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

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Abstract

In this paper I investigate the relationship between fertility and old-age support in developing countries. In the first part of the paper, I present a two-period model. In the first period, parents decide on the quantity and the quality of children and savings. In the second period, children decide on transfers to parents. I then derive the effects of an exogenous increase in fertility in the first period on parents' and children's choices. I show that an exogenous shock to fertility decreases the transfers that each child makes to parents due to the increase in sibship size but, despite that, the total transfers parents receive from children increase. As parents adjust their investment in children's quality and savings, the overall effect of the increase in fertility on transfers is ambiguous. In the second part, I use household-level data from China and Indonesia to test the model predictions. I use the incidence of twins in the first birth as a source of exogenous variation in the quantity of children. I find that twinning in the first birth increases completed fertility of older mothers in China and Indonesia by 0.8 children. Then I show evidence that transfer to parents decreases in the number of siblings, but total transfers from children increase in the number of children. Lower savings cannot explain the increase in total transfers. However, parents do respond to the increase in fertility by reducing investment in their children's human capital. Despite children having lower quality, the estimates indicate that parents consume more during old age.

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1 Introduction

This paper studies the relationship between fertility and old-age support in developing countries. The old-age security theory of fertility argues that parents with more children receive more transfers during old age and, therefore, save less. However, this prediction may not hold if higher fertility causes parents to invest less in children's human capital. On the other hand, the quantity-quality tradeoff model predicts an inverse relationship between fertility and children's human capital, but do not account for children's role in parents' old-age consumption.

The contribution of this paper is twofold. First I provide causal evidence that fertility increases income from transfers and consumption during old age. Second, I investigate the channels through which fertility affects transfers. I accomplish that by developing a conceptual framework that draws on the quantity-quality tradeoff 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 show how this conceptual framework changes the benchmark model and derive predictions for the effects of fertility on old-age support which I test using household-level data from China and Indonesia.

The role of children as a source of income to older parents is particularly prominent in developing countries, like China and Indonesia, where a large fraction of the population lives in rural areas and often lacks access to old-age pension systems.[1] As we can see in Figure 1, 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 do parents expect to be supported by children when they retire, but also the observed fraction of households receiving transfers from children is large and increases with the age of the household in both China and Indonesia, as seen in Figures 3 and 2. These figures also highlight an important feature of the lifecycle income in these two countries, which is that younger households earn more income from labor compared

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

to older households. This evidence can explain why most of the intergenerational transfers in developing countries run from the adult children to their parents and suggests that these transfers are motivated by old-age support.

This paper is divided into two parts. In the first part, I present the conceptual framework, in which I consider two periods. In the first period, parents decide on the quantity and quality of children and savings for period-two consumption given their exogenous income. In the second period, the adult children decide non-cooperatively on 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 in the second period. I obtain the effects of increasing the number of siblings, the quality of children and parents' savings on the transfer that each child makes to parents and total transfers in equilibrium. Then I characterize the parental demands for quantity and quality of children and savings when the effects of their choices on old-age consumption are accounted for. I proceed by carrying out a comparative statics analysis. I show that an exogenous shock to fertility decreases the transfer that each child makes to parents due to the increase in sibship size but, despite that, total transfers that parents receive from children increase. As parents adjust their investments in children's quality and savings, the overall effect of the exogenous change in fertility in the first period on transfers that parents receive in the second period is ambiguous.

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 the fact 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. I explore the incidence of twins in the first birth.[2] The argument is that, if one makes the reasonable assumption

[2] 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 et al. (2010), Rosenzweig and Zhang (2009), Li et al. (2008), and Rosenzweig and Wolpin (1980b)) and female labor supply (see Caceres-Delpiano (2012), Cruces and Galiani (2007), Black et al. (2005), Jacobsen et al. (1999), Angrist and Evans (1998), and Bronars and Grogger (1994)).

that all couples wish to have at least one child, then the increase in fertility following the birth of twins is uncorrelated with parental preferences.

The results are based on reduced form estimates of the effects of twins (the fertility shock) on outcomes of parents and children. To estimate these effects, I use the Indonesian Family Life Survey (IFLS) and the China Health and Nutrition Survey (CHNS) to draw two samples of mothers 47 to 75 years old. In addition, I use the IFLS to draw a sample of adult children 25 to 45 years old. 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 siblings, I do not present estimates of the effects of a fertility shock on adult children's outcomes for China.

First, I show that the incidence of twins in the first birth increases completed fertility of older mothers in both China and Indonesia. 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 the results are robust to the relatively low frequency of twinning incidence in both datasets, I use data on the birth history of women 15 to 49 years old from the 1994, 1997, 2003 and 2007 Demographic Health Surveys in Indonesia, along with data from the 2000 and 2010 Indonesian Censuses and the 1990 Chinese Census, to show that women whose first born 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 fertility on transfers. Using the sample of adult children from Indonesia, I find evidence that children are 10 percentage points less likely to make transfers to parents and transfer about 17,400 rupiahs less when their mothers experienced an exogenous increase in fertility. The estimate corresponds to approximately 19% of the sample average transfer to parents. These results are consistent with the effect of sibship size on transfers to parents predicted by the model. Despite the negative effect on transfer to parents, I find that parents with more children receive more transfers. The estimates are positive and large in both Chinese and Indonesian samples of older mothers. The increase in total transfers is about 429 yuans in China and 188,000 rupiahs in Indonesia (which correspond to 26% and 33% of the average transfer receipt in the Chinese and Indonesian samples, respectively). Moreover, per-capita consumption of non-food items is larger amongst parents who experienced an exogenous increase in fertility.

Finally, I assess the effects of a fertility shock on children's human capital and parental savings.[3] There is evidence of an adverse effect of fertility on adult children's human capital, as measured by educational attainment. I estimate that the effect is a 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.

One might be concerned that the fertility shock affects parents' lifetime income through its effect on younger mothers' labor supply. Therefore, 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 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 transfers from children.

[3] I measure parental savings using the per capita non-earned household income in the Chinese sample of older mothers and the face value of assets in the form of savings and receivables in the Indonesian sample of older mothers.

However, the increase in fertility reduces the quality of children, as measured by years of schooling. Despite children having lower quality, parents consume more and mothers enjoy higher levels of leisure during old age.

This paper is organized as follows. In the next section, I present the conceptual framework. Then I discuss the channels through which an exogenous variation in the quantity of children affects 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 used in the empirical analysis and show suggestive evidence of the quantitative importance of financial transfers from children to older parents. In Section 5, I present the main results for the effects of fertility on transfers, children's quality and parents' savings. In Section 6, I conclude the paper.

2 Conceptual 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. Next, I extend this model to account for the fact that parents can influence their 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 Tradeoff 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 quantity 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, which is determined by first-period savings s.

In the first period, parents are endowed with an exogenous income I, but they do not earn any income in the second period. Total expenditure on children is πnq, where π is the marginal cost of per-child quality. There is an opportunity cost to save for future consumption, given by p_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, as introduced in Becker and Lewis (1973). 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 large.

In this model, children do not make transfers to parents during retirement years and parents' future consumption can only be affected by the first-period savings, so that $c_p = s$. Given this setup, we can write the parents' problem as

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

which yields a system of first-order conditions

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

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

$$c_f: \; U_f = \lambda \tag{4}$$

$$s: \; U_p = \lambda p_s \tag{5}$$

where λ is the Lagrange multiplier and U_n, U_q, U_f, and U_s are the marginal utilities of n, q, c_f and s. Notice that the shadow 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 tradeoff (Becker and Lewis (1973), Willis (1973)).

Next, I derive the partial effects of an exogenous change in n on q, c_f and s. This approach is analogous to the rationing problem studied by Tobin and Houthakker (1950). The authors show that, when the supply of a rationed commodity changes independently from prices, income and preferences, the changes in the unrationed goods yield information on the ratio of compensated cross- and own-price effect.

