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Private interhousehold transfers: What happens to sender households?*

Yuji Tamura†

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Abstract

I examine household resource reallocation when private transfers are sent to nonhousehold members living elsewhere. The literature has so far focused on the impact of private transfers on the recipients, but not on the senders. Potential endogeneity of private transfers is handled by fixed-effect instrumental-variable estimation. Vietnamese panel data from the 1990s suggest that outward interhousehold transfers by parents reduce the sender household's expenditures on the education of each of their children.

Keywords: inter vivos transfer, human capital investment, Vietnam, VLSS

JEL classification: D10, D64, J13, I22, O15

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1 Introduction

The economic literature on inter vivos transfers has so far focused on questions such as "What motivates the transfers?" (e.g. Becker, 1974; Lucas and Stark, 1985; Cox, 1987; Townsend, 1994; Foster and Rosenzweig, 2001), "Do public transfers crowd them out?" (e.g. Cox and Jakubson, 1995; Cox et al., 1998; Albarran and Attanasio, 2003; Jensen, 2004), and "How do they affect the recipients?" (e.g. Cox Edwards and Ureta, 2003; Yang, 2008; Calero et al., 2009; Acosta, 2011; Alcaraz et al., 2012). Needless to say, these questions are crucial to better our understanding of the workings of private transfers. In this paper, however, I ask a different question that complements the existing studies, namely, "How do interhousehold transfers influence resource allocation in the sender household?".[1] In particular, I examine human capital investment among children in transferrer households where their parents are the senders, using household survey data from Vietnam. To the best of my knowledge, this is the first study of the impact of interhousehold transfers on sender households.

Why is it important to investigate the impact of interhousehold transfers on the senders? First, the impact of the transfers should be evaluated on both recipients and senders, not just the former. Existing studies have concentrated on the effects on the recipients, and most of them have found that private transfers—more specifically, remittances—are beneficial to the recipients. For example, Alcaraz et al. (2012) examine how remittances from the United States have affected children in the recipient households in Mexico. They find that the private transfers reduce their labor supply and improve their school attendance. Yang (2008) also finds the same in Philippine data: he additionally finds that remittances encourage capital-intensive business activities by the recipient households.[2] However, the effects on the other side of private transfers, i.e. the senders, have so far been ignored. Without filling this gap in our knowledge, we are unable to assess the overall impact of private transfers.

Second, existing studies have found that public transfers partially crowd out private transfers.[3] For example, Jensen (2004) finds that, in South Africa, an increase in public pension to the elderly by one rand has resulted in a reduction in private transfers from

[1] In this paper, the term "household" refers to the unit formed by coresiding individuals who are related by blood or marriage.

[2] According to the recent migration literature, positive effects of remittances on the households left behind are more than offset by negative effects of the absence of migrated household members, particularly during the period immediately after the migration: See Antman (2011) and Gibson et al. (2011).

[3] An exception is Cox and Jakubson (1995) who provide some evidence that public transfers may have increased private transfers in the United States.

their children by about a quarter of a rand. Albarran and Attanasio (2003) also find partial crowding-out in Mexico: they provide some evidence that this partial crowding-out is due to the imperfect enforceability of informal risk-sharing contracts. Based on these findings, private transfers may appear more efficient and attractive than public transfers, since public income redistribution is administratively costlier than private transfers and hence potentially reduces the size of the pie available for redistribution. Private transfers also target recipients more precisely than public transfers. However, if private transfers had negative effects on the senders and public transfers were able to reduce or remove some of these adverse effects, the cost of conducting public transfers might be worth paying.

This study examines human capital investment among children in households where their parents are the senders of private interhousehold transfers. As mentioned above, human capital investment is an outcome variable that existing studies have frequently used in evaluating the impact of private transfers on the recipients in developing countries. Therefore, it is natural to study this outcome variable so that we can compare the impact on the senders with that on the receivers. To sketch causal channels from private transfers to human capital investment, I employ a simple Beckerian model of non-cooperative altruistic agents in two households: a parent and the child in one household, and a relative living elsewhere. The model yields the hypothesis that parents' spending for child education decreases when they increase transfers to relatives who suffer from a negative income shock. I then test this prediction using Vietnamese household panel data collected during the 1990s when the country experienced a rapid economic growth. Vietnam during this period is suitable for this study because inter vivos transfers between households took place very commonly in the country (Cox, 2004).

The challenge for empirically investigating the impact of interhousehold transfers on household resource allocation is how to deal with the problems of simultaneity and reverse causality that are common to many applied econometric studies. The first problem is that if interhousehold transfers and human capital investment are determined simultaneously by some third factor, there is no causality between the two, and any correlation we may find between the two is spurious. The second problem is that any correlation between the two may suggest the causality from human capital investment to the transfers, and not the other way round. In this paper, I obtain instrumented first-difference estimates in order to deal with the potential endogeneity of interhousehold transfers.

The first two waves of the Vietnam Living Standards Survey (1992-1993 and 1997-1998) allow us to form the shortest panel of households with detailed information on individuals, enabling us to control for time-invariant unobservable heterogeneity through first differencing. This is useful for handling the likely simultaneity problem caused by fixed characteristics idiosyncratic to the child and his or her household. However, first differencing does not solve the simultaneity problem generated by time-variant unobservable heterogeneity across observations. That is, the cross-wave changes in interhousehold transfers and human capital investment might both be driven by the corresponding change in some third factor that is specific to the child and/or his or her household. Moreover, first differencing does not eliminate the possibility of reverse causality. Therefore, I instrument the cross-wave change in interhousehold transfers by the variables that directly affect it but not the cross-wave change in household expenditures for child education: the latter is affected only indirectly via the change in the private transfers. The instruments are constructed by using information on relatives living elsewhere. Based on the literature on informal risk-sharing and consumption smoothing (e.g. Townsend, 1994; Ravallion and Chaudhuri, 1997; Ligon et al., 2002; Fafchamps and Lund, 2003, Attanasio and Ríos-Rull, 2003), I reason that the households that had relatives living in provinces severely hit by a natural disaster must have exogenously increased outgoing transfers to provide them with assistance.

Empirical evidence indicates with 99% confidence that an increase in the net transfer by one million Vietnamese dong[4] reduces the total household expenditure on the education of each child by at least 10 percent.[5] A less conservative estimate at the 95% confidence level is a fall by at least 34 percent. These estimates suggest an adverse effect of interhousehold transfers on children within sender households.

In the next section, I present a conceptual framework and derive a hypothesis. Section 3 presents econometric analysis. Section 4 concludes.

2 Conceptual framework

In this section, I provide a simple conceptual framework for the relationship between interhousehold transfers and human capital investment in a household. In the following model à la Becker (1974), private transfers are motivated by altruistic preferences. Of course, this is not the only motivation for private transfers. For example, as Cox (1987:

[4]In this paper, all monetary figures are expressed at the January 1993 national average price level. 1 million dong is approximately 44% of the country's GNI per capita in 1993.

[5]In my robustness check analysis at the end of Section 3, I compute upper bounds of confidence intervals. Hence my statement here includes "at least".

518-519) has shown, exchange motives can also induce private transfers. In fact, in many situations, private transfers seem motivated by a combination of different factors. This study is not intended to distinguish between transfers based on altruism and other reasons, and I do not suggest that the hypothesis derived below is unique to transfers based on altruistic preferences.[6]

Consider three agents, denoted by $i = \{p, c, r\}$ for Parent, Child, and Relative, respectively. Parent and Child live together to form a household, while Relative lives elsewhere to form another household. Agent i gains a utility $x^i(q^i, k)$ from i's consumption of the amount q^i of multi-purpose goods and Parent's investment in Child's human capital, k. The goods and human capital investment are both normal, i.e. $\partial x^i/\partial q^i, \partial x^i/\partial k > 0$. The utility functions are well behaved, i.e. $x^i(0, k) = x^i(q^i, 0) = 0$, $\partial^2 x^i/\partial q^{i2}, \partial^2 x^i/\partial k^2 < 0$, and by Young's theorem $\partial^2 x^i/\partial q^i \partial k = \partial^2 x^i/\partial k \partial q^i > 0$. The second argument, k, is a device to incorporate future benefits of current human capital investment without explicitly setting the model over time. The agents expect today's human capital investment to increase returns to Child's labor in the future. High returns to Child's labor benefit not only Child but also Parent and Relative because Child cares about the other two. Not to mention, Child may gain extra utility today from doing human capital accumulation activities. Human capital investment is thus modeled as public goods for these three related agents.

