The Value of Children: Intergenerational Transfers, Fertility, and Human Capital*

Jaqueline M. de Oliveira†

March 15th

Abstract

In this paper, I study the relationship between fertility and old-age support in developing countries. I present a two-period model in which parents decide on the quantity and the quality of children and savings during childbearing years and children choose transfers to parents during parents' retirement years. Using this framework, I show that an exogenous increase in parents' fertility has an ambiguous effect on old-age transfers. On the one hand, total transfers increase due to the rise in the number of children, although each child transfers less as the number of siblings rises. On the other hand, the increase in fertility changes parents' optimal choices of human capital and savings. In particular, I show that the quantity-quality trade-off is weaker when old-age transfers take place. In the empirical analysis, I use individual-level data from China and Indonesia to test the model predictions. I exploit twinning in the first birth as a source of exogenous variation in the number of children. I find that twinning increases completed fertility of older mothers. Then, I show causal evidence that elder parents with more children receive more old-age transfers. Lower parental savings do not explain the latter effect. I find that children with more siblings make smaller transfers to parents. Parents respond to the increase in fertility by investing less in children's education. Despite children having lower human capital, the estimates indicate that parents with more children consume more during old age.

Keywords: Children, Human Capital, Quantity-Quality Trade-off, Intergenerational Transfers, Old-age, Savings, China, Indonesia

JEL classification codes : J13, J24, J26, O15, O16

*I am extremely grateful to Mark Rosenzweig, T. Paul Schultz, and Christopher Udry for their guidance and support. I am also thankful to Dan Keniston, Nancy Qian and all the participants of the Development Workshops at Yale University whose questions and suggestions benefited the paper.

†Ph.D. candidate at Yale University.

1 Introduction

The old-age security models of fertility rely on the assumption that family size bears a positive causal relation to old-age income through the financial assistance that children provide to parents during retirement years. As a result, one of the predictions is that the economic forces that reduce fertility lead to higher household savings. However, this prediction may not hold if higher fertility induces lower parental investments in children's human capital which, in turn, reduces their income and their ability to financially support their old parents.[1]

The other strand of the literature on the determinants of fertility is grounded in the quantity-quality trade-off models, advanced in Becker and Lewis (1973) and Willis (1973).[2] This class of models predicts an inverse relationship between fertility and investments in children's human capital, and provides an explanation for why birth rates decline when income rises even when children are not inferior goods.[3] However, these models usually neglect the fact that, in most low-income countries, children are not only "consumption goods", but they also provide parents with old-age security. This means that parents could potentially face different trade-offs when investing in quantity and quality of children in a setting where children play a direct role in parents' old-age consumption.

[1] In a seminal article, Caldwell (1976) advances the idea that the demographic transition was created by a decline in the intergenerational transfers running from children to parents. The macroeconomics literature has extensively relied on the idea that the old-age security is a motive for having children. For models that study the relationship between fertility and savings, see Modigliani and Cao (2004), Boldrin and Jones (2002), Chakrabarti (1999), Cisno and Rosati (1992), and Raut and Srinivasan (1994). For studies of the effects of social security on fertility, see Boldrin, Nard, and Jones (2005), Rosati (1996), Cigno (1993), Nishimura and Zhang (1992), and Cigno and Rosati (1992). In the applied microeconomics literature, Banerjee, Meng, and Qian (2010) exploit the one-child policy as a source of exogenous variation in fertility in order to explain the rise in the savings rate in China. With few exceptions, these studies do not account for the role of parental investments in human capital in children's financial ability to support old parents.

[2] Several models have considered the relationship between quantity and quality in studying phenomena such as economic growth, demographic transition, labor supply, and income distribution, just to name a few (see Prettner, Bloom, and Strulik (2012), Jones, Schoonbroodt, and Tertilt (2008), Moav (2005), de la Croix and Doepke (2004), Doepke (2004), Galor and Weil (2000), Ehrlich and Lui (1991), Becker, Murphy, and Tamura (1990), Becker and Barro (1988), Rosenzweig and Wolpin (1980a), and Becker and Tomes (1976)).

[3] For a comprehensive summary of empirical studies on the effects of fertility on outcomes, including children's educational attainment and health status, see Schultz (1993) and Schultz (2008). Empirical evidence of the quantity-quality trade-off is mixed. Existing studies have examined this relationship using a variety of empirical strategies, including variations in family planning policy and access to contraceptives (see Qian (2009), Miller (2005), Sinha (2003), Roy and Foster (1996), and Rosenzweig and Schultz (1987)) and birth of twins (see Angrist, Lavy, and Schlosser (2010), Black, Devereux, and Salvanes (2010), Rosenzweig and Zhang (2009), Li, Zhang, and Zhu (2008), Caceres-Delpiano (2006), Black, Devereux, and Salvanes (2005), and Rosenzweig and Wolpin (1980b)). Hanushek (1992) finds evidence of the quantity-quality trade-off when looking at the effects of birth order on children's achievement, as measured by test score performance.

In this paper, I study the relationship between fertility and old-age support in developing countries. The contribution to the literature is twofold. First, I provide causal evidence that fertility increases transfers and consumption during parents' old age. So far, the empirical literature has not established this causal link. Second, I investigate the channels through which fertility affects old-age support. In my investigation, I develop a conceptual framework that draws on the quantity-quality trade-off model of Becker and Lewis (1973) and incorporates the effects of parental choices of number of children, children's human capital, and savings on parents' old-age consumption. I demonstrate how these channels change the benchmark model and derive predictions for the effects of fertility on old-age support, which I test using individual-level data from China and Indonesia.

Most countries around the world are facing a rapid population aging. According to recent projections, by 2050 there will be 2 billion people aged 60 and older, which amounts to 22% of the world population (Banister, Bloom, and Rosenberg (2010)). The pace of this demographic change is faster in developing countries than in developed countries (United Nations DESA (2009)). At the same time, the lack of access to a public pension system is widespread among the elderly population in the developing world.[4] Unsurprisingly, there is heavy reliance of the elderly on transfers from adult children.[5] These facts make understanding the relationship between fertility and transfers a question of first-order importance for researchers and policy makers.

This paper is divided into two parts. In the first part, I present a simple two-period model. In the first period, parents decide on the quantity and quality of children, and savings for period-two consumption given their exogenous income.[6] In the second period, the adult children choose, in a non-cooperative game, how much to transfer to parents given their quality endowments, parents' savings, and number of siblings. I solve the model by first deriving the Nash equilibrium in the game played by the adult siblings

[4]In China, 8.2% of the non-working rural population aged 60 and older have pension benefits (Wang (2006)); in Indonesia, only 10% of all individuals have access to some form of pension coverage (Arifianto (2004)).

[5]Figure 1 shows that 62% of individuals in the rural areas of China plan to rely on children for financial support during old age, whereas only 5% plan to rely on the public pension system. Not only older parents expect to be supported by children when they retire, but also the observed percentage of households receiving transfers from children is large and increases with the age of the household in both China and Indonesia (see Figures 2 and 3). Moreover, these figures highlight an important feature of the lifecycle income in these economies, consistent with the rapid income growth experienced by these countries in recent years, that younger households earn more income from labor relative to older households. This lifecycle pattern is reflected in that most of the intergenerational transfers in economically developing countries run from the adult children to their parents and is consistent with the belief that transfers from children are an important source of old-age support.

[6]The terms "quality" and "human capital" are used interchangeably.

in the second period. I obtain the partial effects of increasing the number of siblings, the human capital of children, and parents' savings on the transfer that each child makes to parents and total transfers. Then, I characterize the parental demands for the quantity and quality of children, and savings when parents account for the effects of their choices on old-age consumption. I proceed by carrying out a comparative statics analysis to show that an exogenous positive shock to fertility in the first period has an ambiguous effect on transfers parents receive in the second period. On the one hand, transfers increase due to the rise in the number of children, although each child transfers less as the number of siblings rises. On the other hand, the increase in fertility changes parents' optimal choices of child human capital and savings and, consequently, affects the relative incomes of parents and children. The direction of these changes is undetermined. In particular, I show that the inverse relationship between fertility and children's human capital is weaker when the model incorporates the old-age transfers because the "returns" to investing in children's quality in terms of the old-age consumption depend positively on the number of children.

In the second part, I carry out the empirical analysis. The main empirical challenge in quantifying the effects of fertility on old-age support is that fertility is jointly determined with other outcome variables that also determine transfers, namely children's human capital and parental savings. Therefore, I need to use variation in fertility that does not reflect differences in parents' unobserved preferences and constraints. In this paper, I use the incidence of twins in the first birth.[7] The argument is as follows. If one assumes that all couples wish to have at least one child, then the increase in fertility following the birth of twins is uncorrelated with unobserved parental preferences and constraints.[8] It is worth mentioning that, while the occurrence of twin is arguably exogenous, twins are

[7]This identification strategy was introduced by Rosenzweig and Wolpin (1980a) to estimate the effects of fertility on the labor supply of young mothers in the U.S.. Other studies have used twins to study the effects of fertility on children's human capital (see Angrist, Lavy, and Schlosser (2010), Black, Devereux, and Salvanes (2010), Rosenzweig and Zhang (2009), Li, Zhang, and Zhu (2008), Caceres-Delpiano (2006), Black, Devereux, and Salvanes (2005), and Rosenzweig and Wolpin (1980b)) and female labor supply (see Caceres-Delpiano (2012), Cruces and Galiani (2007), Jacobsen, III, and Rosenbloom (1999), Angrist and Evans (1998), and Bronars and Grogger (1994)).

[8]The occurrence of twin births can be related to demographic characteristics of mothers. Jian-Ping Gan and Zheng (2007) use data on birth record from the National Vita Statistics in the 1990 Census of China to study the differences in the incidence of twinning between urban and rural areas of China. They find that the maternal age accounts for most of the variations in the dizygotic twin rate. Hoekstra, Zhao, Lambalk, Willemsen, Martin, Boomsma, and Montgomery (2008) also point to maternal age as the major factor contributing to the time trend in twinning rate around the world. On this account, the argument that twinning is orthogonal to preferences is conditional on controlling for the age of mother at first birth. Rosenzweig and Wolpin (1980a) show that, despite maternal age being a choice variable, sufficient covariation restrictions exist that allow "consistent" estimates of the effects of twinning on outcomes.

different from singletons.[9] I account for these differences in my estimates and discuss the implications for how I interpret the main results.

The results are based on reduced form estimates of the effects of twinning (the fertility shock) on outcomes of parents and children. To estimate these effects, I use the 2000 Indonesian Family Life Survey (IFLS) and the 2000, 2004, 2006, and 2009 China Health and Nutrition Survey (CHNS) to draw two samples of mothers aged 47 to 75 years old. In addition, I use the IFLS to draw a sample of adult children aged 25 to 45 years old.[10]

First, I show that the incidence of twins in the first birth increases completed fertility of older mothers. The estimated effect is an increase of 0.77 in the number of children born in China and 0.79 in Indonesia. To ensure that these results are robust to the small number of twins in my samples, I use additional data on the birth history of women 15 to 49 years old from the 1994, 1997, 2003, and 2007 Demographic Health Survey in Indonesia, as well as data from the 2000 and 2010 Indonesian Census and the 1990 Chinese Census, to show that women whose first-born children are twins have on average more children compared to those who have a first-born singleton. The estimates indicate an increase of about 0.70-0.80 in the average number of children born, which is similar to the estimates I obtain using my samples of older mothers.

Next, I present the estimates of the effects of an increase in family size on old-age transfers. Old-age individuals who experienced an exogenous positive shock to family size receive more transfers in total from their children.[11] The estimates are positive and large in both Chinese and Indonesian samples of older individuals. The increase in total transfers is about 429 CNY in China and 188,100 IDR in Indonesia (which corresponds to 9% and 13% of the household per capita income before transfers in the Chinese and Indonesian samples, respectively). Moreover, per capita consumption of non-food items is larger among parents who experienced an exogenous increase in fertility.

Consistent with the prediction of the non-cooperative game of transfers, I find evidence that children from exogenously larger families transfer individually less to their older parents. Using the sample of adult children from Indonesia, I find that children are

[9]Twins have lower birth weight compared to non-twins (Rosenzweig and Zhang (2009)). Black, Devereux, and Salvanes (2007), Case, Fertig, and Paxson (2005), Behrman and Rosenzweig (2004), and Currie and Hyson (1999) find long-term effects of low birth weight on children's outcomes, namely educational attainment, health, and earnings.

[10]I choose these surveys because they allow me to use the date of birth of children born to older women to measure the incidence of multiple births and also provide data on transfers among parents and children. However, since the CHNS does not provide data on nonresident siblings, I do not present estimates of the effects of a fertility shock on adult children's outcomes for China.

[11]Transfers are measured at the couple level when the older mother is currently married; transfers are measured at the individual level when the older mother is single or widow. Old-age male individuals who are single or widow are excluded from the sample due to lack of data on the birth date of the offspring.

10 percentage points less likely to make transfers to parents and transfer about 17,400 IDR less when their mothers experienced an exogenous increase in fertility.

Finally, I estimate the response of child human capital and savings to an exogenous increase in fertility. The results point to an adverse effect of fertility on adult children's human capital, as measured by educational attainment. I estimate that the effect is a significant decrease of approximately 0.93 years in the completed schooling of adult children in the Indonesian sample. Because the CHNS does not provide data on adult children's siblings in China, I use a sample of younger Chinese children drawn from the 1990 Chinese Census to estimate the effects of fertility on human capital of children. Consistent with the results for Indonesia, I find that children of mothers who have twins in the first birth have lower educational attainment. However, I do not find evidence that an increase in fertility decreases savings in any of my two samples of older mothers.

The conceptual framework does not account for the effects of fertility on younger mother's labor supply. However, it is possible that this channel plays a role in determining parental retirement income. To examine this effect empirically, I present additional estimates using data on labor supply available from the 1990 Chinese Census and 1997-2007 IFLS. I find that, in China, fertility decreases labor force participation of younger mothers. In Indonesia, I do not find any effect on the labor supply of younger mothers, but I show that older mothers are less likely to work during old age. The latter result is consistent with my conceptual framework in that mothers with higher fertility consume more leisure due to the increase in old-age support.

In summary, I find evidence that an exogenous increase in fertility decreases the transfer that a child makes to parents but increases total transfers that parents receive from children. Lower parental savings cannot explain the increase in old-age transfers. However, the higher fertility reduces investment in children's human capital, as measured by years of schooling. Despite children having lower quality, parents consume more and mothers enjoy more leisure during old age when they have more children.

This paper is organized as follows. In the next section, I present the conceptual framework that I developed to study the channels through which fertility affects old-age transfers. In Section 3, I discuss the use of twins in the first birth as a source of exogenous variation in fertility. In Section 4, I describe the Chinese and Indonesian samples I use in the empirical analysis and show suggestive evidence of the quantitative importance of transfers from children to older parents. In Section 5, I present the main results of the effects of fertility on transfers, children's quality, and parents' savings. In Section 6, I empirically investigate alternative explanations and carry out robustness checks. Finally, in Section 7, I present the conclusion and discuss directions for future research.

2 Theoretical Framework

In this section, I present the benchmark model in which parents decide on the quantity and quality of children and savings when children do not make transfers to parents. I derive comparative statics results for parents' optimal choices of quality of children and savings following an increase in fertility that is orthogonal to preferences and unobserved constraints. Next, I extend this model to account for the fact that parents can influence transfers and old-age consumption by choosing the quantity and the quality of children. Using this extended framework, I derive the effects of an exogenous increase in the quantity of children on parents' optimal choices of quality of children and savings and compare to the results from the benchmark model. Finally, I show how fertility affects the transfer that each child makes to parents and total transfers that parents receive from children.

2.1 The Quantity-Quality Trade-off without Transfers from Children

The set up is as follows. There are two periods. The first period is the childbearing years. The second period is the retirement years. Parents' utility in the first period depends on the number of children, n, the per-child quality, q, and the family consumption, c_f. In the second period, parents derive utility from their old-age consumption, c_p. The parents' utility is represented by $U(n, q, c_p, c_f)$, where $U_m > 0$ and $U_{mm} < 0$, $m \in \{n, q, p, f\}$.

In the first period, parents are endowed with an exogenous income, I, but they do not earn income in the second period. Total expenditure on children is $\pi_q nq$, where π_q is the marginal cost of per-child quality. There is an opportunity cost to save for future consumption, given by π_s. The price of period-one family consumption is normalized to one. The budget constraint features the standard interaction between the quantity and the quality of children (Becker and Lewis (1973), Willis (1973)). That is, it costs parents more to increase per-child quality when the number of children is large. It is also more costly to have more children of given quality when per-child quality is high.[12]

In this preliminary model, I do not allow for children to make transfers to parents during retirement years. This implies that parents' old-age consumption can only be affected by the first-period savings, so that $c_p = s$. Given this setup, one can write the parents' problem as

[12]It should be noted that in the quantity-quality trade-off model in Becker and Lewis (1973) and Willis (1973)the old-age consumption does not enter the parents' utility function.

$$\begin{aligned} \max_{n,q,s,c_f} \quad & U(n,q,s,c_f) \\ \text{s.t.} \quad & I = \pi_q nq + \pi_s s + c_f \end{aligned} \tag{1}$$

This optimization problem yields a system of first-order conditions

$$n: \; U_n = \lambda \pi_q q \tag{2}$$

$$q: \; U_q = \lambda \pi_q n \tag{3}$$

$$s: \; U_p = \lambda \pi_s \tag{4}$$

$$c_f: \; U_f = \lambda \tag{5}$$

price of the quantity of children depends on per-child quality. Similarly, the shadow price of per-child quality depends on the quantity of children. This interaction gives rise to an inverse relationship between the quantity and the quality of children that does not rely on any assumptions about preferences. This result is known as the quantity-quality trade-off (Becker and Lewis (1973), Willis (1973)).

Next, using this preliminary model, I study how parents adjust the optimal investment in children's human capital and old-age savings when fertility is exogenously shifted around the optimal determined by equations (2)-(5).[13] In order to focus on the interaction between n and q in the budget constraint, I assume that the utility function is separable in all arguments, that is, $U_{lm} = 0$, for $l \neq m$ with $l, m \in \{n, q, p, f\}$. In addition, I assume that $U_{ll} < 0$. Treating n as a parameter, $\overline{n}$, the partial effects of $\overline{n}$ on q, s, and c_f are given by the equations bellow:

$$\frac{\partial q}{\partial \overline{n}} = \frac{1}{\Delta}\{-\phi_{12}\pi_q q + \phi_{22}\lambda \pi_q\} \tag{6}$$

$$\frac{\partial s}{\partial \overline{n}} = \frac{1}{\Delta}\{\phi_{13}\pi_q q - \phi_{23}\lambda \pi_q\} \tag{7}$$

$$\frac{\partial c_f}{\partial \overline{n}} = \frac{1}{\Delta}\{-\phi_{14}\pi_q q + \phi_{24}\lambda \pi_q\} \tag{8}$$

[13]Tobin and Houthakker (1950-1951) and Pollak (1969) studied the problem in which the demands for market-provided goods are functions of prices and the quantities of "preallocated" goods. For the purposes of this paper, one can interpret the occurrence of twin birth as analogous to an exogenous change in the predetermined component of fertility and derive comparative statics results of the partial effects of this change on the demand for the other goods. I discuss the twin methodology in more detail in the next section.

where Δ is the determinant of the bordered Hessian matrix of the problem in which n is treated as a parameter and the ϕ_{ij}'s are its cofactors. I present the details of the derivation of these effects in Appendix A. The first term in equations (6), (7), and (8) is the "income effect" of an increase in $\overline{n}$. The second term is the "price effect". One can show that, under the assumption of separability in the utility function, the income effect is negative for all the variables. The price effect on the demand for per-child quality is negative since, from the second-order conditions for maximization, $\phi_{22} < 0$. This result is very intuitive and follows from the dependence of the shadow price of q on n. An increase in $\overline{n}$ works as an increase in the price of q, but do not affect the marginal utilities of the other goods in the parents' utility function. For the other variables, the price effect is positive.