In order to focus on the interaction between q and n in the budget constraint, I assume that the utility is separable in all arguments, that is, $U_{lm} = 0$, for $l \neq m$ with $l, m \in \{n, q, f, s\}$. In addition, I assume that $U_{ll} < 0$. Treating n as a parameter $\overline{n}$, the effects of a variation in $\overline{n}$ on q, s and c_f are given by the equations bellow:

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

$$\frac{\partial c_f}{\partial \overline{n}} = \frac{1}{\Delta}\{-\phi_{14}\pi q + \phi_{24}\lambda\pi\} \tag{7}$$

$$\frac{\partial s}{\partial \overline{n}} = \frac{1}{\Delta}\{\phi_{13}\pi q - \phi_{23}\lambda\pi\} \tag{8}$$

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. The details of the derivation of these effects are presented in Appendix A. The first term in equations (6), (7) and (8) is the "income effect" of an exogenous increase in n. The second term is the "price effect". One can show that, under the assumptions made about the utility function, the income effect is negative for all the variables. The price effect on the per-child quality is negative. This result is very intuitive and follows from the dependence of the shadow price of q on n. An exogenous increase in n works as an increase in the price of q when we assume that the marginal utility of q is independent of n. For the other variables, the price effect is positive.

To sum up, in this version of the quantity-quality tradeoff model, an exogenous increase in the quantity of children causes parents to substitute away from the quality of children toward current and future consumption following the increase in the price of quality relative to the price of c_f and s. The income effect from the increase in n further decreases q, so that this model predicts an unambiguous fall in parental investments in children's quality. But since the income effect is positive for c_f and s (or c_p), one cannot tell for sure how the increase in n affects current family consumption and old-age consumption.

2.2 The Quantity-Quality Tradeoff with Transfers from Children

Now I consider the case in which the retirement income of the parents is affected by the financial support they receive from their adult children. During the childbearing years, parents choose n, q, c_f, and s given their income I. In the retirement years, the adult children decide non-cooperatively on how much to transfer to their parents taking n, q and s as given. I use backward induction to find the equilibrium in this model. First, I obtain the optimal transfer from children to parents and parents' consumption in the second period, which is a function of n, q, and s. Next, I derive parents optimal choices of n, q, and s while accounting for how these choices affect 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. Each child's utility depends on own consumption, c_k, and on parents' old-age consumption, c_p. Each child is endowed with q, which was set by parents in the first period. To simplify the exposition, I assume that a child's income level I_k is determined only by their 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 or to make transfer to parents, T_k. Parents consume their savings, s, and total transfers received from children, $\sum_{k=1}^{n} T_k$.

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

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

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

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

where V_k and V_p are the child's marginal utility from own and parents' consumption, respectively. I assume that V_k and $V_p > 0$ and that V_{kk} and $V_{pp} < 0$. The utility function is also separable in the arguments, so that $V_{kp} = V_{pk} = 0$. The first-order condition implies that, for a given level of transfers, an increase in the child's quality relative to parents' savings creates an incentive for the child to transfer more, which 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 transfer to parents.

As in the standard quantity-quality tradeoff model of Becker and Lewis, all children receive the same amount of parental investment in quality. I assume further that all children have the same preferences for own consumption and parents' old-age consumption. These assumptions imply that the only pure strategy Nash equilibrium in the game played by the adult children is symmetric. Assuming 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:

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

An interior solution exists provided that $V_k(q) < V_p(s)$. 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 the number of children, n. One can see that an increase in n has a positive effect on total 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. I first investigate 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 n, keeping q and s constant, yields the following prediction:

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

where $\gamma = \frac{V_{pp}}{V_{kk}} > 0$. The intuition is as follows. Suppose we add a child to the family who has quality and preferences such that, at a given s, she 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 is decreasing in n.

Now, I focus on the effects that an increase in n has on the total resources that parents receive from all children in the new equilibrium. 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 in total. 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 and reach an equilibrium. Intuitively, an increase in family size increases the family wealth, with the benefits being 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, for s the effects are $\frac{\partial T^*}{\partial s} = -\frac{\gamma}{1+n\gamma} < 0$ 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 transfer that each child makes to parents and also total transfers from children and an increase in the amount of resources that parents save for old-age consumption has a negative effect on both transfer per-child and total transfers from children. 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 results above, one can define the function $c_p(n, q, s)$ that shows how parents' old-age consumption varies with n, q, and s and show that $c_p(n, q, s)$ is increasing in all arguments, with the partial effects 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' saving increases old-age consumption by less than it does in the model without transfers from children. In addition, we 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, c_f and s when they account for the effects on old-age consumption.

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 model, however, old-age consumption can be affected not only by savings, but also by the quantity and quality of children. The problem is now:

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

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

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

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

$$c_f: \; U_f = \lambda \tag{20}$$

$$s: \; U_p \frac{\partial c_p}{\partial q} = \lambda p_s \tag{21}$$

When comparing first-order conditions (2)-(5) to first-order conditions (18)-(21) one can see that, for any prices π and p_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 an exogenous change in n affects q, s and c_f. We can show that the partial effects are as follows:

$$\frac{\partial q}{\partial \overline{n}} = \frac{1}{\Delta^t}\{-\phi^t_{12}\pi q + \phi^t_{22}\lambda\pi + (-\phi^t_{22}U^t_{qn} + \phi^t_{32}U^t_{sn})\} \tag{22}$$

$$\frac{\partial c_f}{\partial \overline{n}} = \frac{1}{\Delta^t}\{-\phi^t_{14}\pi q + \phi^t_{24}\lambda\pi + (-\phi^t_{24}U^t_{qn} + \phi^t_{34}U^t_{sn})\} \tag{23}$$

$$\frac{\partial s}{\partial \overline{n}} = \frac{1}{\Delta^t}\{\phi^t_{13}\pi q - \phi^t_{23}\lambda\pi + (\phi^t_{23}U^t_{qn} - \phi^t_{33}U^t_{sn})\} \tag{24}$$

where Δ^t is the determinant of the bordered Hessian matrix and ϕ^t_{ij}'s are the cofactors from the model (18)-(20) when n is treated as a parameter. The second-order conditions for utility maximization imply that $\Delta^t < 0$ and ϕ^t_{22}, ϕ^t_{33}, and $\phi^t_{44} > 0$. Here U^t_{qn} and U^t_{sn} are the derivatives of the left hand side of equations (19) and 21 with respect to n. I show the derivation of the partial effects and the equations for the cofactors in Appendix B.

In the benchmark model, an exogenous increase in n reduces q due to the negative income and price effects. In the extended model, the effect of an increase in n on q is ambiguous. One can interpret the terms in equation (22) in order to understand the implications of introducing transfers into the quantity-quality tradeoff model for parents' choices. The first term captures the effect of increasing n on the budget constraint. It is easy to show that $\phi^t_{12} < 0$ if $\pi > p_s$, so that the "income effect" of an increase in 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 n on the shadow price of q relative to the other commodities, s and c_f. Since $\phi^t_{22} > 0$, 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 n. In Appendix B I show that the sign of U^t_{qn} is ambiguous. Under certain assumptions about children's preferences, an increase in n increases the returns to children's quality in terms of old-age consumption, that is, $\frac{\partial^2 c_p}{\partial n \partial q} > 0$.[4] This creates a complementarity between n and q that eases the quantity-quality tradeoff even when n and q are separable in the parents' utility

[4]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 again. However, from the assumption that the marginal utility is decreasing in parents' consumption, when the number of siblings is large, the gains in the children's utility from an increase in parents' consumption is smaller relative to when the number of siblings is small, *ceteris paribus.* This means that parents' consumption has to increase by more when n is larger.

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 n increases exogenously.[5] When the marginal utility of s decreases, parents substitute away from s toward q. In summary, when n affects old-age consumption, the effect of an exogenous increase in n on q is ambiguous. Although 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 (24). Since the sign of ϕ_{13}^t is unknown, the "income effect" is ambiguous. The second term, $-\phi_{23}^t \lambda \pi$, is negative and shows the increase in s due to the increase in the shadow price of q. Finally, the term in parentheses 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

We can use the framework developed previously to derive the implications of an 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 decrease in the transfers that each child makes to parents and an increase in total transfers that parents receive from children. The indirect effect is ambiguous and depends on how the optimal levels of q and s respond to the shock in fertility. Although I cannot obtain estimates of $\frac{\partial \overline{T}}{\partial q}$ and $\frac{\partial \overline{T}}{\partial s}$, in the empirical analysis that follows I present estimates of $\frac{d\overline{T}}{d\overline{n}}$ and also estimates of $\frac{\partial q}{\partial \overline{n}}$ and $\frac{\partial s}{\partial \overline{n}}$.

