)	(5)	(6)
	Savings	Savings	Savings	Savings/Income	Savings/Income	Savings/Income
Dep Var Means	**17162.28**	**17162.28**	**17162.28**	**0.26**	**0.26**	**0.26**
# Kids	-14,122.101	-14,154.726	-18,570.845	-0.110	-0.110	-0.158
	(5,490.252)	(5,458.640)	(5,741.993)	(0.075)	(0.074)	(0.085)
# Kids x 1st is a Son			11,052.450			0.118
			(8,052.866)			(0.116)
1st is a Son		803.004	-19,909.942		0.007	-0.215
		(2,428.493)	(15,321.510)		(0.044)	(0.230)
Observations	475	475	475	475	475	475
R-squared	0.008	0.008	0.001	0.018	0.018	0.006
F-stat (1st Stage)	53.51	55.86	20.02	53.51	55.86	20.02
Joint			-7518			-0.0394
t-stat	-0.938	-0.370	-0.938			-0.370

Notes: All estimates control for baseline controls: city fixed effects, age of the household head and its squared term, education of the household head and its squared term. Robust standard errors are presented in parentheses. The instruments are: a dummy variable for whether the first child is born after 1972, and the interaction terms between whether the first child is male and dummy variables for if the first child is born after 1972. The sample uses households that have their first child during 1967-77, and where the age of the household head is 50-65. Source: RUMiC (2008).

Table 6: The Instrumented Effect of Fertility on Income and Labor Supply

	Dependent Variables								
	Income							Labor Supply	Expenditure
	(1) Total	(2) Wages	(3) Other Labor	(4) Business	(5) Interest & Rent	(6) Pension	(7) Welfare	(8) Work Dummy	(9) Total
Dep Var Means	**49583.57**	**19707.85**	**120.08**	**2131.92**	**1800.40**	**25649.94**	**288.84**	**0.54**	**32421.29**
# Kids	-11,235.635	-8,803.967	-65.054	-1,851.312	-411.131	-211.733	60.291	-0.052	7,335.210
	(5,531.261)	(5,032.290)	(133.689)	(1,481.890)	(1,332.209)	(2,617.513)	(216.577)	(0.091)	(6,224.907)
# Kids x 1st is a Son	8,636.033	-2,890.283	-897.833	5,317.647	1,397.635	3,020.517	1,760.603	-0.229	-2,416.417
	(9,696.207)	(9,046.956)	(493.458)	(4,017.573)	(2,284.721)	(4,598.215)	(1,264.436)	(0.166)	(6,668.845)
1st is a Son	-11,361.338	5,893.038	1,778.735	-7,844.860	-2,742.535	-3,919.591	-2,679.564	0.445	8,548.604
	(18,092.449)	(16,843.011)	(953.745)	(7,048.226)	(4,797.064)	(8,483.059)	(2,042.683)	(0.302)	(12,220.239)
Observations	475	475	475	475	475	475	475	475	475
R-squared	0.280	0.126	-0.081	0.160	0.198	0.346	-0.079	0.114	0.215
F-stat (1st Stage)	20.02	20.02	20.02	20.02	20.02	20.02	20.02	20.02	20.02
Joint	-2600	-11694	-962.9	3466	986.5	2809	1821	-0.281	4919
t-stat	-0.263	-1.236	-1.698	0.835	0.543	0.613	1.431	-1.638	0.819

Notes: All estimates control for baseline controls: city fixed effects, age of the household head and its squared term, education of the household head and its squared term. Robust standard errors are presented in parentheses. The instruments are: a dummy variable for whether the first child is born after 1972, and the interaction terms between whether the first child is male and dummy variables for if the first child is born after 1972. The sample uses households that have their first child during 1967-77, and where the age of the household head is 50-65. Source: RUMiC (2008).