To sum up, in this variant of the quantity-quality trade-off model, an exogenous increase in the quantity of children causes parents to substitute away from child human capital toward current and future consumption because the price of q increases relative to the price of s (that is, c_p) and c_f. The income effect from the increase in $\overline{n}$ further decreases q, so that this model predicts an *unambiguous* fall in parental investments in child quality. However, since the income effect is positive for s and c_f, one cannot tell how the increase in $\overline{n}$ affects current family consumption and old-age consumption.

2.2 The Quantity-Quality Trade-off with Transfers from Children

In this section, I consider a model in which the retirement income of parents is affected by the financial assistance they may receive from their grown-up children. During the child-bearing years, parents choose n, q, s, and c_f given their income, I. In the retirement years, the adult children choose non-cooperatively the amount of transfers to their parents taking n, q, and s as given. I find the subgame perfect equilibrium in this game by backward induction. First, for any given n, q, and s, I obtain the optimal transfer from children to parents and parents' consumption in the second period. Then, I derive parents optimal choices of n, q, and s while accounting for how these choices affect their second-period consumption.

2.2.1 The Adult Children's Problem

I index each child by k, where $k = 1, ..., n$, and the parents by p. A child's utility depends on own consumption, c_k, and on parents' old-age consumption, c_p, and is represented by $V(c_k, c_p)$, with $V_k, V_p > 0$ and $V_{kk}, V_{pp} < 0$. Each child is endowed with q, which is set by parents in the first period. To simplify the exposition, I assume that a child's income, I_k,

is determined only by her quality endowment and that the return to quality is equal to one, so that $I_k = q$. The income can be used for own consumption and to make transfer to parents, T_k. Parents consume their savings, s, and total transfers received from children, $\sum_{k=1}^{n} T_k$.

To determine the optimal transfer chosen by the grown-up children, I assume that children play a non-cooperative transfer game. Although the cooperative bargaining models have been amply used to study the intra-household allocation of resources, they are less appealing for modeling the decision-making among adult siblings who generally have separate households and are more likely to have conflicting interests.[14]

One can write the maximization problem of each child as follows:

$$\begin{aligned} \max_{T_k} \quad & V(q - T_k, s + T_k + \sum_{j \neq k} T_j) \\ \text{s.t.} \quad & T_k \geq 0 \end{aligned} \tag{9}$$

The first-order condition yields the following equations that define the best response of child k to the transfer choices of her siblings:

$$\begin{aligned} V_k(q - T_k^*, s + T_k^* + \sum_{j \neq k} T_j) &= V_p(q - T_k^*, s + T_k^* + \sum_{j \neq k} T_j) \text{ if } T_k^* > 0 \\ V_k(q - T_k^*, s + T_k^* + \sum_{j \neq k} T_j) &> V_p(q - T_k^*, s + T_k^* + \sum_{j \neq k} T_j) \text{ if } T_k^* = 0 \end{aligned} \tag{10}$$

Given the level of transfers, an increase in the child's quality relative to parents' savings creates an incentive for the child to transfer more. This increases total parental resources through transfers. However, when the child transfers more, the marginal utility of parents' consumption decreases for the other children, in which case they individually transfer less to parents, offsetting the initial increase in total transfers. In equilibrium, the children transferring resources to parents have no incentive to change the amount of transfer. The children whose marginal utility of parents' consumption is low do not make transfers to parents.

The symmetric equilibrium

Next, I study the equilibrium in the game of transfers. I assume that all children have the same preferences for own consumption and parents' consumption. As in the stan-

[14]Other studies of family-provided elderly care that have adopted the non-cooperative approach are Antman (2012), Byrne, Goeree, Hiedemann, and Stern (2009), Fontaine, Gramain, and Wittwer (2009) and Hiedemann and Stern (1999).

dard quantity-quality trade-off model, all children receive the same amount of parental investment in quality. This implies that the only pure strategy Nash equilibrium in the game played by the adult children is symmetric. Assuming an interior solution, in such equilibrium each child chooses the same transfer, so that $T_k^* = T^*$. This optimal level of transfer to parents is the solution to the following equation:

$$V_k(q - T^*, s + nT^*) = V_p(q - T^*, s + nT^*) \tag{11}$$

An interior solution exists provided that $V_k(q, s) < V_p(q, s)$. Notice that the first-order condition implies not only that the optimal transfer is determined by the incomes of children and parents, q and s, but also by family size, n. One can see that an increase in n has a positive effect on the total amount of transfers that parents receive from children, nT^*. As the increase in family size increases parents' resources, the marginal utility of own consumption increases relative to parents' consumption and each child subsequently reduces transfer to parents.

In what follows, I assess the changes in the equilibrium transfers implied by an exogenous change in n, holding q and s fixed. For simplicity, I make the additional assumption that a child's utility is separable in its arguments, so that $V_{kp} = V_{pk} = 0$. I first derive the effects of an increase in n on the transfer that each child makes to parents, T^*. Total differentiation of equation (11) with respect to T^* and n, keeping q and s constant, yields the following:

$$\frac{\partial T^*}{\partial n} = -\frac{T^*\gamma}{1 + n\gamma} < 0 \tag{12}$$

where $\gamma = \frac{V_{pp}}{V_{kk}} > 0$. The intuition is as follows. Suppose one adds a child to the family who, at a given s, has an incentive to make a transfer. Suppose also that the equilibrium transfer T^* does not change. This means that total transfers to parents are larger than before, which decreases the marginal utility of parents' consumption relative to the marginal utility of own consumption for all children. To equate the marginal utilities in the new equilibrium, the consumption of each child increases, which means that transfer per-child is smaller. Therefore, *ceteris paribus*, individual transfer to parents is decreasing in the number of siblings.

Now, denote total transfers by $\overline{T} = nT^*$. The effect of changing n on $\overline{T}$, while holding q and s constant, is

$$\frac{\partial \overline{T}}{\partial n} = \frac{T^*}{1 + n\gamma} > 0. \tag{13}$$

That is, despite the fact that each child transfers less to parents in the new equilibrium, parents receive more transfers overall. This is so because when each child transfers less to parents their consumption increases, which in turn causes the marginal utility of own consumption to decrease relative to the marginal utility of parents' consumption. Therefore, total transfers have to go up in order to equate both marginal utilities. Intuitively, an increase in family size, everything else constant, increases the family wealth and the benefits are shared among all members in the form of higher consumption.

Additionally, the effects of a change in q, keeping n and s constant, are $\frac{\partial T^*}{\partial q} = \frac{1}{1+n\gamma} > 0$ and $\frac{\partial \overline{T}}{\partial q} = \frac{n}{1+n\gamma} > 0$. Similarly, $\frac{\partial T^*}{\partial s} = -\frac{\gamma}{1+n\gamma} < 0$ and $\frac{\partial \overline{T}}{\partial s} = -\frac{n\gamma}{1+n\gamma} < 0$. To sum up, for given levels of n and s, an increase in child's quality increases the transfer that each child makes to parents and also total transfers that parents receive from children, and an increase in the amount of resources that parents save for old-age consumption has a negative effect on both the per-child transfer and total transfers. The magnitudes of these effects depend on γ, which reflects how large is the decrease in the marginal utility following an increase in parents' consumption relative to the decrease in the marginal utility due to an increase in children's consumption.

Finally, from the parents' budget constraint $c_p = s + nT^*$, one can show that the old-age consumption is increasing in n, q, and s and the partial effects are given by

$$\frac{\partial c_p}{\partial n} = \frac{T^*}{1+n\gamma} > 0 \tag{14}$$

$$\frac{\partial c_p}{\partial q} = \frac{n}{1+n\gamma} > 0 \tag{15}$$

$$\frac{\partial c_p}{\partial s} = \frac{1}{1+n\gamma} > 0 \tag{16}$$

Notice that an increase in parents' savings increases old-age consumption by less than it does in the model without transfers from children. In addition, one can see that the return to the quality of children in terms of old-age consumption of parents is higher than the return to savings. In what follows, I consider the parents' problem of choosing n, q, s, and c_f.

2.2.2 The Parents' Problem

As in the benchmark model, parents face the problem of choosing n, q, and s given their exogenous income I. In this extended model, however, old-age consumption can be affected not only by savings, but also by the quantity and quality of children. That is, in

the model that allows for old-age transfers, the quantity and the quality of children are not only consumption goods for parents, but also investment goods. The optimization problem becomes:

$$\begin{aligned} \max_{n,q,s,c_f} \quad & U^t(n,q,c_p(n,q,s),c_f) \\ \text{s.t.} \quad & I = \pi_q nq + \pi_s s + c_f \end{aligned} \tag{17}$$

where $U^t(n,q,c_p,c_f) = U(n,q,c_p(n,q,s),c_f)$, the superscript t standing for *transfers*. This problem yields the following system of first-order conditions:

$$n: \; U_n + U_p \frac{\partial c_p}{\partial n} = \lambda \pi_q q \tag{18}$$

$$q: \; U_q + U_p \frac{\partial c_p}{\partial q} = \lambda \pi_q n \tag{19}$$

$$s: \; U_p \frac{\partial c_p}{\partial s} = \lambda \pi_s \tag{20}$$

$$c_f: \; U_f = \lambda \tag{21}$$

When comparing first-order conditions (2)-(4) to first-order conditions (18)-(20) one can see that, for any prices π_q and π_s, parents invest more in quantity and quality of children and less in savings when transfers from children take place compared to the case in which they can only affect old-age consumption through savings.

The next step is to assess the implications of having $\frac{\partial c_p}{\partial n}$ and $\frac{\partial c_p}{\partial q} > 0$ for how a change in $\overline{n}$ affects q, s, and c_f. One can show that the partial effects are as follows:

$$\frac{\partial q}{\partial \overline{n}} = \frac{1}{\Delta^t}\{-\phi_{12}^t \pi_q q + \phi_{22}^t \lambda \pi_q + (-\phi_{22}^t U_{qn}^t + \phi_{32}^t U_{sn}^t)\} \tag{22}$$

$$\frac{\partial s}{\partial \overline{n}} = \frac{1}{\Delta^t}\{\phi_{13}^t \pi_q q - \phi_{23}^t \lambda \pi_q + (\phi_{23}^t U_{qn}^t - \phi_{33}^t U_{sn}^t)\} \tag{23}$$

$$\frac{\partial c_f}{\partial \overline{n}} = \frac{1}{\Delta^t}\{-\phi_{14}^t \pi_q q + \phi_{24}^t \lambda \pi_q + (-\phi_{24}^t U_{qn}^t + \phi_{34}^t U_{sn}^t)\} \tag{24}$$

where Δ^t is the determinant of the bordered Hessian matrix and ϕ_{ij}^t's are the cofactors from the model (19)-(21) when n is treated as a parameter, $\overline{n}$. The second-order conditions for utility maximization imply that $\Delta^t < 0$ and ϕ_{22}^t, ϕ_{33}^t, and $\phi_{44}^t > 0$. Here U_{qn}^t and U_{sn}^t are the derivatives of the left hand side of equations (19) and (20) with respect to $\overline{n}$. I show the derivation of the partial effects and the equations for the cofactors in Appendix B.

Recall that, in the benchmark model, an increase in $\overline{n}$ reduces q due to the negative income and price effects. In the extended model, the effect of an increase in $\overline{n}$ on q is ambiguous. In equation (22), the first term captures the effect of increasing $\overline{n}$ on q that arises from a change in the budget constraint. It is easy to show that $\phi_{12}^t < 0$ if $\pi_q > \pi_s$, that is, the "income effect" of an increase in $\overline{n}$ on q is negative when the marginal cost of increasing per-child quality exceeds the opportunity cost of savings. The second term shows the effect of increasing $\overline{n}$ on the shadow price of q relative to the other goods, s and c_f. Since $\phi_{22}^t > 0$, the sign of the "price effect" is also negative, as in the benchmark model.

Finally, the term in parentheses captures the changes in the marginal utilities of q and s caused by the increase in $\overline{n}$. In Appendix B, I show that the sign of U_{qn}^t is undetermined. Under certain assumptions about children's preferences, an increase in $\overline{n}$ raises the returns to children's quality in terms of old-age consumption, that is, $\frac{\partial^2 c_p}{\partial n \partial q} > 0$.[15] The intuition for this result is as follows. When the quality of children increases, they make more transfers to parents so that the marginal utilities of own consumption and parents' consumption are equalized. However, from the assumption that the marginal utility is decreasing in parents' consumption, the gain in the children's utility from an increase in parents' consumption is smaller when the number of siblings is large relative to when the number of siblings is small, *ceteris paribus*. Therefore, an increase in the quality of children (or, equivalently, their income) induces a larger increase in transfers and, consequently, parents' consumption, when $\overline{n}$ is larger. *This creates a complementarity between n and q that eases the quantity-quality trade-off even when n and q are separable in the parents' utility function*.

The term $\phi_{32}^t U_{sn}^t$ is negative and captures the decrease in the marginal utility from s (and c_p) when $\overline{n}$ increases.[16] When the marginal utility of s decreases, parents substitute away from s toward q. In summary, when $\overline{n}$ affects old-age consumption, the effect of an increase in $\overline{n}$ on q is ambiguous. While the change in relative prices reduces the demand for q, the changes in the marginal utilities of q and s create an effect that goes in the opposite direction, as parents substitute away from s toward q.

The partial effect on s appears in equation (23). Since the sign of ϕ_{13}^t is unknown, the "income effect" is ambiguous. The second term, $-\phi_{23}^t \lambda \pi_q$, is negative and shows the increase in s due to the increase in the shadow price of q. Finally, the term in parentheses

[15] These assumptions are that $V_{ppp} = V_{kkk} = 0$. However, I show in Appendix C that one can also obtain the same results under the assumption that the adult children's preferences are characterized by Cobb-Douglas utility functions of the form $V(c_k, c_p) = \alpha_k log(c_k) + \alpha_p log(c_p)$, where α_k,$\alpha_p > 0$.

[16] This decrease follows from $\frac{\partial c_p}{\partial n}$ being positive instead of zero as in the benchmark model.

is positive and captures the decrease in s due to the changes in the marginal utilities of q and s. This is in contrast with the predictions from the benchmark model, in which the "price effect" is unambiguously positive.

2.2.3 The Effects of an Increase in Fertility on Transfers

One can use the framework developed previously to derive the implications of an exogenous increase in fertility in the first period for parents' optimal choices of per-child quality and savings and for children's optimal transfers. The effects are

$$\begin{aligned} dT^* &= \frac{\partial T^*}{\partial \overline{n}} d\overline{n} + \frac{\partial T^*}{\partial q}\frac{\partial q}{\partial \overline{n}} d\overline{n} + \frac{\partial T^*}{\partial s}\frac{\partial s}{\partial \overline{n}} d\overline{n} \\ d\overline{T} &= \frac{\partial \overline{T}}{\partial \overline{n}} d\overline{n} + \frac{\partial \overline{T}}{\partial q}\frac{\partial q}{\partial \overline{n}} d\overline{n} + \frac{\partial \overline{T}}{\partial s}\frac{\partial s}{\partial \overline{n}} d\overline{n} \end{aligned}$$

The direct effect of increasing fertility is a reduction in the transfers that each child makes to parents and a rise in total transfers that parents receive from children. The indirect effects are ambiguous and depend on how the optimal levels of q and s respond to the shock in fertility. Although I cannot obtain estimates of the partial effects $\frac{\partial \overline{T}}{\partial q}$, $\frac{\partial T^*}{\partial q}$, $\frac{\partial \overline{T}}{\partial s}$, and $\frac{\partial T^*}{\partial s}$, in the empirical analysis that follows I present estimates of $\frac{d\overline{T}}{d\overline{n}}$, $\frac{dT^*}{d\overline{n}}$, $\frac{\partial q}{\partial \overline{n}}$, and $\frac{\partial s}{\partial \overline{n}}$.

3 Twin-first Methodology

Multiple births are arguably outcomes of a pregnancy that are difficult to predict and, therefore, cannot be determined by behavior.[17] Unsurprisingly, many studies have used twinning as a source of exogenous variation in the supply of children to investigate the effects of a change in fertility on various outcome of children and mothers.

The twin-first methodology was introduced by Rosenzweig and Wolpin (1980a).[18] The authors argue that, to the extent that the probability of the incidence of multiple births increases with the number of births, comparing outcomes of women who gave birth to

[17] The adoption of fertility treatments that increase the risk of multiple births implies that behavior might affect the occurrence of multiple births. However, this problem is unlikely to arise in the context investigated in this paper, where the targeted population lives mostly in rural areas and, therefore, cannot afford fertility treatments. Such treatments subsidized by government are unheard of. Also, I examine cases in which the mothers had twins before fertility treatments were available.

[18] They used the incidence of twins in the first birth to predict the response of labor force participation of mothers to unanticipated fertility shocks using a sample of 12,605 American women 15 to 44 years old.

twins at any parity with the outcomes of those women who had singletons in all pregnancies might also capture differences in outcomes due to differences in preferences for number of children. Therefore, twin births that occurred in the first pregnancy represent the ideal natural experiment in that women who had twins would prefer the same number of children as those women who did not have twins.

There is one important fact about twins. The medical literature has emphasized that, while the rate of monozygotic twinning occurrence is relatively stable, the rate of dizygotic twinning is highly correlated with maternal age at birth.[19] This association requires controlling for that age at first birth when using the incidence of multiple births as a source of variation in family size. While including the age at first birth might raise concerns to the extent that this is a choice variable potentially correlated with unobservable preferences, one can still obtain "consistent" estimates of the twin-first effect. The reason is because twins first is orthogonal to the other determinants of the outcome variable and because age at first birth is orthogonal to the other determinants of the occurrence of twins in the first birth (Rosenzweig and Wolpin (1980a)).

The empirical analysis is based on reduced form estimates of the twin-first effect on outcomes of parents (fertility, total transfers from children, consumption, and savings) and adult children (sibship size, transfer to parents, schooling, and income). The estimates are obtained using two samples of older mothers, one from China and another one from Indonesia, and one sample of adult children, also from Indonesia.[20]

The specification is as follows:

$$Y_{itj} = \alpha_0 + \alpha_1 TWIN_i + \alpha_2 AGEFB_i + \alpha_3 AGE_{it} + \epsilon_{it} + \delta_t + \mu_j \tag{25}$$

where $i = m, c$, with m indexing the mothers and c the adult children, t is the year and j is the community. Y_{itj} is the outcome variable of interest. $TWIN_i$ is a dummy variable indicating whether the mother gave birth to twins in the first birth, $AGEFB_i$ is the age of the mother at first birth, and AGE_{it} is the current age of the mother. For the estimates using the sample of adult children, the $TWIN_c$ dummy indicates cases in which the child's oldest siblings were twins or the child was herself a twin. Finally, δ_t is the year fixed effect and μ_j is the community fixed effect. Whenever appropriate, I also include a dummy for rural residence.

[19] The medical literature discusses the increase in the probability of multiple births with the age of the mother at conception (see Smits and Monden (2011), Hoekstra, Zhao, Lambalk, Willemsen, Martin, Boomsma, and Montgomery (2008), Jian-Ping Gan and Zheng (2007), and Mittler (1971)).

[20] Lack of data on siblings prevents me from carrying out the estimates for a sample of adult children in China.

First, I obtain estimates of the effects of twins first on the number of children born using the samples of older mothers. I also present estimates of the effects of twinning on number of siblings alive for the sample of adult children. I expect this effect to be positive and significant, but not larger than one. This is because some adjustment of subsequent births occurs in response to an unexpected extra birth experienced early in the woman's childbearing years.

For the two samples of older mothers, I estimate the twin-first coefficient in equation (25) on total transfers received from children and consumption of non-food items. Since the model predicts that an exogenous fertility increase might affect transfers through its effect on savings, I estimate the twin-first effect on the value of assets.