2.1 Utilities

Suppose that the agents care about each other in their own ways. Parent's total utility is given by

$$\begin{aligned} v^p\left(q^p, k, v^c(\cdot), v^r(\cdot)\right) = \; & \alpha_p^p x^p\left(q^p, k\right) \\ & + \alpha_c^p v^c\left(q^c, k, v^p(\cdot), v^r(\cdot)\right) \\ & + \alpha_r^p v^r\left(q^r, k, v^p(\cdot), v^c(\cdot)\right) \end{aligned} \tag{1}$$

where $\alpha_j^p \in (0, 1)$ with $j = \{p, c, r\}$ and $\Sigma_j \alpha_j^p = 1$ are Parent's caring weights. α_p^p is the weight given to the subutility from the own consumption of goods and investment in

[6] In fact, in Section 3 where I conduct instrumented first-difference estimation, a negative income shock to relatives living elsewhere is found to increase, rather than decrease, outgoing transfers. This relationship can be observed in both cases of altruistic transfers and exchange-motivated transfers (Cox, 1987: 514-517). Rapoport and Docquier (2006: Table 2) usefully summarize theoretical predictions from different motivations for remittances.

Child's human capital, $x^p(\cdot)$, whereas α_j^p with $j \neq p$ is the weight given to agent j's total utility, $v^j(\cdot)$.[7] Similarly, Child's total utility is

$$\begin{aligned} v^c\left(q^c, k, v^p(\cdot), v^r(\cdot)\right) &= \alpha_p^c v^p\left(q^p, k, v^c(\cdot), v^r(\cdot)\right) \\ &\quad + \alpha_c^c x^c\left(q^c, k\right) \\ &\quad + \alpha_r^c v^r\left(q^r, k, v^p(\cdot), v^c(\cdot)\right), \end{aligned} \tag{2}$$

and Relative's is

$$\begin{aligned} v^r\left(q^r, k, v^p(\cdot), v^c(\cdot)\right) &= \alpha_p^r v^p\left(q^p, k, v^c(\cdot), v^r(\cdot)\right) \\ &\quad + \alpha_c^r v^c\left(q^c, k, v^p(\cdot), v^r(\cdot)\right) \\ &\quad + \alpha_r^r x^r\left(q^r, k\right). \end{aligned} \tag{3}$$

The three agents are thus assumed to care about each other's total utility.[8] These three equations can be rewritten such that they care about each other's subutilities as follows:[9]

$$u^p\left(x^i\left(q^i, k\right)\right) = \delta_p^p x^p\left(q^p, k\right) + \delta_c^p x^c\left(q^c, k\right) + \delta_r^p x^r\left(q^r, k\right), \tag{4}$$

$$u^c\left(x^i\left(q^i, k\right)\right) = \delta_p^c x^p\left(q^p, k\right) + \delta_c^c x^c\left(q^c, k\right) + \delta_r^c x^r\left(q^r, k\right), \tag{5}$$

$$u^r\left(x^i\left(q^i, k\right)\right) = \delta_p^r x^p\left(q^p, k\right) + \delta_c^r x^c\left(q^c, k\right) + \delta_r^r x^r\left(q^r, k\right), \tag{6}$$

where $\delta_j^i \in (0,1)$ with $\Sigma_j \delta_j^i = 1$ are functions of caring weights α_h^g, $g, h = \{p, c, r\}$.

2.2 Constraints

The resource constraint for the household where Parent and Child coreside is

$$\tilde{y}^p \equiv y^p + \tau^{rp} - \tau^{pr} \geq q^p + q^c + k \tag{7}$$

where $y^p \geq 0$ is the household's pre-transfer income, $\tau^{ij} \geq 0$ transfers from i to j, and $\tilde{y}^p \geq 0$ the post-transfer income. It is assumed that interhousehold transfers are sent

[7] In this simple presentation, I treat the caring weights as exogenous, but more generally they may be functions of prices and income, e.g. Browning and Chiappori (1998).

[8] This formulation allows for example the case where Parent may want Child to consume a larger share of the household budget net of the transfer to Relative, i.e. $\left(\alpha_c^p/\alpha_p^p\right) / \left(\alpha_c^c/\alpha_p^c\right) > 1$ is permitted. See Bergstrom (1989: Puzzle 1).

[9] The derivation is given in Appendix A.

from/to Parent.[10] The unit price of multi-purpose goods is normalized to one. The resource constraint for Relative is

$$\tilde{y}^r \equiv y^r + \tau^{pr} - \tau^{rp} \geq q^r. \tag{8}$$

These two resource constraints hold at equality by assuming non-satiation.

2.3 Order of events

The two adults, Parent and Relative, play a noncooperative game. I assume that Child does not make any decision. The order of events in each period is as follows:

1. Pre-transfer income, y^p and y^r, become known.
2. Parent and Relative simultaneously decide on their transfers to each other, τ^{pr} and τ^{rp}.
3. Parent decides on how much to spend on educating Child, k, Child's consumption of goods, q^c, and his own consumption of goods, q^p.

In the model, y^r has no direct effect on k, q^c, and q^p, but has indirect effects via τ^{pr} and τ^{rp}. Hence an exogenous change in y^r is the instrument for interhousehold transfers when we estimate the impact of $\tau^{rp} - \tau^{pr}$ on k in this paper. Let us see this by solving the model backward.

2.4 Intrahousehold income allocation

At the last stage of the game, Parent decides on the allocation of disposable income within his household by solving

$$\max_{k,q^c,q^p \geq 0} u^p\left(x^i\left(q^i, k\right)\right) \text{ s.t. } \tilde{y}^p = k + q^c + q^p \tag{9}$$

[10] In the data I analyze below, the estimation sample of children did not send interhousehold transfers even though I do not condition on the incidence of sending transfers. Furthermore, the number of children who received interhousehold transfers is small. Approximately 98 percent of the senders were the household heads or their spouses in the whole sample. The assumption reflects this feature of the data.

where $\tilde{y}^p$ is fixed at this stage. Assuming the existence of an interior solution, the first order conditions (FOCs) imply

$$\delta_p^p \frac{\partial x^p}{\partial q^p}\bigg|_{q^{p*},k^*} = \delta_c^p \frac{\partial x^c}{\partial q^c}\bigg|_{q^{c*},k^*} = \sum_i \delta_i^p \frac{\partial x^i}{\partial k}\bigg|_{q^{i*},k^*} \tag{10}$$

$$\wedge\ \tilde{y}^p = k^* + q^{c*} + q^{p*}. \tag{11}$$

where Relative's goods consumption is also fixed at this stage, i.e. $q^{r*} = \tilde{y}^r$. These three equations in three unknowns determine Parent's most preferred share of the post-transfer income by each expenditure item.

At the end of this section, I summarize how the quantities $\{k^*, q^{c*}, q^{p*}\}$ respond to a change in y^r. But first, I examine how $\{k^*, q^{c*}, q^{p*}\}$ respond to a change in $\tilde{y}^p$. At first glance, this seems trivial, as the standard consumer model would show that the equilibrium expenditures are all increasing in income without changing the share of income by each item. However, here, a change in $\tilde{y}^p$ will affect marginal rates of substitution by changing $\tilde{y}^r$ by the same unit in the opposite direction, as implied by (10) where $\delta_r^p \partial x^r/\partial k$ is a function of $q^{r*} = \tilde{y}^r$. In other words, in this framework, the share of disposable income by each expenditure item is a function of disposable income. Therefore, it is not so obvious how $\{k^*, q^{c*}, q^{p*}\}$ respond to a change in $\tilde{y}^p$. Nevertheless, I do find that the three equilibrium quantities are all increasing in $\tilde{y}^p$.