Table 7: Summary of Transfer and Savings Rates

Children	τ	s
m	0.092	0.262
f	0.024	0.346
mm	0.058	0.185
mf	0.023	0.269
fm	0.057	0.192
ff	0.023	0.276
θ	0.095	
$n = 1$	0.060	0.304
$n = 2$	0.0435	0.231
average	0.052	0.268

A Data Appendix

The sample frame used in the RUMiC is the same as the one used in the National Bureau of Statistics (NBS) *Annual Urban Household Income and Expenditure Survey* (UHIES). Sample selection is based on several stratifications at the provincial, city, county, township, and neighborhood community levels. Households are randomly selected within each chosen neighborhood community. The UHIES covers all 31 provinces, whereas the UHIES sample households were drawn from nineteen cities in nine of the provinces of the UHIES sample.[24] This sampling frame typically miss migrant laborers. For our study, this is an advantage in that we can assume that urban households we observe in 2008 also had urban status when they had their first child.

The survey was conducted in March and April, 2008. In addition to general information (including fertility) for household members, the questionnaire also included the demographic characteristics, education, and employment situation of other family members who are not residing with the household head and spouse, including parents, children, and siblings.[25] This allows us to know the total fertility history and characteristics of adult children such as sex, age and marital status. In our study, total fertility is synonymous with the total number of living children. In our sample, the total number of living children is very similar to the total number of children ever born since infant mortality during the early 1970s was very low (Banister and Hill, 2004).

The information on household income and expenditure from the RUMiCI in China are directly recorded from the UHIES survey, where the income and expenditure are collected using a diary record. Specifically, households are required to record each item (disaggregated for hundreds of product categories) purchased and income received for each day for a full year (in our case is for the year 2007). Enumerators visit sample households once or twice

[24] The provinces included in the RUMiCI urban survey are: Shanghai, Guangdong, Jiangsu, Zhejiang, Henan, Anhui, Hubei, Sichuan, and Chongqing. The detailed list of cities can be found at http://rumici.anu.edu.au

[25] The questionnaires are available from http://rumici.anu.edu.au

each month to review the records, assist the household with questions, and to take away the household records for data entry and the aggregation of the annual data at the local Statistical Bureau Office.

The UHIES data is the best available data on urban household economic variables. It is not publicly available, but has been used in several recent studies. The data also have several weaknesses, which has been thoroughly discussed in by past studies such as Han, Cramer and Wahl (1997), Ravallion and Chen (1999) and Gibson, Huang and Rozelle (2003). According to these studies, the quality of the household surveys are in general good and most of the problems are confined to rural surveys. However, there are problems in the urban surveys that could affect studies of savings. First, the indicators used for consumption and expenditure lack consistency over time (e.g. the categories for durable consumption changed quite dramatically during two decades of rapid economic growth). Second, the urban surveys do not fully account for food consumption because they do not account for meals consumed away from home, although this is accounted for in expenditures for food. Finally, the onerous task of recording a daily diary of income, consumption and expenditure makes it difficult to recruit certain households. The first problem should not affect our study as we only use one cross-section and focus on urban residents. The second problem could cause us to underestimate consumption. We address this by using data on expenditures, which have been shown by the studies we cite above to be more accurate for urban household surveys. There is little we can do to directly address the last problem except to keep it in mind when considering the external validity of our results. According to interviews with NBS statisticians and a detailed examination of income and expenditure distributions conducted by researchers in study of the income distribution and income taxation using the UHIES data, researchers concluded that the households that refuse to participate are typically the poorest and the richest households (Piketty and Qian, 2009). This makes it difficult to use the UHIES to study the extreme tails of the income distribution, but should not affect our study, which focuses on the mean household.

Another important fact to keep in mind when assessing the external validity of our estimates is that China is the only country in the world that uses such comprehensive twelve month expenditure records.[26] Gibson et al. (2003) found that extrapolating annual totals from expenditures using some months of the year caused sharp decreases in expenditure measures.[27] This means that measures of household savings in China – the difference between income and expenditure – are not directly comparable to measures of household savings from other countries. (Unlike expenditures, income data is collected in a similar fashion as many other countries). In other words, if the same statistical methods employed in most of the world were also employed in China, then Chinese savings rates will be higher than what they are in our data (or any savings data that is based off of the UHIES). This error in measurement of what will be the dependent variable in our analysis should not affect our estimates. However, it needs to be taken into account when comparing mean savings rates in China with other countries. Specifically, one would need to know the correlation between household's expenditures with different months.