In the sample of Indonesian adult children, I look at the twin-first effect on per-child transfers to parents. I assess the implications of an exogenous change in fertility for past parental decisions on quality of children by obtaining estimates of the twin-first effect on adult children's educational attainment and health status, as measured by years of schooling and body mass index (BMI), respectively. For the sake of completeness, I conduct the analysis for children's educational attainment in China using a sample of younger children.

The caveat in using the adult child's BMI as a measure of investment in children's human capital is that it reflects past parental allocation decisions, but it is more likely to be determined by the adult child's current resources. For this reason, the sign of the twin-first effect could be positive since, according to the model, the increase in sibship size might increase not only parents old-age consumption, but also the adult children's consumption.[21]

One major issue with using twins to identify the causal effect of fertility on any outcome variable is the well documented inferior endowment at birth of twins compared to singletons. This endowment difference has implications for how parents allocate resources across children, as discussed in Rosenzweig and Zhang (2009). The authors conclude that, in China, parents reinforce the differences in endowment by investing more in the quality of the singleton children born before the twins. The overall effect of the unexpected extra child is still to lower investment in per-child quality. For the purposes of this paper, this reinforcing behavior of parents does not alter the implications drawn from the model. If no endowment differences existed and, therefore, no reinforcing behavior took place, per-child quality would have been larger and transfers from children to parents would be larger compared to the case with endowment differences and reinforcing be-

[21] Another limitation is that BMI is a non-monotonic measure of health status (BMI above 18.5 is good, but BMI above 30 is bad).

havior. Whichever estimate of the twin-first effect on transfers I obtain is at least as large as the effect in the ideal situation where the unanticipated child does not have inferior endowments.

4 Data Sources

The empirical strategy discussed in the previous section imposes two main data requirements. The first requirement is data on transfers from children and transfers to parents. The second requirement is data on the date of birth of children born to older women that allow me to construct the twin-first variable. For those reasons, the data used in this paper come from two sources: the China Health and Nutrition Survey (CHNS) and the Indonesian Family Life Survey (IFLS). In this section, I describe the samples I use to obtain quantitative estimates of the effects of a fertility shock on old-age transfers.

4.1 China

The first source of data is the China Health and Nutrition Survey. The CHNS is a longitudinal survey conducted by the Carolina Population Center, University of North Carolina. The survey focuses on health outcomes and nutrition status of Chinese households, but also collects extensive data on household economy and demographic characteristics of its members. It covers nine Chinese provinces: Guangxi, Guizhou, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Liaoning, and Shandong. I use data from the waves 2000, 2004, 2006, and 2009, since for these years the survey collected household-level data on transfers received from children. The CHNS also contains the birth history of women who are not in childbearing age. More specifically, it provides the year and the month of birth of each child, as well as the year and the month of death. Therefore, I am able to use the CHNS to measure the occurrence of twin births without error. The downside of the CHNS is the lack of data on the nonresident siblings. This means that I cannot quantify the effects of a fertility shock on the outcomes of adult children in China. In what follows, I discuss the sample selection criterion and provide some basic descriptive statistics for my sample of Chinese elderly mothers.

Sample of Mothers

The sample is composed of mothers who are female head or spouse, 47 to 75 years old in 2000[22], and who had at least one child. I further restrict the sample to individuals living in rural areas due to the well-known rural-urban gap in social-security provision in China.[23] In Table 1, I show descriptive statistics for the Chinese sample. I pool the data from the waves 2000, 2004, 2006, and 2009 and account for that by clustering the standard errors at the individual level in all estimation results for China.[24] There is a total of 6,133 observations; 1,520 women appear in the 2000 wave, 1,573 in 2004, 1,567 in 2006, and 1,473 in 2009. There are 12 mothers who had twins in the first birth in 2000; in 2004, 2006, and 2009, there are 10, 10, and 11 mothers who gave birth to twins in the first birth, respectively.[25] The twinning rate in the Chinese sample is 7 births in 1,000. The average fertility in the sample is 2.6 children. These numbers are plausible in the Chinese context in that most of the women in the sample were subjected to the restrictions on childbearing imposed by the family planning policies in the 70's.[26] When the sample is divided by the twinning status, one can see that fertility is higher among women who had twins in the first birth suggesting that, while some degree of ex post adjustment to fertility takes place, the incidence of twins is associated with an increase in completed fertility.

In Table 1, I show suggestive evidence that intergenerational transfers are important for Chinese households. On average, 33% of households received transfers from children over the 2000-2009 period and among those who received financial transfers from children, transfers amounted to approximately 34% of the household income before transfers.[27] When the sample is divided according to the twinning status, one can see that a much higher percentage of households received transfers from children in the sample of mothers with twins relative to the other mothers. The size of the transfers was also larger in the twin sample, both overall and conditional on transfers being positive.

[22]The retirement age for female workers in China is 50 years. I include women 47 to 49 years old in order to increase the number of twins in my sample.

[23]The social-security system in China is very segmented and its organization and benefits vary substantially depending on rural-urban status (Hussain (1994)). All urban employees of government, state-owned, and collective-owned firms benefit from a comprehensive insurance scheme. On the other hand, labor insurance does not extend to rural wage employees. The system also excludes the rural self-employed workers.

[24]All the monetary variables used in the estimates for China are inflated to 2009 values.

[25]Given the panel feature of the survey, most women appear in more than one wave.

[26]Couples in rural areas were often imposed a cap of two children following the one-child policy in 1979. The fact that 25% of the sample are women older than 60 and, therefore, less affected by the restrictions on fertility, explains why the average number is larger than the cap of two children.

[27]Household income before transfers corresponds to the sum of income from wages, farming, non-farming business, gardening and fishing of all household members.

4.2 Indonesia

The second source of data is the Indonesian Family Life Survey. The IFLS is a longitudinal survey, administrated by the RAND Corporation, which covers households located in 13 of the 26 Indonesian provinces in 1993 and comprises approximately 83% of the country's population as of that year. The IFLS contains a broad range of information collected at the individual and household levels, including indicators of economic well-being, such as consumption, income, and assets, education and labor market outcomes, fertility, health status, as well as relationships among coresident and noncoresident family members and transfers among noncoresident family members.

The IFLS asks respondents older than 15 years about all children living outside the household, including data on intergenerational transfers and demographic characteristics, such as age and education. Therefore, the unit of analysis is the mother, not the household.[28] Additionally, I use household-level data on expenditure with non-food consumption items, as well as data on the value of assets.[29] Finally, the IFLS provides basic demographic data on all siblings alive (whether or not residing in the household) and parents. More importantly, the survey collects information on the size of the financial transfers made to nonresident parents.

Sample of Mothers

From the IFLS 2000, I draw a sample of mothers who are 47 to 75 years old in 2000 and have at least one child. The sample includes women living in rural or urban areas.[30]

The household roster contains information on the date of birth (year and month) of children who reside in the household. In addition, for each adult individual, the survey collected data on the date of birth of children living outside the household. However, in some cases the date of birth was not available for all children listed in the resident and nonresident children rosters, so the twin-first variable is constructed as follows. For the women with complete data on year and month of birth for all children alive, I assigned value one to the twin-first dummy when the oldest children had the same year and month

[28]The data on transfers refer to the amount received by the couple when the mother has a husband. Transfers received by male individuals without a female spouse at home are not being considered in the analysis that follows.

[29]Non-food items include electricity, water, fuel, telephone, personal toiletries, and household item, such as laundry soap, cleaning supplies and the like. Expenditures with those items were reported using the last month as reference period and were, therefore, multiplied by 12 in order to obtain annual measures. Other non-food items are clothing and household supplies and furniture. For the last items, the reference period was the past year, so no transformations were necessary.

[30]Unlike in China, lack of access to old-age pension is not limited to those living in rural areas.

of birth. For women with missing data on the month of birth, but complete data on the year of birth, I assigned the twinning status to women whose oldest kids had the same year of birth. Some women did not have complete data on year of birth. In those cases, I assigned the twinning status using the age of children reported in the survey rosters. In my sample, 43% of women had the twin-first dummy assigned using information on the age of their children; 47% had the twin-first status assigned using both the year and month of birth and 10% using only the year of birth.

In Table 2, I present summary statistics for the Indonesian sample of mothers. There are 3,029 women in the sample, 29 of which had twins in the first birth. This means that the twinning rate among the Indonesian mothers is 10 births in one thousand. This number is higher compared to the Chinese sample, in part due to some measurement errors when using the age to assign the twinning status. To see that, when I limit the sample to younger mothers (37 to 75 years old) for whom I had complete data on the year of birth of all children, the twinning rate is about 7 births in 1,000, which is close to the Chinese rate and also consistent with the rates found in the medical literature.[31] I present estimates using this sample of younger mothers with better data on twins when I discuss the robustness of my main results.

Fertility in Indonesia is higher (average of 5.3 children) compared to China (2.6 children). Fertility is also higher in the sample of Indonesian women who gave birth to twins in the first birth. The measure of transfers includes cash transfers and the monetary value of food stuff and other goods the households received from children in the past 12 months. About 52% of the households reported that they received cash or in-kind transfers from children. Among those households who received financial support from their children, on average the transfer amount corresponded to 38% of the household income before transfer, which suggests that, like in China, children are an important source of income for parents during old age.

[31] Smits and Monden (2011) examine the variation in twinning rates across developing countries using data on women aged 15 to 49 from the DHS. For China, the authors report the twinning rate estimated in Jian-Ping Gan and Zheng (2007) based on the birth record data from the National Vital Statistics in the 1990 Chinese Census. They find that the twinning rate for Indonesia is 7.2 per 1,000 births, whereas the rate for China is 7.9 per 1,000 births. As one can see, the twinning rates in the samples of older mothers I draw from the IFLS and the CHNS are similar. Additionally, the twinning rates are consistent with the U.S. rate:Rosenzweig and Wolpin (1980a) use a sample of American mothers and find that 87 of the 12,605 women in his sample had twins in the first birth, which corresponds to a rate of approximately 7 per 1,000 births.

Sample of Adult Children

The IFLS 2000 does not collect data on the age of siblings in the nonresident sibling roster. For this reason, I draw the sample of adult children from the IFLS 1997. The sample includes 3,703 individuals who were 25 to 45 years old in 1997, male or female, whose relationship status in the household is head or head's spouse, and who had at least one of the two parents alive and living outside the household. The survey does not contain the date of birth of siblings who live outside the household. Alternatively, I use information on the age of siblings to construct the twin-first dummy. The procedure is as follows. If the two oldest siblings of the adult child had the same age (or the child herself was the oldest and had a sibling of the same age), I assume that this child was born to a mother who had a twin in the first birth.

In Table 3, I present the summary statistics. In this sample, 68% of children made transfers to parents, conditional on having at least one of the parents living outside the household. The average transfer to parents and the fraction of children making transfers are lower among children with twin siblings. As expected, the average number of siblings is higher among children with twin siblings.

It is worth noting that the twinning rate produced when using the age of siblings alive is higher compared to the previous cases - 13 births in 1,000. This is not surprising and it is likely due to two factors. First, in a setting with high fertility, births are more likely to be closely spaced. Second, the survey collects data on the age of nonresident and resident siblings in different months and this could further increase the probability that ages coincide. While there is no easy way to circumvent these issues, I present some evidence in the next section showing that the estimates of the effects of twinning on fertility do not differ substantially whether I use the age or the date of birth to measure twin occurrence.

5 Fertility and Old-age Transfers

5.1 Fertility

5.1.1 Twinning and Fertility

In this section, I show evidence that the occurrence of twinning in the first birth increased the completed fertility of Chinese and Indonesian mothers. In Table 4, I present the estimates using my two samples of mothers 47 to 75 years old. The dependent variable is the

number of children born.[32] In addition to controlling for the mother's age at first birth and the mother's current age, I include year and community fixed effects for the estimates using the Chinese data and district fixed effects for the estimates using the Indonesian data. Overall, I find evidence that the incidence of twins in the first birth increases fertility.

The large effect observed in Indonesia seems odd at first, since one would imagine that, in a high fertility setting like the Indonesian where couples have on average 5.3 children, the impact of a fertility shock in the first birth on completed fertility would be small.[33] Estimates of the effect of twinning on fertility are widely available for developed countries, but not for developing countries.[34] For this reason, I use three additional sources of data on Indonesian mothers to assess the fertility effects of twinning in the first birth. The first two sources are 2% samples from the 2000 and 2010 Censuses drawn from the IPUMS International. The Censuses provide data on the year and month of birth of all household members, which allows me to measure twinning accurately. In addition, the Censuses convey information on the number of children born by a woman, as well as the age of the eldest own child in the household. I restrict the samples to female heads and head's spouses since for these women own children can be located within the household using the constructed family relationships. However, because information on date of birth is only available for household members, I further restrict the sample to women whose reported number of children ever born is the same as the number of children currently living in the household.

This feature of the Census data calls for some caution when interpreting the estimates, since bias from sample selection problems may arise. One can expect that this sample selection causes the estimates of the twin-first effect to be downward biased because the samples only include women whose all children ever born are alive at the time of the survey. If these mothers have preference for a smaller family size, they might be more willing to adjust their fertility following the occurrence of twins in the first birth. I show later that, in Indonesia, the twin-first estimates are smaller for the samples drawn from

[32]The CHNS and the IFLS ask female respondents about the number of children alive and living in the household, the number of children alive and living outside the household and the number of children who have died. For both samples, I measure the number of children born by the sum of these three variables reported in the most recent wave.

[33]This point is made by Angrist, Lavy, and Schlosser (2010). In analyzing the effect of twinning on second birth on sibship size, the authors find an increase of about half a sibling amongst a sample of Israeli adult children, which is smaller compared to another study using American children. The effect is even smaller for those kids of African and Asian backgrounds (about a 0.15-siblings increase).

[34]To the best of my knowledge, there are two papers which report estimates of the twinning effect on fertility using samples from developing countries. In addition to Angrist, Lavy, and Schlosser (2010), Caceres-Delpiano (2012) present estimates that ranges from 0.75 to 0.90 using data from the Demographic and Health Surveys on 40 developing countries.

the 2000 and 2010 Census compared to the estimates for the third source of data on twins and fertility, which I discuss next.

The third source of data on twins is the Demographic and Health Survey (DHS). I stacked the surveys for the years 1994, 1997, 2003, and 2007 in order to increase the sample size and the number of twins in the first birth. The DHS targets women in childbearing age (15 to 49 years old) and collects detailed information on all births by a woman. The survey includes a variable indicating whether the pregnancy resulted in singleton or multiple births. The survey also provides year and month of birth, which allows me to identify twinning that occurred in the first birth.

In Table 5, I show the results for all the samples. The coefficients generated for both Censuses are virtually the same, indicating an increase of 0.7 children due to a twin shock to fertility in the first birth. The estimates are higher in the DHS sample but, within standard errors, the effect is similar to the ones observed in the Census.

In Table 6, I present estimates for different age intervals and age at first birth. As can be seen, for women who had recently experienced the shock to fertility, the effect on the number of children born is an increase of one child. For those who had the first child before the age of 25, the effect of twinning in the first birth on the average number of children born is smaller among the sample of older mothers, suggesting that women adjust their fertility after the shock. However, the estimates are still large and significantly different from zero. Among women 35 to 49 years old, the estimates in Table 6 show an increase of 0.72-0.75 on the number of children born. These results are in contrast with those in Rosenzweig and Wolpin (1980a) for a sample of American women, in which the effect on fertility dropped to almost zero for women closer to the end of their childbearing years. These differences are consistent with the idea that fertility control is less perfect in developing countries compared to developed countries.

5.1.2 Twinning Measures: Age vs. Date of Birth

In this section, I compare estimates of the effect of twinning on number of children born when twinning status is assigned based on year and month of birth to estimates when the assignment of twins is based on the age of children in years. In these empirical results, I use the sample of mothers from the IFLS 2000. The sample includes women 37 to 75 years old for whom I could observe complete data on the year of birth of all children listed in the children roster. The purposes of this analysis is to assess the extent to which I incur measurement error when I use the age match as a proxy for twinning. This assessment is particularly useful when interpreting results based on the sample of adult children, since

data on date of birth of nonresident siblings are not available.

I show the estimates in Table 7. It is important to note that the twinning rate obtained when using the age match is about 14 children per one thousand, whereas the rate when using the date of birth is 7 births in one thousand. The twinning rate is higher in the former case because it is possible for two non-twin siblings to have the same age when birth spacing is close. Clearly, measuring twinning using the age match can be problematic for my identification strategy since I would be assigning the twinning treatment to mothers who chose to have births closely spaced and are probably the ones with preferences for a larger number of children.

In spite of that, the difference in the estimates I show in Table 7 is not large. The estimates of the effect of twinning on the conditional mean, presented in columns (1) and (2), show a coefficient on the accurate twinning measure about 0.15 larger compared to the age-matched proxy. Furthermore, the point estimates for the conditional median in columns (3) and (4) are virtually identical. These results provide suggestive evidence that the age match does a good job in measuring twinning.

In Table 8, I present additional results on the differences in the estimates when using the age and the date of birth to measure twinning occurrence. I use data from the 2000 and 2010 Indonesian Censuses. Here also, the twinning rate I calculate using the children's age is twice as large as the rate obtained using the date of birth. This is the case for both samples. As can be seen, the estimates vary depending on which measure I use. However, the differences are not as large as one would expect if the cases mistakenly assigned as twins are women who are choosing to have births closely spaced in time. They are about 0.10 larger in 2010 Census and 0.06 larger in the 2000 Census. This also suggests that the bias from using age match as proxy for twinning is not severe.

5.2 Total Transfers from Children

In this section, I provide evidence that mothers who experienced an exogenous increase to fertility due to the birth of twins receive significantly more transfers compared to the other mothers. These mothers are also more likely to receive old-age support from their children. In Tables 9 and 10, I show the results for China and Indonesia, respectively. In both tables, column (2) presents the Tobit average marginal effect on the expected value of transfers when conditioning on positive transfers, that is, $\partial E(T|T > 0, \mathbf{x})/\partial \mathbf{x}$. Additionally, column (3) shows the Tobit average marginal effect on the expected value of transfers, that is, $\partial E(T|\mathbf{x})/\partial \mathbf{x}$. The latter estimate takes into account the marginal effect on the probability that transfers occur. In columns (4) and (5), I present the estimated

marginal effect on the probability that parents receive old-age transfers, $\partial P(T > 0|\mathbf{x})/\partial \mathbf{x}$, computed using the Tobit and the Probit models, respectively.

The estimated marginal effects are positive and statistically significant in the two samples. In China, the marginal effect on the conditional expected value of transfers is 429 CNY, which corresponds to approximately 9% of the mean household per capita income.[35] The marginal effect on the expected value of transfers is slightly larger, 485 CNY, equivalent to 10% of the mean household per capita income. From previous results, the incidence of twinning increases fertility by 0.77 in China. If the fertility shock caused an increase in total transfers only through the increase in the number of children, the marginal effect on $E(T|T > 0, \mathbf{x})$ with respect to fertility would be $429 \div 0.77 = 557$ CNY, meaning that an increase in fertility of one child would have raised total transfers by 12% of the average household per capita income.

In Indonesia, the estimated average marginal effect on $E(T|T > 0, \mathbf{x})$ is 188,100 IDR, which corresponds to 13% of the mean household per capita income. The marginal effect on $E(T|\mathbf{x})$ is much larger, 247,300 IDR, and amounts to 22% of the household income. The same computation carried out for China indicates that, if the increase in the number of children were the only force driving transfers, one extra child would have increased transfers by $188 \div 0.79 = 237$ IDR, or 21% of the household income.

The fertility shock also increases the probability that parents receive old-age transfers, as I show in columns (4) and (5), Tables 9 and 10. The Probit estimates indicate an increase of 14 percentage points in the probability of receiving financial support from children in China and 16 percentage points in Indonesia, although in the latter case the estimates are only significant at 10%. For Indonesia, I present the OLS estimate of the twin-first effect on per capita consumption of non-food items in column (6), Table 10. Data on consumption expenditures are not available for China. Although the coefficient is not precisely estimated, the effect is positive and large - about 6% of the mean household per capita income. I do not find any effect on consumption of food items.