Lemma 1 Other things equal, Parent's and Child's consumption of goods and Parent's spending for educating Child are all increasing in the household's disposable income.

Proof. See Appendix B. □

2.5 Interhousehold transfers

At the second last stage of the game, the two adults simultaneously and noncooperatively decide on interhousehold transfers to each other, given the total income available to the two households and taking into account that Parent can decide on the allocation of his household's post-transfer income at the final stage.

2.5.1 Parent's most preferred allocation of the total income across the households

Parent maximizes his utility with respect to his household's post-transfer income, i.e.

$$\begin{aligned} \max_{\tilde{y}^p \geq 0} u^p \left(x^i \left(q^i, k\right)\right) \text{ s.t. } Y &= \tilde{y}^p + q^r \\ \wedge \ \{k, q^c, q^p\} &= \{k^* (\tilde{y}^p), q^{c*}(\tilde{y}^p), q^{p*}(\tilde{y}^p)\} \end{aligned} \tag{12}$$

where $Y \equiv y^p + y^r$ is the total resource available to the two households. Assuming the existence of an interior solution, it is implicitly given by

$$\delta_p^p \frac{\partial x^p}{\partial q^p} \frac{\partial q^{p*}}{\partial \tilde{y}^p} + \delta_c^p \frac{\partial x^c}{\partial q^c} \frac{\partial q^{c*}}{\partial \tilde{y}^p} - \delta_r^p \frac{\partial x^r}{\partial q^r} + \sum_i \delta_i^p \frac{\partial x^i}{\partial k} \frac{\partial k^*}{\partial \tilde{y}^p} = 0. \tag{13}$$

Let us denote the solution by $\tilde{y}^{pP}$ where superscript P is added to indicate Parent's most preferred $\tilde{y}^p$.

2.5.2 Relative's maximization problem

Since Relative knows that it is Parent who finally divides $\tilde{y}^p$ into k, q^c, and q^p according to (10)-(11),

$$\begin{aligned} \max_{\tilde{y}^p \geq 0} u^r \left(x^i \left(q^i, k\right)\right) \text{ s.t. } Y &= \tilde{y}^p + q^r \\ \wedge \ \{k, q^c, q^p\} &= \{k^* (\tilde{y}^p), q^{c*}(\tilde{y}^p), q^{p*}(\tilde{y}^p)\}. \end{aligned} \tag{14}$$

Assuming the existence of an interior solution, Relative's optimum is implicitly given by

$$\delta_p^r \frac{\partial x^p}{\partial q^p} \frac{\partial q^{p*}}{\partial \tilde{y}^p} + \delta_c^r \frac{\partial x^c}{\partial q^c} \frac{\partial q^{c*}}{\partial \tilde{y}^p} - \delta_r^r \frac{\partial x^r}{\partial q^r} + \sum_i \delta_i^r \frac{\partial x^i}{\partial k} \frac{\partial k^*}{\partial \tilde{y}^p} = 0. \tag{15}$$

Let us denote the solution by $\tilde{y}^{pR}$ where superscript R is added to indicate Relative's optimal $\tilde{y}^p$.

Lemma 2 Parent's and Relative's most preferred $\tilde{y}^p$, $\tilde{y}^{pP}$ and $\tilde{y}^{pR}$, are both increasing in Relative's pre-transfer income.

Proof. This is simply because a change in y^r affects the size of the pie to share, Y, but not the optimal rule for dividing the pie between the two households. □

2.5.3 Equilibrium transfers

Each adult can decide only on the amount of outward transfers: incoming transfers are under the control of the other adult. Equilibrium transfers, $(\tau^{pr*} \geq 0, \tau^{rp*} \geq 0)$, depend on caring parameters as well as pre-transfer income relative to most preferred quantities. Each player makes a positive transfer only if his household's pre-transfer income is greater than his ideal post-transfer income for the household. Appendix C lists all possibilities, and the equilibrium transfer pair is one of them. The following lemma applies to any equilibrium pair.

Lemma 3 A fall in Relative's pre-transfer income either increases or does not change Parent's household's net outward transfers, $\tau^{pr*} - \tau^{rp*}$.

Proof. (i) If $(\tau^{pr*}, \tau^{rp*}) = (0, 0)$ initially, then a fall in y^r does not affect τ^{rp*}, but it may increase τ^{pr*} because it reduces $\tilde{y}^{pP}$ and may result in $\tilde{y}^{pP} < y^p$ consequently. (ii) If $(\tau^{pr*}, \tau^{rp*}) = \left(y^p - \tilde{y}^{pP}, 0\right)$ initially, then a fall in y^r does not affect τ^{rp*}, but it increases τ^{pr*}. (iii) If $(\tau^{pr*}, \tau^{rp*}) = \left(0, y^r - \tilde{y}^{rR}\right)$ initially, then a fall in y^r reduces τ^{rp*} because $\tilde{y}^{rR}$ decreases by less than the fall in y^r. The fall in y^r may increase τ^{pr*} because it reduces $\tilde{y}^{pP}$ and may result in $\tilde{y}^{pP} < y^p$ consequently. (iv) If $(\tau^{pr*}, \tau^{rp*}) = \left(y^p - \tilde{y}^{pP}, y^r - \tilde{y}^{rR}\right)$ initially, then a fall in y^r reduces τ^{rp*} because $\tilde{y}^{rR}$ decreases by less than the fall in y^r. The fall in y^r increases τ^{pr*}. $\square$

Thus, a sufficiently large negative shock to Relative's income is likely to increase Parent's net transfers to Relative. This will in turn reduces Parent's household's post-transfer income available for goods consumption and human capital investment. Accordingly, by Lemma 1, Parent's spending for Child's human capital accumulation falls.

Hypothesis *A sufficiently large fall in Relative's pre-transfer income induces an increase in the net transfer from Parent, which in turn decreases Parent's spending for educating Child.*

3 Empirical analysis

The challenges for empirically investigating the impact of private interhousehold transfers on resource allocation within sender households are the problems of simultaneity and reverse causality that are common to many applied econometric studies. The simultaneity problem addresses the issue that household resource allocation decisions, including interhousehold transfers, may be jointly determined at the household level by some third factor, making the transfers an endogenous regressor. The possibility of reverse causality exists in this study, as educational spending could cause interhousehold transfers by reducing the household budget available for outward transfers. This is not a problem if the human capital investment decision were made for planned or anticipated transfers because the educational spending decision would then be made in response to the transfers despite the fact that the transfers would take place after educational expenditures.[11] But the human capital investment decision could be made regardless of future transfers, in which case reverse causality exists if educational spending is negatively correlated to interhousehold transfers. In this study, I will attempt to deal with these endogeneity problems by instrumented first-difference estimation that takes into account both time-invariant and time-variant unobservable heterogeneity.

3.1 Data

I analyze data collected by the first two waves of the Vietnam Living Standards Survey (VLSS) to test the hypothesis that household expenditures on the education of each child at home decrease when the parents increase outward interhousehold transfers. The first wave surveyed 4,800 households in the country between September 1992 and October 1993. The sampling design was self-weighted, i.e. each household had the same probability of being included in the sample. 80 percent of the sample were in rural areas, and the rest in urban areas. Out of these nationally representative households, the second wave could reinterview 4,305 between December 1997 and December 1998.[12]

I use a subsample of the reinterviewed households. In particular, I concentrate on families with the same household head in both waves so that first differencing can cleanly remove time-invariant unobservable characteristics of the household head.[13] I then fur-

[11] Unfortunately, as Cox and Fafchamps (2008: 3736) have pointed out, most surveys including the one I examine in this paper focus on realized, instead of potential, transfers.

[12] Out of the 495 non-resurveyd households, 96 were in 3 Red River Delta communes that were dropped due to the second wave sampling design. 281 households had moved out of their communes since the first interview, 19 were temporarily away from their communes, 1 was dissolved, 12 refused to be reinterviewed, and the rest weren't reinterviewed for an unknown reason. The World Bank (2000; 2001) gives more detailed information on these two VLSS waves.

