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Parental human capital investment and old-age transfers from children: Is it a loan contract or reciprocity for Indonesian families?[☆]

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Abstract

This paper proposes two alternative models of intergenerational transfers linking parental investment in human capital of children to old-age support. The first model formulates these transfers as a pure loan contract and the second model as self-enforcing reciprocity. Both models predict neutrality of intergenerational redistribution of resources within the family, also known as the "difference in income transfer derivatives property". Two models, however, provide different reasons for the failure of this property, and yield different policy implications for parental human capital investment and provision of old-age support. Specification tests on the Indonesian Family Life Survey data reject the pure loan model in favor of the reciprocity model. The estimated difference in

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income transfer derivatives for this data is found to be significantly higher than the difference estimated by Altonji, Hayashi and Kotlikoff Altonji et al. (1992) [Altonji, J.G., Hayashi, F. and Kotlikoff, L.J. (1992). Is the Extended Family Altruistically Linked? Direct Tests Using Micro Data. The American Economic Review, vol. 82(5): 1177–98.] for the U.S. PSID data.

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1. Introduction

In Becker's model (1974) of resource transfers from parents to children, parents are altruistic towards children but children are selfish. An important implication of this model is that if parents transfer positive amount of resources to their children, publicly provided intergenerational transfer programs that marginally redistribute resources from children to parents are neutralized by an increase of private transfers from parents to children that exactly offset such public transfers. For a given total family income, the distribution of income within family is irrelevant for consumption and transfer decisions taken by individual family members. More specifically, decisions taken by an altruistic household head who makes positive transfers to other members will coincide with decisions taken by family members themselves.

More formally, let E_k be the income of the child, E_p be the income of the parent, and T be the positive transfer from parent to child. Parental altruism will imply the difference in income transfer derivatives property $\frac{\partial T}{\partial E_p} - \frac{\partial T}{\partial E_k} = 1$, first derived formally by Cox (1987). Altonji et al. (1997) formally estimated this difference using PSID data in the U.S. and found it to be around 0.13 instead of 1 as predicted by altruism models. Other studies offer mixed evidence on altruistic transfers within the family. Behrman et al. (1982) formulated an alternative model of altruistic transfers in which parents make transfers to children to offset their children's earnings inequality. McGarry and Schoeni (1995) found that parents give more to less well off children and elderly parents, suggesting that such transfers are not motivated by exchange motives. However, Altonji et al. (1992) and Hayashi (1995) found that the distribution of resources within the family affects the distribution of food consumption, rejecting the hypothesis that the extended family is altruistically linked.

To test the exchange motive for transfers, some studies explicitly model transfer of resources from parents to children as exchange of money for non-market services received from children. In Bernheim et al. (1985) bequest is modeled as strategic exchange for children's services, such as visits in old age. Other studies, Cox (1990), Cox and Rank (1992), found that money transfers are correlated with services received such as child care, and interpreted this as evidence of quid-pro-quo exchange in intra-family transfer behavior.

Another possible motive for parental transfer to children that has received little attention in the literature is investment in children's education to receive old-age transfers. In a theoretical model of parental investment in children's education, Becker et al. (1990) extended the quality–quantity model of parental human capital investment to an overlapping generations growth model in which such investment in children is motivated by parental altruism. However, in this model, parental transfers could not be linked to transfers from children because agents live only during one period. In an alternative overlapping generations growth model (Raut, 1990), parental investment in children's human capital is explicitly motivated by the amount of transfer anticipated from children during old-age. But the amount of transfer from children to parents is determined exogenously by social norms or other enforcement mechanisms.[1] Using Indonesian data, Lillard and Willis (1996) found that transfers from children to parents are positively correlated with children's education level and interpreted this as evidence that parental educational investment in children is paid back during old age, thus ensuring parental old age security.

In this paper, we consider alternative models of parental investment in children's education, and test them directly using the Indonesian Family Life Survey (IFLS) data set. In the next section, we formulate two models of parental human capital investment and old age transfer from children. In both models, two-sided altruism plays a significant role. In the first model, the pure loan model, parents determine both the schooling loan amount to children and the level of transfer from children in old-age. Children are passive recipients of the loan contract, as long as they are not made worse-off by the terms of the contract. This approach presumes that there are cultural and social norms that enforce such inter-generational contract. By contrast, the second model of transfers is based on reciprocity with each child autonomously deciding how much to transfer to parents rather than making the transfer to conform to social or cultural expectations as in the pure loan model. In the second model, the level of parental investment in children's education and the amount of transfer from children to old parents are determined simultaneously in Nash equilibrium. We study the properties of the optimal solution and derive the difference in income transfer derivatives property in each model. We then derive testable restrictions on the estimation equations to differentiate the two models empirically.

Section 3 discusses and compares our estimation strategy with the approach taken by Altonji et al. (1997). Section 4 describes the data and variables in this study. Section 5 reports the main empirical results. Section 6 concludes the paper.

2. Theoretical framework

We formulate two models of inter-vivo transfers linking parental investment in their children's education when parents are adult and transfer of resources from children to old parents. In both models, two-sided altruism between parents and children influence transfer. Although this represents a departure from other models in the literature where parents are altruistic and children are selfish, there is no a priori reason to assume children's selfishness, so we consider altruism in children in our models a reasonable behavioral assumption.

In the first model, parental educational investment and old-age transfers from children are an implicit pure loan contract, the terms of which are set by parents, with children

[1] In Raut (1996), both upward and downward transfers are endogenized in a similar overlapping generations model.

being passive recipients of the loan contract. The transfer that parents want to receive from a child is the pure loan repayment amount, net of the amount that parents want to give to the child because they care for the child's well-being. In this model, although it is possible for parents to be uninformed about the child's actions in adulthood or about the type of the child as a credit risk (see Tran (1998) for a loan contract model with moral hazard), as in previous studies in the literature, we assume away information asymmetry between parents and children in the loan contract. Thus, the first model could be viewed as exchange of transfers similar to other exchange models among family members who exchange cash for services (Cox, 1987, 1990; Altonji et al., 1997).

In the second model, transfers are motivated by reciprocity with two-sided altruism. Parents decide how much to invest in children's human capital out of benevolence and altruism towards them, anticipating that children will reciprocate with resource transfers to parents in old age. Children voluntarily decide the transfer amount to old parents out of altruism. Parents make human capital investment decisions before children make old-age transfer decisions, opening up the possibility that parents could manipulate children's transfer behavior to their advantage, as in a Stackleberg equilibrium (see Raut, 1996). However, here we assume that parents are altruistic and benevolent towards their children. Both parents' and children's decisions are order independent, that is, benevolent parents' decisions are not influenced by the order in which decisions by parents and children are made. Parents transfer the amount they would have transferred as a best response to their children's transfer, had their children made the transfer first. Such altruistic transfers are a Nash equilibrium consistent with altruistic reciprocal gift behavior (see Kolm, 2000 for a more detailed discussion).

Children may vary in their degree of altruism, their learning and earning abilities, and parents may have imperfect information about the extent of their altruism. This makes return from investment in children uncertain. The riskiness of parental human capital investment may be further increased by children's migration to better paid jobs far away from home, even after taking into account the spatial risk-pooling effects of such migration (Rosenzweig and Stark, 1989). However, in this paper, for tractability, we abstract from these uncertainty issues. In both models, we assume that children from the same parents are identical in endowment of abilities and in altruism towards parents. Thus, they receive identical transfers from parents and behave identically towards them, since there would be no sibling rivalry nor parental preference for one child over another. We now present our basic framework more formally.

Consider an overlapping generations framework where each person's life-cycle consists of two periods: adult age and old age. Adult age is also the period of parenthood. Although husband and wife may differ in some respects, they are assumed to converge in family decisions. That is, we assume perfect assortative mating of parents with respect to attributes that are relevant for parental human capital investment decisions, such as education, income, and preferences. There is no distinction between father and mother who are treated as a single representative parent. Thus a representative parent has n identical children of ability τ and invests the same amount on each child.

A parent earns incomes E_{p1} in period 1, and E_{p2} in period 2. Let T_1 be the amount of human capital investment that the parent makes on each of her n identical children in period 1, with human capital investment being limited to schooling expenditures only. Let T_2 be the amount of resources that the parent receives from each child in period 2. When the child is young and goes to school, the amount of his schooling depends on how much he can spend on his education. Assume that he invests whatever amount his parent gives to him for education. In period 2, the child becomes adult and participates in the labor market. His earnings E_{k2} depends on the amount of schooling investment T_1 and his ability or talent level τ, as denoted by E_{k2} (T_1,τ). We assume that the earnings function E_{k2} (T_1, τ) satisfies the Inada condition with respect to T_1 that $\partial E_{k2}(T_1, \tau)/\partial T_1 \rightarrow \infty$ as $T_1 \rightarrow 0$.