Overall, these estimates show that the effect of an exogenous increase in fertility on old-age support is positive and significantly large. But investigating the forces underlying this causal relationship is also of first-order importance. In the previous subsections, I showed evidence that mothers who had twins in the first birth have higher completed fertility. Therefore, part of the observed increase in total transfers can be attributed to the increase in family size, consistent with predictions from the model I developed in section

[35]This income measure is the sum of the income from labor sources (business, farming, fishing, gardening, livestock, and wages) and income from non-labor sources excluding transfers (retirement income and subsidies).

2. However, the estimated positive causal effect could reflect the lower income of parents who chose to save less for their old-age consumption following the exogenous increase in their fertility. In the next subsection, I examine this channel.

5.3 Parental Savings

In the previous section, I presented conclusive evidence of a positive causal relationship between family size and old-age transfers. However, as highlighted in section 2, the exogenous increase in fertility has implications for parents' optimal choices that can have additional effects on transfers. If parents save less in response to the increase in family size, the estimates I show in Tables 9 and 10 will also reflect the lower marginal utility of parents' consumption.

In this section, I address this matter by estimating the empirical relationship between fertility and old-age savings. This task is challenged by the lack of appropriate measures of savings or income during the time parents experienced the exogenous increase in fertility. All current measures of household income and assets will reflect not only past parental decisions about asset accumulation but also the effect of current transfers.

The CHNS only collects data on asset holdings at the household level, which makes it difficult to disentangle the value of current asset that reflects past wealth accumulation decisions of the older members from current decisions on asset accumulation of the younger members. With this limitation in mind, in column (6) in Table 9 I report OLS results using as dependent variable the value of per capita household asset holdings.[36] The estimated coefficient is not significant, suggesting that the increase in total transfers following an exogenous increase in fertility cannot be explained by lower savings in China.

Unlike the CHNS, the IFLS provides detailed information on assets at the individual level. To improve upon the previous estimates, I use information on assets owned by the individual, not the household.[37] For married women, I add the value of assets held by the husband. Due to a relatively large number of missing observations on the value of individual assets, I include women who are between 40 and 75 years of age in order to increase the sample size. Column (8) in Table 10 shows the results. Better measure of old-age savings notwithstanding, the estimates do not seem to indicate that parents save more in response to an increase in the number of children.

[36] Household assets include household appliances, tools, equipments, and real state.

[37] Individual assets include jewelry, household appliances, savings, and receivables, and the value of house, land, and livestock that are not being used in business activities.

5.4 Transfers to Parents

In quantity-quality trade-off model with transfers, an exogenous increase in fertility is expected to decrease the amount of transfers that each child makes to their parents through two channels. First, it increases sibship size. Second, it affects the child's ability to give transfers if parents optimally reduced investment in human capital. I examine the first channel in this subsection and the second channel in the next subsection.

In Table 11, I present estimates of how an increase in fertility affects transfer to parents using the sample of Indonesian adult children aged 25 to 45. Column (1) shows the twin-first effect on the number of siblings. Recall that the dummy $TWIN$ in this case indicates whether the child was born to a mother who had twins in the first birth, regardless of whether the child is a twin or if she has two older siblings who are twins. All specifications include controls for the child's age and sex. One can see that the effect on the number of siblings alive is large in magnitude, although not statistically significant.

Results in columns (2) and (3) refer to the Tobit marginal effects on $E(T|T > 0, \mathbf{x})$ and $E(T|\mathbf{x})$. The effects are are negative and statistically significant (-17,400 IDR and -24,000 IDR) and correspond to 1.8% and 2.6% of the household per capita income, respectively. If the increase in fertility had no effect on children's human capital, then one could say that an increase of one sibling would cause a child to decrease transfers by $17,400 \div 0.68 = 25,558$ IDR, which is equivalent to 2.8% of children's household per capita income.

Finally, there is also evidence that children are less likely to provide old-age transfers to parents following an exogenous increase in the number of siblings. I present the Tobit and Probit estimates of the marginal effect of twinning on $P(T|T > 0, \mathbf{x})$. Both estimates are negative, but the Probit estimate is not precisely estimated. The Tobit result states that the fertility shock leads to a decrease of 10 percentage points in the probability that a child will make transfers to her older parents. Overall the results are consistent with the model predictions for the effects of the quantity of children on transfers, holding human capital and savings constant.

5.5 Children's Human Capital

The estimates in Table 11 are consistent with the existence of a direct effect of sibship size on adult children's decision to make transfers. On the other hand, there is also evidence suggesting that children of mothers with twins have lower human capital, which also contributes to explaining the negative effect on transfer to parents. Column (6) shows that these children have 0.93 fewer years of schooling relative to children with no twin siblings. The lower educational attainment is reflected in the lower per capita household

income from labor, as shown in column (8).[38] There is no significant difference in the health status, as measured by the body mass index. This finding is not surprising considering that the BMI of adult children captures current nutrition status and poorly reflects human capital investments made during childhood.

Twinning can have an additional adverse effect on transfer to parents. As noted in Rosenzweig and Zhang (2009), twins are of lower quality on average compared to singletons, net of family-size effects, reflected in their lower birthweight. Parents also respond to this difference in endowments, which can add to the lower quality of twins when parents reinforce endowment differences and invest less on their human capital in favor of their healthier singleton children. The authors find evidence of reinforcing behavior in China. To address this issue, in Table 12 I present estimates including a dummy variable (TWINCHILD) that indicates whether the child is herself a twin. The coefficients are not precisely estimated in any of the regressions and do not allow me to reject the hypothesis that twin children are not different from the singletons with twin siblings. However the signs of the coefficients are consistent with the existence of a negative effect of having more siblings and an adverse effect of having lower human capital on transfers to parents.

Due to lack of data on adult children's siblings, I cannot estimate the same effects on educational attainment using the CHNS. For completeness, I use data from the 1990 Chinese Census to show how the human capital of younger children is affected by an exogenous increase in the number of siblings. The unit of analysis is the child and the sample is restricted to children from female head or spouse whose children born are currently living in the household. The dependent variable is a dummy indicating whether the child has age-appropriate educational level.[39] In Table 13 I present the results. Columns (1) and (2) show estimates for a sample of children 13 to 25 years old. In columns (3) and (4) I restrict the sample to children younger than 19 to avoid sample selection bias due to lack of data on children not living in the household. I also include estimates that distinguish children who have twin siblings from twin children. Overall, I find evidence that children from twin-first mothers have lower educational attainment. The negative effect can be attributed to being a twin as opposed to having twin siblings, although the coefficients on $TWINCHILD$ are not precisely estimated.

[38] I measure income using per capita household income instead of individual income in order to mitigate sample selection problems, since the sample is also composed of women who do not work for pay.

[39] For children 13 to 18 years old, the dummy takes on value one if the child completed primary school, and zero otherwise. For children 19 to 25 years old, the dummy assumes value one if the child had completed secondary school, and zero otherwise.

6 Additional Results and Robustness Checks

6.1 Mother's Labor Supply

A fertility shock experienced by the mothers during their childbearing age might have impacted negatively their supply of labor and their ability to save for old-age consumption. Although this mechanism is not introduced in the model in section 2, in this section, I examine the effects of twinning on the labor supply of young mothers in Indonesia using two sources of data: the IFLS and the DHS. The first survey asks detailed questions on individuals' employment status. I use that information for the waves 1997, 2000, and 2007. The sample of mothers is composed of women aged 15 to 47 in the IFLS 2000, to be comparable to previous results on transfers. Because some women appear in more than one wave of the IFLS, the standard errors are clustered at the individual level. In the first column of Table 14 the measure of labor supply is a dummy variable indicating whether the mother reported that she was working, or helping to earn income during the past week as her primary activity. The second measure, shown in column (2), treats as a working mother those women who were not currently working but reported they have worked for at least one hour in the last week. Finally, the third measure, presented in column (3), includes as a working mother those women who were not currently working but reported they have worked previously. For all the three measures, the Probit estimates are statistically zero, showing no effect on the labor supply of younger mothers. Additional evidence is shown in columns (4) and (5) using data from the DHS for the years 1994, 1997, 2003, and 2007. Twinning does not seem to have decreased the supply of labor in the previous year or in the last week.[40]

In Table 15, I present another set of estimates using individual level employment history data from the IFLS. The employment history module provides data on working status for up to 19 years, from 1988 to 2007, depending on which year the mother is interviewed. To carry out this analysis, I draw two samples. One sample of younger women 15 to 46 in 2000 and another sample of older women 47 to 75 in 2000. The dependent variable used in the estimates for the sample of younger women is a dummy variable indicating whether the woman worked in at least one of the years in which she was between 15 to 46 years old. For the sample of older mothers, the dependent variable measures whether the woman worked at least one of the years in which she was 47 to 75 years old. There are on average 13 years of data on working status for women in the first sample, and 9 years

[40]The measure used in the estimates presented in column (4) is based on the following question asked in the survey "Have you worked during the past 12 months?". The measure in column (5) is based on the question "Are you currently working?".

of data for the second sample. The Probit estimates show no effect on the labor supply of young Indonesian mothers. However, older mothers with twins were less likely to work at the ages 47 to 75. This effect on the labor supply of old mother is consistent with the prediction that mothers enjoy higher consumption (namely leisure) when they have more children.

Next, I use data from the 1990 Chinese Census to assess the effects of a fertility shock on the labor supply of mothers in China. The sample is limited to women who reported having the same number of children ever born as the number of children living in the household, for whom data on year and month of birth are available. I further restrict the sample to women 15 to 47 years old so the results are comparable to the ones presented for Indonesia. Only the nine Chinese provinces covered by the CHNS are included in the sample.

The measure of labor supply is a dummy variable for whether the mother was employed. If the mother was unemployed or inactive, I assigned value zero to the labor supply dummy variable.[41] In Table 16, I show results of the effects of a fertility shock on both the number of children born and employment status. The estimate in column (1) points to an increase of 0.70 on fertility following the birth of twins. This number is very close to the estimates presented for Indonesia using the 2000 and 2010 Censuses. Column (2) shows results obtained when I include an interaction term between twinning in the first birth and the age of the mother. As in the Indonesian case, the estimates are consistent with the effect of the shock diminishing as the woman approaches the end of her childbearing years. To see that, the effect of twinning for a mother who is 20 years old is $1.42 - 20 * 0.022 = 0.98$, which is close to one child. Twenty years later when the mother is 40, one should expect that the fertility shock on the first birth increased the number of children by 0.54 children on average, assuming that the age effect is linear. What is most important for the purposes of this paper is that the fertility shock in the very first birth seems to have an effect on fertility that persists over time, increasing the completed fertility of older mothers who may have had less access to birth control to compensate for the unanticipated shock to fertility. This persistence can be attributed to the prevalence of imperfect fertility control in developing countries.

Finally, columns (3) and (4) show results for female labor supply. Overall, twinning decreases the labor supply of mother in about 0.02 percentage points. This effect is precisely estimated possibly due to the large sample size, but its magnitude is small. This can be due to there being heterogeneous effects for women in different stages of their life cycle, as the estimates of the fertility effects of twinning suggest. This becomes ev-

[41] The results are robust to treating the unemployed women as part of the labor force.

ident when an interaction term between the age and the twinning status is added. The estimated effect for a woman about 20 years of age is a decrease of about 0.05 percentage points in the probability of being employed. Twenty years later when the mother is 40, there would be no difference in labor supply for mothers who had a twin in their first birth. This life-cycle effect is consistent with the findings in Rosenzweig and Wolpin (1980a).

In summary, the increase in the number of children caused by the birth of twins does not seem to have an effect on the supply of labor among Indonesia mothers. The same is not true in China, where the estimates indicate that mothers with more children work less, although the impact dies out as the women approach the end of their childbearing years. The sources of disparities in the response of the labor supply to an increase in fertility need further investigation. However, the labor supply estimates suggest that the interpretation of the main finding in this paper, which is that fertility increases the size of the financial support from children, should account for this additional channel, at least in the Chinese context.

6.2 Coresidence

In addition to cash and in-kind transfers, children provide support to elderly parents in the form of coresidence. Among the sample of Indonesian mothers used in the main empirical analysis, I observe that 60% of the subjects have at least one child older than 25 living in the same household. In the Chinese sample, wave 2009, the fraction of mothers living with at least one child older than 25 is 48%. If parents' and children's decisions about living arrangements are determined by family size, one might be worried that the finding that a fertility shock increases financial transfers is reflecting these other choices. To check for this channel, I present estimates of the effects of twinning in the first birth on the number of children living in the household in Table 17. Columns (1) and (4) show results obtained when using the number of children older than 15 as the dependent variable. Columns (2) and (5) and columns (3) and (6) show results for the number of resident children older than 18 and 25, respectively. There is no evidence that an increase in fertility affects the number of coresident children in any of my samples of older mothers.

6.3 IV Estimates

The approach I follow in order to assess the effects of fertility on old age support is based on reduced form estimates of the twin-first effect on total transfers and individual transfer

to parents, followed by estimates of the same effects on the possible channels affecting transfers, as guided by the conceptual framework. However, many studies that explore the twins methodology as source of identification use twins as an instrument for fertility. For the sake of comparison, in Table 18 I show the IV estimates in which I use twinning in the first birth as an instrument for number of children in the transfer equation. The results for China are based on the same sample used in the reduced form estimates. The IV estimates for Indonesia were based on a larger sample in order to increase power. In addition to the mothers 47 to 75 years old, I include women 40 to 46 years old, which increases the sample size to 4,600 observations, 40 of which were identified as twin-first mothers.

Overall, the IV estimates of the average marginal effect of fertility on the expected value of transfers agree with the reduced form estimates. Estimates are statistically significant at 5% (10%) among the Chinese (Indonesian) sample. The effects on the probability of receiving transfers are also positive and significant in both samples. Additionally, columns (7), (8), and (9) show results for a sample restricted to women whose data on year of birth were available for all children listed in the survey roster. Results are consistent with a positive and large effect of fertility on transfers.

It is worth stressing that these estimates need to be interpreted with caution. The exclusion restrictions are possibly violated in that, as demonstrated in the model, the exogenous increase in fertility also leads to changes in children's human capital and savings, which also determine total transfers.

6.4 Transfers from Other Relatives

I provide evidence that fertility increases old-age consumption of parents through income from transfers. However, this might not be the case if total transfers from children crowd out the transfers that elder individuals receive from other family members. To verify that, I present additional results for China using the total transfers from other relatives as a dependent variable in Table 19. Columns (1) and (2) show estimates of the average marginal effect on the expected value of transfers, whereas columns (3) and (4) show Tobit and Probit estimates of the average marginal effect on the probability of receiving transfers. There is no evidence that transfers from other family members are crowded out by transfers from children in China.

6.5 Robustness Checks

6.5.1 Twinning and offspring sex composition

One concern is that parents might respond differently to the birth of female twins compared to male twins. This is particularly problematic in the contexts I am analyzing, given the well-known preference for male sons in Asian cultures. As a first check, I present the sex ratio among twins first in Table 20 using data from the 1980 U.S. Census, the 1990 Chinese Census and the 1994, 1997, 2003, and 2007 Indonesian DHS. Based on the test of difference in means, I cannot reject the null hypothesis that the fraction of girls and the fraction of boys among first-born twins are the same in the U.S. and Indonesia. On the other hand, among first-born twins in China, the fraction of girls is significantly larger compared to boys. Understanding this difference requires further investigation that is beyond the scope of this paper. Regardless of the source of this "girl bias", this means that my estimates using the Chinese sample can underestimate the effect of fertility on transfers, given that sons are expected to provide more support to old-parents compared to girls (Banerjee, Meng, and Qian (2010)).

In Table 21 I test whether the fertility shock had an effect on the sex composition of children. The dependent variable is the fraction of male children. The sample includes women who are 40 to 75 years of age, which explains the larger sample size compared to the main results. Overall, I find no evidence that the shock to fertility altered the sex composition of the offspring. These results are reassuring in that the estimated effects on transfers do not seem to be explained by changes in the sex composition in favor of more male children.

6.5.2 Twinning and birth spacing

The birth of twins not only increases family size, but also implies a shock to birth intervals. If old-age transfers depend on the age distribution of the offspring, the estimates will reflect this additional channel. In Tables 22 and 23, I present estimates of the twin-first effect on total transfers controlling for the average age of the children and the average spacing between births. Overall, the estimates are robust to the inclusion of these potential twin correlates.

6.5.3 Log Transfers

In this subsection, I present results using the log of the total transfers as the dependent variable. I follow the procedure described in Cameron and Trivedi (2010), chapter 16.

I construct a new variable that is the log of the total transfers. The missing values are replaced by the minimum of the transformed variable. Among the Chinese sample, the minimum value is 3.10; among the Indonesian sample, the minimum is 0.40.

In Table 24, I show the new estimates. Columns (1) and (3) give the average marginal effects on $E(T|T > 0)$ and columns (2) and (4) present the effects on $E(T)$. The estimates are virtually the same across the two samples and show a positive and statistically significant effect on transfers.

6.5.4 Sample of Younger Mothers

In Indonesia, I use information on date of birth of children to identify the birth of twins. But for many mothers in the sample I use the age of children when the date of birth was not available. The occurrence of missing data on date of birth was larger among older mothers. This is reflected in the higher twinning rate among the 47-to 75-year-old women in the sample. In order to check for the robustness of the results using this less than perfect method (age of children) to identify twins, in Table 25 I show the estimates based on a sample of younger women for whom I could observe at least the year of birth of all children listed in the survey rosters. The twinning rate in this sample is 7 in 1,000 births, which is closer to the twinning rate among the Chinese sample and with twinning rates reported in the literature. The average marginal effect on transfer and the effect on the probability of receiving transfer are smaller compared to the estimate for the 47- to 75-year-old sample, consistent with transfers being more prevalent among older mothers (only 25% of mothers aged 37 to 75 received transfers, whereas 52% of mothers aged 47 to 75 received transfers). In spite of that, the signs and magnitudes are consistent with fertility causing parents to receive more support from children.

6.5.5 Net Transfers

I estimated the twin-first effect on the total amount of transfers received from children. It is possible, however, that the benefits of higher fertility in terms of old-age transfers are offset if parents with more children also make larger transfers to their children. In China, only 9.5% of households reported they had transferred cash to children.[42] In Indonesia this percentage is much higher, approximately 32%.[43]

[42]Data on transfer to children were collected for the 2000, 2004, and 2006 waves only. This percentage is based on the pooled sample of women 47 to 75 years old.

[43]It is worth mentioning that the question about transfer to children asked in the CHNS refers to cash transfers. It might be that the values are underestimated due to excluding in-kind transfers.

In Table 26, I present estimates for net transfers. Columns (3), (4), (8), and (9) show results for net transfers when I treat negative values as zeros. The estimates of the average marginal effect on $E(T|T > 0)$ and $E(T)$, where T stands for the net transfers, are positive and statistically significant for China. The estimates are also positive for Indonesia, but smaller compared to the results for total transfers and also statistically insignificant. Additionally, columns (5) and (10) present results including negative values of net transfer. All the estimates are positive and large, but not statistically significant.

Overall, the estimates for net transfers suggest that, at least in the Indonesian setting, a model that accounts for financial transfers running from parents to children needs to be considered in future work.

7 Conclusion

In this paper, I study the relationship between fertility and intergenerational transfers in China and Indonesia. The framework I develop predicts that the effect of an exogenous increase in fertility on transfers is ambiguous. On the one hand, although the transfer that each child makes to parents decreases in sibship size, parents receive more financial support in total when they have more children. On the other hand, as parents adjust their investment in children's human capital and savings following the exogenous increase in fertility, transfers could increase further or even decrease.

In the empirical analysis I examine the mechanisms introduced in the model. I address the empirical challenges that arise from the endogeneity in fertility using the incidence of twinning in the first birth as a source of exogenous variation in family size. I show that twinning amounts to a positive shock to completed fertility. The estimates indicate an increase of 0.77 in the number of children born among Chinese mothers and 0.79 among Indonesian mothers. Then I show that this positive shock to fertility has a strong and positive effect on total transfers that parents receive from children, but a negative effect on the amount of transfers that each child makes to parents. These results are consistent with the model predictions regarding the effects of an increase in family size on old-age transfers, holding the other determinants of parents' and children's income constant.