[13] Most households in the data set had the same head in both waves, and approximately 4 percent of the resurveyed sample are lost by this conditioning. Note that the same head in both interviews does not necessarily deny the possibility that the head was a different person for a period in between the two

ther restrict the sample to families where household members other than the head and the head's spouse did not send any transfer to a non-member. This ensures that an interhousehold transferrer is either the head or the spouse, or both, and no one else in households I study.[14] I then drop households where the heads are 70 years old or older.[15] A few polygamous households are also dropped. From the remaining households, I take the head's children whose ages fall in the range from 7 up to 18 years at both interviews.[16] There are 2,731 such individuals in 1,714 households.

[Insert Table 1 here]

Table 1 presents the means of variables for analysis by the household's cross-wave-change-in-the-net-transfer status.[17] The first variable listed in the table is the outcome variable of interest—the cross-wave change in the total household spending for the education of the child.[18] The spending information in each wave refers to the 12-month period prior to the interview. The reference period is long and hence the collected information is likely to be noisy, but this is the only period that corresponds to the available information on private interhousehold transfers in the data set. The educational expenditure is in thousands of Vietnamese dong. This variable (and all other variables that are expressed in monetary terms in this study) is adjusted to both temporal and spatial price level differences and are expressed at the January 1993 national average price level. On average, the educational spending increased across the waves. Clearly, the average increase is larger among children whose households also increased the net transfer across the waves (24 percent of the estimation sample children): 54 percent larger than the

interviews. The use of first differencing implicitly assumes that the head did not change across the two waves.

[14] This restriction does not drop many households because approximately 98 percent of interhousehold transferrers are the household heads and their spouses in the data.

[15] Since Cox (2004) shows strong associations between retirement and incoming transfers in this Vietnamese data set, I removed these households with elderly heads even though they had a young child of their own at home. Naturally, there are not many elderly heads who had a young child of their own. Dropping households where the heads are 65 years old or older gives similar results.

[16] As a result, the examined children were 7 to 13 years old at the first interview.

[17] For interested readers, I also present cross-sectional summary statistics in Table A1. Note that, since I describe the data as two cross sections (one for each wave) in that table, I use the head's children whose ages are in the range from 7 up to 18 in at least one wave instead of those who fall in this age range at both interviews. Accordingly, a child in Table A1 was not necessarily interviewed in both waves. Also, the household head was not necessarily the same in both waves.

[18] The total expenditure includes tuition and registration fees, contributions to parents' associations and schools, purchases of textbooks, stationery goods, school uniforms, transport fees, lunch expenses, and other study-related expenses (Section 2 of the survey questionnaire).

increase among the rest of the estimation sample children. The uncontrolled correlation between the cross-wave changes in the net transfer and educational spending is positive. According to the World Bank,[19] the gross national income per capita was 2,268,708 dong in 1993. Hence a child in a household with a cross-wave increase in the net transfer received approximately 11 percent of the GNI per capita for his/her education, whereas a child in a household without a transfer increase received about 7 percent of it.

The explanatory variable of interest is the cross-wave change in the net transfer from the household: the first item in the list of controlled variables at the household level. It is given in millions of dong. In this study, the net interhousehold transfer measure includes both gifts and informal loans. As Cox and Fafchamps (2008: 3735) have noted, what a household calls a gift may in fact be given in expectation of some future reciprocal help, and also what it calls a loan can contain an element of gift if it is given interest free without a strict repayment deadline. Therefore, although the data enable us to distinguish between gifts and informal loans, I do not separate them in this paper.[20] The average cross-wave increase among households that increased the net transfer is 1.12 million dong, and the average change among the rest of the households is minus 480,000 dong.[21]

I control for other characteristics at both individual and household levels. At the individual level, I control for the child's sex, age, health status, the number of household members older than him/her but below 70, and the number of members younger than him/her. Obviously, the cross-wave change in age does not differ much across individuals, and hence I do not control for that. However, I control for the initial, i.e. first-wave, age because educational expenditures are likely to be dependent on the level of schooling which is positively correlated to age. In constructing the cross-wave change in the health status, I categorize the child as unhealthy if he/she was so ill that his/her anthropometric information could not be collected when the surveyor visited the household. It is unclear a priori whether and how educational spending differs between healthy and unhealthy children. The cross-wave change in the number of coresiding members who are younger than the child, and also working age members older than him/her, is included to capture the change in the child's position in the household. Table 1 indicates that the average number of younger members (mostly younger siblings) increased across the waves, but

[19] See the notes for Table 1.

[20] Removing informal loans from the transfer measure does not change the results. Estimates using the net gift transfer are available from the author upon request.

[21] There are 604 children (29% of 2,069) whose households reduced the net transfer across the waves. The average decrease among them is minus 1.65 million dong.

the increase was smaller among households with a positive cross-wave change in the net transfer.

The rest of the explanatory variables relate to the household and its head. In addition to the numbers of older working-age household members and younger members (which differ across individuals), I control for three other household-composition variables. One is the cross-wave change in the number of household members aged 70 or above, and the other two relate to the existence of the head's spouse. The first one is a measure of the number of dependants at home, additional to the number of household members younger than the child in question. The other two variables indicate that heads with a cross-wave increase in the net transfer were slightly less likely to have a spouse initially, and have room to get a spouse by the second survey.

Since parents are still likely to exert strong influence over children in the age range that I study, I control for more of the household head's (i.e. one of the child's parent's) characteristics than the existence of a spouse: sex, age, ethnicity, religion, and health status. I also control for the head's highest educational qualification attained. I use the head's education instead of taking either the average or the max of educational attainment among the parents, assuming that the head makes the final decisions in the household. The head's highest educational qualification is the information from the first interview because this variable does not change after the first wave in most households. The head's age is also the information from the first survey because the cross-wave changes in age do not differ much across individuals. The average head age is approximately 40 years in the first survey. Household heads with a cross-wave increase in the net transfer are slightly less likely to be male than the other heads, and also slightly less likely to belong to ethnic minority. They are more educated on average.

I attempt to control for both initial level and cross-wave change in the household wealth by using the first-wave value of dwelling, the first-wave value of durable goods, and the cross-wave change in the value of durable goods.[22] The dwelling value refers to the value at the time of interview. Unfortunately, there are many missing observations on this information in the second wave. Hence I use only the first-wave value. The value of durable goods is a preferred measure of household wealth because information on the purchase date of each item is available. I compute the total present value of durable goods purchased by household members more than 12 months ago.[23] Thus, the purchase

[22] The VLSS information on household savings is not suitable for capturing wealth in this study because it is the amount at the time of interview. Thus, the information on private transfers precedes that on savings.

[23] The durable goods include TV, video player/recorder, stereo, radio, computer, camera, fridge/freezer,

timing suggests that it refers to household wealth determined before both interhousehold transfers and educational expenditures. Table 1 shows that households with increased net transfers are initially wealthier than the rest of the households. It also shows that all households increased wealth on average, but households with increased net transfers increased it more than the remaining households.

The household's status of having a farm or nonfarm business is also controlled for. Households with increased net transfers are initially slightly less likely to manage agricultural activities than the other households. Still over 80 percent of households managed such activities, regardless of the net transfer status. The cross-wave change in self-managed agricultural activities indicates a general tendency to stop such activities. On the other hand, households are equally likely to self-manage non-agricultural business activities regardless of the net transfer status. Households with a cross-wave increase in the net transfer are slightly less likely to be located in rural areas.

3.2 Estimation

By exploiting the longitudinal nature of the first two VLSS waves, I control for time-invariant unobservables at the individual level through first differencing. Suppose households that are more altruistic tend to regard human capital investment more highly. As a result, households that transfer more also spend more on child education. Now suppose an exogenous event generates urgent need to assist relatives living elsewhere. Then, more altruistic households further increase outward transfers and as a result reduce educational spending. On the other hand, less altruistic households increase transfers little, if any, and as a result educational spending remains the same. Consequently, educational spending by more altruistic households gets closer to that by less altruistic households. In this case, other things equal, the difference in educational spending across households becomes small, as the difference in private transfers increases. Then, the cross-sectional IV estimation could underestimate the impact of private transfers on educational expenditures.[24] Therefore, it is important to control for time-invariant unobservable heterogeneity.

air conditioner, washing machine, water heater, gas/electric cooker, automobile, motorbike, boat, sewing machine, and furniture. The full list is in Section 12C of the survey questionnaire.