Let c_{it} be the consumption of agent i in period t, with $i=p$, k and $t=1$, 2. The parent cares for her child's well-being and the child cares for his parent's well-being. This two-sided altruism is incorporated into the utility functions as follows:

$$\text{Parent's utility function}: \ u(c_{p1}) + \beta U(c_{p2}, v_p(c_{k2})) \tag{1}$$

$$\text{Child's utility function}: \ V\ (c_{k2}, u_k(c_{p2})) \tag{2}$$

In this general specification, v_p (c_{k2}) represents the parent's perception of her child's utility from his consumption of c_{k2} in period 2. We allow the parent's perception of her child's utility v_p (c_{k2}) to differ from her child's actual utility v (c_{k2}). Similarly, u_k represents the child's perception of his parent's utility when the parent consumes c_{p2} in her old-age. In our notational convention, the parent's felicity index is represented by the lower or upper U function and the child's index is represented by the lower or upper V function.

Whenever possible we will use general utility functions. However, to derive specific results, we will specify the utility functions as follows:

$$\begin{array}{lll} U(c_{p2}, v_p(c_{k2})) = u(c_{p2}) + \gamma_p v_p(c_{k2}), \gamma_p>0 & \ldots & \text{(U1)} \\ V(c_{k2}, u_k(c_{p2})) = v(c_{k2}) + \gamma_k u_k(c_{p2}), \gamma_k>0 & \ldots & \text{(U2)} \\ v_p(c_{k2}) = v(c_{k2}) & \ldots & \text{(U3)} \\ u_k(c_{p2}) = u(c_{p2}) & \ldots & \text{(U4)} \\ v(c_{k2}) = u(c_{k2}) & \ldots & \text{(U5)} \\ u(c) = \alpha \ln c, \alpha>0 & \ldots & \text{(U6)} \end{array} \tag{3}$$

Assumptions (U1) and (U2) imply that U and V are separable. Assumption (U3) means that the parent values her child's consumption the way the child himself does. (U4) has similar interpretation. (U5) tells us that both parent and child derive satisfaction in the same way. Assumption (U6) specifies the felicity index to be Cobb–Douglas. While the results in this paper generalize to constant elasticity of marginal utility (CME) utility functions, $u(c)=c^{\rho-1}/\rho-1$, $\rho\neq 1$, for expositional ease, we use the Cobb–Douglas utility function. The separability specifications in (U1) and (U2) are quite general. They allow for altruism to be expressed in terms of welfare as well as in terms of the felicity index of the other agent.[2] The felicity index U in the parent's utility function depends on the number of children, n. This is incorporated in specification (U1) by letting γ_p be a function of n. Similarly, how much a child cares about his parent may depend on the number of siblings he has. This is incorporated in specification U2 by letting γ_k be a function of the total number of children, including siblings and himself, n. While it is reasonable to assume that γ_p is increasing in n, γ_k is either independent of n or decreasing in n at a lower rate than γ_p, such that $\gamma_p \cdot \gamma_k$ is increasing in n. This is true for instance when γ_k is constant, as presumed by most studies in the literature. We maintain this presumption in the rest of the paper. We also appeal to a known mathematical result that it is generically impossible for a parent–child pair to have $\gamma_p(n)$ and $\gamma_k(n)$ such that $\gamma_p \cdot \gamma_k$ is independent of n.[3] For the Cobb–Douglas specification (U6), without loss of generality, we will normalize the utility weights such that $\alpha + \alpha\beta = 1$.

During period 1, the parent is not liquidity constrained, but her young children are. Let s be the assets (financial and physical) that a parent saves for old-age. The budget constraints of the parent in two periods are given by,

$$c_{p1} + nT_1 + s = E_{p1}$$

$$c_{p2} = (1 + r)s + nT_2 + E_{p2} \tag{4}$$

When the parent faces perfect capital markets and is not liquidity constrained, savings s is unrestricted in sign, and the budget constraints in Eq. (4) can be collapsed into the following inter-temporal budget constraint:

$$c_{p1} + \frac{c_{p2}}{1 + r} = E_{p1} + \frac{E_{p2}}{1 + r} + \frac{nT_2}{1 + r} - nT_1 \equiv \mathcal{Y}(T_1, T_2) \tag{5}$$

The child's budget constraint is:

$$c_{k2} = E_{k2}(T_1, \tau) - T_2 \tag{6}$$

In the next two subsections, we present two alternative models of how the intergenerational transfer pair (T_1, T_2) is determined.

[2] To see this, let us consider only period 2, and denote by U and V respectively the utility of parent and child. Let us suppose that

$$U = u(c_{p2}) + \gamma_p V \text{ and } V = v(c_{k2}) + \gamma_k U$$

substituting the second expression in the first expression, and solving for U (and similarly for V) we get

$$U = \frac{1}{1 - \gamma_p\gamma_k}\left[u(c_{p2}) + \gamma_p v(c_{k2})\right] \text{ and } V = \frac{1}{1 - \gamma_p\gamma_k}\left[v(c_{k2}) + \gamma_p u(c_{p2})\right]$$

which are basically the linear monotonically increasing transformation of the utility specifications we have assumed, provided that $\gamma_p \cdot \gamma_k < 1$.

[3] More precisely, the Lebesgue measure of such an event in the space of parameters is zero, i.e., the event is unlikely to happen.

2.1. Parental educational expenditures and old-age transfers as pure loan

In the first model, the parent is the dominant decision maker. This behavioral assumption is consistent with other models in the literature on intergenerational transfers (Becker, 1974; Cox, 1987). The parent designs an implicit contract (T_1, T_2) and makes her savings decision s. While it is possible that $T_2<0$, that is, the parent transfers resources to children instead of receiving resources from her children during old age, we restrict ourselves to $T_2 \geq 0$ here and will come back to this point further in the paper. The parent's problem is:

$$\max_{T_1, T_2 \geq 0, s} u\left(c_{\mathrm{p}1}\right) + \beta U\left(c_{\mathrm{p}2}, v_{\mathrm{p}}\left(c_{\mathrm{k}2}\right)\right)$$

subject to the budget constraints (5) and (6) and to the participation constraint of the child:

$$V\left(E_{\mathrm{k}2}(T_1, \tau) - T_2, u_{\mathrm{k}}\left(c_{\mathrm{p}2}\right)\right) \geq V\left(E_{\mathrm{k}2}(0, \tau), u_{\mathrm{k}}\left(c_{\mathrm{p}2}^{\mathrm{o}}\right)\right) \tag{7}$$

where $c_{\mathrm{p}2}^{\mathrm{o}}$ denotes the level of consumption that the parent would optimally choose for herself during the second period if she did not make an educational loan to her child. This participation constraint ensures that the child is better or no worse off with the loan than without it. We assume the Inada condition on $E_{\mathrm{k}2}$ (T_1, τ), so that at the optimum $T_1>0$. We also assume both parental and children's altruism to be strong enough so that the participation constraint (7) is not binding.[4] T_2 is not exceedingly high because the parent cares enough for the child's consumption and the child is happier giving T_2 than not giving to the parent. Solving the parent's problem with respect to s, T_1, T_2 yields the first order condition with respect to s:

$$\frac{u'\left(c_{\mathrm{p}1}\right)}{\partial U / \partial c_{\mathrm{p}2}} = \beta(1+r), \tag{8}$$

the first order condition with respect to T_1:

$$\frac{u'\left(c_{\mathrm{p}1}\right)}{v_{\mathrm{p}}'(c_{\mathrm{k}2})} = \frac{\beta}{n} \cdot \frac{\partial U}{\partial v_{\mathrm{p}}} \cdot \frac{\partial E_{\mathrm{k}2}}{\partial T_1}, \tag{9}$$

and the first order condition with respect to T_2:

$$\frac{\partial U / \partial c_{\mathrm{p}2}}{v_{\mathrm{p}}'(c_{\mathrm{k}2})} \leq \frac{1}{n} \cdot \frac{\partial U}{\partial v_{\mathrm{p}}}, \text{ with equality holding when } T_2>0. \tag{10}$$

[4] Explicit bounds on altruism parameters to ensure that the participation constraint is not binding at the optimal solution can be derived formally. This does not shed additional light on our analysis, so we assume that the parameters are within these bounds.

Dividing Eq. (9) by Eq. (8),

$$\frac{\partial U/\partial c_{\mathrm{p2}}}{v_{\mathrm{p}}'(c_{\mathrm{k2}})} = \frac{\partial U/\partial v_{\mathrm{p}}}{n(1+r)} \cdot \frac{\partial E_{\mathrm{k2}}}{\partial T_1} \tag{11}$$

and substituting Eq. (10) into Eq. (11) for the households with $T_2>0$ yields:

$$\frac{\partial E_{\mathrm{k2}}(T_1, \tau)}{\partial T_1} = 1 + r \tag{12}$$

Eq. (12) alone determines how much the parent will invest in each of her children's education. The parent's education decision for each child is market efficient as the parent will invest in each child's education up to the point where the marginal increase in the child's earnings from one more dollar invested equals the market interest rate. Thus, the parent's return to educating a child equals the market rate of return on other assets.