The other mechanism that could explain the positive causal effect of fertility on old-age support is parental savings. In my empirical analysis, I do not find evidence of this mechanism. On the other hand, there is evidence that an increase in fertility adversely affects children's educational attainment. In spite of the children's lower quality, I find that parents with more children consume more and mothers are less likely to work during

old age. Overall, these results suggest that the estimated effect of fertility on old-age support is a lower bound to the true effect net of changes in parents' optimal investment in children's human capital.

From a policy standpoint, the empirical findings produced in this dissertation suggest that extending access to old-age pension in low-income countries could have far reaching implications for economic development beyond improving the welfare of the elderly population. As the need to rely on financial assistance from children decreases as a consequence of the pension coverage, the potential reduction in family size could lead to higher investments in human capital and income.

When choosing the number and the quality of children, forward looking parents account for the "returns" of these choices in terms of old-age consumption. In this paper, I showed that the returns to having more children are positive. In future work, I will quantify the effects of investing in children's education on old-age support. I will extend the framework and consider two effects. On the one hand, more educated children earn more income and are more able to support parents when they retire. On the other hand, the returns to children's human capital may only be realized if the children migrate. In this scenario, if migration brings about weaker family ties, it is not clear that investing in children's human capital increases old-age transfers. Additionally, I will investigate the elasticity of old-age transfers to contemporaneous changes in children's income. The IFLS is particularly suitable for examining this question because the survey collects data on income from various sources, as well as transfers to parents living outside the household, for the same individuals at several points in time. This feature of the data allows me to control for the possible unobserved heterogeneity in children's preferences and endowments that are correlated with the amount of financial support provided to old parents.

References

ANGRIST, J., V. LAVY, AND A. SCHLOSSER (2010): "Multiple Experiments for the Causal Link between the Quantity and Quality of Children," *Journal of Labor Economics*, 28(4), 773–824.

ANGRIST, J. D., AND W. N. EVANS (1998): "Children and Their Parents' Labor Supply: Evidence from Exogenous Variation in Family Size," *The American Economic Review*, 88(3), pp. 450–477.

ANTMAN, F. M. (2012): "Elderly Care and Intrafamily Resource Allocation when Children Migrate," *Journal of Human Resources*, 47(2), 331–363.

ARIFIANTO, A. (2004): "Public pension reform in Indonesia: Issues and the way forward," SMERU, Jakarta.

BANERJEE, A., X. MENG, AND N. QIAN (2010): "The Life Cycle Model and Household Savings: Micro Evidence from Urban China," Available from http://www.econ.yale.edu/ nq3/.

BANISTER, J., D. E. BLOOM, AND L. ROSENBERG (2010): "Population Aging and Economic Growth in China," PGDA Working Papers 5310, Program on the Global Demography of Aging.

BECKER, G. S., AND R. J. BARRO (1988): "A Reformulation of the Economic Theory of Fertility," *The Quarterly Journal of Economics*, 103(1), pp. 1–25.

BECKER, G. S., AND H. G. LEWIS (1973): "On the Interaction between the Quantity and Quality of Children," *Journal of Political Economy*, 81(2), pp. S279–S288.

BECKER, G. S., K. M. MURPHY, AND R. TAMURA (1990): "Human Capital, Fertility, and Economic Growth," *Journal of Political Economy*, 98(5), pp. S12–S37.

BECKER, G. S., AND N. TOMES (1976): "Child Endowments and the Quantity and Quality of Children," *Journal of Political Economy*, 84(4), pp. S143–S162.

BEHRMAN, J. R., AND M. R. ROSENZWEIG (2004): "Returns to Birthweight," *The Review of Economics and Statistics*, 86(2), 586–601.

BLACK, S. E., P. J. DEVEREUX, AND K. G. SALVANES (2005): "The More the Merrier? The Effect of Family Size and Birth Order on Children's Education," *The Quarterly Journal of Economics*, 120(2), pp. 669–700.

BLACK, S. E., P. J. DEVEREUX, AND K. G. SALVANES (2007): "From the Cradle to the Labor Market? The Effect of Birth Weight on Adult Outcomes," *The Quarterly Journal of Economics*, 122(1), 409–439.

BLACK, S. E., P. J. DEVEREUX, AND K. G. SALVANES (2010): "Small Family, Smart Family? Family Size and the IQ Scores of Young Men," *Journal of Human Resources*, 45(1), 33–58.

BOLDRIN, M., AND L. E. JONES (2002): "Mortality, Fertility, and Saving in a Malthusian Economy," *Review of Economic Dynamics*, 5(4), 775–814.

BOLDRIN, M., M. D. NARD, AND L. E. JONES (2005): "Fertility and Social Security," NBER Working Papers 11146. National Bureau of Economic Research.

BRONARS, S. G., AND J. GROGGER (1994): "The Economic Consequences of Unwed Motherhood: Using Twin Births as a Natural Experiment," *The American Economic Review*, 84(5), pp. 1141–1156.

BYRNE, D., M. S. GOEREE, B. HIEDEMANN, AND S. STERN (2009): "Formal Home Health Care, Informal Care, And Family Decision Making," *International Economic Review*, 50(4), 1205–1242.

CACERES-DELPIANO, J. (2006): "The Impacts of Family Size on Investment in Child Quality," *Journal of Human Resources*, 41(4).

——— (2012): "Can We Still Learn Something From the Relationship Between Fertility and Mother's Employment? Evidence From Developing Countries," *Demography*, 49(1), 151–174.

CALDWELL, J. C. (1976): "Toward A Restatement of Demographic Transition Theory," *Population and Development Review*, 2(3/4), pp. 321–366.

CAMERON, A. C., AND P. K. TRIVEDI (2010): *Microeconometrics Using Stata, Revised Edition*. StataCorp LP.

CASE, A., A. FERTIG, AND C. PAXSON (2005): "The lasting impact of childhood health and circumstance," *Journal of Health Economics*, 24(2), 365–389.

CHAKRABARTI, R. (1999): "Endogenous fertility and growth in a model with old age support," *Economic Theory*, 13(2), 393–416.

CIGNO, A. (1993): "Intergenerational transfers without altruism : Family, market and state," *European Journal of Political Economy*, 9(4), 505–518.

CIGNO, A., AND F. C. ROSATI (1992): "The Effects of Financial Markets and Social Security on Saving and Fertility Behaviour in Italy," *Journal of Population Economics*, 5(4), pp. 319–341.

CISNO, A., AND F. C. ROSATI (1992): "Jointly determined saving and fertility behavior: theory and estimates for Germany, Italy, UK, and USA," *European Economic Review*, 40, 1561–1589.

CRUCES, G., AND S. GALIANI (2007): "Fertility and female labor supply in Latin America: New causal evidence," *Labour Economics*, 14(3), 565–573.

CURRIE, J., AND R. HYSON (1999): "Is the Impact of Health Shocks Cushioned by Socioeconomic Status? The Case of Low Birthweight," *American Economic Review*, 89(2), 245–250.

DE LA CROIX, D., AND M. DOEPKE (2004): "Public versus private education when differential fertility matters," *Journal of Development Economics*, 73(2), 607–629.

DOEPKE, M. (2004): "Accounting for Fertility Decline During the Transition to Growth," *Journal of Economic Growth*, 9(3), 347–383.

EHRLICH, I., AND F. T. LUI (1991): "Intergenerational Trade, Longevity, and Economic Growth," *Journal of Political Economy*, 99(5), 1029–59.

FONTAINE, R., A. GRAMAIN, AND J. WITTWER (2009): "Providing care for an elderly parent: interactions among siblings?," *Health Economics*, 18(9), 1011–1029.

GALOR, O., AND D. N. WEIL (2000): "Population, Technology, and Growth: From Malthusian Stagnation to the Demographic Transition and beyond," *The American Economic Review*, 90(4), pp. 806–828.

HANUSHEK, E. A. (1992): "The Trade-off between Child Quantity and Quality," *Journal of Political Economy*, 100(1), pp. 84–117.

HIEDEMANN, B., AND S. STERN (1999): "Strategic play among family members when making long-term care decisions," *Journal of Economic Behavior & Organization*, 40(1), 29–57.

HOEKSTRA, C., Z. Z. ZHAO, C. B. LAMBALK, G. WILLEMSEN, N. G. MARTIN, D. I. BOOMSMA, AND G. W. MONTGOMERY (2008): "Dizygotic twinning," *Human Reproduction Update*, 14(1), 37–47.

HUSSAIN, A. (1994): "Social Security in Present-Day China and Its Reform," *The American Economic Review*, 84(2), pp. 276–280.

JACOBSEN, J. P., J. W. P. III, AND J. L. ROSENBLOOM (1999): "The Effects of Childbearing on Married Women's Labor Supply and Earnings: Using Twin Births as a Natural Experiment," *Journal of Human Resources*, 34(3), 449–474.

JIAN-PING GAN, ZHONG-HUA WU, Z.-M. T., AND J. ZHENG (2007): "The Comparison of Twinning Rates Between Urban and Rural Areas in China," *Twin Research and Human Genetics*, 10, 633–637.

JONES, L. E., A. SCHOONBROODT, AND M. TERTILT (2008): "Fertility Theories: Can They Explain the Negative Fertility-Income Relationship?," NBER Working Papers 14266, National Bureau of Economic Research, Inc.

LI, H., J. ZHANG, AND Y. ZHU (2008): "The Quantity-Quality Trade-Off of Children in a Developing Country: Identification Using Chinese Twins," *Demography*, 45(1), pp. 223–243.

MILLER, G. (2005): "Contraception as Development? New Evidence from Family Planning in Colombia," NBER Working Papers 11704, National Bureau of Economic Research, Inc.

MITTLER, P. J. (1971): *The Study of Twins*. Harmondsworth, Penguin.

MOAV, O. (2005): "Cheap Children and the Persistence of Poverty," *Economic Journal*, 115(500), 88–110.

MODIGLIANI, F., AND S. L. CAO (2004): "The Chinese Saving Puzzle and the Life-Cycle Hypothesis," *Journal of Economic Literature*, 42(1), 145–170.

NISHIMURA, K., AND J. ZHANG (1992): "Pay-As-You-Go Public Pensions with Endogenous Fertility," *Journal of Public Economics*, 48(2), 239–258.

POLLAK, R. A. (1969): "Conditional Demand Functions and Consumption Theory," *The Quarterly Journal of Economics*, 83(1), 60–78.

PRETTNER, K., D. E. BLOOM, AND H. STRULIK (2012): "Declining fertility and economic well-being: do education and health ride to the rescue?," PGDA Working Papers 8412, Program on the Global Demography of Aging.

QIAN, N. (2009): "Quantity-Quality and the One Child Policy:The Only-Child Disadvantage in School Enrollment in Rural China," NBER Working Papers 14973, National Bureau of Economic Research, Inc.

RAUT, L. K., AND T. N. SRINIVASAN (1994): "Dynamics of Endogenous Growth," *Economic Theory*, 4(5), 777–90.

ROSATI, F. C. (1996): "Social security in a non-altruistic model with uncertainty and endogenous fertility," *Journal of Public Economics*, 60(2), 283 – 294.

ROSENZWEIG, M. R., AND T. P. SCHULTZ (1987): "Fertility and investments in human capital: Estimates of the consequence of imperfect fertility control in Malaysia," *Journal of Econometrics*, 36(1-2), 163–184.

ROSENZWEIG, M. R., AND K. I. WOLPIN (1980a): "Life-Cycle Labor Supply and Fertility: Causal Inferences from Household Models," *Journal of Political Economy*, 88(2), pp. 328–348.

——— (1980b): "Testing the Quantity-Quality Fertility Model: The Use of Twins as a Natural Experiment," *Econometrica*, 48(1), pp. 227–240.

ROSENZWEIG, M. R., AND J. ZHANG (2009): "Do Population Control Policies Induce More Human Capital Investment? Twins, Birth Weight and China's "One-Child" Policy," *The Review of Economic Studies*, 76(3), 1149–1174.

ROY, N., AND A. D. FOSTER (1996): "The Dynamics of Education and Fertility: Evidence from a Family Planning Experiment," Discussion Paper 073, University of Pennsylvania.

SCHULTZ, T. P. (1993): "Demand for children in low income countries," in *Handbook of Population and Family Economics*, ed. by M. R. Rosenzweig, and O. Stark, vol. 1 of *Handbook of Population and Family Economics*, chap. 8, pp. 349–430. Elsevier.

——— (2008): "Population Policies, Fertility, Women's Human Capital, and Child Quality," in *Handbook of Development Economics*, ed. by T. P. Schultz, and J. A. Strauss, vol. 4, chap. 52, pp. 3249–3303. Elsevier, 1 edn.

SINHA, N. (2003): "Fertility, Child Work and Schooling Consequences of Family Planning Programs: Evidence from an Experiment in Rural Bangladesh," Working Papers 867, Economic Growth Center, Yale University.

SMITS, J., AND C. MONDEN (2011): "Twinning across the Developing World," *PLoS ONE*, 6(9),).

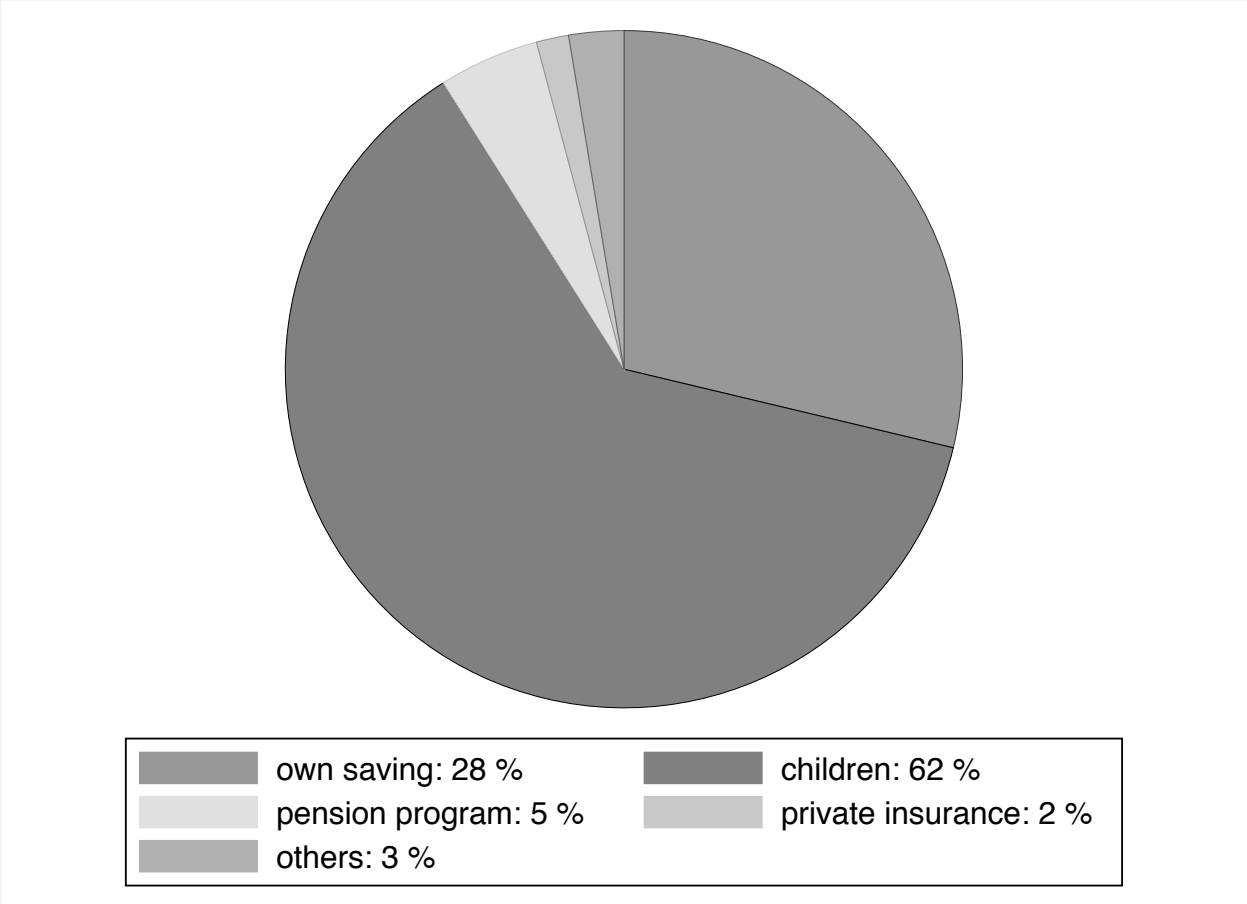
TOBIN, J., AND H. HOUTHAKKER (1950-1951): "The Effects of Rationing on Demand Elasticities," *Review of Economic Studies*, 18(3), 140–153.

UNITED NATIONS DESA (2009): "Wold Population Ageing 2009," Discussion paper.

WANG, D. (2006): "China's Urban and Rural Old Age Security System: Challenges and Options," *China & World Economy*, 14(1), 102–116.

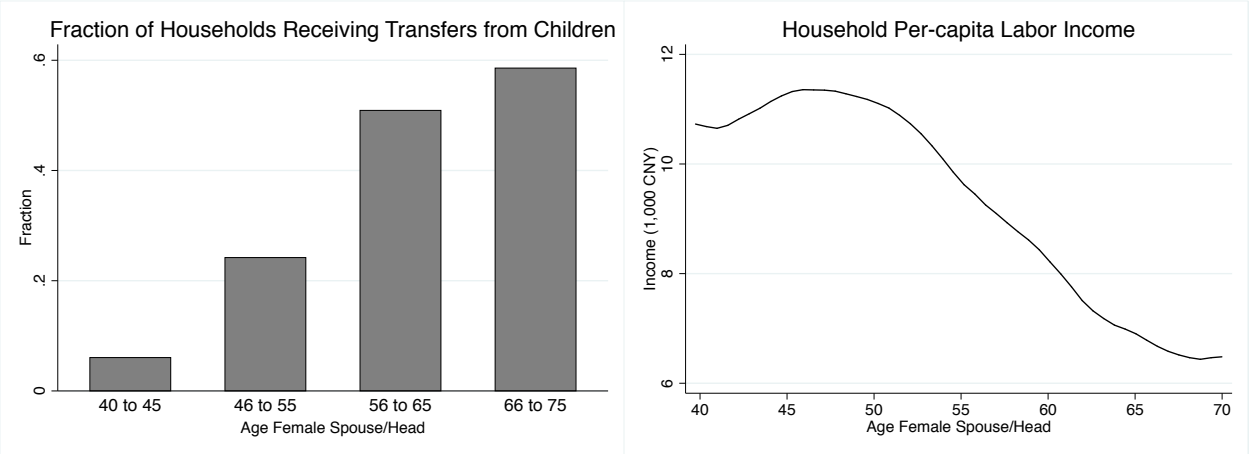
WILLIS, R. J. (1973): "A New Approach to the Economic Theory of Fertility Behavior," *Journal of Political Economy*, 81(2), S14–64.