B Human Capital

Without Partial Equilibrium Q-Q Trade-off

We introduce endogenous human capital investment into the previous model with exogenous transfers. We first consider the case in which in partial equilibrium there is no quantity-quality trade-off, so that nor the costs nor the benefits of investing in children human capital depend from the number of children itself. We model human capital as an increase in

[26]Surveys in many other countries observe households for a week, a fortnight, or a month, and estimates of income and consumption from these periods are annualized by multiplying by 52, 26, or 12. The length of the recall period typically depends on the category of consumption, with long reference periods used for costly and/or infrequently consumed items and short reference periods for frequently consumed and minor items that would be easily forgotten (ILO., 1980).

[27]They also found that such extrapolations sharply increased measures of inequality. This may be due to the fact that by using data from only a few months, random shocks to expenditures are given too much weight. Also, see Deaton (1997) for a detailed discussion of the statististical tradeoffs of different data collection methods.

individual productivity, the wage income of an individual at time t is thus given by $A_t w_t h_t$. Aggregate income is still produced with a Cobb-Douglas production, where labor is calculated in efficiency unit, as standard in the human capital literature, so that $Y = K_t^{\alpha} \left(A_t \tilde{h}_t L_t\right)^{1-\alpha}$. Due to the assumption of competitive markets, the interest rate is now $1 + r_t = \alpha k_t^{\alpha} \tilde{h}_t^{1-\alpha}$ and wage per efficiency unit is $w_t = (1-\alpha) \tilde{h}_t^{-\alpha} k_t^{\alpha}$, so that an individual at time t earns labor income equal to $A_t h_t w_t$, which is increasing in his own human capital and decreasing in aggregate human capital. Usual notation applies, so that $\tilde{h}_t$ is the aggregate human capital per worker. Parents may invest in the human capital, h_{t+1}, of their children paying a convex cost $A_t w_t h_{t+1}^{\gamma}$, where $\gamma > 1$. Parents are willing to invest in the human capital of their children due to the fact that, by doing so, they will increase their children labor income and thus transfers from children to parents. All other assumptions and notation are kept the same. The problem of a young individual (parent) thus read as follows:

$$\max_{c_t^Y, c_{t+1}^m, n_{t+1}, h_{t+1}} \log\left(c_t^Y\right) + \beta \log\left(c_{t+1}^O\right)$$

$$s.t.$$

$$c_t^Y + \frac{c_{t+1}^O}{1+r_{t+1}} \leq A_t w_t h_t \left(1 - \tau_t(n_t) - \psi - \theta(n_{t+1}) \frac{h_{t+1}^{\gamma}}{h_t} n_{t+1}\right) + \frac{A_{t+1} w_{t+1}}{1+r_{t+1}} \left(\tau_{t+1}(n_{t+1}) h_{t+1} n_{t+1} + \psi \tilde{h}_{t+1} \tilde{n}_{t+1}\right)$$

$$n_{t+1} \leq \chi,$$

This problem gives the following FOC

$$c_t^Y = \frac{1}{1+\beta} W_t$$

$$c_{t+1}^O = \frac{\beta(1+r_{t+1})}{1+\beta} W_t$$

$$(1+r_{t+1}) \left(\theta(n_{t+1}) + \frac{\partial \theta(n_{t+1})}{\partial n_{t+1}} n_{t+1}\right) = \frac{A_{t+1} w_{t+1} h_{t+1}^{1-\gamma}}{A_t w_t} \left(\tau(n_{t+1}) + \frac{\partial \tau(n_{t+1})}{\partial n_{t+1}} n_{t+1}\right) - \lambda$$

$$A_t w_t \theta\left(n_{t+1}\right) n_{t+1}=\frac{1}{\gamma} \frac{A_{t+1} w_{t+1}}{1+r_{t+1}} h_{t+1}^{1-\gamma} \tau_{t+1}\left(n_{t+1}\right) n_{t+1}.$$

Rearranging the last equation, we get that

$$h_{t+1}=\left[\frac{A_{t+1} w_{t+1} \tau_{t+1}\left(n_{t+1}\right)}{\gamma A_t w_t \theta\left(n_{t+1}\right)\left(1+r_{t+1}\right)}\right]^{\frac{1}{\gamma-1}},$$

from which we can notice that human capital investment in any given children does not depends directly from the number of children, but only from their relative cost, $\theta\left(n_{t+1}\right)$, and benefit, $\tau_{t+1}\left(n_{t+1}\right)$. In particular, if we focus on the simple case when both the transfer rate and the cost per children are independent from the number of children themselves, there is no quantity-quality trade-off. However, human capital investment decreases in the interest rate, since when the interest rate is higher, the investment in children's human capital has effectively lower returns.