As Eq. (12) shows, the level of investment in each child's education does not depend on the total number of children, but only on the market interest rate and on the unobserved ability parameter of the child. The lower is the market interest rate or the greater is the talent of the child, the higher will be the investment in his schooling. This is to be expected when parents treat investment in the schooling of children as a loan.

It is not possible to get a general explicit solution for T_2. Under the separability assumption (U1), however, Eq. (8) can be rewritten as:

$$\frac{u'\left(c_{\mathrm{p2}}\right)}{v_{\mathrm{p}}'(c_{\mathrm{k2}})} = \frac{\gamma_{\mathrm{p}}}{n}. \tag{13}$$

The effect of n on T_2 is complex. Suppose γ_{p} is increasing in n, and γ_{p}/n is decreasing in n. Then a parent with more children has lower marginal utility of own consumption relative to the marginal utility of her child's consumption in period 2. Hence, she will have higher level of second period consumption c_{p2} relative to each child's consumption c_{k2}. Assuming the Cobb–Douglas utility function, as in (U5) and (U6), we have an explicit solution for T_2 as follows:

$$T_2 = \left[\frac{1}{1+\alpha\beta\gamma_{\mathrm{p}}}\right] E_{\mathrm{k2}} + \left[\frac{(1+r)\alpha\beta\gamma_{\mathrm{p}}}{1+\alpha\beta\gamma_{\mathrm{p}}}\right] T_1 - \left[\frac{(1+r)\alpha\beta\gamma_{\mathrm{p}}}{\left[1+\alpha\beta\gamma_{\mathrm{p}}\right]\cdot n}\right] \left[E_{\mathrm{p1}} + \frac{E_{\mathrm{p2}}}{1+r}\right] \tag{14}$$

It is interesting to note that without parental altruism, $\gamma_p=0$, the terms of a pure loan contract would be T_1 (Eq. (12)) and $T_2=E_{\mathrm{k2}}$ (Eq. (14)). According to these terms, the parent would take all of her child's earnings. This could not be the case though, because the child's participation constraint (14) would become binding, making T_2 lower than E_{k2}. Assume also that γ_p lies within the bounds so that the participation constraint (7) is not binding. The optimal amount T_2 in Eq. (14) thus depends on both the parent's permanent income and the child's earnings and will be less than $T_2=(1+r)\ T_1$, the amount that the parent wants to get when there is no altruism. This suggests an *excess sensitivity test*: if after controlling for T_1 the other variables in Eq. (14) have significant effect on T_2, we will have evidence against absence of altruism.

In one-sided altruism models, enforceability in transfers from children is resolved by assuming social norms that keep children from defaulting on their loan from parents (Becker, 1974; Becker and Murphy, 1988; Cox, 1987) or by assuming parents' knowledge of their children's trustworthiness (Cox, 1990). Similarly, in our loan model, there is nothing that forces the child to transfer T_2 to his parent in period 2. But because the child cares for his parent, he will honor the contract provided that his marginal utility $\partial V/\partial T_2$ is non-negative[5] at the solution. If instead, his marginal utility is negative at the solution, the parent would have to resort to coercion or other enforcement mechanisms to obtain T_2 from her child. Coercion and other mechanisms can take different forms depending on the institutions of a society.

One enforcement mechanism is a judicial procedure to enforce contracts among family members. Many countries, however, do not have such legal institutions, either due to traditional beliefs or lack of legal framework. Another enforcement mechanism comes from established social norms. Many societies develop social rules and norms for punishing individuals who do not observe social rules. Although social norms may be effective for enforcing implicit contracts in small communities, in large towns and cities, or if children have the possibility of moving away from the community, this enforcement mechanism may be ineffective. A more specialized social norm is family norm considered by Anderberg and Balestrino (2003). They assume that family members do not exhibit any kind of altruism towards other members. In these economies, without a binding contract for old-age transfer, parents would not invest in their children's education. They consider family norms or punishment–reward rules among family members as trigger strategies that specify that an agent i should make socially desirable transfers (T_1, T_2) if everyone has done so in the past; however, if anyone in the past failed to transfer (T_1, T_2), agent i would not make any transfer at all. To make this type of social norm self-enforcing or stable, they consider a stationary subgame perfect equilibrium and show that when $n>r$, it is possible to have such social norms enforce a Pareto undominated contract (T_1, T_2) (see Raut, 1996 for another discussion of this type of strategies). Another enforcement mechanism commonly observed in many traditional societies is through coresidence. Parents coreside with their children so that they can obtain old-age support from their children. In our data set, however, we have information on transfers only for non-coresident parents, so we will assume that the implicit intergenerational loan contract is enforced by some unspecified social mechanism.

2.2. Parental educational expenditures and old-age transfers as reciprocity with two-sided altruism

In the previous model, the parent decides both T_1 and T_2, subject to the child's participation constraint. In the second model, the parent decides T_1, and the child decides

[5] In case $\partial V/\partial T_2>0$, i.e., the child would like to transfer more than the parent would like him to, we can assume that parent's decision is enforced.

T_2 in a Nash equilibrium[6] framework. This contract is self-enforcing and does not require an exogenous enforcement mechanism. Why? Because both parent and child care for each other, and because it is optimal for both to make the transfers.

As in the previous model, we restrict the analysis to households with $T_2 \geq 0$. Taking the child's decision as given, the parent solves the following:

$$\max_{T_1 \geq 0, s} u(c_{p1}) + \beta U(c_{p2}, v_p(c_{k2}))$$

subject to budget constraints in Eqs. (4) and (5).

Taking his parent's decisions s and $T_1 \geq 0$ as given, the representative child decides $T_2 \geq 0$ by solving the problem:

$$\max_{T_2 \geq 0} V(c_{k2}, U^k(c_{p2}))$$

subject to the budget constraints defined by Eq. (6) and the second line of Eq. (4). The first order conditions with respect to s and T_1 for the parent's problem are exactly the same as Eqs. (8) and (9) in the first model. The first order condition with respect to T_2 is given by:

$$\frac{u_k'(c_{p2})}{\partial V / \partial c_{k2}} \geq \frac{1}{n \partial V / \partial u_k}, \text{with equality holding when } T_2 > 0 \tag{15}$$

Unlike the first model, there is no closed form solution for T_1 in general. Assuming that U and V are separable (i.e., assuming (U1) and (U2)), Eq. (15) for households with $T_2 > 0$, which is analogous to Eq. (13) in the previous model, becomes:

$$\frac{u_k'(c_{p2})}{v'(c_{k2})} = \frac{1}{n\gamma_k} \tag{16}$$

Assuming perfect alignment of perceived and actual felicity indices (i.e., assuming (U3) and (U4)), Eq. (16) becomes:

$$\frac{u'(c_{p2})}{v'(c_{k2})} = \frac{1}{n\gamma_k} \tag{17}$$

It follows that

$$E_{k2}'(T_1, \tau) = \frac{1+r}{\gamma_k \gamma_p} \tag{18}$$

Unlike in the previous model, the optimal schooling investment level T_1 here depends on the degree of two-sided altruism. It is reasonable to expect that γ_k and γ_p are both less than one. This implies that there will be under-investment in schooling. The greater is

[6] For a similar model based on two-sided altruism, and for a discussion of problems associated with various equilibrium concepts, see Raut (1996).

either agent's altruism, the higher is parental investment in children. Given our presumption that $\gamma_k \cdot \gamma_p$ is increasing in n, it follows from Eq. (18) that parents with more children will invest more in their human capital. This result is in contrast with the negative relationship between quality and number of children found by Becker and Lewis (1973) where number of children n is endogenous. However, in our framework, n is exogenous.

For the Cobb–Douglas utility function, we derive the following explicit solution for T_2:

$$T_2 = \frac{\gamma_k}{\alpha\beta + \gamma_k} E_{k2} + \frac{(1+r)\alpha\beta}{\gamma_k + \alpha\beta} T_1 - \left(\frac{(1+r)\alpha\beta}{(\gamma_k + \alpha\beta)\cdot n}\right)\left[E_{p1} + \frac{E_{p2}}{1+r}\right] \tag{19}$$

Under the assumption that the altruism parameters are within the bounds such that the participation constraint in the first model is not binding, and the optimal transfer from the child is acceptable to the parent (i.e., not too large a transfer), we note an interesting difference between Eqs. (14) and (19): conditional on T_1, Eq. (19) involves only γ_k, the child's altruism towards his parent, whereas Eq. (14) involves only the parent's altruism towards her child, γ_p. Without instruments to identify altruism parameters, these equations are observationally equivalent and can not be relied on to yield a test to differentiate between the two models. Our empirical strategy will have to rely on other parameter restrictions that will be discussed in the econometric implementation section.