[24] Table A2 presents the result from IV estimation of the cross-sectional version of the same specification as for Table 3(a). It seems to be consistent with my speculation. The estimated coefficient on the net transfer is insignificant, but cross-sectional estimation cannot tell whether this is due to unobservable heterogeneity or not.

The estimated equation is

$$\Delta y_{ij} = \eta + \Delta \mathbf{x}'_{ij}\boldsymbol{\beta} + \Delta \mathbf{z}'_j\boldsymbol{\gamma} + \mathbf{x}'_{ij1}\boldsymbol{\lambda} + \mathbf{z}'_{j1}\boldsymbol{\mu} + \Delta u_{ij} \tag{16}$$

where Δy_{ij} is the cross-wave change in the expenditure for the education of child i in household j, η the cross-wave change in the intercept, $\Delta \mathbf{x}_{ij}$ the vector of cross-wave changes in exogenous variables at the individual level, $\Delta \mathbf{z}_j$ the vector of cross-wave changes in exogenous variables at the household level, $\mathbf{x}_{ij1}$ the vector of observables at the individual level in wave 1, $\mathbf{z}_{j1}$ the vector of observables at the household level in wave 1, and Δu_{ij} the cross-wave change in the random error term. $\Delta \mathbf{z}_j$ includes the explanatory variable of our interest, i.e. the cross-wave change in the net interhousehold transfer. $\mathbf{x}_{ij1}$ and $\mathbf{z}_{j1}$ include both time-variant and time-invariant variables. They include the sex and age of the child and the household head, the head's ethnicity, religion, and highest educational qualification attained, the existence of the head's spouse at home, whether the household self-manages agricultural activities, whether it self-manages non-agricultural business activities, the total value of the household's durable goods, and the value of its dwelling value. (See Table 1.) In the case of time-variant variables, they control for the difference in initial conditions across the panel of children. We can estimate (16) by OLS, provided that Δu_{ij} is correlated with neither $\Delta \mathbf{x}_{ij}$, $\mathbf{x}_{ij1}$, $\Delta \mathbf{z}_j$, nor $\mathbf{z}_{j1}$. This assumption is satisfied if u_{ijt} for each wave $t = 1, 2$ is uncorrelated with $\mathbf{x}_{ijt}$ and $\mathbf{z}_{jt}$ for both waves.[25]

First differencing enables us to control for unobservable time-invariant heterogeneity at the individual and household levels. However, it does not control for unobservable time-variant heterogeneity that may determine both the change in the net interhousehold transfer and the change in the household expenditure for child education simultaneously. There also remains a concern with reverse causality. That is, outward transfers may be caused by a household budget increased by a fall in educational spending. Therefore, first-difference estimates do not necessarily reflect causality from the net transfer to educational expenditure. As I am interested in the impact of the net transfer on human capital investment, I attempt to deal with the potential endogeneity by instrumental variables that directly affect the change in the net interhousehold transfer, but the change in educational spending is affected by them only indirectly through a change in the household budget caused by the net-transfer change.

My instruments are based on information about relatives living elsewhere. From

[25]Thus, the assumption is violated if for example $\mathbf{x}_{ij2}$ includes the lagged dependent variable y_{ij1} so that $y_{ij1} - y_{ij0}$ is in $\Delta \mathbf{x}_{ij}$. This is not possible with the shortest panel.

December 1997 to June 1998, Vietnam suffered from one of the most acute droughts in history. The rainfall was 40 to 250 mm, accounting for only 5 to 20 percent of the average, and the temperature was between 35° and 42° Celsius. Approximately 3.8 million people lacked fresh water in the country, and many agricultural activities were disrupted.[26] The idea is that an unexpectedly acute drought would exogenously generate urgent need for interhousehold assistance from unaffected or less severely affected people to devastated victims—in particular, closely related victims. This would directly influence the transferrer's budget, which would in turn require a reallocation of resources within the sender household.

The second wave of VLSS (Section 1D of the survey questionnaire) provides information on first-wave household members who left their households at some time between the first and second surveys and became a non-member in the second wave. This enables me to know who left why, where, and when after the first survey. For each household, I count the number of wave-1 member relatives who left the household before the beginning of the second survey to the regions that were severely affected by the drought. Obviously, this count underestimates the number of relatives who lived in drought-hit regions. To supplement this underestimate, I also count second-wave household members' children who formed households in those drought-hit regions at the time of the second interview (Section 1C of the survey questionnaire). Note that most of those children are already adult,[27] and hence we can safely include them in the count.[28] In summary, my main instrument is the number of relatives living in communes severely affected by the drought for the households that are not in those seriously affected areas themselves.[29] The instrumental variable is thus defined at the household level. It is important to exclude households that were located in affected areas themselves because their educational expenditures are likely to be directly affected by the natural disaster. Rural communes of Uplands, North Central Coast, South Central Coast, and Central Highlands are chosen as the particularly suffered areas, according to the Socialist Republic of Vietnam (2002: 27). In the analysis below, I will also try the indicator of the existence of such a relative

[26] The Socialist Republic of Vietnam (2002: 27) gives more detail.

[27] Schooling children who lived elsewhere but were financially dependent are regarded as household members in the survey (Section 1A of the survey questionnaire).

[28] Otherwise, outward transfers to those children may themselves be household expenditures for child education.

[29] My count of relatives still underestimates the actual number, as we can easily imagine that there are other relatives living elsewhere who were neither household members at the time of the first survey nor children of household members. Unfortunately, I do not have sufficient information to identify all relatives living elsewhere.

as an alternative instrument.[30]

[Insert Figure 1 here]

Approximately 4.5 percent of the estimation sample record a positive number of relatives in those drought-hit communes and were at the same time located outside the affected area. Figure 1 presents the frequency distribution across the number of relatives. Approximately 31 percent of children in households that record a positive number of relatives also record a cross-wave increase in the net transfer, 24 percent a cross-wave decrease, and 45 percent no change. The OLS regression of the indicator version of the instrumental variable on the cross-wave change in the net transfer and a constant gives a statistically significant positive correlation of .47 at 5 percent. Using the number, instead of existence, of relatives, the correlation is .12 statistically significant at 10 percent.

3.3 Results

Table 2 presents the first result from using the existence, instead of the number, of relatives in drought-hit communes for households located outside those communes in order to instrument the cross-wave change in the net interhousehold transfer. I present 2SLS heteroskedasticity-robust estimates from both first- and second-stage estimation. The

[30] As an alternative to the drought, I also constructed these IVs based on Typhoon Linda. On November 2, 1997, the southern tip of the country was hit by this typhoon at the wind speed of approximately 100 km per hour, the worst tropical storm to strike the area since 1904. Tens of thousands of people were left homeless, and almost 500,000 hectares of rice fields were destroyed. The typhoon rapidly developed in the South China Sea (called the East Sea in Vietnam) on November 1. People did not have sufficient time to prepare for its strike, and certainly people outside the affected area did not prepare a transfer in anticipation of such a powerful disaster. (IIED, 1997) The idea was inspired by Cox (2004: 596-597) who points out that this natural disaster occurred just one month before the second survey began. As severely affected areas, I chose Tien Giang, Vinh Long, Kien Giang, Ca Mau, and Bac Lieu where 6,196 to 163,026 houses were reported to have been destroyed according to the United Nations Development Program (January 6, 1998, http://reliefweb.int/node/2403). Unfortunately, the number of houses in each province just before the typhoon is unknown, as the modern Vietnamese housing census after independence took place once a decade starting in 1979. Using data from the third census in April 1999 (although too much time had passed since the end of October 1997 at this census point), it seems that these five provinces had at least 10 percent of houses destroyed by the typhoon, while the other affected provinces had much less houses destroyed. Of course, housing damage is not the only negative shock that could attract incoming transfers, but it seems a reasonable indicator for the extent of the overall negative shock. While the event ensures exogeneity, there are only a small number of households that were located outside the affected area and at the same time had a relative inside it in my estimation sample. Therefore, I have judged that Typhoon Linda-based instruments are unfortunately unreliable in my study.