Figure 1: EXPECTATIONS ABOUT THE SOURCE OF OLD-AGE SUPPORT, RURAL CHINA, 2002



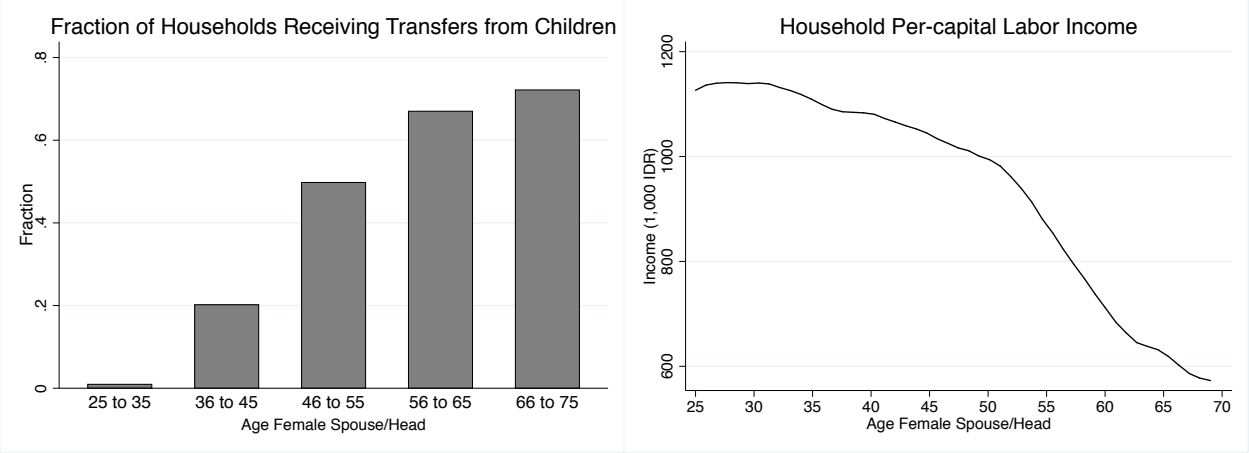
Sample size: 9,200 individuals
Source: Chinese Household Income Project, 2002

Figure 2: TRANSFERS AND INCOME BY AGE OF FEMALE SPOUSE/HEAD, RURAL CHINA, 2009



The smooth curve at the right is the result of local mean regression of per-capita household income from labor on the age of the female head or head's spouse, with a bandwidth of 3. Source: CHNS, 2009

Figure 3: TRANSFERS AND INCOME BY AGE OF FEMALE SPOUSE/HEAD, INDONESIA, 2000



The smooth curve at the right is the result of local mean regression of per-capita household income from labor on the age of the female head or head's spouse, with a bandwidth of 3. Source: IFLS, 2000

Table 1: SUMMARY STATISTICS - SAMPLE OF CHINESE MOTHERS AGED 47 TO 75

	China - CHNS 2000, 2004, 2006 and 2009					
	All Sample		Mothers with Twins		Mothers with no Twins	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Transfer (CNY) [a]	557.2	1391.0	1201.3	2740.5	552.5	1375.8
Fraction receiving transfers	0.33	0.47	0.43	0.50	0.33	0.47
Transfer (CNY) | T>0	1691.6	1989.1	2782.0	3646.9	1681.3	1965.4
Transfer/HH income	0.34	1.01	0.32	0.51	0.34	1.02
Per capita household assets	1631.1	4533.7	1127.3	1495.9	1634.7	4547.9
Twin-first incidence	0.007	0.084				
N. children born	2.57	1.25	3.43	1.35	2.56	1.24
Age of mother at first birth	24.7	4.7	24.2	2.7	24.7	4.7
Age of mother	53.9	7.3	51.8	4.9	53.9	7.3
Avg. age of children	26.6	6.5	26.0	4.2	26.6	6.5
N. obs.	6133		44		6089	

[a] Monetary values are inflated to 2009 values using the consumer price index available from the CHNS.

Table 2: SUMMARY STATISTICS - SAMPLE OF INDONESIAN MOTHERS AGED 47 TO 75

	Indonesia - IFLS 2000					
	All Sample		Mothers with Twins		Mothers with no Twins	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Transfer (IDR) [a]	301.9	758.6	603.4	1209.4	299.0	752.6
Fraction receiving transfers	0.52	0.50	0.66	0.48	0.52	0.50
Transfer (IDR) | T>0	583.3	973.5	921.0	1402.3	579.1	967.0
Transfer/HH Income	0.38	1.07	0.22	0.36	0.39	1.07
Per-capita consumption	298.3	384.6	374.8	451.6	297.6	383.9
Couple assets [b]	4094.7	9869.7	3377.0	6549.5	4131.8	9979.3
Twin-first incidence	0.010	0.097				
N. children born	5.35	3.01	6.07	2.31	5.34	3.01
Age of mother at first birth	26.4	7.4	27.5	7.0	26.4	7.4
Age of mother	57.5	7.8	56.2	7.9	57.5	7.8
Avg. age of children	27.9	8.3	26.4	6.0	27.9	8.4
N. obs.	3029		29		3000	

[a] Monetary values are expressed in 1,000 IDR

[b] These numbers are based on a slightly larger sample that includes women 40 to 75 years old. This sample if composed of 2590 women, 25 of which had twins in the first birth. This inclusion was intended to increase the sample size, given the large number of missing data on individual-level assets.

Table 3: SUMMARY STATISTICS - SAMPLE OF INDONESIAN ADULT CHILDREN AGED 25 TO 45

	Indonesia - IFLS 1997					
	All Sample		Children with Twin Sibling		Children with no Twin Sibling	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Transfer (IDR) [a]	63.6	130.5	40.3	54.3	64.0	131.2
Fraction making transfer	0.68	0.47	0.60	0.49	0.68	0.47
HH per capita income	911.4	1210.3	619.8	603.1	915.4	1216.1
Twin-first incidence	0.013	0.115				
N. siblings alive	4.58	2.26	5.02	3.09	4.58	2.25
Child years of schooling	7.18	4.43	6.47	3.62	7.19	4.44
Age of child	35.2	6.1	35.8	6.2	35.2	6.1
Fraction of male children	0.43	0.50	0.44	0.50	0.43	0.50
Age of mother at first birth	21.1	6.4	23.6	6.7	21.1	6.4
Age of mother	61.6	10.2	61.2	9.4	61.6	10.3
N. obs.	3703		50		3653	

[a] Monetary values are expressed in 1,000 IDR

Table 4: TWIN-FIRST EFFECT ON NUMBER OF CHILDREN BORN, MOTHERS AGED 47 TO 75, CHINA AND INDONESIA

Dep. Var.: *Number of Children Born*		
	China [a]	Indonesia [b]
TWIN	0.77	0.79
	(0.40)	(0.44)
AGEFB	-0.15	-0.01
	(0.01)	(0.01)
AGE	0.07	0.07
	(0.00)	(0.01)
Constant	1.82	2.10
	(0.21)	(0.52)
Year FE	Yes	-
Region FE	Yes	Yes
N. obs.	6133	3029
N. twins	44	29

[a] OLS estimates. Standard errors clustered at household level are in parentheses. The sample includes women 47 to 75 years old in 2009, 44 to 75 years old in 2006, 42 to 75 years old in 2004, and 40 to 75 years old in 2000, with at least one child alive at the year of the survey. The sample is restricted to rural households. Community and survey-year fixed effects are added. Source: CHNS 2000, 2004, 2006, and 2009.

[b] OLS estimates. Standard errors robust to heteroskedasticity are in parentheses. The sample includes women 47 to 75 years old in 2000, with at least one child alive at the year of the survey. District fixed effects and dummy for rural status are added. Source: IFLS 2000.

Table 5: TWIN-FIRST EFFECT ON NUMBER OF CHILDREN BORN, INDONESIA

	Dep. Var.: *Number of Children Born*								
	Indonesia - 1994, 1997, 2003, and 2007 [a]			Indonesia - 2000 [b]			Indonesia - 2010 [b]		
	All Sample	Age ≤ 35	Age > 35	All Sample	Age ≤ 35	Age > 35	All Sample	Age ≤ 35	Age > 35
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
TWIN	0.84	0.87	0.72	0.76	0.76	0.58	0.69	0.76	0.61
	(0.06)	(0.05)	(0.11)	(0.02)	(0.02)	(0.05)	(0.02)	(0.02)	(0.03)
AGEFB	-0.18	-0.18	-0.19	-0.11	-0.12	-0.1	-0.09	-0.11	-0.08
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
AGE	0.15	0.18	0.12	0.09	0.14	0.03	0.06	0.12	0.01
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Constant	1.53	0.71	3.22	1.95	0.78	4.39	2.34	0.97	4.58
	(0.04)	(0.03)	(0.10)	(0.02)	(0.02)	(0.05)	(0.01)	(0.01)	(0.02)
N. obs.	110344	58374	51970	402705	249266	153439	583740	300834	282906
N. twins	510	281	229	1332	762	570	2301	1124	1177

[a] OLS estimates. Standard errors robust to heteroskedasticity are in parentheses. The sample includes women aged 15 to 49 who gave birth to at least one child. Province and survey-year fixed effects and dummy for rural status are added. Source: DHS 1994, 1997, 2004, and 2007.

[b] OLS estimates. Standard errors robust to heteroskedasticity are in parentheses. The sample includes women aged 15 to 65 who gave birth to at least one child. The sample is restricted to female heads and head's spouses whose reported number of children ever born is the same as the number of coresident children. Province and dummy for rural status are added. Source: Indonesian Census, 2000 and 2010.

Table 6: TWIN-FIRST EFFECT ON NUMBER OF CHILDREN BORN, BY AGE GROUP AND AGE AT FIRST BIRTH, MOTHERS AGED 15 TO 49, INDONESIA

Dep. Var.: *Number of Children Born*				
Indonesia - 1994, 1997, 2003, and 2007				
		Mother's Age		
		15-24	25-34	35-49
Age at first birth:				
Under 25	*Coef.*	0.99	0.81	0.75
	S.d.	(0.06)	(0.08)	(0.14)
	N	15458	36264	42331
Under 35	*Coef.*		0.82	0.72
	S.d.		(0.07)	(0.12)
	N. obs.		42916	51450
Mean dep. var.		1.37	2.43	3.37

OLS estimates. Standard errors robust to heteroskedasticity are in parentheses. The sample includes women aged 15 to 49 who gave birth to at least one child. Province and survey-year fixed effects and dummy for rural status are added. Source: Indonesian DHS 1994, 1997, 2004, and 2007.

Table 7: TWIN-FIRST EFFECT ON NUMBER OF CHILDREN BORN, BY MEASURE OF TWINNING STATUS, WOMEN AGED 37 TO 75, INDONESIA

	Dep. Var.: *Number of Children Born*			
	Indonesia - 2000			
	Conditional Mean		Conditional Median	
	DOB	AGE	DOB	AGE
	(1)	(2)	(3)	(4)
TWIN	0.73	0.58	0.62	0.62
	(0.40)	(0.26)	(0.52)	(0.36)
AGEFB	-0.11	-0.11	-0.14	-0.13
	(0.01)	(0.01)	(0.01)	(0.01)
AGE	0.10	0.10	0.10	0.10
	(0.01)	(0.01)	(0.01)	(0.01)
Constant	2.41	2.40	2.43	2.44
	(0.38)	(0.38)	(0.37)	(0.38)
District FE	Yes	Yes	Yes	Yes
N. obs.	3353	3353	3353	3353

Standard errors robust to heteroskedasticity are in parentheses. The sample includes women aged 37 to 75 for whom I observe complete data on the year of birth of all children listed in the roster. District and dummy for rural status are added. Columns (1) and (3) show estimates using the date of birth of children to assign the twin-first treatment. Columns (2) and (4) show estimates using the age match to assign the twin-first treatment. Source: IFLS 2000.

Table 8: TWIN-FIRST EFFECT ON NUMBER OF CHILDREN BORN, BY MEASURE OF TWINNING STATUS, MOTHERS AGED 15 TO 65, INDONESIA

	Dep. Var.: *Number of Children Born*			
	Indonesia - 2000		Indonesia - 2010	
	DOB (1)	AGE (2)	DOB (3)	AGE (4)
Coef.	0.70	0.76	0.70	0.80
S.d.	(0.03)	(0.02)	(0.02)	(0.02)
N. obs.	402705	402705	583740	593860
N. twins	1332	3108	2301	4160

Standard errors robust to heteroskedasticity are in parentheses. Sample includes women aged 15 to 65 who gave birth to at least one child. The sample restricted to female heads and head's spouses whose reported number of children ever born is the same as the number of coresident children. Province and dummy for rural status are added. Columns (1) and (3) show estimates using the date of birth of children to assign the twin-first treatment. Columns (2) and (4) show estimates using the age match to assign the twin-first treatment Source: Indonesian Census, 2000 and 2010.

Table 9: TWIN-FIRST EFFECT ON NUMBER OF CHILDREN BORN, TRANSFERS FROM CHILDREN, AND SAVINGS, WOMEN AGED 47 TO 75, CHINA

	China - 2000, 2004, 2006, and 2009					
Dep. Var.	Children	Total Transfers	Total Transfers	Prob. Transfers	Prob. Transfers	Household Assets
	OLS	Tobit	Tobit	Tobit	Probit	OLS
	(1)	(2)	(3)	(4)	(5)	(6)
TWIN	0.77	429.21	485.67	0.18	0.13	-232.94
	(0.40)	(186.04)	(210.49)	(0.08)	(0.08)	(371.84)
AGEFB	-0.15	-29.92	-33.86	-0.01	-0.01	-1.67
	(0.01)	(3.16)	(3.56)	(0.00)	(0.00)	(16.17)
AGE	0.07	46.8	52.96	0.02	0.02	-28.16
	(0.00)	(2.83)	(3.19)	(0.00)	(0.00)	(9.86)
ME Tobit	-	$E(T\|T>0)$	$E(T)$	$P(T>0)$	-	-
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Community FE	Yes	Yes	Yes	Yes	Yes	Yes
Mean dep. var.	2.56	1691.63	1691.63	0.33	0.33	1631.07
S.d. dep. var.	(1.24)	(1989.09)	(1989.09)	(0.47)	(0.47)	(4533.73)
N. obs.	6133	6133	6133	6133	6133	5813
N. twins	44	44	44	44	44	41

Standard errors clustered at household level are in parentheses. The sample includes women 47 to 75 years old in 2009, 44 to 75 years old in 2006, 42 to 75 years old in 2004, and 40 to 75 years old in 2000, with at least one child alive at the year of the survey. The sample is restricted to rural households. Community and survey-year fixed effects are added. The dependent variable in columns (2) and (3) is the value of cash and in-kind transfers received from nonresident children in the past 12 months (in CNY). The dependent variable in columns (4) and (5) is an indicator for whether the household received transfers from nonresident children. The dependent variable in column (6) is the per capita value of household assets, including household appliances, tools, equipments, and real state. Source: CHNS 2000, 2004, 2006, and 2009.

Table 10: TWIN-FIRST EFFECT ON NUMBER OF CHILDREN BORN, TRANSFERS FROM CHILDREN, CONSUMPTION, AND SAVINGS, MOTHERS AGED 47 TO 75, INDONESIA

	Indonesia - 2000						
Dep. Var.	Children	Total Transfers	Total Transfers	Prob. Transfers	Prob. Transfers	Consumption Non-food	Couple Assets
	OLS (1)	Tobit (2)	Tobit (3)	Tobit (4)	Probit (5)	OLS (6)	OLS (7)
TWIN	0.79	188.15	247.36	0.19	0.16	88.42	22.1
	(0.44)	(98.01)	(128.79)	(0.10)	(0.10)	(68.42)	(1101.91)
AGEFB	-0.01	-6.5	-8.54	-0.01	-0.01	-0.46	20.77
	(0.01)	(1.24)	(1.63)	(0.00)	(0.00)	(1.05)	(48.43)
AGE	0.07	6.02	7.91	0.01	0.01	-0.98	12.5
	(0.01)	(1.05)	(1.37)	(0.00)	(0.00)	(1.05)	(31.24)
ME Tobit	-	$E(T\|T>0)$	$E(T)$	$P(T>0)$	-	-	-
Year FE	-	-	-	-	-	-	-
District FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean dep. var.	5.37	583.42	583.42	0.52	0.52	297.45	4094.68
S.d. dep. var.	(3.00)	(968.70)	(968.70)	(0.50)	(0.50)	(383.36)	(9869.67)
N. obs.	3029	3029	3029	3029	3028	2983	2590
N. twins	29	29	29	29	29	29	25

Standard errors robust to heteroskedasticity are in parentheses. The sample includes women 47 to 75 years old in 2000, with at least one child alive at the year of the survey. District fixed effects and dummy for rural status are added. The dependent variable in columns (2) and (3) is the value of cash and in-kind transfers received from nonresident children in the past 12 months (in 1,000 IDR). The dependent variable in columns (4) and (5) is an indicator for whether the household received transfers from nonresident children. The dependent variable in column (6) is the per capita consumption of non-food items, including electricity, water, fuel, telephone, personal toiletries, and household items. The dependent variable in column (7) is the value of assets measured at the individual level. For married women, I add the value of assets held by the husband. Individual assets include jewelry, household appliances, savings, and receivables, and the value of house, land, and livestock that are not being used in business activities. Due to a relatively large number of missing observations on the value of individual assets, I include women who are between 40 and 75 years of age in order to increase the sample size. Source: IFLS 2000.

Table 11: TWIN-FIRST EFFECT ON SIBSHIP SIZE, TRANSFER TO PARENTS, EDUCATION, AND INCOME, ADULT CHILDREN AGED 25 TO 45, INDONESIA

	Indonesia - 1997							
Dep. Var.	Siblings	Transfer to Parents	Transfer to Parents	Prob. Transfers	Prob. Transfers	Years Schooling	BMI	Income (pc)
	OLS (1)	Tobit (2)	Tobit (3)	Tobit (4)	Probit (5)	OLS (6)	OLS (7)	OLS (8)
TWIN	0.68	-17.4	-24.0	-0.10	-0.08	-0.93	-0.08	-297.3
	(0.42)	(7.9)	(10.9)	(0.05)	(0.06)	(0.51)	(0.51)	(98.6)
AGEFB	-0.08	-0.25	-0.35	0.00	0.00	-0.08	-0.01	-7.39
	(0.01)	(0.28)	(0.39)	(0.00)	(0.00)	(0.02)	(0.01)	(4.66)
AGE	0.05	0.40	0.56	0.00	0.00	0.02	0.01	2.45
	(0.01)	(0.23)	(0.32)	(0.00)	(0.00)	(0.01)	(0.01)	(3.99)
ME Tobit	-	$E(T\|T>0)$	$E(T)$	$P(T>0)$	-	-	-	-
District FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean dep. var.	4.58	93.6	93.6	0.68	0.68	7.17	22.55	911.4
S.d. dep. var.	(2.25)	(149.2)	(149.2)	(0.47)	(0.47)	(4.42)	(3.47)	(1210.3)
N. obs.	3703	3703	3703	3703	3687	3670	3378	3579
N. twins	50	50	50	50	50	49	46	48

Standard errors robust to heteroskedasticity are added. The sample includes individuals aged 25 to 45 in 1997 who are household heads or head's spouses and who had at least one of the parents alive and not coresiding. District fixed effects and dummy for rural status are added. Regressions also include control for the age and the sex of the adult children. The dependent variable in column (1) is the number of siblings alive. The dependent variable in columns (2)-(3) is the value of cash and in kind transfers made to nonresident parents in the past 12 months. The dependent variable in columns (4) and (5) is an indicator for whether the individual made transfers to parents. The dependent variable in column (6) is the completed years of schooling. The dependent variable in column (7) is the body mass index (kg/m^2). The dependent variable in column (8) is the household per capita income. Source: IFLS 1997.