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

3 Twin-first Methodology

Multiple births are arguably outcomes of a pregnancy that are difficult to predict and, therefore, cannot be determined by behavior.[6] 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 variables of children and mothers. The twin-first methodology was first introduced by Rosenzweig and Wolpin (1980a).[7] 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 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.

Since the likelihood of the incidence of twinning increases with the age of the mother at birth, all the specifications in the empirical analysis include the age of the mother at first birth.[8]

The empirical analysis is based on reduced form estimates of the twin-first effect on a series of outcome variables, which are chosen based on the model predictions, using two samples of older mothers, one from China and another one from Indonesia, and one sample of adult children, also from Indonesia. The specification is as follows:

[6] Adoption of fertility treatments that increase the risk of multiple births implies that behavior might affect the occurrence of twinning. 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. Treatments subsidized by government are unheard of.

[7] 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.

[8] The medical literature discusses the increase in the probability of multiple births with the age of the mother at conception (Mittler (1971)). In the economics literature, Rosenzweig and Wolpin (1980a) argue that this association requires controlling for that age at first birth in the estimation of twinning effects. They demonstrate that, despite the timing of the first child being a choice variable, one can obtain "consistent" estimates of the twin-first effect. This is so because twins first is orthogonal to the other determinants of the outcome variable (in their paper the outcome is the labor supply of mothers) and because age at first birth is orthogonal to the other determinants of the occurrence of twins in the first birth.

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

where $i = m, c$ and m indexes 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 year fixed effect and μ_j is community fixed effect. Whenever appropriate, I also include a dummy for rural residence.

First, I obtain estimates of the effects of twins first on the number of children born using the samples of 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 later births occurs in response to an unexpected extra birth experienced very early in the woman's childbearing years.

For the two samples of older mothers, I estimate the twin-first coefficient in equation 25 on 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 from savings for the Indonesian sample and the effect on non-earned household *per-capita* income in the Chinese sample.[9]

In the sample of Indonesian adult children, I look at the twin-first effect on transfer 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 completeness, I perform the same analysis for China using a sample of younger children. The adult child's BMI reflects past parental

[9]The choice of measure of savings is guided by the availability of data.

allocation decisions, but it is more likely to be determined by the child's current resources. For this reason, the sign of the twin-first effect could be positive since the increase in sibship size increases consumption. The sign of the effect of an increase in fertility on the measures of children's human capital is not restricted in the model with transfers.

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. This question is investigated by 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 behavior. 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

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. For those reasons, the data used in this paper come from two sources: the Chinese Health and Nutrition Survey (CHNS) and the Indonesian Family Life Survey (IFLS). Next, I present descriptive statistics of the samples.

4.1 China

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 those are the years in which household-level data on transfers received by parents from children are collected. The CHNS also provides the birth history for women who are not in child bearing age, with the year and month of birth of each child, as well as year and month of death. This feature of the survey allows me to identify those women who had twins at the first birth, if it occurred, without measurement error. Data on siblings are not available, so that I cannot assess the implications of higher fertility on transfers to parents in China.

Sample of Mothers

The sample used to estimate the relationship between fertility and transfers is composed of mothers who are female head or spouse, 47 to 75 years old, and who had at least one child. The sample is further restricted to mothers in the rural area due to the well known differences in access to social security coverage between the rural and urban population in China. Table 1 presents descriptive statistics for the Chinese sample. The data from the four waves are pooled. 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 a twin at first birth in 2000; in 2004, 2006 and 2009, 10, 10 and 11 mothers gave birth to twins in the first birth, respectively.[10] The twinning rate in the Chinese sample is 7 births in one thousand. The average fertility in the sample is 2.7 children. These numbers are plausible in the Chinese context in that most of the women in the sample were subjected

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

to the restrictions on child bearing imposed by the family planning policies in the 70's.[11] As expected, when the sample is divided by twinning status of the women, we see that fertility is higher amongst women who gave birth to twins.

The numbers on Table 1 show evidence of the importance of transfers for the Chinese households. On average, 38% of households received transfer from children over the 2000-2009 period, and among those who received financial resource from children, transfers corresponded to approximately 35% of the household income before transfers.[12] When the sample is split by twinning status, we see that a much larger fraction of households received transfers from children in the sample of mothers with twins. Transfer amounts were also larger in the twin sample, both overall and conditional on transfers being positive.

4.2 Indonesia

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 member and transfers among noncoresident family members. The IFLS asks adult respondents about all children living outside the household, including some basic demographic characteristics such as age and education. Detailed information on transfers from nonresident children is also collected. In addition, the survey provides basic demographic data on all nonresident siblings and parents who are alive. Data on the amount of financial transfers made to alive nonresident parents are also available. The

[11]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.

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

waves used in the empirical analysis are the IFLS 2000, which gives me the sample of mothers, and IFLS 1997, from which I draw the sample of adult children.

Sample of Mothers

From the IFLS 2000, I drew a sample of mothers who were 47 to 75 years old and had at least one child. The sample includes women living in either rural or urban areas. Data on transfers received from children living outside the household are collected at the individual level, so that the unit of analysis in Indonesia is the mother.[13] In addition to transfers from children, I also investigate the effects of fertility on household expenditure on non-food consumption goods.[14]

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 children living outside the household, including the date of birth of those children. However, in some cases the date of birth was not available for all children listed in the resident and nonresident children rosters. For those women with complete data on year and month of birth for all children alive at the time the survey is conducted, I assigned twinning in the first birth to those mothers whose oldest children had the same year and month of birth. For those with incomplete date of birth but complete data on the year of birth, I assigned the twinning status to women whose oldest kids had same year of birth. Finally, some women did not have complete data on year of birth, in which case I assigned the twinning status using the age of children reported in the survey rosters. In my sample, 43% of women had the twinning at first birth dummy assigned using information on the age of their children; 47% had the twinning status assigned using both the year and month of birth and 10% using the year of birth.

[13] It is worth mentioning that the data on transfer refers to the amount received by the couple when the mother has a husband. Transfer received by male individuals without a female spouse at home are not being considered in the analysis that follows.

[14] 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.

Table 2 presents 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 amongst the Indonesian mothers is 10 births in one thousand. The number is high compared to the Chinese sample, in part due to some measurement errors when using the age to assigned the twinning status. To see that, in a sample of Indonesian women 37 to 75 with complete data on year of birth, the twinning rate is about 7 births in one thousand, which is similar to the Chinese rate and also consistent with the rates found in the literature.[15] Estimates using this sample are presented in the robustness section.

Fertility in Indonesia is higher (average of 5.3 children) compared to China (2.7 children). Fertility is also higher in the sample of Indonesian women who gave birth to twins in the first birth. Transfer refers to cash transfers and the monetary value of food stuff and other goods the household received from children in the past 12 months. About 52% of the households reported that they received cash or in-kind transfers from children. Amongst those households who received financial support from their children, on average the transfer amount corresponded to 38% of the household income before transfer, which shows that children are an important source of income to their parents in Indonesia.

Sample of Adult Children

The IFLS 2000 does not collect data on the age of siblings in the nonresident sibling roster so I drew 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 their parents alive and living out of the household. Unfortunately the survey does not provide the date of birth of siblings. Alternatively, I use information on the age of siblings to construct the indicator of twin at first birth for the sample of adult children. If the two oldest siblings of the child had the same age (or the child herself was the oldest and had a sibling of same

[15]Rosenzweig and Wolpin (1980a) use a sample of American mothers and find that 87 of the 12,605 women in the sample had twins in the first pregnancy, which corresponds to a rate of approximately 7 in a thousand births.

age), I assume that this child was born to a mother who had a twin in the first pregnancy. Using the age instead of the actual date of birth might cause a child to be assigned to the "twin-first" treatment when in fact her siblings were not twins but, instead, were born close to each other. This means that the twinning dummy variable would be picking up cases where the child's mother had preference for close birth spacing. While there is no easy way to circumvent this issue, I present some evidence in the next section showing that the estimates of the effects of twinning on fertility do not differ drastically whether I use the age or the date of birth to identify the twins in the IFLS 2000 sample.