2.3. Income transfer derivative properties and policy implications

In this section we show that while the income transfer derivative property holds in both models, the implications of this property for the neutrality of public transfers programs such as the pay-as-you-go social security system of transfers differ across models. We also show that private educational investment in children may not be optimal.

The difference in income transfer derivative property was derived for a one-period model of transfers in which the parent cares for the child but the child cares only about his own consumption (Cox, 1987). In our models, both parent and child care for each other. In addition, transfers go both ways, but in two different periods. In the first model, the parent is the dominant agent who makes decisions for both herself and the child. In the second model, the parent makes schooling investment T_1 and savings s decisions optimally, assuming the child's optimal decision about T_2. The child's decision depends on his income in the second period, which is a function of parental transfer T_1 in the first period.

In what sense can we invoke the income transfer derivative property? Consider families with T_1, T_2>0. Suppose that, in period 1, agents know that, in period 2, a dollar will be taken from each child and the proceeds of n dollars will be given to the parent. This is a pure redistribution within the family during period 2. By what amount would the transfer from children to parent be reduced, if any? More formally, what is the total effect on T_2? Let $\tilde{E}_{p2}$ be the second period value of the parent's permanent income, measured in the same unit as E_{k2}. Holding total family income $\tilde{E}_{p2}$ $+nE_{k2}$ constant, let there be redistribution of incomes within the family such that $\Delta E_{k2}=-1$, and $\Delta\tilde{E}_{p2}=n$. The total effect of these two income changes on T_2 is given by:

$$\frac{\partial T_2}{\partial E_{k2}}\Delta E_{k2}+\frac{\partial T_2}{\partial \tilde{E}_{p2}}\Delta\tilde{E}_{p2}=-\frac{\partial T_2}{\partial E_{k2}}+n\frac{\partial T_2}{\partial \tilde{E}_{p2}}$$

Neutrality implies that the total effect equals to -1. The property of the equilibrium solution that makes the total effect equal to -1 is known in the literature as the *difference in income transfers derivative property*. To calculate the net change in our case, we would have to take into account the effect of the redistribution on all endogenous variables, T_1, s and T_2. In Appendix A, we show that for both models, the following difference in income transfer derivatives property holds:

$$\frac{\partial T_2}{\partial E_{k2}}-n\frac{\partial T_2}{\partial \tilde{E}_{p2}}=1. \tag{20}$$

In the first model, since the parent is the sole decision maker, the neutrality result necessarily holds since the parent is already at the optimum when making consumption and investment decisions over her life cycle. Forcibly taking a dollar from the child to give to the parent would only result in the parent voluntarily taking a dollar less from her child. Thus, neutrality always holds in the first model.[7] In the second model, whether neutrality holds or not depends on the sign of the parent's marginal utility of T_2:

$$\text{(a)}\ \frac{\partial U\left(c_{p2},v_p(c_{k2})\right)}{\partial T_2}\leq 0;\ \text{(b)}\ \frac{\partial U\left(c_{p2},v_p(c_{k2})\right)}{\partial T_2}>0 \tag{21}$$

For parent–child pairs behaving according to (a), because children already transfer more than what parents would have liked them to, parents return the excess tax to children. For parent–child pairs behaving according to (b), parents would not return the excess tax to children because they did not receive sufficient transfer from their children before the tax. Which of these two constraints holds in equilibrium? Assuming separability of the utility functions, perfect alignment of perceived and actual felicity indices, and limited altruism of economic agents with $0<\gamma_p<1$, and $0<\gamma_k<1$, it can be shown that in equilibrium, (b) is always true.

Thus, in the second model, a social security program that transfers more than the amount voluntarily transferred by children is not neutral. If such a program making transfers to the elderly were established, the children who would voluntarily transfer more than the social security amount to parents would see their transfer reduced to exactly offset the social security transfer. Children who would voluntarily transfer less than the social security amount would not get the excess tax amount back from their parents. The net effect is that the social security program increases total upward transfers.

[7] Note, however, that this neutrality result does not hold in the case of a forced redistribution from the parent to the child. Given the terms of the loan contract, there is nothing that compels the child to give back the money taken forcibly from the parent.

Our second model provides justification for a publicly provided social security program, though not of the pay-as-you-go type. Neither is it of the fully funded type, such as the personal retirement account system advocated by proponents of social security privatization. But it is fully funded in the sense that for parent–child pairs for which $\gamma_p \cdot \gamma_k < 1$, parents pay a social security tax higher than T_1 in Eq. (18), to be invested by the social security administration in the human capital of children. When adult, children pay the amount T_2 in Eq. (19) out of their earnings, which have been raised by the schooling investment financed by the tax in the previous period. This leads to higher growth in children's incomes, and both generations are better off. The idea that a social compact between generations, where parents invest in children's human capital and in return receive old age support, can enhance growth in incomes was also proposed by Becker and Murphy (1988) in a slightly different framework. In their framework, parents are altruistic towards children but children are selfish. Poor parents who do not leave bequest cannot make their children pay back the educational loan by reducing the bequest amount, unlike rich parents who leave a positive bequest. Thus, in this framework, a fully funded social security program of the type discussed in this section can improve human capital investment in children and hence growth. Although in our second model, we assume two periods, two-sided altruism, and do not make assumptions about parents' bequest behavior, the policy implications for publicly funded education and social security programs are similar to Becker and Murphy's.

To sum up, testing the two models empirically is particularly relevant for educational policy. Should educational investment be entirely left to households, or are there ways in which intervention into these decisions improves social welfare? Under the loan model, parental investment in children's education is socially optimal, as long as social norms provide the necessary reinforcement mechanism for repayment of the loan. But under the two-sided altruism model, some parents underinvest in their children's human capital. Thus, intervention into family decisions improves efficiency for these parents and children.

3. Econometric implementation

The key estimation equations are the optimal parental human capital investment equation T_1 and of the old-age resource transfer equation T_2. The excess sensitivity of T_2 to regressors other than T_1 in Eq. (19) and, in particular, a significant non-positive coefficient estimate on T_1 will provide evidence of existence of altruism but they do not provide a test to statistically differentiate the two models. To test which model is more consistent with the data, our identification strategy relies instead on the sensitivity of T_1 to the number of children n as discussed in details below.

From Eqs. (12) and (14) for the pure loan model, and Eqs. (18) and (19) for the reciprocity model, it is clear that while both T_1 and T_2 are endogenously determined for each parent–child pair, T_1 and T_2 have a recursive structure. Thus, under the pure loan null hypothesis, their error terms are stochastically independent. We estimate these equations recursively by estimating T_1 first, then estimate T_2.

In the following we specify T_1. An implication of Eq. (12) is that when parents are not liquidity constrained–capital markets are perfect for parents but not for children because children can not participate in capital markets–parental investment on children's education T_1 depends only on the market interest rate and the ability of the child. However, in developing countries, even parents are likely to be liquidity constrained. Thus, T_1 may depend on variables describing parents' socio-economic background and ease of borrowing, such as parents' wage earning (E_{p1}), and parents' human capital level,[8] and asset holdings. Holding all other variables constant, we expect that a liquidity constrained parent invests less in each child if she has more children. Under the null model, which is our first model, T_1 does not depend on n. Under the alternative model, which is our second model, T_1 is an increasing function of n. This is because T_1 depends on $\gamma_p \cdot \gamma_k$ which we presumed to be increasing in n. If the effect of n is significant and positive, this is evidence in favor of the alternative model. If other covariates are significant, this is evidence of parents being liquidity constrained. Representing socio-economic background variables by Z, the unobserved ability of the child and all other random factors in T_1 by ϵ_1, we specify the parent's transfer equation as:

$$\ln T_1 = \beta_0 + \beta_1 Z + \epsilon_1 \tag{22}$$

In this paper, we use educational attainment of the child as a proxy for T_1, because education related transfers from parents to children are infrequently observed in our data set.

We now specify T_2. It is clear from the Euler equations that both models have observationally equivalent parametric representation of T_2 (Eqs. (14) and (19)). However, we can use excess sensitivity of T_2 to variables other than T_1 as evidence against pure loan without altruism and in favor of altruism.

For estimation purposes, we write the solutions (14) and (19) in the following common form:

$$T_2^*(X, \theta) = X'\beta + \epsilon_2 \tag{23}$$

where X and β are the regressor and parameter vectors as in Eqs. (14) or (19), and ϵ_2 is a random variable. Let $\theta=(\beta, \epsilon_2)$ and let $f(\theta)$ be the population density function of θ. Because estimation of this equation is performed on households with positive upstream transfers, $T_2=\max\{0, X'\beta+\epsilon_2\}$, this regression is censored from the left.

Obviously, it is important to allow each parent–child pair to have either positive, zero or negative transfers so that, within each model, every pair belongs to either a group of unsatisfied recipients, unsatisfied donors, or to a group where both donor and recipient in the pair are satisfied (satisfaction here is measured in terms of marginal utility of transfer being zero). In addition, it would be interesting to recover the unobserved heterogeneity parameters k and p from the data. This would require the multiple regime extension of the twin Tobit model, as originally proposed by Rosett (1959).