Next let's focus of steady states, and for simplicity let's assume that $\tau(n)=\tau$ and $\theta(n)=\theta$. The equilibrium human capital investment is given by

$$h=\left[\frac{(1+g) \tau}{\gamma \theta(1+r)}\right]^{\frac{1}{\gamma-1}}$$

thus independent from the number of children for a given interest rate - in partial equilibrium. Next we want to compute the relationship of human capital and fertility in general equilibrium. The law of motion of capital is now given by

$$k_{t+1}=(1-\alpha) \frac{s_t\left(\tilde{n}_t, \tilde{n}_{t+1}, 1+g\right)}{(1+g) \tilde{n}_{t+1}} \tilde{h}_t^{1-\alpha} k_t^\alpha$$

so that the interest rate in steady state is given by

$$1+r=\alpha k^{\alpha-1} \tilde{h}^{1-\alpha}=\frac{\alpha(1+g) \tilde{n}}{(1-\alpha) \tilde{s}}$$

as in the case without human capital investment[28]. We can then substitute the expression for interest rate to get

$$h = \left[\frac{(1-\alpha)\,\tilde{s}\tau}{\gamma\alpha\theta\tilde{n}} \right]^{\frac{1}{\gamma-1}}$$

so that for a given saving rate, the human capital investment is decreasing in fertility. A quantity-quality trade-off thus emerges in general equilibrium, due to the role of fertility on the interest rate.

With Partial Equilibrium Q-Q Trade-off

Alternatively we can consider the case in which a quantity-quality trade-off emerges also in partial equilibrium. It is interesting in fact to discuss if a partial equilibrium quantity-quality trade-off alters the general equilibrium properties of the model. We here show that this is not the case. A partial equilibrium Q-Q trade-off could be modeled as a cost of human capital investment that is increasing in the number of children, so that the cost of investing in children human capital is now given by $\zeta(n_{t+1}) A_t w_t h_{t+1}^{\gamma}$, where $\frac{\partial\zeta(n_{t+1})}{\partial n_{t+1}} > 0$. The first order condition for human capital investment becomes

$$h_{t+1} = \left[\frac{A_{t+1} w_{t+1} \tau_{t+1}(n_{t+1})}{\gamma\zeta(n_{t+1}) A_t w_t \theta(n_{t+1})(1+r_{t+1})} \right]^{\frac{1}{\gamma-1}}$$

from which it is immediate to notice that human capital investment decrease in the number of children. However, we have previously shown that in steady state the interest rate does not depend from the level of human capital, so that a quantity-quality trade-off in partial equilibrium does not have any consequence for the general equilibrium property of the model. As a consequence, even when parents face a quantity-quality trade-off the general equilibrium effect of fertility on savings is substantially lower than the partial equilibrium one.

[28] To interpret this result, we can notice that also the level of population, L, does not matter for the interest rate, but only his growth rate. In steady state human capital is constant, and thus does not enter the expression for the interest rate.

C Endogenous Transfers

Setting Individuals value their own consumption and the wealth of their parents. Every individual thus solves

$$\max_{c_t^Y, c_{t+1}^m, \tau_t, n_{t+1}} \log\left(c_t^Y\right) + \beta \log\left(c_{t+1}^O\right) + \delta \log\left(e_{t-1}^Y\right)$$

$$s.t.$$

$$c_t^Y + \frac{c_{t+1}^O}{1+r_{t+1}} \leq A_t w_t \left(1 - \tau_t\left(n_t\right) - \psi - \theta\left(n_{t+1}\right) n_{t+1}\right) + \frac{A_{t+1} w_{t+1}}{1+r_{t+1}} \left(\tau_{t+1}\left(n_{t+1}\right) n_{t+1} + \psi \tilde{n}_{t+1}\right)$$

$$e_{t-1}^Y \leq A_{t-1} w_{t-1} + \frac{A_t w_t}{1+r_t} \left(\tau_t\left(n_t\right) + \tilde{\tau}_t\left(n_t\right)\left(n_t - 1\right) + \psi \tilde{n}_t\right).$$