Table 3 shows summary statistics for the children in the sample. The twinning rate produced when using the age of siblings alive is 13 births in one thousand. This high rate is not surprising and can be due to two factors. First, in a setting with high fertility, it is not uncommon for births to be closely spaced. In addition, information on age of nonresident siblings and coresident siblings is collected during different months, which increases the probability that ages coincide. However, in the results that follow I show that the estimated effect on fertility is similar to that produced using the sample of mothers which, due to the availability of date of birth, should be less prone to measurement errors.

In this sample, 68% of children transferred financial resources to parents, conditional on having at least one of the parents living outside the household. Average transfer to parents is lower amongst children with twin siblings, as well as the proportion of children who made transfers. The average number of siblings is higher for children with twin siblings.

5 Results

5.1 Fertility

5.1.1 Twinning and Fertility

In this section, I present the estimates of the effects of twinning on fertility for the samples of Chinese and Indonesian mothers. Results are presented in Table 4. The dependent variable is the number of children born. In addition to control for mother's age at first birth and mother's current age, I include year and community fixed effects for the sample of Chinese mothers and district fixed effects for the sample of Indonesian mothers. The point estimates indicate a large and statistically significant effect of twinning in the first birth on completed fertility.

The large effect observed in Indonesia might seem 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 pregnancy on completed fertility would be small.[16] Estimates of the effect of twinning on fertility are widely available for developed countries, but not for developing countries.[17] 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 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 head and spouse of head since for these women own children can be located within the household using the constructed family relationships. However, because information on date of birth

[16]This point is made by Angrist et al. (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).

[17]To the best of my knowledge, in addition to Angrist et al. (2010), Caceres-Delpiano (2012) reports estimates that ranges from 0.75 to 0.90 using data from the Demographic and Health Surveys on 40 developing countries.

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.

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.

Table 5 shows 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 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 show estimates for different age intervals and age at first birth. As can be seen, for women who had recently experienced the shock on 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 amongst the sample of older mothers, suggesting that they adjust their fertility after the shock. However, the estimates are still large and significantly different from zero. Amongst 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 more imperfect 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 the case 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 of the measurement error incurred when using the age match as a proxy for twinning, which is useful when interpreting results based on the sample of adult children, for whom data on date of birth of nonresident siblings are not available from the survey.

Table 7 present the estimates. It is worth mentioning 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 siblings to have the same age when birth spacing is close, even though they are not twins. Clearly, measuring twinning using age match can be particularly problematic for identifying causal effects since we would be assigning the twinning treatment to mothers who chose to have births closely spaced and, therefore are likely the ones with preferences for a larger number of children.

In spite of that, the difference in the estimates shown in 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 proxy. However, point estimates of the effects on the conditional median in columns (3) and (4) are virtually identical. These results suggest that the age match does a good job in measuring twinning.

Additional evidence from the Indonesian 2000 and 2010 Censuses is shown in Table 8. The twinning rate identified using of the children's age doubles in the two samples. As can be seen, the estimates differ depending on whether we use the date of birth or the age to locate twins in the first pregnancy. 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

This section presents estimates of the twin-first effect on the total amount of transfers received from children for the two samples of mothers 47 to 75 years old. Columns (2) and (7) in Table 9 show Tobit estimates of the average marginal effect of twinning on the expected value of total transfers, conditional on transfers being positive, for China and Indonesia, respectively. Both estimates are positive and statistically significant at 5% significance level. The effects are large in magnitude when compared to the sample average transfers among those receiving transfers. In China, the average marginal effect of 429 yuans is about 26% of the sample average transfers. In Indonesia, the estimated average marginal effect is of 188,000 rupiahs, which corresponds to 32% of the sample mean. The results also point to a positive effect of a fertility shock on the probability of receiving transfers, shown in columns (3), (4), (8) and (9). The Probit estimates show an increase of 14 percentage points for China and 16 percentage points for Indonesia, although in the latter case the estimates are only significant at 10%. The OLS estimates of the twin-first effect on per capita consumption of non-food items is shown in column (10). The estimated effect is positive and large (about 30% of sample average), but is not precisely estimated.

The reduced form approach carried out throughout the paper is justified by the comparative statics based on an exogenous variation in the supply of children following the birth of twins. However, many studies that explore the twins methodology as source of identification use twinning as an instrument for fertility. For the sake of comparison, Table 10 presents IV estimates in which I use twinning in the first birth as an instrument for number of children on 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 amount of transfers are similar to 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 (5) and (6) 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.

5.3 Savings

The results shown in the previous subsection point to a positive causal relationship between fertility and total transfers. However, the effects of a fertility shock on transfers through changes in parental savings need to be assessed. This task is difficult due to the lack of appropriate measures of savings or income during the time the women 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 contemporaneous transfers. My approach to measuring parental savings is as follows. I use per capita unearned income for the sample of Chinese mothers and per capita household assets from savings and receivables for the sample of Indonesian mothers.[18] Columns (5) and (11) in Table 9 show Tobit estimates of the average marginal effects of twinning on the expected value of the outcomes. The choice of Tobit is justified by the fact that only 22% of households in the Chinese sample received income from retirement pensions and subsidies and only 25% of the households in the Indonesian sample reported that some member in the household owned savings. My results suggest that, amongst parents in China and Indonesia, an increase in fertility does not reduce savings for old-age consumption.

[18] Unearned income includes income from retirement and subsidies, but excludes income from transfers.

5.4 Transfers to Parents

According to the conceptual framework featuring transfers from children, an exogenous increase in fertility is expected to decrease the amount of transfers that each child makes to her parents through two channels. First, it increases sibship size, causing each child to transfer less. Second, it affects children's ability to financially support their parents due to a decrease in past parental investment in children's quality. The first channel is assessed in this subsection and the second channel is investigated in the following subsection.

Table 11 presents estimates for the sample of Indonesian adult children 25 to 45 years old. The first column shows that children of mothers who had twins have 0.68 more siblings alive compared to the other children. Columns (2) to (4) show that children who had twin siblings (or were twins with another sibling) were less likely to transfer money to parents and, conditional on transferring resources, they transferred less. Estimate of the average marginal effects shows that these children transferred 17,400 less to parents, which corresponds to 19% of the sample average transfer to parents. They were also 10 percentage points less likely to support their old parents. These findings are consistent with the model predictions, in that children reduce transfer to parents when there are more siblings to help share care for their old parents.

5.5 Children's Human Capital

The estimates in Table 11 are consistent with the existence of a direct effect of number of siblings on children's decision to make transfers. However, there is also evidence suggesting that children of mothers with twins have lower quality, which also contributes to explaining the large negative effects on transfer to parents. Column (5) 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, shown in column (7).[19] There is no significant difference in the health status, as measured by the body mass index. This finding is not surprising considering that the

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

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 have 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, Table 12 presents estimates including a dummy variable (TWINCHILD) which 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 both a negative effect of having more siblings and an adverse effect of having lower human capital on transfer 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 Chinese Census 1990 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.[20] Table 13 shows the results. Columns (1) and (2) presents results for a sample of children 13 to 25 years old. In columns (3) and (4) I present results for a sample restricted 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, the results indicate 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,

[20]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 school, and zero otherwise.

although the coefficients on $TWINCHILD$ are not precisely estimated.

5.6 Additional Results

5.6.1 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. In this section, I investigate 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 15 to 47 years old interviewed in the IFLS 2000, to be comparable to previous results on transfers. 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 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 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.[21]

Another set of estimates is presented in Table 15 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. Two samples were drawn for this analysis. One sample of younger women 15 to

[21] 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?".

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 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 restricted 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. It is worth mentioning that the results are robust to treating the unemployed women as part of the labor force. Table 16 shows results for the effects of a fertility shock on both the number of children born and employment status. Column (1) shows an increase of 0.70 on fertility. This number is very close to the estimates presented for Indonesia using the 2000 and 2010 Censuses. Column (2) shows results obtained when an interaction term between twinning in the first birth and the age of the mother is included. As in the Indonesian case, the estimates are consistent with the effect of the shock diminishing as the woman approaches the end of her child bearing 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, we should expect that the fertility shock on the first pregnancy 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 pregnancy 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.

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 evident 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).

5.6.2 Coresidence

Aside from 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

5.6.3 Robustness Checks

Sample of younger mothers: This section presents additional results to check for the robustness of the twin-first effect on transfer from children. In Indonesia, I use information on date of birth of children to identify the birth of twins. For many mothers in the sample, however, 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 amongst 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, Table 18 presents estimates which are 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 amongst 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.