educational spending is in natural logarithm in the main equation. Therefore, multiplying the coefficient on the cross-wave change in the net interhousehold transfer by 100 gives a percentage change in household expenditure for child education caused by a million dong increase in the net transfer.[31]

Looking at the first-stage result, the excluded indicator instrument is significant at 5 percent, suggesting that the net transfer from the household increases by 470,000 million dong. The size of the F-statistic for the instrument is often used as an indicator for the strength of the excluded instrument: the rule of thumb is that it is sufficiently strong if $F > 10$. Here, F is below 4 (shown toward the bottom of the table), implying that the correlation between the instrument and the cross-wave change in the net transfer is not sufficiently strong. The partial R^2 between these two is also very low and hence suggests the same. The tests of endogeneity indicate that the cross-wave change in the net transfer is indeed endogenous in the main equation. However, these tests are reliable only when the instrument is strong. Hence the test results are only suggestive.

Turning to the main equation, the cross-wave change in the net transfer has a negative coefficient. The 2SLS estimate of the marginal effect is statistically insignificant. However, the estimate is biased toward OLS when the instrument is weak. The OLS estimate without instrumenting is shown at the bottom of the table. It is minus .02, and is statistically significant at 5 percent. It suggests that an increase in the net transfer by one million dong reduces the educational expenditure by 2 percent. Since one million dong is a large amount (approximately 44% of GNI per capita), the impact appears economically insignificant. The 2SLS estimate of statistically insignificant minus 1.20 suggests that the OLS bias is upward. For inference with the weak instrument, Mikusheva and Poi's (2006) coverage-corrected p-value based on the conditional likelihood-ratio test is given below the 2SLS estimate. It indicates that the negative coefficient is statistically significant at less than 5 percent. However, it should be noted that their p-value is not heteroskedasticity-robust, and hence it is only suggestive.

[Insert Table 2 here]

[31] I have also examined the impact of the net transfer on educational spending in levels instead of natural log, and the results are similar.

3.3.1 Existence of relatives outside drought-hit areas for households located inside those areas

In constructing our instrument, we have excluded households that were themselves located in drought-hit communes because educational spending is likely to be affected directly by the drought in those households. However, Table 2 shows that, while households located in drought-hit communes decreased the net interhousehold transfer by 270,000 dong on average (statistically significant at 5%), their educational expenditures did not differ ceteris paribus. This suggests that we may drop the indicator of being located in the affected areas from the main equation, and utilize households located in affected communes to construct an additional instrument. My additional instrument is the number of relatives outside drought-hit communes for households located in the affected communes. Following the same reasoning as I used in constructing the number of relatives in drought-hit communes for households located outside the affected communes, I expect that the net transfers from these households would fall because they reduce or stop outward transfers and increase inward transfers from their relatives. Clearly, a household cannot record a positive number in both instrumental variables.

Approximately 3.6 percent of the estimation sample record a positive number of relatives outside drought-hit areas and were at the same time located inside the affected areas. Figure 2 presents the frequency distribution across the number of relatives. The OLS regression of the indicator version of this instrumental variable on the cross-wave change in the net transfer and a constant gives a statistically significant correlation of minus 1.01 at 5 percent. Using the number, instead of existence, of relatives, the correlation is minus .61 statistically significant at 10 percent.

[Insert Figure 2 here]

Panel (a) of Table 3 presents the LIML result from dropping the indicator of being located in the affected areas from the main equation and adding the existence, instead of the number, of relatives outside drought-hit communes for households located in the affected communes to the first-stage equation. The two excluded instruments are both significant at 5 percent. The indicator of having at least one relative in drought-hit communes for households located outside those communes maintains a positive coefficient. The newly added instrument has an expected negative sign. The estimate indicates that drought-affected households with relatives outside the hit areas decrease the net interhousehold transfer by 870,000 dong on average. The F-statistic has increased to 4.40, but the correlation between the instruments and the cross-wave change in the net transfer is still not sufficiently strong. The partial R^2 also remains close to zero. The test of over-identifying restrictions seems to suggest that the just-identified result in Table 2 is more reliable than the current result. The estimated coefficient on the cross-wave change in the net transfer in the main equation remains statistically insignificantly negative. Its magnitude is smaller than before, which is expected because the bias toward OLS increases as the number of instruments increases. Mikusheva and Poi's non-robust coverage-corrected p-value indicates that it is now insignificant at 5 percent.

[Insert Table 3 here]

3.3.2 Using the number of relatives

Since it is possible for households located outside drought-hit communes that the more relatives are affected by the disaster the more transfers are required for assistance, I replace the indicator instrument in Table 2 with the number of relatives. The 2SLS result is presented in Panel (b) of Table 3. The fit seems to marginally improve, but the main message of Table 2 does not change.

Panel (c) of Table 3 presents the LIML result from replacing the two indicator instruments in Panel (a) of the table with the corresponding count instruments. Again, the main message does not change, but the second instrument is now statistically insignificant.

3.3.3 Robustness checks

The main message seems that my excluded instruments are not sufficiently strongly correlated with the cross-wave change in the net interhousehold transfer. As a result, the impact of the net transfer on the household expenditure on child education is imprecisely estimated. It is consistently negative, but the statistical significance remains ambiguous. This is in a way expected because my instruments do not capture unobservable time-variant heterogeneity across drought-hit communes, as well as across households within each affected commune.[32]

I follow Angrist and Krueger (2001: 79-80) and have looked at the estimated coefficients on my instruments after the OLS regression of the reduced form. I find both

[32] Unfortunately, the data do not allow us to know about recipients' households' characteristics.

existence and number of relatives in drought-hit areas for households located outside the affected areas are significantly negative (the former at less than 5% and the latter at less than 1%). However, neither existence nor number of relatives outside drought-hit areas for households located in the affected areas is statistically significant. This suggests that we should focus on the results from the just identified specifications in Tables 2 and 3(b). The impact of the net interhousehold transfer is thus negative even though the partial correlation between these two instruments and the cross-wave change in the net transfer is not sufficiently strong.

By looking at the estimated marginal effect of the net interhousehold transfer in Tables 2 and 3(b), we notice that the magnitude of the estimates is nonsensically large. They suggest that an increase in the net transfer by one million dong (which is less than the average increase among households with increased net transfers) reduces household expenditures on the child's education by more than 100 percent! In order to obtain a more sensible magnitude, I follow Chernozhukov and Hansen (2008) to compute a reduced form-based heteroskedasticity-robust correct-coverage confidence interval for the marginal effect of the net transfer.[33] I obtain approximately minus .34 as the upper bound of the 95% confidence interval and minus .10 as that of the 99% confidence interval for Table 3(b).[34] This suggests that the impact of the net interhousehold transfer is to reduce household expenditures on child education by at least 10 percent with 99% confidence and 34 percent with 95% confidence. The size of the impact thus seems economically significant.

4 Conclusion

This study has offered a first step to understand the impact of interhousehold transfers on the members of the sender household. The empirical analysis shows that an increase in the net interhousehold transfer reduces the total household expenditure on the education of each child. This finding suggests that interhousehold transfers might have adverse effects on the members of the sending households, and calls for further studies of the relationships between private transfers and outcome variables in sender households.

If interhousehold transfers decrease the sender household's human capital investment

[33] I adapted the Stata code obtained from http://faculty.chicagobooth.edu/christian.hansen/research/ to compute the confidence intervals.

[34] The lower bound goes below -1, as expected. The computation of the lower bound is omitted by selecting $[-1, 2]$ as the set of potential values for the marginal effect of the net transfer, as a reduction of more than 100 percent is unrealistic.

in each child, the child's future economic and social prospects are constrained. This could hurt not only the child in question but potentially also the next generation that he or she will parent. Furthermore, potential gains to the recipients of the interhousehold transfer may well be outweighed by potential losses to the senders. For example, when the current recipients reciprocate financial assistance in response to the adversity facing to the current senders in the future, children in the latter households could already be fully working adults. They probably miss out educational opportunities due to outgoing interhousehold transfers that take place when they are children.