Table 12: TWIN-FIRST EFFECT ON TRANSFER TO PARENTS AND HUMAN CAPITAL OF TWIN CHILDREN, ADULT CHILDREN AGED 25 TO 45, INDONESIA

	Indonesia - 1997				
Dep. Var.	Transfer to Parents	Transfer to Parents	Prob. Transfers	Years Schooling	BMI
	Tobit (1)	Tobit (2)	Tobit (3)	OLS (4)	OLS (5)
TWIN	-8.8	-12.2	-0.05	-0.86	-0.37
	(12.0)	(16.7)	(0.07)	(0.95)	(0.68)
TWINCHILD	-13.4	-18.5	-0.08	-0.11	0.44
	(15.7)	(21.7)	(0.09)	(1.12)	(0.97)
AGEFB	-0.24	-0.34	0.00	-0.08	-0.01
	(0.28)	(0.39)	(0.00)	(0.02)	(0.01)
AGE	0.40	0.55	0.00	0.02	0.01
	(0.23)	(0.32)	(0.00)	(0.01)	(0.01)
ME Tobit	$E(T\|T>0)$	$E(T)$	$P(T>0)$	-	-
District FE	Yes	Yes	Yes	Yes	Yes
Mean dep. var.	93.6	93.6	0.68	7.17	22.55
S.d. dep. var.	(149.2)	(149.2)	(0.47)	(4.42)	(3.47)
N. obs.	3703	3703	3703	3670	3378
N. twins	50	50	50	48	45

Standard errors robust to heteroskedasticity are added. The sample includes individuals aged 25 to 45 in 1997 who are household heads or head's spouses and who had at least one of the parents alive and not coresiding. District fixed effects and dummy for rural status are added. Regressions also include control for the age and the sex of the adult children. $TWINCHILD$ is a dummy for whether the adult child is a twin. The dependent variable in columns (1)-(2) is the value of cash and in kind transfers made to nonresident parents in the past 12 months. The dependent variable in column (3) is an indicator for whether the individual made transfers to parents. The dependent variable in column (4) is the completed years of schooling. The dependent variable in column (5) is the body mass index (kg/m^2). Source: IFLS 1997.

Table 13: TWIN-FIRST EFFECT ON YOUNG CHILDREN'S EDUCATIONAL ATTAINMENT, YOUNG CHILDREN AGED 13 TO 25, CHINA

	China - 1990			
Dep. Var.	Child Has Educational Attainment Appropriate for Her Age			
	Ages 13 to 25		Ages 13 to 18	
	Probit (1)	Probit (2)	Probit (3)	Probit (4)
TWIN	-0.031	0.003	-0.024	-0.006
	(0.014)	(0.024)	(0.013)	(0.023)
TWINCHILD		-0.043		-0.024
		(0.029)		(0.026)
AGEFB	0.011	0.011	0.012	0.012
	(0.000)	(0.000)	(0.000)	(0.000)
AGE	0.002	0.002	-0.003	-0.003
	(0.000)	(0.000)	(0.000)	(0.000)
Mean dep. var.	0.49	0.49	0.71	0.71
S.d. dep. var.	(0.50)	(0.50)	(0.45)	(0.45)
N. obs.	376956	376956	277479	277479
N. twins	1705	1334	1245	936

Standard errors robust to heteroskedasticity are in parentheses. The sample includes young children from female heads or head's spouses whose all children ever born are currently living in the household. The sample includes only children from households living in any of the nine Chinese provinced covered by the CHNS. *TWINCHILD* is a dummy for whether the adult child is a twin. Province fixed effects are added. The dependent variable is an indicator for whether the child has age-appropriate educational level. For children aged 13 to 18 the dummy takes value one if the child completed primary school and zero otherwise. For children aged 19 to 25 the dummy takes value one if the child completed secondary school and zero otherwise. Source: Chinese Census 1990.

Table 14: TWIN-FIRST EFFECT ON LABOR SUPPLY, MOTHERS AGED 15 TO 47, INDONESIA

	Indonesia - 1997, 2000, and 2007 [a]			Indonesia - 1994, 1997, 2003, and 2007 [b]	
Dep. Var.	Worked last wk	Worked 1 hr	Ever worked	Worked last yr	Working now
	Probit	Probit	Probit	Probit	Probit
	(1)	(2)	(3)	(4)	(5)
TWIN	0.03	0.02	-0.01	0.04	0.02
	(0.06)	(0.06)	(0.06)	(0.03)	(0.02)
AGEFB	0.00	0.00	0.01	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
AGE	0.01	0.01	0.01	0.01	0.01
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Mean dep. var.	0.48	0.54	0.70	0.55	0.57
S.d. dep. var.	(0.50)	(0.50)	(0.46)	(0.50)	(0.49)
N. obs.	14765	14765	14762	54510	104753
N. twins	91	91	91	290	486

[a] Standard errors clustered at the individual level are in parentheses. Columns (1)-(3) use a sample of mothers aged 15 to 47 drawn from the IFLS. District and survey year fixed effects and a dummy for rural status are added. The dependent variable in column (1) is a dummy variable indicating whether the mother reported that she was working, or helping to earn income during the past week as her primary activity. In column (2), the dependent variable indicating whether the a woman who were not currently working reported they have worked for at least one hour in the last week. The dependent variable in column (3) indicates whether a woman who were not currently working reported they have worked previously. Source: IFLS 1997, 2000, and 2007

[b] Standard errors robust to heteroskedasticity. Columns (4)-(5) use a sample of mothers aged 15 to 47 drawn from the DHS. Province and survey year fixed effects and dummy for rural status are added. The dependent variable in column (4) in an indicator for whether the woman worked in the past year. The dependent variable in column (5) is a dummy for whether the woman is currently working. Source: Indonesian DHS 1994, 1997, 2003, and 2007.

Table 15: TWIN-FIRST EFFECT ON LABOR SUPPLY HISTORY, MOTHERS AGED 15 TO 75, INDONESIA

	Indonesia - 1994, 1997, 2000, and 2007	
Dep. Var.	Worked at ages 15 to 46	Worked at ages 47 to 75
Sample	Women 15 to 46	Women 47 to 75
	OLS (1)	OLS (2)
TWIN	-0.01	-0.16
	(0.05)	(0.06)
AGEFB	0.01	0.01
	(0.00)	(0.00)
AGE	0.00	-0.02
	(0.00)	(0.00)
Mean dep. var.	0.90	0.80
S.d. dep. var.	(0.28)	(0.28)
Avg. years in panel	13	9
N. obs.	5381	2184
N. twins	34	24

OLS estimates. Standard errors robust to heteroskedasticity are in parentheses. Column (1) uses a sample of mothers aged 15 to 46 in 2000. Column (2) uses a sample of mothers aged 47 to 75 in 2000. The estimates use individual level employment history data from the IFLS. The employment history module provides data on working status for up to 19 years, from 1988 to 2007, depending on which year the mother is interviewed. District fixed effects and dummy for rural status are added. The dependent variable in column (1) is a dummy indicating whether the woman worked during at least one of the years in which she was between the ages of 15 and 46. The dependent variable in column (2) is a dummy indicating whether the woman worked during at least one of the years in which she was between the ages of 47 and 75. Source: Indonesian DHS 1994, 1997, 2003, and 2007.

Table 16: TWIN-FIRST EFFECT ON FERTILITY AND LABOR SUPPLY, MOTHERS AGED 15 TO 47, CHINA

	China - 1990			
Dep. Var.	Children		Working now	
	OLS	OLS	Probit	Probit
	(1)	(2)	(3)	(4)
TWIN	0.7032	1.4188	-0.0210	-0.0926
	(0.0127)	(0.0650)	(0.0042)	(0.0222)
TWIN X AGE		-0.0225		0.0023
		(0.0022)		(0.0007)
AGEFB	-0.13	-0.13	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)
AGE	0.09	0.09	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Mean dep. var.	1.98	1.98	0.93	0.93
S.d. dep. var.	(0.99)	(0.99)	(0.26)	(0.26)
N. obs.	645913	645913	645913	645913
N. twins	3053	3053	3053	3053

Standard errors robust to heteroskedasticity are in parentheses. The sample includes women aged 15 to 47 who gave birth to at least one child. The sample is restricted to female heads and head's spouses whose reported number of children ever born is the same as the number of coresident children. The sample only includes women from households living in one of the nine Chinese provinces covered by the CHNS. Province fixed effects are included. The dependent variable in columns (1)-(2) is the number of children born. The dependent variable in columns (3)-(4) is a dummy indicating whether the woman is currently working. Source: Chinese Census 1990.

Table 17: TWIN-FIRST EFFECT ON NUMBER OF CORESIDENT CHILDREN, MOTHERS AGED 47 TO 75, INDONESIA

	China - 2000, 2004, 2006, and 2009 [a]			Indonesia - 2000 [b]		
Dep. Var.	N. children older than 15	N. children older than 18	N. children older than 25	N. children older than 15	N. children older than 18	N. children older than 25
	OLS (1)	OLS (2)	OLS (3)	OLS (4)	OLS (5)	OLS (6)
TWIN	0.07	0.10	0.12	0.10	0.13	0.11
	(0.20)	(0.20)	(0.15)	(0.20)	(0.20)	(0.14)
AGEFB	0.03	0.01	-0.02	-0.02	-0.03	-0.04
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
AGE	-0.05	-0.03	0.03	-0.02	0.00	0.04
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Constant	2.53	1.65	-1.00	3.06	1.81	-0.75
	(0.16)	(0.17)	(0.14)	(0.16)	(0.15)	(0.11)
Year FE	Yes	Yes	Yes	-	-	-
Region FE	Yes	Yes	Yes	Yes	Yes	Yes
Mean dep. var.	1.07	0.94	0.45	1.47	1.30	0.78
S.d. dep. var.	(0.89)	(0.84)	(0.67)	(1.09)	(1.01)	(0.80)
N. obs.	6133	6133	6133	3029	3029	3029
N. twins.	44	44	44	29	29	29

[a] Standard errors clustered at the household level are in parentheses. The sample includes women 47 to 75 years old in 2009, 44 to 75 years old in 2006, 42 to 75 years old in 2004, and 40 to 75 years old in 2000, with at least one child alive at the year of the survey. The sample is restricted to rural households. Community and survey-year fixed effects are added. Source: CHNS 2000, 2004, 2006, and 2009.

[b] Standard errors robust to heteroskedasticity are in parentheses. The sample includes women 47 to 75 years old in 2000, with at least one child alive at the year of the survey. District fixed effects and dummy for rural status are added. Source: IFLS 2000.

Table 18: TWIN-FIRST EFFECT ON TRANSFERS FROM CHILDREN, IV ESTIMATES, CHINA AND INDONESIA

	China - 2000, 2004, 2006, and 2009 [a]			Indonesia - 2000 [b]					
Dep. Var.	Total Transfers	Total Transfers	Prob. Transfers	Total Transfers	Total Transfers	Prob. Transfers	Total Transfers	Total Transfers	Prob. Transfers
	IVTobit (1)	IVTobit (2)	IVProbit (3)	IVTobit (4)	IVTobit (5)	IVProbit (6)	IVTobit (7)	IVTobit (8)	IVProbit (9)
CHILDREN	409.06	466.49	0.113	207.15	241.61	0.100	243.16	265.38	0.098
	(207.32)	(232.05)	(0.060)	(125.85)	(132.76)	(0.013)	(150.18)	(153.53)	(0.024)
AGEFB	37.52	42.78	0.01	-7.24	-8.45	-0.01	-15.52	-16.94	-0.01
	(34.37)	(38.80)	(0.01)	(3.67)	(4.72)	(0.00)	(14.00)	(15.91)	(0.01)
AGE	23.97	27.34	0.02	-5.12	-5.97	0.00	2.12	2.31	0.00
	(13.09)	(15.17)	(0.01)	(11.70)	(13.31)	(0.01)	(4.04)	(4.49)	(0.00)
ME Tobit	$E(T\|T>0)$	$E(T)$	-	$E(T\|T>0)$	$E(T)$	-	$E(T\|T>0)$	$E(T)$	-
Year FE	Yes	Yes	Yes	-	-	-	-	-	-
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N. obs.	6133	6133	6133	4600	4600	4592	3234	3234	3215
N. twins	44	44	44	40	40	40	21	21	21

[a] IV estimates. Standard errors clustered at the household level are in parentheses. The sample includes women 47 to 75 years old in 2009, 44 to 75 years old in 2006, 42 to 75 years old in 2004, and 40 to 75 years old in 2000, with at least one child alive at the year of the survey. The sample is restricted to rural households. Community and survey-year fixed effects are added. The dependent variable in columns (1) and (2) is the value of cash and in-kind transfers received from nonresident children in the past 12 months (CNY). The dependent variable in column (3) is an indicator for whether the household received transfers from nonresident children. Source: CHNS 2000, 2004, 2006, and 2009.

[b] IV estimates. Stardard errors robust to heteroskedasticity are in parentheses. The sample includes women aged 40 to 75 in 2000 with at least one child alive at the year of the survey. This approach is adopted to increase power. Results shown in columns (7), (8), and (9) are based on a sample of women 40 to 75 years old for whom data on year of birth are not missing for any of the listed children. District fixed effects and dummy for rural status are added. The dependent variable in columns (4), (5), (7), and (8) is the value of cash and in-kind transfers received from nonresident children in the past 12 months (1,000 IDR). The dependent variable in columns (6) and (9) is an indicator for whether the household received transfers from nonresident children. Source: IFLS 2000.

Table 19: TWIN-FIRST EFFECT ON TRANSFERS FROM PARENS AND OTHER RELATIVES, MOTHERS AGED 47 TO 75, CHINA

	China - 2000, 2004, 2006, and 2009			
Dep. Var.	Total Transfers	Total Transfers	Prob. Transfers	Prob. Transfers
	Tobit (1)	Tobit (2)	Tobit (3)	Probit (4)
TWIN	9.79	7.74	0.00	-0.01
	(111.02)	(87.78)	(0.04)	(0.05)
AGEFB	-2.89	-2.28	0.00	0.00
	(2.47)	(1.95)	(0.00)	(0.00)
AGE	-0.17	-0.14	0.00	0.00
	(1.79)	(1.41)	(0.00)	(0.00)
ME Tobit	$E(T\|T>0)$	$E(T)$	$P(T>0)$	-
Year FE	Yes	Yes	Yes	Yes
Community FE	Yes	Yes	Yes	Yes
N. obs.	6133	6133	6133	5994
N. twins	44	44	44	44

Standard errors clustered at the household level are in parentheses. The sample includes women 47 to 75 years old in 2009, 44 to 75 years old in 2006, 42 to 75 years old in 2004, and 40 to 75 years old in 2000, with at least one child alive at the year of the survey. The sample is restricted to rural households. Community and survey-year fixed effects are added. The dependent variable in columns (1) and (2) is the value of cash and in-kind transfers received from nonresident parents and transfers from other relatives in the past 12 months (CNY). The dependent variable in columns (3) and (4) is an indicator for whether the household received transfers from from nonresident parents and transfers from other relatives. Source: CHNS 2000, 2004, 2006, and 2009.

Table 20: SEX RATIO AMONG FIRST-BORN TWINS, FIRST-BORN TWINS, U.S., INDONESIA, AND CHINA

	Twin-first Sex Ratio		
	U.S.	Indonesia	China
	1980	1994, 1997, 2003, and 2007	1990
Female twins	0.504	0.497	0.532
Male twins	0.495	0.502	0.467
Test Ho: female-male = 0			
t-statistics [b]	0.74	-0.10	3.03
p-value	0.45	0.92	0.00
N. twins [c]	5670	420	2132

The samples include all same-sex twin-first pairs born to mothers 15 to 49 years old at the time of the survey. The results based on Census data are restricted to children born to mothers whose reported number of children born is the same as the number of children currently living in the household. The alternative hypothesis is that the proportion of female twins is different from the proportion of male twins. Sources: U.S. Census 1980, Indonesian DHS 1994, 1997, 2003, and 2007; Chinese Census 1990.

Table 21: OFFSPRING SEX COMPOSITION, MOTHERS AGED 40 TO 75, CHINA AND INDONESIA

Dep. Var.	N. Sons/N. Children	
	China - 2000, 2004, 2006, and 2009 [a]	Indonesia - 2000 [b]
TWIN	0.02	-0.03
	(0.06)	(0.04)
AGEFB	0.00	0.00
	(0.00)	(0.00)
AGE	0.00	0.00
	(0.00)	(0.00)
Constant	0.45	0.59
	(0.12)	(0.03)
Year FE	Yes	Yes
Region FE	Yes	Yes
Mean dep. var.	0.55	0.50
S.d. dep. var.	(0.34)	(0.31)
N. obs.	9800	4632
N. twins	69	40

[a] Standard errors clustered at the household level are in parentheses. The sample includes women aged 40 to 75 with at least one child alive in the survey years 2000, 2004, 2006, and 2009. Community and survey year fixed effects are added. The dependent variable is the fraction of children who are males. Source: CHNS 2000, 2004, 2006, and 2009.

[b] Standard errors robust to heteroskedasticity are in parentheses. The sample includes women aged 40 to 75 with at least one child alive in the survey year 2000. District fixed effects and dummy for rural status are added. The dependent variable is the fraction of children who are males. Source: IFLS 2000.

Table 22: TWIN-FIRST EFFECT ON TRANSFERS FROM CHILDREN, ADDITIONAL CONTROLS, MOTHERS AGED 47 TO 75, CHINA

	China - 2000, 2004, 2006, and 2009					
Dep. Var.	Total Transfers	Total Transfers	Total Transfers	Total Transfers	Prob. Transfers	Prob. Transfers
	Tobit (1)	Tobit (2)	Tobit (3)	Tobit (4)	Tobit (5)	Tobit (6)
TWIN	429.21	429.69	485.67	486.08	0.18	0.18
	(186.04)	(188.55)	(210.49)	(213.29)	(0.08)	(0.08)
AGEFB	-29.92	-39.01	-33.86	-44.13	-0.01	-0.02
	(3.16)	(9.49)	(3.56)	(10.72)	(0.00)	(0.00)
AGE	46.8	56.66	52.96	64.1	0.02	0.02
	(2.83)	(10.67)	(3.19)	(12.04)	(0.00)	(0.00)
Other controls:						
Avg. age of children	No	Yes	No	Yes	No	Yes
Avg. birth spacing	No	Yes	No	Yes	No	Yes
ME Tobit	$E(T\|T>0)$	$E(T\|T>0)$	$E(T)$	$E(T)$	$E(T\|T>0)$	$E(T\|T>0)$
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Community FE	Yes	Yes	Yes	Yes	Yes	Yes
N. obs.	6133	6133	6133	6133	6133	6133
N. twins	44	44	44	44	44	44

Standard errors clustered at the household level are in parentheses. The sample includes women 47 to 75 years old in 2009, 44 to 75 years old in 2006, 42 to 75 years old in 2004, and 40 to 75 years old in 2000, with at least one child alive at the year of the survey. The sample is restricted to rural households. Community and survey-year fixed effects are added. The dependent variable in columns (1)-(4) is the value of cash and in-kind transfers received from nonresident children in the past 12 months (CNY). The dependent variable in columns (5)-(6) is an indicator for whether the household received transfers from nonresident children. Source: CHNS 2000, 2004, 2006, and 2009.

Table 23: TWIN-FIRST EFFECT ON TRANSFERS FROM CHILDREN, ADDITIONAL CONTROLS, MOTHERS AGED 47 TO 75, INDONESIA

	Indonesia - 2000					
Dep. Var.	Total Transfers	Total Transfers	Total Transfers	Total Transfers	Prob. Transfers	Prob. Transfers
	Tobit (1)	Tobit (2)	Tobit (3)	Tobit (4)	Tobit (5)	Tobit (6)
TWIN	188.15	166.6	247.36	215.56	0.19	0.16
	(98.01)	(94.01)	(128.79)	(121.58)	(0.10)	(0.09)
AGEFB	-6.5	-30.7	-8.54	-39.72	-0.01	-0.03
	(1.24)	(2.77)	(1.63)	(3.52)	(0.00)	(0.00)
AGE	6.02	33.08	7.91	42.81	0.01	0.03
	(1.05)	(3.21)	(1.37)	(4.10)	(0.00)	(0.00)
Other controls:						
Avg. age of children	No	Yes	No	Yes	No	Yes
Avg. birth spacing	No	Yes	No	Yes	No	Yes
ME Tobit	$E(T\|T>0)$	$E(T\|T>0)$	$E(T)$	$E(T)$	$E(T\|T>0)$	$E(T\|T>0)$
Year FE	-	-	-	-	-	-
District FE	Yes	Yes	Yes	Yes	Yes	Yes
N. obs.	3029	3029	3029	3029	3029	3029
N. twins	29	29	29	29	29	29

Standard errors robust to heteroskedasticity are in parentheses. The sample includes women 47 to 75 years old in 2000 with at least one child alive at the year of the survey. District fixed effects and dummy for rural status are added. The dependent variable in columns (1)-(4) is the value of cash and in-kind transfers received from nonresident children in the past 12 months (1,000 IDR). The dependent variable in columns (5)-(6) is an indicator for whether the household received transfers from nonresident children. Source: IFLS 2000.