Net transfers: I have estimated the twin-first effect on the total amount of transfers received from children. It is possible, however, that the financial benefits of higher fertility be 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.[22] In

[22]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.

Indonesia this percentage is much higher, approximately 32%.[23] Table 19 shows results using net transfer as the dependent variable. Columns (2) and (5) show results for net transfers when negative values are replaced with zeros. The twin-first effect on net transfer is positive and large for both samples. The estimate is statistically significant at 10% significance level in China, but not in Indonesia. Additionally, columns (3) and (6) present results including negative values of net transfer. The effects are not precisely estimated due to the large concentration of zero values in the middle of the distribution of the dependent variable. The size of the twin-first effect, on the other hand, are very large and in accordance with the main results shown previously.

Transfers from other relatives: One of the claims made in this paper is that fertility increases old-age consumption of parents through transfers. However, this might not be the case if 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 20. Column (1) shows the average marginal effect on transfers, whereas columns (2) and (3) show Tobit and Probit estimates of the effects on the probability of receiving transfers. Overall, there is no evidence that transfers from other family members are crowded out by transfers from children in China.

Transfers as share of income: All the estimates indicate that parents with more children receive more financial support during old age. One might also be interested in knowing whether transfers are higher as a share of household income from labor sources. Here it is not clear which direction the result should go. On one hand, mothers can afford to work less, which can decrease income from labor. On the other hand, the income from transfer can be used to feed the other household members, which can increase their productivity and, consequently, income. Results from Table 21 suggest that transfer as a fraction of income increases with fertility, which is consistent with the previous result showing that the labor supply of older mothers decrease. In China, the twin-first effect

[23] 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

on transfer per income is positive and significant at 5% significance level, pointing to an increase of 0.11 yuans. In Indonesia, the effect is positive (an increase of 0.07 rupiahs) but not statistically significant.

Other results: Another concern might be that the small number of twins in the sample is causing extreme values to play a disproportionate role in the reduced form estimates seen in Table 9. To check that, I use the log of transfers, replacing missing values by a very small number, 0.0001. The results are shown in Table 21. For both samples, the twin-first effect is positive and significant at 10%. Finally, Table 22 presents estimates of the effect of twinning on total transfers including controls for the average age of children, average spacing between births and the gender of the eldest child (or children, in the case of twins). Since the controls are endogenous, the table does not show their coefficients. The estimates are robust to the inclusion of controls, suggesting that the results are not being driven by the correlation of twinning with other potential determinants of transfers.

6 Conclusion

This paper investigates the relationship between fertility and intergenerational transfers using household-level data from China and Indonesia. The empirical challenges that arise from the endogeneity in fertility are addressed using the incidence of twinning in the first pregnancy as a source of exogenous variation in family size. The conceptual framework which models the behavior of adult children predicts that transfers to parents increase in sibship size but despite that, parents with more children receive more financial support in total. However, the exogenous shock to the supply of children experienced by the parents also affects their decision on how much to invest in per-child quality and savings, which determine transfers. Reduced form estimates show that twinning 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. Twinning also increases the number of children born by about 0.77 children in China and 0.79 in Indonesia. These results suggest that part of the observed twin-first effect on transfers is due to the mechanism highlighted in the model. I also show evidence that twinning has a negative effect on adult children's schooling, which suggests that the effect of fertility on transfers net of changes in parents' optimal investment in per-child quality is at least as large as the estimates presented in the paper.

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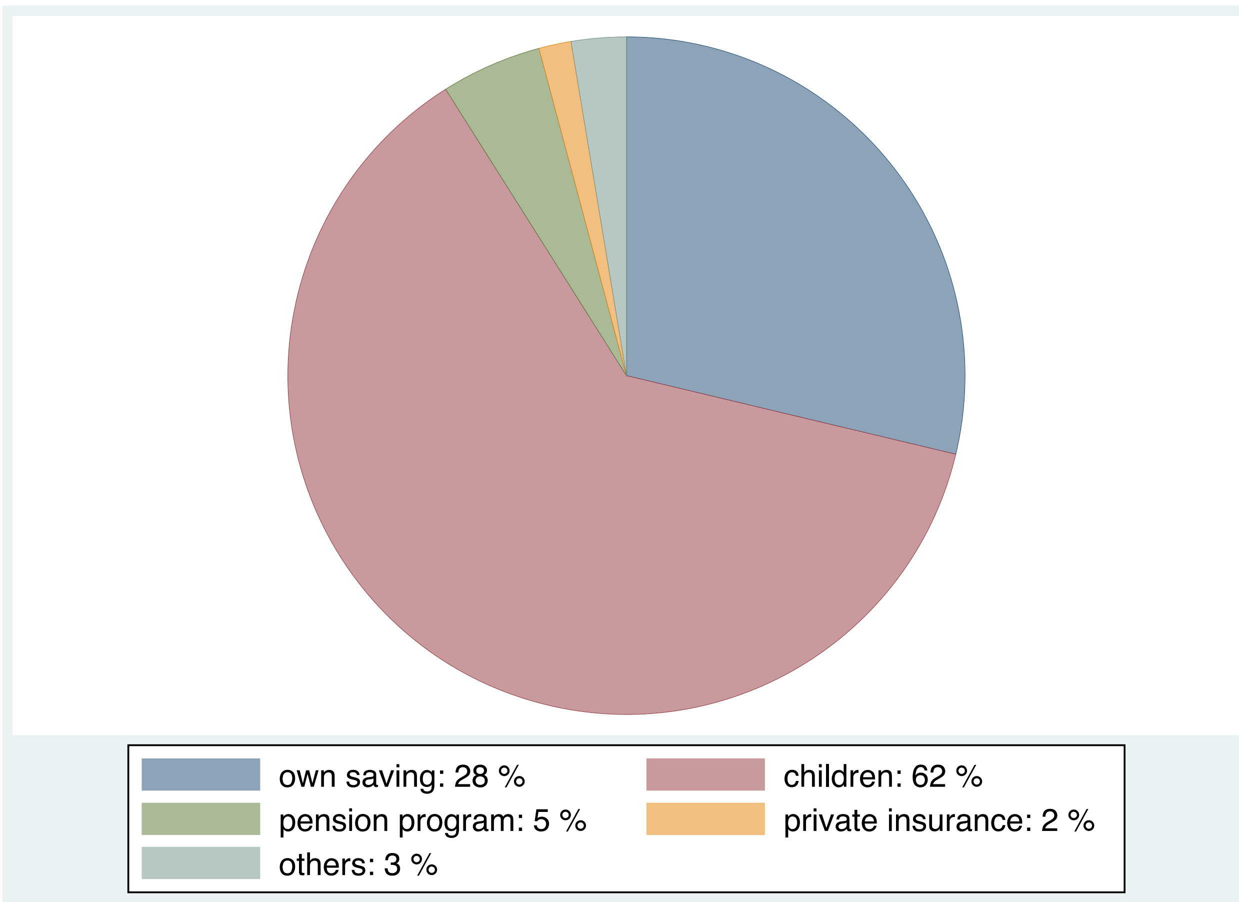
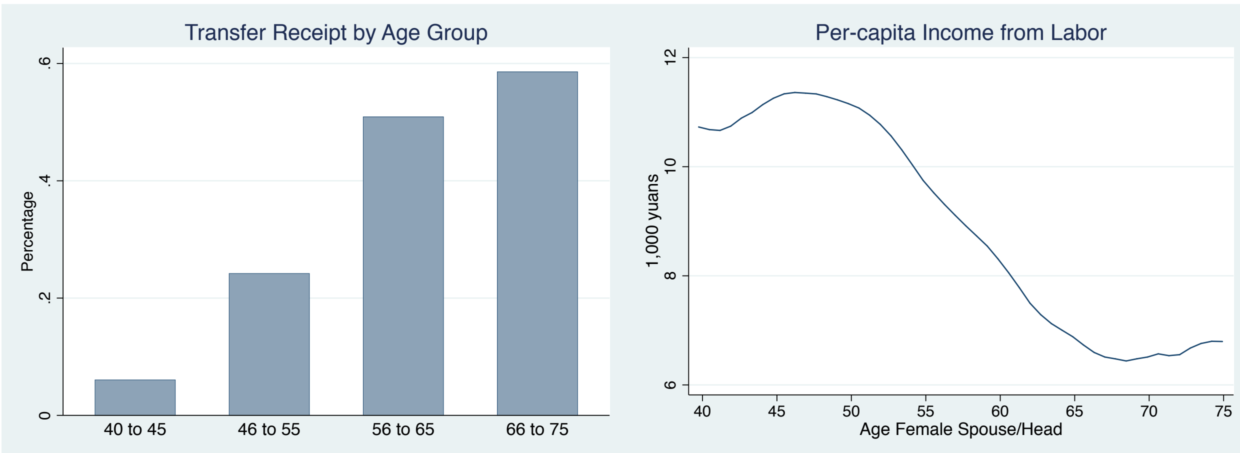
Figure 1: Expectations about the source of old-age support, rural China, 2002