[8] There are other channels through which parental human capital, in particular the mother's human capital, may affect investment in children's human capital.

Our first estimation approach to T_2 assumes that all agents have the same utility function and the same set of fixed parameters β. As specified in Eq. (23), ϵ_2 captures the measurement error in variables and approximation error in the utility functions that are the source of unobserved heterogeneity across households. Assuming $E\ (\epsilon_2|X)=0$, we estimate Eq. (23) as a Tobit equation and report these results in the next section.

A second estimation approach to T_2 assumes that agents differ in their degree of altruism, giving rise to unobserved heterogeneity. β's are random coefficients that vary across individuals and $\theta=\beta$. Assuming that θ is distributed independently of X with mean vector $\bar{\beta}=E(\beta)$, variance–covariance matrix $V=E(\beta-\bar{\beta})\cdot(\beta-\bar{\beta})'$, and denoting $\epsilon_2=X\ (\beta-\bar{\beta})'$, we rewrite Eq. (23) as:

$$T_2^*(X,\theta) = X\bar{\beta}' + \epsilon_2$$

where ϵ_2 is a random variable with conditional mean $E\ (\epsilon_2|X)=0$ and conditional variance $\sigma^2\ (X)=X'VX$. This standard censored regression model with heteroscedasticity can be estimated with a modified Heckman's two-step procedure. Alternatively, it can be estimated with the fully efficient maximum likelihood procedure by making distributional assumptions about random parameter vector β. Heckman's two-step method is semi-parametric and does not require as many distributional assumptions, but is less efficient than the fully parametric maximum likelihood method. We find, as generally is the case, the maximum likelihood estimates of limited dependent variable models to be sensitive to distributional assumptions and have not followed this econometric approach in this paper.

We follow a third approach, implemented in Altonji et al. (1997) (AHK), which is less parametric and uses a more flexible functional form than the above two procedures. Although we have derived linearly separable regressors in the optimal solution T_2 under strong assumptions on utility functions, for more general utility functions, $T_2{*}\ (X,\ \theta)$ may not be a linearly separable function in $X's$. The AHK approach assumes a more general specification of $T_2^*\ (X,\ \theta)$ which might be rationalized by more general utility functions than the Cobb–Douglas specification we used above. We describe the procedure next and compare our estimates of the difference in income transfer derivatives with AHK's.

Let us denote by $\theta*\ (X)$ the set of θ such that $T_2^*\ (X,\ \theta)>0$, given X. The subset of the population on which $\theta*\ (X)$ is estimated is the self-selected population of children who make positive old-age transfers to their parents. The size of this sub-population is $\pi(X)=\int_{\theta^*(X)}f(\theta)\mathrm{d}\theta$, which is the probability that $T_2^*\ (X,\ \theta)>0$, given X. Let $f_X(\theta)$ be the conditional density of θ, given X, in the selected population. Assuming again the independence of θ and X, $f_X(\theta)$ is simply equal to $f(\theta)/\pi(X)$. Instead of assuming a specific linear form for the latent transfer Eq. (23), assume that it has a flexible form. The expectation of the transfer function conditional on the self-selected population is:

$$\bar{T}_2(X) \equiv E(T_2^*(X,\theta)|X, T_2^*>0) = \int_{\theta^*(X)} T_2^*(X,\theta) f_X(\theta)\mathrm{d}\theta. \tag{24}$$

Thus, for a random sample from the self-selected population for which the observed transfer $T_2(X)$ coincides with the latent transfer function (the optimal transfer solution) $T_2^*(X)$, we have:

$$T_2^*(X) = \bar{T}_2(X) + \xi, \text{where } \xi \text{ is a ramdom variable with } E(\xi|X) = 0$$

Altonji, Hayashi and Kotlikoff took a third order polynomial in X's to approximate $\bar{T}_2\ (X)$, and a third order polynomial in X's to approximate $g(X)$ in their Probit model specification $\pi(X)=\Phi(g(X))$. We take second order polynomials in X's, since they are sufficiently flexible for our estimation purposes.

Recall the income transfer derivatives property in Eq. (20) that holds for the self-selected population with $T_2>0$. Our interest is to estimate the population average of the left hand side of Eq. (20), that is, to estimate the following:

$$E\left[\frac{\partial T_2^*(X,\theta)}{\partial E_{\mathrm{k2}}} - \frac{\partial T_2^*(X,\theta)}{\partial \tilde{E}_{\mathrm{p2}}/n}\middle| X, T_2>0\right] = E\left[\frac{\partial T_2^*(X,\theta)}{\partial E_{\mathrm{k2}}}\middle| X, T_2>0\right] - E\left[\frac{\partial T_2^*(X,\theta)}{\partial \tilde{E}_{\mathrm{p2}}/n}\middle| X, T_2>0\right]. \tag{25}$$

To estimate this expression, we need a procedure to estimate the population average of the marginal effect $E\left[\frac{\partial T_2^*(X)}{\partial X_i}|X, T_2>0\right]$ for the self-selected population with positive transfers. To that end, from Eq. (24) we derive the following:[9]

$$\frac{\partial \bar{T}_2(X)}{\partial X_i} = E\left[\frac{\partial T_2^*(X)}{\partial X_i}\middle| X, T_2>0\right] - \frac{\partial \pi(X)}{\partial X_i}\cdot\frac{\bar{T}_2(X)}{\pi(X)}$$

From this expression it follows that:

$$E\left[\frac{\partial T_2^*(X)}{\partial X_i}\middle| X, T_2>0\right] = \frac{\partial \bar{T}_2(X)}{\partial X_i} + \frac{\partial \pi(X)}{\partial X_i}\cdot\frac{\bar{T}_2(X)}{\pi(X)} \tag{26}$$

The first term of Eq. (24) is the *direct effect*, the second term is the *indirect effect*, and the sum of these two effects is the population average of the marginal effect referred in Table 7 as *total effect*.

From our main sample of respondents, we first estimate the functions $\bar{T}_2\ (X)$ and $\pi(X)$ using the second order polynomial in X's specification as discussed above, then calculate the sample mean of the direct effect and indirect effect at each sample observation. Since there is no small nor large sample theory for calculating the standard errors of these estimated direct and indirect effects, we follow the bootstrapping method, a non-parametric technique to avoid having to make distributional assumptions. More specifically, drawing 149 bootstrap samples, and for each bootstrap sample (which is, in fact, a random sample with replacement of observations from the main sample), we estimate the direct and indirect effects as discussed earlier. We then use the 149 estimated values of each effect to calculate

[9] While taking the derivative with respect to X_i of the integral in Eq. (24), there is also a third term involving $\int_{\partial\theta^*(X)/\partial X_i} T_2^*\ (X,\theta) f_X\ (\theta)\mathrm{d}\theta$. But since $T_2{}^*\ (X,\theta)$ is zero at the boundary of the set $\theta^*\ (X)$, this integral is zero.

its standard error. The t-statistics based on these standard errors are reported in Table 7 and in the last column of Table 6.

4. The IFLS data set

The Indonesian Family Life Survey is a multi-purpose household survey conducted in 1993 by Rand and Lembaga Demografi, the Demographic Institute at the University of Indonesia. It was designed to study fertility behavior, infant and child health outcomes, migration and employment patterns, and health and socio-economic functioning of the older population in Indonesia. Its sample of 7224 households is drawn from 13 provinces, which account for 83% of the country's population.

The household survey sample is stratified on provinces then randomly selected within provinces. The sample frame used by the IFLS is based on the one used by the 1993 SUSENAS, a socioeconomic survey of 60,000 households conducted by the Indonesian Central Bureau of Statistics. In the smaller provinces, urban households are oversampled to facilitate rural–urban and Javanese–non-Javanese comparisons. The IFLS questionnaire design is modeled after the Malaysian Family Life Surveys, the Indonesian Resources Mobilization Study and the Indonesian Demographic and Health Surveys. Three sections of the questionnaire collect information at the household level, and the remaining three collect information at the individual level from adult respondents, ever married women and, by proxy, young children.

After dropping households with missing data, we have a sample of 7128 households. Their characteristics are summarized in Table 1. As this table indicates, the average annual total household incomes is 8,547,749 Rupiahs or approximately US$4096. A large part of total average household incomes, 8,193,237 Rupiahs, comes from wage incomes. The remaining incomes come from farm and non-farm businesses. Nevertheless, a relatively large proportion of households, 38%, own a farm business, while 27% of households own a non-farm business.