The previous notation applies. Also notice that when deciding how much money to transfer to parents, individuals take as given the number of their siblings, n_t, and the transfer of their siblings, $\tilde{\tau}_t\left(n_t\right)$. We focus on a symmetric solution.

Comparison with Boldrin and Jones (2002) Boldrin and Jones (2002) uses a utility function of the form

$$U = \log\left(c_t^Y\right) + \beta \log\left(c_{t+1}^O\right) + \delta \log\left(c_t^O\right)$$

such that children value the consumption of their parents when parents are old. This assumption implies that parents have a strategic incentive not to save in the first period because savings crowd out transfers from children. We introduce the assumption that children care about the total wealth of the parents in such a way as to abstract from the previously described strategic element. Conceptually, we are assuming that children have the ability to commit not to transfer to parents even if parents are poor, so that parents in the first period decide how much to save without any strategic distortion.

Solution The first order conditions are given by

$$c_t^Y = \frac{1}{1+\beta} W_t$$

$$c_{t+1}^O = \frac{\beta \left(1 + r_{t+1}\right)}{1+\beta} W_t$$

$$\left(1 + r_{t+1}\right) \left(\theta \left(n_{t+1}\right) + \frac{\partial \theta \left(n_{t+1}\right)}{\partial n_{t+1}} n_{t+1}\right) = \frac{A_{t+1} w_{t+1}}{A_t w_t} \left(\tau \left(n_{t+1}\right) + \frac{\partial \tau \left(n_{t+1}\right)}{\partial n_{t+1}} n_{t+1}\right) - \lambda$$

$$c_t^Y = \frac{1}{\delta} e_{t-1}^Y \left(1 + r_t\right) \tag{13}$$

which are identical to the model with exogenous transfer rates, but with the addition of a fourth condition, which endogenously pins down the transfer rate.[29] Using these four first order conditions, we can solve for the optimal transfer rate, which is

$$\tau_t \left(n_t\right) = -\psi + \left[\frac{1}{1+\beta} + \frac{n_t}{\delta}\right]^{-1} \cdot \left\{ \left(\frac{1}{1+\beta}\right) \left[\frac{\left(1 - \theta n_{t+1}\right)}{1+\beta} + \frac{A_{t+1} w_{t+1}}{A_t w_t} \frac{\left(\tau_t \left(n_{t+1}\right) n_{t+1} + \psi \tilde{n}_{t+1}\right)}{\left(1 + r_{t+1}\right)\left(1+\beta\right)}\right] - \frac{1}{\delta} \left(1 + r_t\right) \frac{A_{t-1} w_{t-1}}{A_t w_t} \right\}.$$

Discussion The transfer rate function has several important features. First, the transfer rate is decreasing in the number of siblings, $\frac{\partial \tau_t(n_t)}{\partial n_t} < 0$. This is consistent with the data and in the model, is due to the strategic interaction between siblings. If a household has many children, each child can free ride on the transfers of siblings, and thus has incentives to reduce her own transfer to her parents. However, the transfer rate is declining less than proportional with the number of siblings, such that households with more children will still enjoy more total transfer.