Sample size: 9,200 individuals

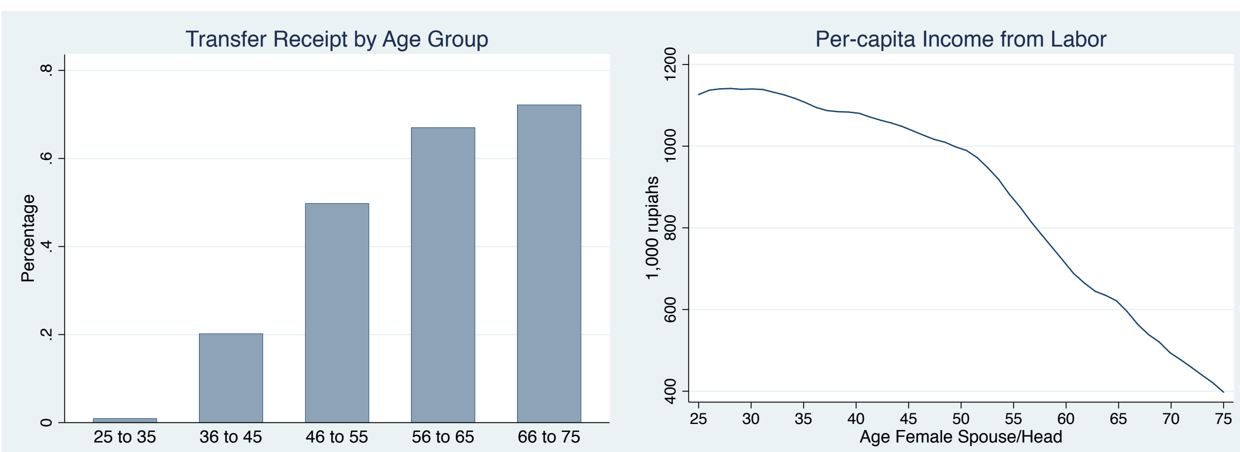
Source: Chinese Household Income Project, 2002

Figure 2: Transfers and income by age of female spouse/head, rural China, 2009



Source: China Health and Nutrition Survey, 2009
Note: The CHNS covers the following Chinese provinces: Guangxi, Guizhou, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Liaoning and Shandong

Figure 3: Transfers and income by age of female spouse/head, Indonesia, 2000



Source: Indonesian Family Life Survey, 2000

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

	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 (CY)	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 (CY) ∣ 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
Non-earned per capita income	476.5	1840.6	286.1	811.8	477.8	1845.9
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.	6133		44		6089	

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

	IFLS 2000					
	All Sample		Mothers with Twins		Mothers with no Twins	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Transfer (RP)[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 (RP) ∣ 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
Per-capita savings	231.1	1311.3	282.7	910.7	230.6	1314.7
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.	3029		29		3000	

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

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

	IFLS 1997					
	All Sample		Children with Twin Sibling		Children with no Twin Sibling	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Transfer (RP) [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.	3703		50		3653	

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

Table 4: TWIN-FIRST EFFECT ON NUMBER OF CHILDREN BORN - SAMPLES OF CHINESE AND INDONESIAN MOTHERS 47 TO 75 YEARS OLD

Dep. Var.: *Number of Children Born*		
	China [a] (2000-2009)	Indonesia [b] (2000)
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 [c]	Yes	Yes
R-sq	0.42	0.061
N	6133	3029
N twins	44	29

Standard errors in parentheses

[a] Standard errors clustered at the household level

[b] Standard errors robust to heteroskedasticity

[c] Community fixed effects were added for China; district fixed effects were added for Indonesia

Table 5: TWIN-FIRST EFFECT ON NUMBER OF CHILDREN BORN BY THE AGE OF THE MOTHER - SAMPLE OF INDONESIAN MOTHERS 15 TO 49 YEARS OLD

	Dep. Var.: *Number of Children Born*								
	DHS - 1994, 1997, 2003 and 2007			Census 2000			Census 2010		
	All Sample	Age $\leq$ 35	Age > 35	All Sample	Age $\leq$ 35	Age > 35	All Sample	Age $\leq$ 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)
R-sq	0.51	0.51	0.32	0.35	0.43	0.18	0.28	0.42	0.17
N	110344	58374	51970	402705	249266	153439	583740	300,834	282906
N twins	510	281	229	1332	762	570	2301	1,124	1,177

Robust standard errors in parentheses

Table 6: TWIN-FIRST EFFECT ON NUMBER OF CHILDREN BORN, BY AGE GROUP AND AGE AT FIRST BIRTH - SAMPLE OF INDONESIAN MOTHERS

Dep. Var.: *Number of Children Born*				
DHS (1994, 1997, 2003 and 2007)				
		Age in survey year		
		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		42916	51450
Avg n. children born		1.37	2.43	3.37

Robust standard errors in parentheses

Table 7: TWIN-FIRST EFFECT ON NUMBER OF CHILDREN BORN, BY MEASURE OF TWINNING STATUS - SAMPLE OF INDONESIAN MOTHERS 37 TO 75 YEARS OLD

	Dep. Var.: *Number of Children Born*			
	IFLS 2000			
	Conditional Mean		Conditional Median	
	DOB [a]	AGE [b]	DOB [a]	AGE [b]
	(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	3353	3353	3353	3353

Robust standard errors in parentheses
[a] These columns show estimates using the date of birth of children to assign the twin-first treatment
[b] These columns show estimates using the age match to assign the twin-first treatment

Table 8: TWIN-FIRST EFFECT ON NUMBER OF CHILDREN BORN, BY MEASURE OF TWINNING STATUS - SAMPLE OF INDONESIAN MOTHERS 15 TO 65 YEARS OLD

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

Robust standard errors in parentheses
[a] These columns show estimates using the date of birth of children to assign the twin-first treatment
[b] These columns show estimates using the age match to assign the twin-first treatment

Table 9: TWIN-FIRST EFFECT ON NUMBER OF CHILDREN BORN, TRANSFERS FROM CHILDREN AND CONSUMPTION - SAMPLES OF CHINESE AND INDONESIAN MOTHERS

	China - CHNS 2000-2009					Indonesia - IFLS 2000					
Dep. Var.	N. Children Born	Transfer (CY)	Prob. Transfer	Prob. Transfer	Unearned Income pc	N. Children Born	Transfer (RP)	Prob. Transfer	Prob. Transfer	Consump. pc	Savings pc
	OLS	Tobit	Tobit	Probit	Tobit	OLS	Tobit	Tobit	Probit	OLS	Tobit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
TWIN	0.77	429.2	0.18	0.13	207.7	0.79	188.1	0.19	0.16	88.4	95.7
	(0.40)	(186.0)	(0.08)	(0.08)	(244.0)	(0.44)	(98.0)	(0.10)	(0.10)	(68.4)	(135.1)
AGEFB	-0.15	-29.92	-0.01	-0.01	-23.57	-0.01	-6.5	-0.01	-0.01	-0.46	-5.01
	(0.01)	(3.16)	(0.00)	(0.00)	(5.58)	(0.01)	(1.24)	(0.00)	(0.00)	(1.05)	(2.57)
AGE	0.07	46.8	0.02	0.02	30.91	0.07	6.02	0.01	0.01	-0.98	-3.5
	(0.00)	(2.83)	(0.00)	(0.00)	(4.03)	(0.01)	(1.05)	(0.00)	(0.00)	(1.05)	(2.16)
Constant	1.82	-	-	-	-	2.1	-	-	-	405.17	-
	(0.21)	-	-	-	-	(0.52)	-	-	-	(67.16)	-
Year FE	Yes	Yes	Yes	Yes	Yes	-	-	-	-	-	-
Region FE [a]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean	2.56	1691.6	0.33	0.33	2185.8	5.37	583.4	0.52	0.52	297.4	851.9
S.d.	(1.24)	(1989.1)	(0.47)	(0.47)	(3436.9)	(3.00)	(968.7)	(0.50)	(0.50)	(383.3)	(2405.9)
N	6133	6133	6133	6133	6051	3029	3029	3029	3028	2983	2965