A policy implication from this study is that public transfers might not be so bad even if they partially crowd out private transfers. We should look at the crowding-out not just in terms of the amount of money transferred. We should consider other costs and benefits of private and public transfers to all parties involved in both short and long runs. If public transfers can redistribute income like private transfers do but without adverse effects associated with private transfers, then there seems to be an argument for introducing public transfers even though administratively inexpensive informal transfers between extended families and socially connected households are subsequently crowded out. I do not suggest that public transfers are superior to private transfers, but I argue that our knowledge about the effects of private transfers on the senders is currently limited. Without filling this gap in the literature on private transfers, the overall welfare impact of introducing public transfers remains ambiguous. Hence this study has offered a first step to understand what happens to the senders of private transfers.

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Appendix

A. Derivation of Eqs. (4)-(6)

By substitution of (3) into (1) and (2), and then (2) into (1), we obtain (4) where

$$
\begin{aligned}
\delta_p^p &\equiv \frac{\alpha_p^p\left(1-\alpha_r^c\alpha_c^r\right)}{\alpha_p^p\left(1-\alpha_r^c\alpha_c^r\right)+\alpha_c^c\left(\alpha_c^p+\alpha_r^p\alpha_c^r\right)+\alpha_r^r\left(\alpha_r^p+\alpha_c^p\alpha_r^c\right)}, \\
\delta_c^p &\equiv \frac{\alpha_c^c\left(\alpha_c^p+\alpha_r^p\alpha_c^r\right)}{\alpha_p^p\left(1-\alpha_r^c\alpha_c^r\right)+\alpha_c^c\left(\alpha_c^p+\alpha_r^p\alpha_c^r\right)+\alpha_r^r\left(\alpha_r^p+\alpha_c^p\alpha_r^c\right)}, \\
\delta_r^p &\equiv \frac{\alpha_r^r\left(\alpha_r^p+\alpha_c^p\alpha_r^c\right)}{\alpha_p^p\left(1-\alpha_r^c\alpha_c^r\right)+\alpha_c^c\left(\alpha_c^p+\alpha_r^p\alpha_c^r\right)+\alpha_r^r\left(\alpha_r^p+\alpha_c^p\alpha_r^c\right)},
\end{aligned}
$$

thus $\delta_j^p \in (0,1)$ with $\Sigma_j \delta_j^p = 1$. δ_p^p implies that Parent's weight on his own consumption utility (α_p^p) is discounted by the product of Child's weight on Relative's total utility and Relative's weight on Child's total utility ($\alpha_r^c\alpha_c^r$). δ_c^p implies that Parent's weight on Child's consumption utility is Child's weight on his own consumption utility (α_c^c) multiplied by the sum of Parent's weight on Child's total utility (α_c^p) and the product of Parent's weight on Relative's total utility and Relative's weight on Child's total utility ($\alpha_r^p\alpha_c^r$). δ_r^p implies that Parent's weight on Relative's consumption utility is Relative's weight on his own consumption utility (α_r^r) multiplied by the sum of Parent's weight on Relative's total utility (α_r^p) and the product of Parent's weight on Child's total utility and Child's weight on Relative's total utility ($\alpha_c^p\alpha_r^c$).

Now, substitute (4) into (2) and (3), then (3) into (2). We obtain ((5) where

$$
\begin{aligned}
\delta_p^c &\equiv \frac{\left(\alpha_p^c+\alpha_r^c\alpha_p^r\right)\delta_p^p}{1-\alpha_r^c\alpha_c^r}, \\
\delta_c^c &\equiv \frac{\left(\alpha_p^c+\alpha_r^c\alpha_p^r\right)\delta_c^p+\alpha_c^c}{1-\alpha_r^c\alpha_c^r}, \\
\delta_r^c &\equiv \frac{\left(\alpha_p^c+\alpha_r^c\alpha_p^r\right)\delta_r^p+\alpha_r^c\alpha_r^r}{1-\alpha_r^c\alpha_c^r},
\end{aligned}
$$

and $\delta_j^c \in (0,1)$ with $\Sigma_j \delta_j^c = 1$. Similarly, by substituting (4) and (5) into (3), we obtain (6) where

$$
\begin{aligned}
\delta_p^r &\equiv \alpha_p^r\delta_p^p+\alpha_c^r\delta_p^c, \\
\delta_c^r &\equiv \alpha_p^r\delta_c^p+\alpha_c^r\delta_c^c, \\
\delta_r^r &\equiv \alpha_p^r\delta_r^p+\alpha_c^r\delta_r^c+\alpha_r^r,
\end{aligned}
$$

and $\delta_j^r \in (0,1)$ with $\Sigma_j \delta_j^r = 1$.

B. Proof of Lemma 1

First of all, note that $q^{r*} = Y - \tilde{y}^p$ where $Y = y^p + y^r$ is the total income available to the two households. Using (10) and (11), let

$$
\begin{aligned}
F^1\left(k, q^c, q^p; \tilde{y}^p\right) &= \tilde{y}^p - k - q^c - q^p = 0, \\
F^2\left(k, q^c, q^p; \tilde{y}^p\right) &= \delta_p^p \frac{\partial x^p}{\partial q^p} - \sum_i \delta_i^p \frac{\partial x^i}{\partial k} = 0, \\
F^3\left(k, q^c, q^p; \tilde{y}^p\right) &= \delta_c^p \frac{\partial x^c}{\partial q^c} - \sum_i \delta_i^p \frac{\partial x^i}{\partial k} = 0.
\end{aligned}
$$