Second, the transfer rate can be rewritten as $\tau_t \left(n_t\right) = \phi \left(n_t\right) - \psi$, where $\phi \left(n_t\right)$ does not depend from ψ. In equilibrium the total wealth of parents depends from $\left(\tau + \psi\right) n$, so that

[29] In contrast, the first order conditions for consumption in the Boldrin and Jones (2002) model are given by $c_t^Y = \frac{1}{1+\phi(n_t)\beta} W_t$, $c_{t+1}^O = \frac{\beta \phi(n_t)(1+r_{t+1})}{1+\phi(n_t)\beta} W_t$, where $\phi \left(n_t\right)$ is a "strategic wedge" generated by the fact that consuming in the second period is more expensive due to the fact that it crowds out transfers from children. Note that we also depart slightly from Boldrin and Jones (2002) because we want to make the endogenous transfer model as comparable as possible with the exogenous transfer model presented in the paper.

if ψ increases by ε and τ decreases by ε the wealth of old parents is unaffected. As can be seen by the first order condition 13, children target an optimal wealth of their parents, and as such the increase in ψ crowds out one to one the transfer rate. This result has important implications for the effect of introducing social security on savings. In the case where the One-Child Policy is binding both before and after the introduction of social security, the change in social security would have no effect on savings, since it crowds out transfers from children by the same amount. Hence the introduction of social security would have an effect on savings only to the extent that may alter fertility decisions.[30]

Third, in a steady state equilibrium, the transfer rate is given by

$$\tau(n) = \left[\left(\frac{1}{1+\beta} + \frac{n}{\delta}\right) - \left(\frac{1}{1+\beta}\right)\left(\frac{1-\alpha}{\alpha}\right)s\right]^{-1}\left[\left(\frac{1}{1+\beta}\right)(1-\theta n) - \frac{1}{\delta}\left(\frac{n}{s}\frac{\alpha}{1-\alpha}\right)\right] - \psi, \tag{14}$$

which does not depend on the growth rate $1+g$. As previously discussed, the transfer rate does not depend on the growth rate because a high growth rate generates two effects: it makes children relatively richer than parents so that they should wish to transfer more money to parents, but it also increases the interest rate so that transfers becomes less valuable and causes children to want to transfer less. In the case with log utility and full depreciation the two effects perfectly offset each other.

Finally, the steady state transfer rate unambiguously decreases in n, for a given s. This occurs for three different reasons: (a) higher numbers of children decrease the incentive of each child to transfer to parents due to the strategic interactions among siblings (first n in equation (14)); (b) higher numbers of children imply that young parents must spend more on child rearing, and thus, they transfer less to their own elderly parents (second n in equation (14); and (c) higher numbers of children imply that the interest rate is higher, thus transfers

[30]It is interesting to note that in a pay-as-you-go social security system, transfers from children are isomorphic to a pay-as-you-go social security system as long as fertility is exogenous, but when fertility becomes endogenous (when the one-child policy is not binding) the two are different to the extent that transfer rates from children are responsive to the number of siblings and this shape both fertility and savings decisions. See **?** for a discussion of the welfare implications of different social security systems in China.

are effectively less valuable, and so children wish to transfer less to parents. The relationship between transfer rate and fertility estimated in the data took into account only the first reason (a). As such, if we believe that children transfer to parents as a result of altruistic behavior, then the general equilibrium forces are even stronger than if we assume the transfer rate exogenous.

In the next section we consider how assuming the transfer rate to be endogenous changes the effect of different combination of policies on the saving rate.

C.1 Relaxing the One Child Policy

When transfer rates are endogenous, then $\frac{\partial \tau_{end}(n)}{\partial n} < \frac{\partial \tau_{exo}(n)}{\partial n}$. This is due to the additional role of the interest rate: when fertility increases the interest rate goes up and thus transfer becomes less valuable, so that children want to transfer less. As a consequence

$$\frac{\partial s_{\tau(end)}(n)}{\partial n} > \frac{\partial s_{\tau(exo)}(n)}{\partial n}$$

Hence since we have shown quantitatively that relaxing the OCP reduces saving by 2.67 percentage-points when transfer rate is exogenous, then when transfer rate is endogenous savings should go down by less, or possibly even increase. Additionally, when the transfer rate is endogenous, saving rate itself has an impact on transfer rate: $\frac{\partial \tau_{end}(s)}{\partial s} > 0$, and since $\frac{\partial s(\tau)}{\partial \tau} < 0$, we know every effect on savings will be attenuated toward zero by the relationship between τ and s.