Robust standard errors in parentheses

[a] Community fixed effects were added for China; district fixed effects were added for Indonesia

Table 10: TWIN-FIRST EFFECT ON TRANSFERS FROM CHILDREN, IV ESTIMATES - SAMPLES OF CHINESE AND INDONESIAN MOTHERS

	China - CHNS 2000-2009		Indonesia - IFLS 2000 [a]			
Dep. Var.	Transfer (CY)	Prob. Transfer	Transfer (RP)	Prob. Transfer	Transfer (RP)	Prob. Transfer
	IVTobit	IVProbit	IVTobit	IVProbit	IVTobit	IVProbit
	(1)	(2)	(3)	(4)	(5)	(6)
CHILDREN	409.1	0.11	207.1	0.10	243.2	0.10
	(207.3)	(0.06)	(125.8)	(0.01)	(150.1)	(0.02)
AGEFB	37.52	0.01	-7.24	-0.01	-15.52	-0.01
	(34.37)	(0.01)	(3.67)	(0.00)	(14.00)	(0.01)
AGE	23.97	0.02	-5.12	0.00	2.12	0.00
	(13.09)	(0.00)	(11.70)	(0.00)	(4.04)	(0.00)
Year FE	Yes	Yes	-	-	-	-
Region FE [b]	Yes	Yes	Yes	Yes	Yes	Yes
N	6133	6133	4600	4592	3234	3215
N twins	44	44	40	40	21	21

[a] IV estimates for Indonesia were based on a larger sample compared to the main reduced form estimates. Here, I include women 40 to 75 years old. This strategy was adopted to increase power
Results shown in columns (5) and (6) 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
[b] Community fixed effects were added for China; district fixed effects were added for Indonesia

Table 11: TWIN-FIRST EFFECT ON SIBSHIP SIZE, TRANSFER TO PARENTS, EDUCATION AND INCOME - SAMPLE OF ADULT CHILDREN 25 TO 45 YEARS OLD

	Indonesia - IFLS 1997						
Dep. Var.	Siblings	Transfer (RP)	Prob. Transfer	Prob. Transfer	Years Schooling	BMI	Income pc
	OLS	Tobit	Tobit	Probit	OLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
TWIN	0.68	-17.4	-0.10	-0.08	-0.93	-0.08	-297.38
	(0.42)	(7.9)	(0.05)	(0.06)	(0.51)	(0.51)	(98.61)
AGEFB	-0.08	-0.25	0.00	0.00	-0.08	-0.01	-7.39
	(0.01)	(0.28)	(0.00)	(0.00)	(0.02)	(0.01)	(4.66)
AGE	0.05	0.40	0.00	0.00	0.02	0.01	2.45
	(0.01)	(0.23)	(0.00)	(0.00)	(0.01)	(0.01)	(3.99)
Constant	3.44	-	-	-	12.18	20.92	1555.42
	(0.34)	-	-	-	(0.56)	(0.50)	(227.50)
District FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean	4.58	93.6	0.68	0.68	7.17	22.55	911.4
S.d.	(2.25)	(149.2)	(0.47)	(0.47)	(4.42)	(3.47)	(1210.3)
R-sq	0.06				0.18	0.08	0.07
N	3703	3703	3703	3687	3670	3378	3579

Robust standard errors in parentheses
Additional controls: child's age and sex

Table 12: TWIN-FIRST EFFECT ON TRANSFER TO PARENTS AND HUMAN CAPITAL OF TWIN CHILDREN - SAMPLE OF INDONESIAN ADULT CHILDREN 25 TO 45 YEARS OLD

	Indonesia - IFLS 1997				
Dep. Var.	Transfer (RP)	Prob. Transfer	Prob. Transfer	Years Schooling	BMI
	Tobit	Tobit	Probit	OLS	OLS
	(1)	(2)	(3)	(4)	(5)
TWIN	-8.8	-0.05	0.03	-0.86	-0.37
	(12.07)	(0.07)	(0.12)	(0.95)	(0.68)
TWINCHILD	-13.35	-0.08	-0.16	-0.11	0.44
	(15.70)	(0.09)	(0.14)	(1.12)	(0.97)
AGEFB	-0.24	0.00	0.00	-0.08	-0.01
	(0.28)	(0.00)	(0.00)	(0.02)	(0.01)
AGE	0.40	0.00	0.00	0.02	0.01
	(0.23)	(0.00)	(0.00)	(0.01)	(0.01)
Constant	-	-	-	12.18	20.92
	-	-	-	(0.56)	(0.50)
District FE	Yes	Yes	Yes	Yes	Yes
Mean	93.6	0.68	0.68	7.17	22.55
Sd	(149.2)	(0.47)	(0.47)	(4.42)	(3.47)
R-sq				0.18	0.08
N	3703	3703	3687	3670	3378

Robust standard errors in parentheses
Additional controls: child's age and sex

Table 13: TWIN-FIRST EFFECT ON YOUNG CHILDREN'S EDUCATIONAL ATTAINMENT - SAMPLE OF CHINESE CHILDREN

	Child has educational attainment appropriate for her age			
	Ages 13 to 25		Ages 13 to 18	
	Probit	Probit	Probit	Probit
	(1)	(2)	(3)	(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	0.49	0.49	0.71	0.71
Sd	(0.50)	(0.50)	(0.45)	(0.45)
N	376956	376956	277479	277479
N twins	1705	1334	1245	936

Robust standard errors in parentheses

Table 14: TWIN-FIRST EFFECT ON LABOR SUPPLY - SAMPLE OF INDONESIAN MOTHERS 15 TO 47 YEARS OLD

	IFLS 1997-2007[a]			DHS 1994-2007	
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	0.48	0.54	0.70	0.55	0.57
S.d.	(0.50)	(0.50)	(0.46)	(0.50)	(0.49)
N	14765	14765	14762	54510	104753
N twins	91	91	91	290	486

[a] Standard errors are clustered at the individual level

Table 15: TWIN-FIRST EFFECT ON LABOR SUPPLY HISTORY - SAMPLE OF INDONESIAN MOTHERS

	IFLS 1993 - 2007	
Dep. Var.	Worked at ages 15 to 46	Worked at ages 47 to 75
Sample	Women 15 to 46	Women 47 to 75
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	0.90	0.80
S.d.	(0.28)	(0.28)
Avg. Years in Panel	13	9
N	5381	2184
N twins	34	24

Robust standard errors in parentheses

Table 16: TWIN-FIRST EFFECT ON FERTILITY AND LABOR SUPPLY - SAMPLE OF CHINESE MOTHERS 15 TO 47 YEARS OLD

	China - Census 1990			
Dep. Var.	Children		Working now	
	OLS	OLS	Probit	Probit
	(1)	(2)	(3)	(4)
TWIN	0.7032	1.4188	-0.021	-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)
Constant	1.58	1.58	-	-
	(0.01)	(0.01)	-	-
Mean	1.98	1.98	0.93	0.93
S.d.	(0.99)	(0.99)	(0.26)	(0.26)
R-sq	0.45	0.45		
N	645913	645913	645913	645913
N twins	3053	3053	3053	3053

Robust standard errors in parentheses

Table 17: TWIN-FIRST EFFECT ON NUMBER OF CORESIDENT CHILDREN - SAMPLES OF CHINESE AND INDONESIAN MOTHERS

	CHNS 2000-2009 [a]			IFLS 2000 [b]		
	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	OLS	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(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 [c]	Yes	Yes	Yes	Yes	Yes	Yes
Mean	1.07	0.94	0.45	1.47	1.30	0.78
S.d.	(0.89)	(0.84)	(0.67)	(1.09)	(1.01)	(0.80)
R-sq	0.28	0.19	0.21	0.13	0.12	0.22
N	6133	6133	6133	3029	3029	3029