Within the household, detailed information is collected on the household head and the head's spouse, on two randomly selected children of the head, aged 14 or less. Among the

Table 1
Characteristics of the surveyed households

Variables	Mean	Standard deviation
Non farm business ownership	0.27	0.44
House ownership	0.10	0.30
Farm ownership	0.38	0.48
Household farm income	119,141.20	752,102.48
Household total non-farm asset values	1,143,168.67	16,303,041.63
Household total non-farm operating income	213,540.60	1,399,504.34
Total household incomes from employment	8,193,236.71	77,104,421.52
Household total farm income (operating+rental)	132,864.26	779,583.06
Household total non-farm incomes (operating+rental)	221,648.07	1,415,026.96
Total household incomes	8,547,749.03	77,118,324.34
Number of households	7128	

remaining members, "a senior member" of the household aged 50 or more and his/her spouse is randomly selected into a sample on which certain information is collected. In addition, for a randomly selected 25% of the households, an individual aged between 15 and 49 and his or her spouse are selected from remaining members of the household into the sample. This provided a sample of 33,081 adult respondents aged 15 and above. The earnings data are collected only for household members who worked outside their own farm or business. In order to impute earnings for the other household members, we estimate a Cobb–Douglas production function for their farm and non-farm business; per worker farm and non-farm business income is a function of capital per worker, $y=f(k)=k^{\sigma}$, where k is the capital per worker and $0<\sigma<1$. Assuming constant returns to scale in production, and perfect competition in labor and capital markets, a worker's wage earnings is set by the marginal product of labor, $w=f(k)-kf'(k)$, which for the Cobb–Douglas case becomes $w=(1-\sigma)k^{\sigma}$. Many studies found σ to be around 1/3. Taking $\sigma=1/3$, we compute the earnings of an individual working on his/her own farm or business to be 2/3 times the household non-wage income per worker. The qualitative results are robust with respect to values of σ.

Ideally we would have carried out analyses on the complete set of respondents in the survey sample. However, complete information on upstream transfers were collected only for respondents and their spouse whose parents are non-coresident, and for non-coresident children of household head respondents. Because of these data limitations, we restrict our sample to working household heads and their spouse who have non-coresident parents. This leaves 5257 respondent–parent pairs in the sample.

Another data limitation is that no information was collected on earnings of non-coresident parents and children. So we used earnings data on the 21,165 respondents to estimate the Mincer earnings function and to impute earnings of non-coresident parents and non-coresident children and to compute permanent income of respondents.

Table 2
Descriptive statistics of the noncoresident respondents and their parents

Variable	Mean	Standard deviation
Characteristics of respondents		
Age	35.86	9.16
Percentage of female respondent	39.03	48.79
Number of years of schooling	6.61	4.72
Total incomes	590,851.31	432,956.07
Amount of transfers to parents	86,758.99	1,196,499.97
Percentage of respondents with positive transfers	34.53	47.55
Characteristics of parents		
Percentage own a business	17.77	38.23
Percentage own a house	88.87	31.45
Percentage own a farm	57.07	49.50
Number of years of schooling	2.89	4.06
Total incomes	427,928.59	312,089.03
Age	62.72	12.13
Percentage working	51.51	49.98
Number of non-coresident respondent–parent pairs	5257	

Table 2 describes the characteristics of our sample of working household heads, their spouse and their non-coresident parents. The mean age of respondents interviewed in our sample is 36 years and their mean educational attainment is 6.6 years of schooling, higher than that of their parents' generation, 2.9. Table 2 also shows that the non-coresident parent is 63 years old on average, and is more likely to work than not. The average money transfer given to parents amounts to 86,759 Rupiahs or approximately US$42.

5. Empirical results

5.1. Earnings function and returns to education

The earnings function is modeled after Mincer's original specification (1974). Our parameter estimates are close to those of Mincer (see Willis, 1986 for a concise discussion of these estimates). As column (a) of Table 3 shows, the average log-earnings of an adult worker, on the left hand side of the regression, is highly correlated with own educational attainment, measured in number of school years. The return to education, measured by the increase in earnings from an additional year of schooling, is 9.4% after controlling for asset ownership, gender, and age.

The life cycle effect, as seen through the effect of the age variable, has the predicted effect. Earnings rise first with age, up to a certain point, then decline. Column (b) in Table 3 shows similar findings to column (a), with the additional result that return to education increases at an increasing rate, as indicated by the positive coefficient of own education squared.

5.2. Parental investment in children's education, T_1

Direct school expenditures incurred by parents would have been the appropriate measure of parental investment in children's education but since they are not recorded consistently in the survey, we use the educational attainment of children as a measure of T_1. The OLS parameter estimates for this transfer equation are shown in Table 4 for several

Table 3
Estimated earnings function

Regressors	(a)	(b)
Intercept	11.4455 (196.854)	11.5626 (182.105)
Female	0.0945 (5.014)	0.0877 (4.641)
House ownership	0.3758 (12.231)	0.3721 (12.114)
Farm ownership	−0.4064 (−20.645)	−0.4035 (−20.500)
Non farm business ownership	0.3417 (16.187)	0.3462 (16.393)
Number of school years	0.0938 (40.068)	0.0658 (10.052)
Number of school years squared		0.0018 (4.578)
Age	0.0481 (17.549)	0.0459 (16.529)
Age squared	−0.0005 (−15.959)	−0.0005 (−15.520)
R^2	0.1467	0.1476
Number of obs.	21,165	21,165

Absolute values of the t-statistics are in parentheses.

Table 4
Regression estimates of children's education level T_1 for various samples

Variables	(1) All	(2) Working	(3) Age>25	(4) Main	(5) Main, age>25
Intercept	1.4918 (2.93)	−0.8178 (1.22)	0.4592 (0.67)	−5.1360 (3.41)	−5.5804 (3.38)
Parent's grade	0.4412 (26.97)	0.5490 (25.44)	0.5811 (25.83)	0.4407 (27.20)	0.4520 (25.12)
Gender dummy, = 1 for a female child	−0.8623 (7.84)	−0.8768 (6.14)	−1.4075 (9.31)	−1.5106 (17.20)	−1.6266 (16.71)
Log incomes of parents	0.2873 (7.13)	0.5271 (9.82)	0.4335 (7.95)	0.8165 (6.84)	0.8444 (6.44)
Parent's number of children	0.2530 (10.27)	0.0979 (2.65)	0.0871 (2.46)	0.1216 (6.50)	0.1366 (6.60)
R^2	0.178	0.2397	0.2527	0.2559	0.2645
n	5150	3125	2886	8013	6700

Absolute values of the t-statistics are in parentheses.

samples: Columns (1)–(3) show results on the sample of children of main respondents. For this sample, a direct measure of parental income is available. In column (1), T_1 is estimated on the sample of children who are not enrolled in school. Column (2) is for the sample of children who are not in school and are working, while column (3) is for the sample that is further restricted to children who are 25 years of age or older. Columns (4) and (5) show results on the sample of main respondents. For this sample, parental income is not available, so we impute this income using the Mincer earnings function. Column (4) reports the estimates for all respondents who are not in school, and column (5) reports the estimates by restricting the sample to respondents and spouses of age 25 or older. The effect of covariates in this equation is consistent across samples, thus showing that the estimation results are robust to the samples used.

For all samples, children's educational attainment is positively correlated with their parents' educational attainment and incomes. The direct effect of parental incomes is evidence of the existence of liquidity constraint and its effect on educational investment in children, once parental education level is controlled for. We also estimated but do not report the T_1 equation for the sample of children with non-coresident parents. For this sample, T_1 is positively correlated with the number of children and parental educational attainment but not with parental incomes, suggesting that non-coresident parents are not liquidity constrained. For all samples, the effect of the child's gender (equals 1 if female and 0 otherwise) is significant and negative, indicating that female children's educational attainment is lower than that of male children, controlling for parental incomes and educational attainment. Similarly, for all samples, number of children is significant and positive, suggesting that parents having more children invest more in the human capital of each child. This finding provides key evidence that parents and children are altruistic in a manner consistent with the second model. To see this, consider Eq. (12) in the pure loan model, where the number of children has no effect on T_1. But according to Eq. (18) in the reciprocity with two-sided altruism model, the effect of number of children on T_1 can be positive. If parents were liquidity constrained, the effect of the number of children on T_1 would have been negative. So, the positive effect of the number of children on T_1 for all samples can only be consistent with the reciprocity with two-sided altruism model.

5.3. Transfers from children to parents

We estimate OLS and censored regression variants for T_2 (Eqs. (14) or (19)). The OLS estimates for ln T_2 and T_2 variants are respectively shown in columns (1) and (2), and Tobit estimates for T_2 are shown in column (3) of Table 5.

In column (1) of Table 5, the OLS equation of log transfer shows that the higher the educational attainment of the child, controlling for the child's incomes, the higher the transfer amount to parents. This result has been interpreted as evidence for the loan repayment hypothesis (Lillard and Willis, 1996). Our estimation results, however, show that this result is sensitive to the specification of the equation. The coefficient of parental incomes is insignificant in all equations but in the OLS equation, which is not the appropriate econometric model, given that we have censored data. House or farm ownership by parents either have no effect or reduce transfers from children. Female children transfer less to their parents than male children, controlling for educational attainment measured by number of schooling years. The higher the parents' age, the higher the transfer amount, as expected, so the older the parents, the more assistance they need and receive.