D Adding Uncertainty on transfer rate

In the empirical section of the paper we have shown that the variance of transfers received from daughters is higher than the one of transfers received from sons. In the benchmark version of the model we have assumed that transfer rates from children are deterministic, here we show that, if transfer rate are instead stochastic, as long as the utility function displays prudence, the saving rate is monotonically increasing in the variance of the transfer rate. As such, household with a daughter should save more not only due to the fact that a daughter transfer less money to her parents, but also due to the fact that there is a larger probability that the daughter would not transfer at all or transfer a very small amount.

The fact that saving increases in the variance of the transfer rate is not surprising. A stochastic transfer rate is almost isomorphic to uninsurable income shocks, and thus, as long as household are prudent they should increase their savings by an amount known in the literature as "precautionary savings". However, the presence of endogenous fertility slightly complicates the relationship, so that it is worth to clearly state the assumption that are necessary in order for the model to match the empirical evidence.

In order to see how prudence maps into a positive relationship between savings and transfer uncertainty let's introduce a slightly more general framework in which a household solves the following problem

$$\max_{s_t, n_{t+1}} u\left(c_t^Y\right) + \beta E^{\Phi}\left[u\left(c_{t+1}^O\right)\right]$$

$$s.t$$

$$c_t^Y \leq y_t - s_t - \theta n_{t+1}$$

$$c_{t+1}^O \leq \left(1 + r_{t+1}\right) s_t + \tau_{t+1}\left(\sigma_\tau^2\right) n_{t+1}$$

$$\tau_{t+1} \sim \Phi\left(\tau, \sigma_\tau^2\right)$$

$$n_{t+1} \leq \chi$$

Given this framework the following proposition holds

Proposition I For a fixed interest rate, if the utility function $u(\cdot)$ entails prudence, so that $u'''(\cdot) > 0$, the optimal saving rate, $s_t^*\left(\sigma_\tau^2\right)$, is increasing in the variance of the transfer rate, $\sigma_\tau^2 \equiv Var\left(\tau_{t+1}\left(\hat{\sigma}_\tau^2\right)\right)$, as long as the variance of total transfers increases as well,

$Corr\left(Var\left(\tau_{t+1}\left(\tilde{\sigma}_{\tau}^{2}\right)n_{t+1}\left(\tilde{\sigma}_{\tau}^{2}\right)\right),\tilde{\sigma}_{\tau}^{2}\right)>0.$

Proof The proof entails two steps. The first step proves the proposition with exogenous fertility. The second step introduces endogenous fertility, and shows that, when an equilibrium exist, the negative relationship between savings and transfer still holds.

First Step We keep fertility fixed. Taking the first order condition with respect to savings gives

$$u_{c}\left(c_{t}^{Y}\right)=\beta\left(1+r_{t+1}\right)E^{\Phi}\left[u_{c}\left(c_{t+1}^{O}\right)\right]$$

Let's call $s_{t}^{*}\left(\tilde{\sigma}_{\tau}^{2}\right)$ the optimal saving rate given a variance of transfer $\tilde{\sigma}_{\tau}^{2}$. By the optimality of the saving rate and the budget constraints, the following must hold

$$u_{c}\left(y_{t}-s_{t}^{*}\left(\tilde{\sigma}_{\tau}^{2}\right)-\theta n_{t+1}\right)=\beta\left(1+r_{t+1}\right)E^{\Phi}\left[u_{c}\left(\left(1+r_{t+1}\right)s_{t}^{*}\left(\tilde{\sigma}_{\tau}^{2}\right)+\tau_{t+1}\left(\tilde{\sigma}_{\tau}^{2}\right)n_{t+1}\right)\right]$$

Let's now consider a different variance of the transfer rate, $\hat{\sigma}_{\tau}^{2}>\tilde{\sigma}_{\tau}^{2}$, then, since $u'''\left(\cdot\right)>0$, by the Jensen inequality the following inequality holds

$$u_{c}\left(y_{t}-s_{t}^{*}\left(\tilde{\sigma}_{\tau}^{2}\right)-\theta n_{t+1}\right)<\beta\left(1+r_{t+1}\right)E^{\Phi}\left[u_{c}\left(\left(1+r_{t+1}\right)s_{t}^{*}\left(\tilde{\sigma}_{\tau}^{2}\right)+\tau_{t+1}\left(\hat{\sigma}_{\tau}^{2}\right)n_{t+1}\right)\right]$$

so that the, with $\hat{\sigma}_{\tau}^{2}$ and $s_{t}^{*}\left(\tilde{\sigma}_{\tau}^{2}\right)$, the marginal utility of consumption tomorrow is higher than the one today, and as such saving rate must increase to restore equilibrium. Therefore $s_{t}^{*}\left(\hat{\sigma}_{\tau}^{2}\right)>s_{t}^{*}\left(\tilde{\sigma}_{\tau}^{2}\right)$.