Table 24: TWIN-FIRST EFFECT ON LOG TRANSFERS, MOTHERS AGED 47 TO 75, CHINA AND INDONESIA

	China - 2000, 2004, 2006, and 2009 [a]		Indonesia - 2000 [b]	
Dep. Var.	Log Transfers	Log Transfers	Log Transfers	Log Transfers
	Tobit	Tobit	Tobit	Tobit
	(1)	(2)	(3)	(4)
TWIN	0.80	1.06	0.81	1.13
	(0.42)	(0.55)	(0.38)	(0.54)
AGEFB	-0.08	-0.11	-0.04	-0.05
	(0.01)	(0.01)	(0.01)	(0.01)
AGE	0.13	0.17	0.04	0.06
	(0.01)	(0.01)	(0.01)	(0.01)
ME Tobit	$E(T\|T>0)$	$E(T)$	$E(T\|T>0)$	$E(T)$
Year FE	Yes	Yes	-	-
Region FE	Yes	Yes	Yes	Yes
Mean dep. var.	4.43	4.43	3.00	3.00
S.d. dep. var.	(1.87)	(1.87)	(2.71)	(2.71)
N. obs.	6133	6133	3029	3029
N. twins	44	44	29	29

[a] Standard errors clustered at the household level are in parentheses. The sample includes women 47 to 75 years old in 2009, 44 to 75 years old in 2006, 42 to 75 years old in 2004, and 40 to 75 years old in 2000, with at least one child alive at the year of the survey. The sample is restricted to rural households. Community and survey-year fixed effects are added. The dependent variable in columns (1)-(2) is the logarithm of the value of cash and in-kind transfers received from nonresident children in the past 12 months (CNY). Source: CHNS 2000, 2004, 2006, and 2009.

[b] Standard errors robust to heteroskedasticity are in parentheses. The sample includes women 47 to 75 years old in 2000 with at least one child alive at the year of the survey. District fixed effects and dummy for rural status are added. The dependent variable in columns (3)-(4) is the logarithm of the value of cash and in-kind transfers received from nonresident children in the past 12 months (1,000 IDR). Source: IFLS 2000.

Table 25: TWIN-FIRST EFFECT ON TRANSFERS FROM CHILDREN, MOTHERS AGED 37 TO 65, INDONESIA

	Indonesia - 2000				
Dep. Var.	Children	Total Transfers	Total Transfers	Prob. Transfers	Prob. Transfers
	OLS (1)	Tobit (2)	Tobit (3)	Tobit (4)	Probit (5)
TWIN [a]	0.83	145.83	141.44	0.11	0.09
	(0.39)	(77.33)	(75.05)	(0.06)	(0.07)
AGEFB	-0.12	-39.60	-38.41	-0.03	-0.04
	(0.01)	(2.96)	(2.91)	(0.00)	(0.00)
AGE	0.12	18.74	18.18	0.01	0.02
	(0.01)	(1.59)	(1.55)	(0.00)	(0.00)
ME Tobit	-	$E(T\|T>0)$	$E(T)$	$P(T>0)$	-
District FE	Yes	Yes	Yes	Yes	Yes
Mean dep. var.	4.09	624.79	624.79	0.25	0.25
S.d. dep. var.	(2.26)	(1118.42)	(1118.42)	(0.43)	(0.43)
N. obs.	3248	3850	3850	3850	3848
N. twins	23	27	27	27	27

Standard errors robust to heteroskedasticity are in parentheses. The sample includes women 37 to 75 years old in 2000 with at least one child alive at the year of the survey and for whom data on year of birth are not missing for any of the listed children. District fixed effects and dummy for rural status are added. Source: IFLS 2000.

Table 26: TWIN-FIRST EFFECT ON NET TRANSFERS, MOTHERS AGED 47 TO 75, CHINA AND INDONESIA

	China - 2000, 2004, and 2006 [a]					Indonesia - 2000 [b]				
Dep. Var.	Total Transfers	Total Transfers	Net Transfers	Net Transfers	Net Transfers	Total Transfers	Total Transfers	Net Transfers	Net Transfers	Net Transfers
	Tobit (1)	Tobit (2)	Tobit (3)	Tobit (4)	OLS (5)	Tobit (6)	Tobit (7)	Tobit (8)	Tobit (9)	OLS (10)
TWIN	429.25	468.44	390.20	409.01	457.03	218.69	247.36	151.51	188.41	194.59
	(219.62)	(239.65)	(229.20)	(244.33)	(312.84)	(99.63)	(128.73)	(104.42)	(129.88)	(250.10)
AGEFB	-31.94	-34.85	-29.45	-31.61	-30.08	-6.32	-8.54	-4.72	-5.87	-4.62
	(3.65)	(3.99)	(3.60)	(3.83)	(6.21)	(1.23)	(1.62)	(1.19)	(1.48)	(1.99)
AGE	52.15	56.91	50.58	55.16	52.31	5.89	7.91	7.41	9.21	7.58
	(3.29)	(3.65)	(3.26)	(3.58)	(5.19)	(1.05)	(1.37)	(1.02)	(1.26)	(1.62)
ME Tobit	$E(T\|T>0)$	$E(T)$	$E(T\|T>0)$	$E(T)$	-	$E(T\|T>0)$	$E(T)$	$E(T\|T>0)$	$E(T)$	-
Year FE	Yes	Yes	Yes	Yes	Yes	-	-	-	-	-
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N. obs.	4660	4660	4660	4660	4660	2976	2976	2976	2976	2976
N. twins	32	32	32	32	32	27	27	27	27	27

[a] Standard errors clustered at the household level are in parentheses. The sample includes women 44 to 75 years old in 2006, 42 to 75 years old in 2004, and 40 to 75 years old in 2000, with at least one child alive at the year of the survey. The sample is restricted to rural households. Community and survey-year fixed effects are added. The dependent variable in columns (1)-(2) is the value of cash and in-kind transfers received from nonresident children in the past 12 months (CNY). The dependent variables in columns (3)-(4) is the difference between total transfers received from children and total transfers made to children, where the negative values were replaced by zeros. The depend variables in column (5) is the difference between total transfers received from children and total transfers made to children, where the negative values were not replaced by zeros. Source: CHNS 2000, 2004, and 2006.

[b] Standard errors robust to heteroskedasticity are in parentheses. The sample includes women 47 to 75 years old in 2000 with at least one child alive at the year of the survey. District fixed effects and dummy for rural status are added. The dependent variable in columns (6)-(7) is the value of cash and in-kind transfers received from nonresident children in the past 12 months (1,000 IDR). The dependent variable in columns (8)-(9) is the difference between total transfers received from children and total transfers made to children, where the negative values were replaced by zeros. The depend variable in column (10) is the difference between total transfers received from children and total transfers made to children, where the negative values were not replaced by zeros. Source: IFLS 2000.

A Partial effects of $\overline{n}$ on q, s, and, c_f in the model without transfers from children

In this appendix, I derive the effects of an exogenous change in n on the demands for the other endogenous variables. The approach is to treat n and a parameter $\overline{n}$ and derive comparative statics results around the optimal n. Totally differentiating the first-order conditions (3)-(5) with respect to $\overline{n}$ and I yields the following set of simultaneous linear differential equations written in matrix form:

$$\begin{bmatrix} 0 & -\pi_q n & -\pi_s & -1 \\ -\pi_q n & U_{qq} & 0 & 0 \\ -\pi_s & 0 & U_{pp} & 0 \\ -1 & 0 & 0 & U_{ff} \end{bmatrix} \begin{bmatrix} d\lambda \\ dq \\ ds \\ dc_f \end{bmatrix} = \begin{bmatrix} \pi_q q & -1 \\ \lambda \pi_q & 0 \\ 0 & 0 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} d\overline{n} \\ dI \end{bmatrix} \tag{A.1}$$

The second-order conditions for utility maximization are $\Delta < 0$ and ϕ_{22}, ϕ_{33} and $\phi_{44} > 0$, where Δ is the determinant of the bordered Hessian matrix and ϕ_{22}, ϕ_{33}, and ϕ_{44} are the cofactors of the elements of the principal diagonal.

Using the Cramer's rule to solve for dq, ds, and dc_f I obtain

$$dq = \frac{1}{\Delta}\{-\phi_{12}(\pi_q q d\overline{n} - dI) + \phi_{22}\lambda \pi_q d\overline{n}\} \tag{A.2}$$

$$ds = \frac{1}{\Delta}\{\phi_{13}(\pi_q q d\overline{n} - dI) - \phi_{23}\lambda \pi_q d\overline{n}\} \tag{A.3}$$

$$dc_f = \frac{1}{\Delta}\{-\phi_{14}(\pi_q q d\overline{n} - dI) + \phi_{24}\lambda \pi_q d\overline{n}\} \tag{A.4}$$

where

$$\begin{aligned} \phi_{12} = & \quad -\pi_q n U_{pp} U_{ff} & < 0 \\ \phi_{13} = & \quad \pi_s U_{qq} U_{ff} & > 0 \\ \phi_{14} = & \quad -U_{qq} U_{pp} & < 0 \\ \phi_{23} = & \quad -\pi_q n \pi_s U_{ff} & > 0 \\ \phi_{24} = & \quad \pi_q n U_{pp} & < 0 \end{aligned}$$

One can decompose the effect of an increase in $\overline{n}$ in two parts. The first part is the income effect from the increase in the price of q, which follows from the interaction be-

tween n and q in the budget constraint. The signs of the cofactors in this problem imply that the income effects are negative for all the variables. The "compensated price effect" (obtained by setting $\pi_q q d\overline{n} = dI$) is negative in (A.2) and positive in (A.3) and (A.4).

B Partial effects of $\overline{n}$ on q, s and, c_f in the model with transfers from children

In this appendix I derive the effects of an exogenous change in n on the demands for q, c_f, and s when parents' old-age consumption is determined by n and q, in addition to s. Lets denote the predetermined level of fertility by $\overline{n}$. First, I define the utility function in problem with transfers as

$$U(\overline{n}, q, c_p(\overline{n}, q, s), c_f) = U^t(\overline{n}, q, s, c_f) \tag{B.1}$$

where $c_p(\overline{n}, q, s)$ is obtained from the adult children's problem derived in section 2. The superscript t indicates that I am now dealing with the problem where children make transfer to parents in the second period.

Totally differentiating (19)-(21) with respect to $\overline{n}$ and I yields the following system of differential equations:

$$\begin{bmatrix} 0 & -\pi_q n & -\pi_s & -1 \\ -\pi_q n & U^t_{qq} & U^t_{qs} & 0 \\ -\pi_s & U^t_{sq} & U^t_{ss} & 0 \\ -1 & 0 & 0 & U^t_{ff} \end{bmatrix} \begin{bmatrix} d\lambda \\ dq \\ ds \\ dc_f \end{bmatrix} = \begin{bmatrix} \pi_q q & -1 \\ \lambda \pi_q - U^t_{qn} & 0 \\ -U^t_{sn} & 0 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} d\overline{n} \\ dI \end{bmatrix} \tag{B.2}$$

where

$$U^t_{qq} = U_{qq} + \underbrace{U_p \frac{\partial^2 c_p}{\partial q^2} + U_{pp}\left(\frac{\partial c_p}{\partial q}\right)^2}_{U^p_{qq}} \tag{B.3}$$

$$U^t_{qn} = \underbrace{U_p \frac{\partial^2 c_p}{\partial q \partial n} + U_{pp}\left(\frac{\partial c_p}{\partial q}\right)\left(\frac{\partial c_p}{\partial n}\right)}_{U^p_{qn}} \tag{B.4}$$

$$U^t_{qs} = U^t_{sq} = \underbrace{U_p \frac{\partial^2 c_p}{\partial q \partial s} + U_{pp}\left(\frac{\partial c_p}{\partial q}\right)\left(\frac{\partial c_p}{\partial s}\right)}_{U^p_{qs}} \tag{B.5}$$

$$U^t_{ss} = U_{pp} + \underbrace{U_p \frac{\partial^2 c_p}{\partial s^2} + U_{pp}\left[\left(\frac{\partial c_p}{\partial s}\right)^2 - 1\right]}_{U^p_{ss}} \tag{B.6}$$

$$U^t_{sn} = \underbrace{U_p \frac{\partial^2 c_p}{\partial s \partial n} + U_{pp}\left(\frac{\partial c_p}{\partial s}\right)\left(\frac{\partial c_p}{\partial n}\right)}_{U^p_{sn}} \tag{B.7}$$

Solving for dq, ds, and dc_f:

$$dq = \frac{1}{\Delta^t}\{-\phi^t_{12}(\pi_q q d\overline{n} - dI) + [\phi^t_{22}\lambda\pi_q + (-\phi^t_{22}U^t_{qn} + \phi^t_{32}U^t_{sn})]d\overline{n}\} \tag{B.8}$$

$$ds = \frac{1}{\Delta^t}\{\phi^t_{13}(\pi_q q d\overline{n} - dI) + [-\phi^t_{23}\lambda\pi_q + (\phi^t_{23}U^t_{qn} - \phi^t_{33}U^t_{sn})]d\overline{n}\} \tag{B.9}$$

$$dc_f = \frac{1}{\Delta^t}\{-\phi^t_{14}(\pi_q q d\overline{n} - dI) + [\phi^t_{24}\lambda\pi_q + (-\phi^t_{24}U^t_{qn} + \phi^t_{34}U^t_{sn})]d\overline{n}\} \tag{B.10}$$

where Δ^t is the determinant of the bordered Hessian matrix in (B.2) and ϕ^t_{ij}'s are the cofactors of the bordered Hessian. The second-order conditions for utility maximization imply that $\Delta^t < 0$ and ϕ^t_{22}, ϕ^t_{33}, and $\phi^t_{44} > 0$.

The signs of the effects in (B.8)-(B.10) depend not only on the assumptions about parents' preferences, but also on the adult children's preferences. From equations (14)-(16) one can see that the signs of the second derivatives of the old-age consumption function, $c_p(n, q, s)$, play an important role and depend closely on $\gamma = \frac{V_{pp}}{V_{kk}}$. Notice that in order to determine these signs I need to make assumptions about the signs and the magnitudes of

the third derivatives of children's utility from own consumption and parents' consumption. To simplify the analysis, I consider the cases in which $V_{ppp} = V_{kkk} = 0$.[44] In this case, it follows that $\frac{\partial^2 c_p}{\partial n^2}$, $\frac{\partial^2 c_p}{\partial n \partial s} < 0$, $\frac{\partial^2 c_p}{\partial n \partial q} > 0$ and $\frac{\partial^2 c_p}{\partial s^2}$, $\frac{\partial^2 c_p}{\partial q^2}$, and $\frac{\partial^2 c_p}{\partial q \partial s} = 0$.[45] Therefore, I can sign the last terms in equations (B.3)-(B.7) as follows: U^p_{qq}, U^p_{qs}, U^p_{qq}, and $U^p_{sn} < 0$ and $U^p_{ss} > 0$. The sign of U^p_{qn} cannot be determined.

The relationships between the cofactors of the problem with transfers and the problem without are as follows:

$$\begin{aligned}
\phi^t_{12} = &\quad \phi_{12} - \pi_q n U^p_{ss} U_{ff} + \pi_s U^t_{qs} U_{ff} &\lessgtr 0 \\
\phi^t_{13} = &\quad \phi_{13} - \pi_q n U^t_{qs} U_{ff} + \pi_s U^p_{qq} U_{ff} &\lessgtr 0 \\
\phi^t_{14} = &\quad \phi_{14} + (U^t_{qs})^2 - U^t_{ss} U^p_{qq} &\lessgtr 0 \\
\phi^t_{22} = &\quad \phi_{22} - U^p_{ss} &> 0 \\
\phi^t_{23} = &\quad \phi_{23} - U^t_{qs} &> 0 \\
\phi^t_{24} = &\quad \phi_{24} + \pi_q n U^p_{ss} - \pi_s U^t_{qs} &\lessgtr 0 \\
\phi^t_{33} = &\quad \phi_{33} - U^p_{qq} &> 0
\end{aligned}$$

In conclusion, when the model is extended to account for the role of children in parents' old-age consumption, it is not clear that changes in the economic environment that lower fertility consequently increase parental investments in children's human capital, even when preferences do no imply complementarity between the quantity and the quality of children. The ambiguity arises from the interaction between the quantity and the quality of children in children's behavior regarding old-age transfers. This interaction is embodied in the derivative $\frac{\partial^2 c_p}{\partial q \partial n}$, which is positive under the assumption that $V_{ppp} = V_{kkk} = 0$. The result also holds for Cobb-Douglas utility functions.

C The Cobb-Douglas case

In this Appendix, I derive the second own and cross derivatives of c_p with respect to n, q, and s. Assume that $V(q - T_k, s + T_k + \sum_{j \neq k} T_j) = \alpha_k log(q - T_k) + \alpha_p log(s + T_k + \sum_{j \neq k} T_j)$, where α_k and α_p are parameters satisfying α_k, $\alpha_p > 0$. Assuming an interior solution, one can derive the utility with respect to T_k and find the symmetric equilibrium transfer, T^*,

[44] In fact, this assumption is stronger than required for the following results to hold. For instance, they hold in the case of Cobb-Douglas utility.

[45] From Young's theorem, $\frac{\partial^2 c_p}{\partial s \partial q} < 0$ $\frac{\partial^2 c_p}{\partial q \partial n} > 0$ and $\frac{\partial^2 c_p}{\partial s \partial q} = 0$.

which is given by the following equation:

$$T^* = \frac{\alpha_p q - \alpha_k s}{\alpha_p + \alpha_k n} \tag{C.1}$$

The parents consumption during old age can be written as follows:

$$c_p = s + n\left(\frac{\alpha_p q - \alpha_k s}{\alpha_p + \alpha_k n}\right) \tag{C.2}$$

It follows from these functional forms that

$$\frac{\partial c_p}{\partial n} = \frac{\alpha_p T^*}{(\alpha_p + \alpha_k n)} > 0 \tag{C.3}$$

$$\frac{\partial c_p}{\partial q} = \frac{\alpha_p n}{(\alpha_p + \alpha_k n)} > 0 \tag{C.4}$$

$$\frac{\partial c_p}{\partial s} = \frac{\alpha_p}{(\alpha_p + \alpha_k n)} > 0 \tag{C.5}$$

Deriving equations (C.3)-(C.5) with respect to n, q, and s gives

$$\frac{\partial^2 c_p}{\partial n^2} = -\frac{2\alpha_k \alpha_p T^*}{(\alpha_p + \alpha_k n)^2} < 0 \tag{C.6}$$

$$\frac{\partial^2 c_p}{\partial n \partial q} = \frac{\partial^2 c_p}{\partial q \partial n} = \frac{\alpha_p^2}{(\alpha_p + \alpha_k n)^2} > 0 \tag{C.7}$$

$$\frac{\partial c_p^2}{\partial n \partial s} = \frac{\partial c_p^2}{\partial s \partial n} = -\frac{\alpha_p \alpha_k}{(\alpha_p + \alpha_k n)^2} < 0 \tag{C.8}$$

$$\frac{\partial^2 c_p}{\partial q^2} = 0 \tag{C.9}$$

$$\frac{\partial^2 c_p}{\partial q \partial s} = \frac{\partial^2 c_p}{\partial s \partial q} = 0 \tag{C.10}$$

$$\frac{\partial^2 c_p}{\partial s^2} = 0 \tag{C.11}$$

The signs of the derivatives in equations (C.6)-(C.8) follow from the fact that $\overline{T} = nT^*$ and that $\frac{\partial T^*}{\partial n} < 0$, $\frac{\partial T^*}{\partial q} > 0$, and $\frac{\partial T^*}{\partial s} < 0$.