OLS estimates of Eq. (19) based on actual transfer amount, instead of logarithmic transformation of amount are shown in column (2) of Table 5. The effect of respondent children's educational attainment becomes insignificant, as well as the effect of other

Table 5
Transfers to parents, T_2

Variables	(1) OLS: lnT_2	(2) OLS: T_2	(3) Tobit: T_2	(4) *Tobit: T_2 (child)
Intercept	−5.1638 (6.49)	−51.8181 (0.74)	−986.1520 (4.88)	−3066.7755 (4.83)
Parent's business ownership	−0.1289 (3.01)	−6.0278 (1.24)	−36.7895 (3.32)	−0.7185 (0.02)
Parent's house ownership	−0.0008 (0.02)	−3.3942 (0.58)	−7.1330 (0.57)	−81.8986 (1.91)
Parent's farm ownership	−0.0835(2.21)	2.1267 (0.50)	−16.1354 (1.70)	−4.7071 (0.17)
Female dummy variable	−0.1110 (3.44)	−0.3932 (0.11)	−20.8605 (2.53)	−78.9701 (2.84)
Number of years of schooling	0.0132 (2.21)	0.0864 (0.14)	−2.3203 (1.55)	−7.8485 (1.42)
Parent's log incomes	0.0928 (2.08)	4.5020 (0.89)	14.6450 (1.31)	1.6362 (0.13)
Age	−0.0030 (1.34)	−0.2949 (1.15)	−1.3571 (2.39)	−4.4968 (1.92)
Parent's age	0.0128 (7.22)	0.2815 (1.39)	3.1238 (6.68)	1.7456 (1.38)
Log incomes	0.3015 (6.52)	0.0611 (0.97)	43.3242 (3.73)	221.5844 (4.44)
Number of children	0.0078 (0.44)	0.4571 (0.23)	1.4666 (0.34)	0.4062 (0.56)
Number of siblings	−0.0093 (1.45)	−1.2502 (1.72)	−4.4052 (2.73)	−1.6192 (1.20)
R^2	0.0685	0.0018	λ=211.8811 (59.00)	λ=448.4731 (36.12)
n	5257	5257	5257	1786

Absolute values of the t-statistics are in parentheses.

The last column with a * corresponds to the sample of children who do not coreside with the surveyed respondents and are not in school, working and over 25 years of age. The other columns are for the sample of non-coresident respondent–parent pairs.

variables. The goodness of fit statistic, R^2, is significantly lower than R^2 in the log transfer equation. Clearly, this equation does a poor job at fitting the data. In the Tobit equation, in column (3) of Table 5, educational attainment of respondent children is no longer significant, while most other variables such as female dummy, own age, parents' age, own log incomes and number of siblings retain their significance.

To check the robustness of our findings, we also estimate the same Tobit model on the sample of children who do not coreside with their parents, who are not enrolled in school, who are working and are 25 years old or older. These estimates are shown in the last column of Table 5. These estimates are very similar to those in column (3) except for the non-significance of parents' age and of number of siblings with this sample. This might be due to the fact that the child cohort is still young and not many siblings are yet eligible to be in the sample. Furthermore, it should be noted that the incomes of these children are imputed using the estimated Mincer earnings function. Yet, despite these data limitations, our estimates are to a great extent robust.

In the specification of the regressions presented in Table 5, parental incomes are measured in terms of current incomes. But we now use the ratio of estimated permanent incomes of parents divided by number of siblings of the respondent to be consistent with the specification derived in the explicit optimal solutions of T_2 in Eqs. (14) or (19). Since the children of many respondents are too young to provide old-age support to their parents, we carry out this analysis only for the main sample of respondents, and not for the non-coresident sample of children.

Parameter estimates of the Probit and Tobit equations and estimates of the marginal effects of interest using the Altonji–Ichimura estimation method are shown

Table 6
Probit, Tobit and selected Altonji–Ichimura parameter estimates for T_2

Regressors	(1) Probit	(2) Tobit	(3) Altonji–Ichimura
Intercept	−1.1340 (−7.994)	−241.4670 (−8.289)	
Parent's business ownership	−0.1440 (−2.838)	−25.8312 (−2.471)	
Parent's house ownership	0.0264 (0.435)	1.4967 (0.123)	
Parent's farm ownership	−0.2276 (−5.619)	−30.3413 (−3.697)	
Female	−0.1353 (−3.345)	−18.4906 (−2.242)	
Number of schooling years	−0.0019 (−0.280)	−0.1475 (−0.110)	−0.9850 (−0.730)
Parent's educational level	0.0190 (3.233)	3.5614 (3.010)	
Ratio of parent's permanent incomes to number of siblings	−0.0048 (−2.165)	−0.6800 (−1.505)	1.4750 (0.403)
Age	−0.0052 (−1.873)	−1.1444 (−2.046)	
Parent's age	0.0185 (9.342)	2.7446 (6.821)	
Respondent's permanent incomes	0.0013 (1.973)	0.2536 (1.884)	0.4287 (2.440)
Number of children	0.0087 (0.393)	2.0460 (0.468)	
Number of siblings	−0.0323 (−3.252)	−6.4001 (−3.173)	−1.4320 (−0.210)
R^2		λ=212.136 (58.97)	
Number of observations	5257	5257	5257

Absolute values of the t-statistics are in parentheses.
The effects in the last column is an estimate of $\partial E[T_2^*(X,\theta)|X, T_2^*>0]/\partial X$ as described in the text.
The variables T_2, ratio of parent's permanent income to the number of siblings n, and the permanent income of the respondent are all measured in '0000.

Table 7
Estimates of the income transfer derivatives

Regressors	Tobit under normal distribution	Altonji–Ichimura flexible form
$\tilde{E}_{p2}/n$: direct effect	−0.680 (1.51)	1.4755 (0.403)
$\tilde{E}_{p2}/n$: indirect effect	−0.125 (3.61)	−0.4944 (4.762)
$\tilde{E}_{p2}/n$: total effect	−0.125 (3.61)*	−0.4944 (4.762)*
E_{k2}: direct effect	0.254 (1.88)	0.4287 (2.440)
E_{k2}: indirect effect	0.034 (0.17)	0.0330 (3.03)
E_{k2}: Total effect	0.254 (1.88)*	0.4620 (2.548)

The standard errors and parameter estimates are computed using bootstrapping with 149 bootstrap samples. Absolute values of the t-statistics are in parentheses.

*'s are based on the significant one of the direct and indirect effects, i.e., we treat an insignificant effect as 0.

in Table 6. The effect of the number of siblings remains significantly negative in both Probit and Tobit estimates, which is consistent with the assumption that γ's depend on n in our reciprocity model. The estimate of this effect using the Altonji–Ichimura method is, however, not significant. Because we redefined the incomes variables, the point estimates of their parameters are not directly comparable with estimates in Table 5. But comparing the sign and significance of other parameter estimates, we find the estimates in this model to be very close to the estimates reported above. For instance, the parameter estimates of the number of years of schooling remain statistically insignificant, and the ratio of parents' permanent incomes to the number of children has significant negative effect in the Probit and Tobit models. However, the estimation using the Altonji–Ichimura method produced an insignificant estimate. This result from the Probit and Tobit models favors the reciprocity with two-sided altruism model over the pure loan without altruism model. This is because in the pure-loan without altruism, T_2 depends positively on T_1 (more precisely, $T_2=(1+r)\ T_1$) and nothing else matters after controlling for T_1. But under reciprocity with two-sided altruism, after controlling for T_1, the effect of the ratio of parents' permanent income to the number of children is negative on T_2 (see Eq. (19) in the second model or Eq. (14) in the first model). Thus, the combined evidence of these results with the evidence from the estimates of the T_1 equation reported earlier lend more support to the reciprocity with two-sided altruism model than to the pure loan model with or without altruism.

Recall the empirical specification of the income transfer derivatives property in Eq. (25), and the estimation methods for the direct, indirect and total effects of the variables $\tilde{E}_{p2}/n$ and E_{k2} described in the section following this equation. The estimated difference in income transfer derivatives is the total effect of E_{k2} minus the total effect of $\tilde{E}_{p2}/n$. We construct a bootstrap sample of size 149 to estimate the indirect effects[10] in the Tobit model and both indirect and direct effects in the flexible functional form model. In computing the total effect, we treat an insignificant effect to be numerically insignificant,

[10] The direct effect is given by the beta coefficient in the case of the Tobit model so we use the standard errors for these estimates from the Tobit model.

or zero. All the direct, indirect and total effects from the Tobit model and the Altonji–Ichimura flexible functional form model are reported in Table 7. The statistically significant estimates of the difference in income transfer derivatives are 0.379 with the Tobit–Probit model and 0.956 with the Altonji–Ichimura model. The second estimate is very close to the prediction of altruistic models of transfers. These estimates are significantly higher than the estimates of 0.13 or less by Altonji, Hayashi and Kotlikoff using the PSID data for downstream transfers. We interpret this finding as additional evidence in favor of the reciprocity with two-sided altruism model.