Second Step We now allow fertility to change as a function of transfer rate uncertainty. Taking the first order condition with respect to fertility gives

$$\theta u_{c}\left(c_{t}^{Y}\right)=\beta E^{\Phi}\left[\tau_{t+1}u_{c}\left(c_{t+1}^{O}\right)\right]$$

which becomes, after substituting the first order condition for savings

$$\theta\left(1+r_{t+1}\right)E^{\Phi}\left[u_c\left(c_{t+1}^{O}\right)\right]=E^{\Phi}\left[\tau_{t+1}u_c\left(c_{t+1}^{O}\right)\right]$$

We can then notice that $Corr\left(\tau_{t+1},u_c\left(c_{t+1}^{O}\right)\right)<0$. This implies that if $\hat{\sigma}_{\tau}^{2}>\tilde{\sigma}_{\tau}^{2}$, then $\frac{E^{\tilde{\Phi}}\left[\tau_{t+1}u_c\left(c_{t+1}^{O}\right)\right]}{E^{\Phi}\left[u_c\left(c_{t+1}^{O}\right)\right]}>\frac{E^{\hat{\Phi}}\left[\tau_{t+1}u_c\left(c_{t+1}^{O}\right)\right]}{E^{\Phi}\left[u_c\left(c_{t+1}^{O}\right)\right]}$: a higher variance of transfer rate effectively decreases the return to children investment. Since, with exogenous interest rate and linear expenditures per child θ, the cost of raising a children is identical for every household, then it does not exist an equilibrium in which two households face different variances of transfer rates from children. However, introducing a convex cost of children, for example by allowing θ to be an increasing function of n_{t+1}, household facing higher variance of transfer rate would have less children.

Next let's consider how the decrease in fertility changes the saving rate. As before, let's consider the case $\hat{\sigma}_{\tau}^{2}>\tilde{\sigma}_{\tau}^{2}$. We have just shown that $n_{t+1}\left(\hat{\sigma}_{\tau}^{2}\right)<n_{t+1}\left(\tilde{\sigma}_{\tau}^{2}\right)$, which implies that, everything else equal, $c_{t+1}^{O}\left(\hat{\sigma}_{\tau}^{2}\right)<c_{t+1}^{O}\left(\tilde{\sigma}_{\tau}^{2}\right)$. This last inequality implies that the saving rate should increase in order to bring the FOC for saving rate back in equilibrium. However, there is a second effect: the negative correlation between n_{t+1} and σ_{τ}^{2} implies that as the variance of transfer rate increases, the variance of transfers increases by less than one for one. The effect of endogenous response of fertility may possibly be so strong that the increase in variance of transfer rate actually decreases the variance of total transfers. If this would be the case the net effect on savings would be ambiguous. The assumption $Corr\left(Var\left(\tau_{t+1}\left(\tilde{\sigma}_{\tau}^{2}\right)n_{t+1}\left(\tilde{\sigma}_{\tau}^{2}\right)\right),\tilde{\sigma}_{\tau}^{2}\right)>0$ excludes this possibility. As such we have shown that even with endogenous fertility savings increases as a function of the variance of transfer rate. ■

As stated in the proposition, the proof is not valid in general equilibrium, nor when endogenous response in fertility are so large that an increase of the variance of transfer rates maps into a decrease of the variance of total transfers. However, the empirical evidence states that household with one son save less with respect to household with one daughter, and that transfers from sons are less volatile than transfers from daughters. Hence the empirical evidence displays a negative correlation between savings and uncertainty of transfer rate for fixed fertility and interest rate. As such the model is able to match the empirical evidence.