[a] Standard errors clustered at the household level
[b] Standard errors robust to heteroskedasticity
[c] Community fixed effects were added for China; district fixed effects were added for Indonesia

Table 18: TWIN-FIRST EFFECT ON TRANSFERS FROM CHILDREN - SAMPLE OF INDONESIAN MOTHERS 37 TO 65 YEARS OLD

	IFLS 2000			
	Children	Transfers (RP)	Prob. Transfer	Prob. Transfer
	OLS	Tobit	Tobit	Probit
	(1)	(2)	(3)	(4)
TWIN [a]	0.83	145.83	0.11	0.09
	(0.39)	(77.33)	(0.06)	(0.07)
AGEFB	-0.12	-39.60	-0.03	-0.04
	(0.01)	(2.96)	(0.00)	(0.00)
AGE	0.12	18.74	0.01	0.02
	(0.01)	(1.59)	(0.00)	(0.00)
Constant	1.50	-	-	-
	(0.40)	-	-	-
District FE	Yes	Yes	Yes	Yes
Mean	4.09	624.79	0.25	0.25
S.d.	(2.26)	(1118.42)	(0.43)	(0.43)
R-sq	0.196			
N	3248	3850	3850	3848
N twins	23	27	27	27

Robust standard errors in parentheses

Women with incomplete data on year of birth of children were excluded from the sample

[a] Twinning rate is 7 in 1000 births

Table 19: TWIN-FIRST EFFECT ON NET TRANSFERS - SAMPLES OF CHINESE AND INDONESIAN MOTHERS

	China - CHNS 2000-2006 [a]			Indonesia - IFLS 2000 [b]		
	Total Transfers	Net Transfers	Net Transfers	Total Transfers	Net Transfers	Net Transfers
	Tobit	Tobit	OLS	Tobit	Tobit	OLS
	(1)	(2) [d]	(3) [d]	(4)	(5) [c]	(6) [d]
TWIN	429.25	390.20	457.03	218.69	151.51	194.59
	(219.62)	(229.20)	(312.84)	(99.63)	(104.42)	(250.10)
AGEFB	-31.94	-29.45	-30.08	-6.32	-4.72	-4.62
	(3.65)	(3.60)	(6.21)	(1.23)	(1.19)	(1.99)
AGE	52.15	50.58	52.31	5.89	7.41	7.58
	(3.29)	(3.26)	(5.19)	(1.05)	(1.02)	(1.62)
Year FE	Yes	Yes	Yes	-	-	-
Region FE [e]	Yes	Yes	Yes	Yes	Yes	Yes
N	4660	4660	4660	2976	2976	2976
N twins	32	32	32	27	27	27

[a] Standard errors clustered at the household level

[b] Standard errors robust to heteroskedasticity

[c] The depend variables in columns (2) and (5) are the difference between total transfers received from children and total transfers made to children, where the negative values were substituted by zeros

[d] The depend variables in columns (3) and (6) re the difference between total transfers received from children and total transfers made to children, where the negative values were not substituted by zeros

[e] Community fixed effects were added for China; district fixed effects were added for Indonesia

Table 20: TWIN-FIRST EFFECT ON TRANSFERS FROM OTHER RELATIVES - SAMPLE OF CHINESE MOTHERS

	CHNS 2000-2009		
	Total Transfers	Prob. Transfer	Prob. Transfer
	Tobit	Tobit	Probit
	(1) [a]	(2)	(3)
TWIN	9.79	0.00	-0.01
	(111.02)	(0.04)	(0.05)
AGEFB	-2.89	0.00	0.00
	(2.47)	(0.00)	(0.00)
AGE	-0.17	0.00	0.00
	(1.79)	(0.00)	(0.00)
Year FE	Yes	Yes	Yes
Community FE	Yes	Yes	Yes
N	6133	6133	5994

Standard errors clustered at the household level
[a] The dependent variable is the sum of transfers from parents and transfers from other relatives

Table 21: TWIN-FIRST EFFECT ON LOG TRANSFERS AND TRANSFERS PER INCOME - SAMPLES OF CHINESE AND INDONESIAN MOTHERS

	CHNS 2000-2009 [a]		IFLS 2000 [b]	
	Log Transfers	Transfers/Income	Log Transfers	Transfers/Income
	Tobit	Tobit	Tobit	Tobit
	(1)	(2) [c]	(3)	(4)[c]
TWIN	0.60	0.11	0.69	0.07
	(0.34)	(0.05)	(0.36)	(0.09)
AGEFB	-0.05	-0.01	-0.03	-0.00
	(0.01)	(0.00)	(0.00)	(0.00)
AGE	0.10	0.02	0.03	0.01
	(0.00)	(0.00)	(0.00)	(0.00)
Year FE	Yes	Yes	-	-
Region FE [c]	Yes	Yes	Yes	Yes
N	6133	5554	3029	2666

[a] Standard errors clustered at the household level
[b] Standard errors robust to heteroskedasticity
[c] The denominator is household income from labor sources
[c] Community fixed effects were added for China; district fixed effects were added for Indonesia

Table 22: TWIN-FIRST EFFECT ON TRANSFERS FROM CHILDREN, ADDITIONAL CONTROLS - SAMPLES OF CHINESE AND INDONESIAN MOTHERS

	CHNS 2000-2009 [a]		IFLS 2000 [b]	
	Tobit	Tobit	Tobit	Tobit
	(1)	(2)	(3)	(4)
TWIN	451.63	482.91	188.15	166.47
	(201.882)	(207.645)	(98.009)	(94.179)
AGEFB	-32.21	-46.56	-6.50	-30.72
	(3.574)	(10.665)	(1.243)	(2.777)
AGE	50.62	67.97	6.02	33.12
	(3.034)	(11.734)	(1.048)	(3.217)
CONTROLS [c]	No	Yes	No	Yes
Year FE	Yes	Yes	-	-
Region FE [d]	Yes	Yes	Yes	Yes
N	5999	5999	3029	3027

[a] Standard errors clustered at the household level
[b] Standard errors robust to heteroskedasticity
[c] Controls: average age of children, average spacing between births and gender of the eldest child (children)
[d] Community fixed effects were added for China; district fixed effects were added for Indonesia

A Partial effects of $\overline{n}$ on q, c_f and s 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)-(4) with respect to $\overline{n}$ and I yields the following set of simultaneous linear differential equations written in matrix form:

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

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

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

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

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

where the cofactors are

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

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 between 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" (which we obtain by setting $\pi q d\overline{n} = dI$) is negative in (A.2) and positive in (A.3) and (A.4).

B Partial effects of $\overline{n}$ on q, c_f and s 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 affected by n and q, in addition to s. First, I define the utility function in problem with transfers as

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

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

Totally differentiating (19)-(20) with respect to $\overline{n}$ and I yields the following system of differential equations:

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

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, we obtain

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

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

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

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

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 we 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 we 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 $V_{ppp} = V_{kkk} = 0$.[24] 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 $\frac{\partial^2 c_p}{\partial q \partial s} = 0$.[25] Therefore, I can sign the last terms in equations (B.3)-(B.7) as follows: U_{qq}^p, U_{qs}^p, U_{qq}^p and $U_{sn}^p < 0$ and $U_{ss}^p > 0$. The sign of U_{qn}^p cannot be determined.

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

$$\begin{aligned}
\phi_{12}^t &= \phi_{12} - \pi n U_{ss}^p U_{ff} + p_s U_{qs}^t U_{ff} && \lesseqgtr 0 \\
\phi_{13}^t &= \phi_{13} - \pi n U_{qs}^t U_{ff} + p_s U_{qq}^p U_{ff} && \lesseqgtr 0 \\
\phi_{14}^t &= \phi_{14} + (U_{qs}^t)^2 - U_{ss}^t U_{qq}^p && \lesseqgtr 0 \\
\phi_{22}^t &= \phi_{22} - U_{ss}^p && > 0 \\
\phi_{23}^t &= \phi_{23} - U_{qs}^t && > 0 \\
\phi_{24}^t &= \phi_{24} + \pi n U_{ss}^p - p_s U_{qs}^t && \lesseqgtr 0 \\
\phi_{33}^t &= \phi_{33} - U_{qq}^p && > 0
\end{aligned}$$

[24] 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.

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