6. Conclusion

In this paper, we have considered two models of intergenerational transfers. The first model treats parental investment in children's education as a loan with the terms of repayment set by parents. In this framework we considered the loan contracts both with and without two-sided altruism and carried out specification tests to choose between the two. Our specification tests rejected the no-altruism case in favor of the two-sided altruism case. In the second model, parents decide how much they want to invest in children, and children decide how much to pay back. In this model, the two-way transfers are determined by reciprocity with two-sided altruism. We have shown that distinguishing between the two models is relevant for education and old age pension financing policies and derived testable parameter restrictions to test which of the two models explains the data better.

We find the number of children to be a significant determinant of the level of human capital investment that parents make for each child. This lends support to the reciprocity with two-sided altruism model, since this variable is irrelevant for the education of a child under the pure loan model. Our highest estimate of 0.956 for the difference in income transfer derivatives using the Altonji–Ichimura flexible functional form is close to 1, as predicted by altruistic models of intergenerational transfers. This stands in sharp contrast with estimates of 0.13 or less found by Altonji, Hayashi and Kotlikoff. Thus, our combined findings on the determinants of upward and downward transfers and on the magnitude of the total effect of incomes transfer derivatives, coupled with the robustness of our results to the samples used lend support to the reciprocity with two-sided altruism.

These results suggest that parental investment in children's education and the voluntary amount of old-age support received by parents are both less than optimal. An appropriately designed social security program that uses the social security tax proceeds to finance children's education and pay for the benefits of the old could improve growth in incomes and welfare of both generations. Furthermore, evidence that parents are liquidity constrained in making human capital investment in children calls for improving efficiency in capital markets. However, we recognize that there may be other channels through which parental incomes and education, in particular mother's education, determine children's education, which may call for other types of policy interventions. This invites further research into this area.

Appendix A

Under separability of utility function (U1) in Eq. (3), we have the following three equations for solving s, T_1 and T_2:

$$\frac{u'\left(c_{\mathrm{p2}}\right)}{v_{\mathrm{p}}{}'\left(c_{\mathrm{k2}}\right)}=\frac{\gamma_{\mathrm{p}}}{n} \tag{27}$$

which is Eq. (13) rewritten,

$$\frac{u'\left(c_{\mathrm{p1}}\right)}{v_{\mathrm{p}}'\left(c_{\mathrm{k2}}\right)}=\frac{\beta(1+r)\gamma_{\mathrm{p}}}{n} \tag{28}$$

which is Eq. (9), and

$$E_{\mathrm{k2}}{}'(T_1;\ldots)=1+r \tag{29}$$

which is Eq. (12) reproduced. We want to compute $\frac{\partial T_2}{\partial E_{\mathrm{k2}}}$ and $\frac{\partial T_2}{\partial E_{\mathrm{p2}}}$ in equilibrium, after eliminating the effect of all endogenous variables. Taking the total derivative of Eqs. (27)–(29) we have

$$\begin{aligned} & u''\left(c_{\mathrm{p2}}\right)\left[(1+r)\partial s+n\partial T_2+\partial E_{\mathrm{p2}}\right] \\ & \quad=\left(\frac{\gamma_{\mathrm{p}}}{n}\right)v_{\mathrm{p}}''(c_{\mathrm{k2}})[\partial E_{\mathrm{k2}}\cdot(E_{\mathrm{k2}}{}'(T_1;\ldots)\partial T_1+1)-\partial T_2] \end{aligned} \tag{30}$$

$$\begin{aligned} & u''\left(c_{\mathrm{p1}}\right)\left[-n\partial T_1-\partial s\right] \\ & \quad=\frac{\beta(1+r)\gamma_{\mathrm{p}}}{n}\cdot v_{\mathrm{p}}''(c_{\mathrm{k2}})[\partial E_{\mathrm{k2}}\cdot(E_{\mathrm{k2}}'(T_1,\ldots)\partial T_1+1)-\partial T_2] \end{aligned} \tag{31}$$

$$E_{\mathrm{k2}}{}''(T_1,\ldots)\cdot\partial T_1=0\Rightarrow\partial T_1=0 \tag{32}$$

Let us denote by $A=u''(c_{\mathrm{p2}})$, $B=(\gamma_{\mathrm{p}}/n)v_{\mathrm{p}}''(c_{\mathrm{k2}})$, and $C=u''(c_{\mathrm{p1}})$. After simplification, Eqs. (30)–(32) yield,

$$\Delta\partial T_2=B\left(\beta A(1+r)^2+C\right)\partial E_{\mathrm{k2}}-AC\partial E_{\mathrm{p2}}$$

where

$$\Delta=nAC+B\left(\beta A(1+r)^2+C\right)$$

From the above, we obtain the income transfer derivatives property for the first model:

$$\frac{\partial T_2}{\partial E_{\mathrm{k2}}}-n\cdot\frac{\partial T_2}{\partial E_{\mathrm{p2}}}=1$$

It is easily seen that following the same steps, the above property holds with respect to $(1+r)$ E_{p1}, instead of E_{p2}, and also for the second model.

References

Altonji, J.G., Hayashi, F., Kotlikoff, L.J., 1992. Is the extended family altruistically linked? Direct tests using micro data. The American Economic Review 82 (5), 1177–1198.

Altonji, J.G., Hayashi, F., Kotlikoff, L.J., 1997. Parental altruism and inter-vivos transfers. Journal of Political Economy 105 (6), 1121–1166.

Anderberg, D., Balestrino, A., 2003. Self-enforcing intergenerational transfers and the provision of education. Economica (70), 55–71.

Becker, G.S., 1974. A theory of social interactions. Journal of Political Economy 82 (6), 1063–1093.

Becker, G.S., Lewis, Gregg H., 1973. On the interaction between the quantity and quality of children. Journal of Political Economy 81 (2), S279–S288.

Becker, G.S., Murphy, K.M., 1988. The family and the State. Journal of Law and Economics 31, 1–18.

Becker, G.S., Murphy, K.M., Tamura, R., 1990. Human capital, fertility and economic growth. Journal of Political Economy 98 (5), S12–S37.

Behrman, J.R., Pollack, R.A., Taubman, P., 1982. Parental preferences and provision for progeny. Journal of Political Economy 90 (1), 52–73.

Bernheim, B.D., Shleifer, A., Summers, L.H., 1985. The strategic bequest motive. Journal of Political Economy 93 (6), 1045–1076.

Cox, D., 1987. Motives for private income transfers. Journal of Political Economy 95 (3), 508–546.

Cox, D., 1990. Intergenerational transfers and liquidity constraints. Quarterly Journal of Economics 105 (1), 187–217.

Cox, D., Rank, M.R., 1992. Inter-vivo transfers and intergenerational exchange. The Review of Economics and Statistics 74 (2), 305–314.

Hayashi, F., 1995. Is the Japanese extended family altruistically linked? A test based on Engel curves. Journal of Political Economy 103 (3), 661–674.

Kolm, Serge-Christophe, 2000. The theory of reciprocity. In: Gerard-Varet, L.A., Kolm, S.C., Ythier, J.M. (Eds.), The Economics of Reciprocity, Giving and Altruism. Macmillan Press Ltd., London:UK.

Lillard, L.A., Willis, R.J., 1996. Motives for Intergenerational Transfers: Evidence from Indonesia and Malaysia. European Society for the Study of Population Economics, 10th Annual Meeting, Uppsala, Sweeden, 1996.

McGarry, K., Schoeni, R.F., 1995. Transfer behavior in the health and retirement study: measurement and the redistribution of resources within the family. Journal of Human Resources 30 (0), S184–S226.

Mincer, Jacob, 1974. Schooling, Experience, and Earnings. NBER, Columbia University Press, New York.

Raut, L.K., 1990. Capital accumulation, income distribution and endogenous fertility in an overlapping generations general equilibrium model. Journal of Development Economics 34 (1/2), 123–150.

Raut, L.K., 1996. Learning to Perfect Manipulation: Implications for Fertility, Savings, and Old-age Security. Working Paper, University of California-San Diego.

Rosenzweig, M.R., Stark, O., 1989. Consumption smoothing, migration, and marriage: evidence from Rural India. Journal of Political Economy 97 (4), 905–926.

Rosett, Richard N., 1959. A statistical model of friction. Econometrica 27 (2), 263–267.

Tran, Lien H., 1998. Credit Contract and Moral Hazard. Manuscript. Rand Corporation, Santa Monica, CA.

Willis, Robert, 1986. Wage determinants: a survey and reinterpretation of human capital earnings functions", chapter 10. In: Ashenfelter, O., Layard, R. (Eds.), Handbook of Labor Economics: Volume I. Elsevier Science Publishers, Amsterdam.