Then, the Jacobian determinant is

$$
\begin{aligned}
|J| \quad &= \quad \begin{vmatrix} \frac{\partial F^1}{\partial k} & \frac{\partial F^1}{\partial q^c} & \frac{\partial F^1}{\partial q^p} \\ \frac{\partial F^2}{\partial k} & \frac{\partial F^2}{\partial q^c} & \frac{\partial F^2}{\partial q^p} \\ \frac{\partial F^3}{\partial k} & \frac{\partial F^3}{\partial q^c} & \frac{\partial F^3}{\partial q^p} \end{vmatrix} = \begin{vmatrix} -1 & -1 & -1 \\ \delta^p_p \frac{\partial^2 x^p}{\partial q^p \partial k} - \sum_i \delta^p_i \frac{\partial^2 x^i}{\partial k^2} & -\delta^p_c \frac{\partial^2 x^c}{\partial k \partial q^c} & \delta^p_p \frac{\partial^2 x^p}{\partial q^{p2}} - \delta^p_p \frac{\partial^2 x^p}{\partial k \partial q^p} \\ \delta^p_c \frac{\partial^2 x^c}{\partial q^c \partial k} - \sum_i \delta^p_i \frac{\partial^2 x^i}{\partial k^2} & \delta^p_c \frac{\partial^2 x^c}{\partial q^{c2}} - \delta^p_c \frac{\partial^2 x^c}{\partial k \partial q^c} & -\delta^p_p \frac{\partial^2 x^p}{\partial k \partial q^p} \end{vmatrix} \\
&= \quad - \begin{vmatrix} -\delta^p_c \frac{\partial^2 x^c}{\partial k \partial q^c} & \delta^p_p \left(\frac{\partial^2 x^p}{\partial q^{p2}} - \frac{\partial^2 x^p}{\partial k \partial q^p} \right) \\ \delta^p_c \left(\frac{\partial^2 x^c}{\partial q^{c2}} - \frac{\partial^2 x^c}{\partial k \partial q^c} \right) & -\delta^p_p \frac{\partial^2 x^p}{\partial k \partial q^p} \end{vmatrix} + \begin{vmatrix} \delta^p_p \frac{\partial^2 x^p}{\partial q^p \partial k} - \sum_i \delta^p_i \frac{\partial^2 x^i}{\partial k^2} & \delta^p_p \left(\frac{\partial^2 x^p}{\partial q^{p2}} - \frac{\partial^2 x^p}{\partial k \partial q^p} \right) \\ \delta^p_c \frac{\partial^2 x^c}{\partial q^c \partial k} - \sum_i \delta^p_i \frac{\partial^2 x^i}{\partial k^2} & -\delta^p_p \frac{\partial^2 x^p}{\partial k \partial q^p} \end{vmatrix} \\
&\qquad - \begin{vmatrix} \delta^p_p \frac{\partial^2 x^p}{\partial q^p \partial k} - \sum_i \delta^p_i \frac{\partial^2 x^i}{\partial k^2} & -\delta^p_c \frac{\partial^2 x^c}{\partial k \partial q^c} \\ \delta^p_c \frac{\partial^2 x^c}{\partial q^c \partial k} - \sum_i \delta^p_i \frac{\partial^2 x^i}{\partial k^2} & \delta^p_c \left(\frac{\partial^2 x^c}{\partial q^{c2}} - \frac{\partial^2 x^c}{\partial k \partial q^c} \right) \end{vmatrix} \\
&= \quad -\delta^p_c \frac{\partial^2 x^c}{\partial k \partial q^c} \delta^p_p \frac{\partial^2 x^p}{\partial k \partial q^p} + \delta^p_p \left(\frac{\partial^2 x^p}{\partial q^{p2}} - \frac{\partial^2 x^p}{\partial k \partial q^p} \right) \delta^p_c \left(\frac{\partial^2 x^c}{\partial q^{c2}} - \frac{\partial^2 x^c}{\partial k \partial q^c} \right) \\
&\qquad - \left(\delta^p_p \frac{\partial^2 x^p}{\partial q^p \partial k} - \sum_i \delta^p_i \frac{\partial^2 x^i}{\partial k^2} \right) \delta^p_p \frac{\partial^2 x^p}{\partial k \partial q^p} - \delta^p_p \left(\frac{\partial^2 x^p}{\partial q^{p2}} - \frac{\partial^2 x^p}{\partial k \partial q^p} \right) \left(\delta^p_c \frac{\partial^2 x^c}{\partial q^c \partial k} - \sum_i \delta^p_i \frac{\partial^2 x^i}{\partial k^2} \right) \\
&\qquad - \left(\delta^p_p \frac{\partial^2 x^p}{\partial q^p \partial k} - \sum_i \delta^p_i \frac{\partial^2 x^i}{\partial k^2} \right) \delta^p_c \left(\frac{\partial^2 x^c}{\partial q^{c2}} - \frac{\partial^2 x^c}{\partial k \partial q^c} \right) - \delta^p_c \frac{\partial^2 x^c}{\partial k \partial q^c} \left(\delta^p_c \frac{\partial^2 x^c}{\partial q^c \partial k} - \sum_i \delta^p_i \frac{\partial^2 x^i}{\partial k^2} \right) \\
&= \quad -\delta^p_c \frac{\partial^2 x^c}{\partial k \partial q^c} \delta^p_p \frac{\partial^2 x^p}{\partial k \partial q^p} + \delta^p_p \left(\frac{\partial^2 x^p}{\partial q^{p2}} - \frac{\partial^2 x^p}{\partial k \partial q^p} \right) \delta^p_c \left(\frac{\partial^2 x^c}{\partial q^{c2}} - \frac{\partial^2 x^c}{\partial k \partial q^c} \right) \\
&\qquad - \left(\delta^p_p \frac{\partial^2 x^p}{\partial q^p \partial k} - \sum_i \delta^p_i \frac{\partial^2 x^i}{\partial k^2} \right) \left(\delta^p_p \frac{\partial^2 x^p}{\partial k \partial q^p} + \delta^p_c \left(\frac{\partial^2 x^c}{\partial q^{c2}} - \frac{\partial^2 x^c}{\partial k \partial q^c} \right) \right) \\
&\qquad - \left(\delta^p_c \frac{\partial^2 x^c}{\partial q^c \partial k} - \sum_i \delta^p_i \frac{\partial^2 x^i}{\partial k^2} \right) \left(\delta^p_c \frac{\partial^2 x^c}{\partial k \partial q^c} + \delta^p_p \left(\frac{\partial^2 x^p}{\partial q^{p2}} - \frac{\partial^2 x^p}{\partial k \partial q^p} \right) \right) \\
&= \quad \delta^p_p \frac{\partial^2 x^p}{\partial q^{p2}} \delta^p_c \left(\frac{\partial^2 x^c}{\partial q^{c2}} - \frac{\partial^2 x^c}{\partial k \partial q^c} \right) - \delta^p_p \frac{\partial^2 x^p}{\partial k \partial q^p} \delta^p_c \frac{\partial^2 x^c}{\partial q^{c2}} \\
&\qquad - \left(\delta^p_p \frac{\partial^2 x^p}{\partial q^p \partial k} - \sum_i \delta^p_i \frac{\partial^2 x^i}{\partial k^2} \right) \left(\delta^p_p \frac{\partial^2 x^p}{\partial k \partial q^p} + \delta^p_c \left(\frac{\partial^2 x^c}{\partial q^{c2}} - \frac{\partial^2 x^c}{\partial k \partial q^c} \right) \right) \\
&\qquad - \left(\delta^p_c \frac{\partial^2 x^c}{\partial q^c \partial k} - \sum_i \delta^p_i \frac{\partial^2 x^i}{\partial k^2} \right) \left(\delta^p_c \frac{\partial^2 x^c}{\partial k \partial q^c} + \delta^p_p \left(\frac{\partial^2 x^p}{\partial q^{p2}} - \frac{\partial^2 x^p}{\partial k \partial q^p} \right) \right) \\
&= \quad \delta^p_p \frac{\partial^2 x^p}{\partial q^{p2}} \delta^p_c \frac{\partial^2 x^c}{\partial q^{c2}} - 2\delta^p_p \frac{\partial^2 x^p}{\partial q^{p2}} \delta^p_c \frac{\partial^2 x^c}{\partial k \partial q^c} - 2\delta^p_c \frac{\partial^2 x^c}{\partial q^{c2}} \delta^p_p \frac{\partial^2 x^p}{\partial k \partial q^p} + 2\delta^p_p \frac{\partial^2 x^p}{\partial k \partial q^p} \delta^p_c \frac{\partial^2 x^c}{\partial k \partial q^c} \\
&\qquad + \sum_i \delta^p_i \frac{\partial^2 x^i}{\partial k^2} \left(\delta^p_p \frac{\partial^2 x^p}{\partial q^{p2}} + \delta^p_c \frac{\partial^2 x^c}{\partial q^{c2}} \right) - \left(\delta^p_p \frac{\partial^2 x^p}{\partial k \partial q^p} \right)^2 - \left(\delta^p_c \frac{\partial^2 x^c}{\partial k \partial q^c} \right)^2 \\
&= \quad \delta^p_p \frac{\partial^2 x^p}{\partial q^{p2}} \delta^p_c \frac{\partial^2 x^c}{\partial q^{c2}} - 2\delta^p_p \frac{\partial^2 x^p}{\partial q^{p2}} \delta^p_c \frac{\partial^2 x^c}{\partial k \partial q^c} - 2\delta^p_c \frac{\partial^2 x^c}{\partial q^{c2}} \delta^p_p \frac{\partial^2 x^p}{\partial k \partial q^p} \\
&\qquad + \sum_i \delta^p_i \frac{\partial^2 x^i}{\partial k^2} \left(\delta^p_p \frac{\partial^2 x^p}{\partial q^{p2}} + \delta^p_c \frac{\partial^2 x^c}{\partial q^{c2}} \right) - \left(\delta^p_p \frac{\partial^2 x^p}{\partial k \partial q^p} - \delta^p_c \frac{\partial^2 x^c}{\partial k \partial q^c} \right)^2
\end{aligned}
$$

where only the last quadratic term is negative and all the other terms are positive. It seems reasonable to assume that the Jacobian determinant is nonzero, i.e.

$$\left(\delta_p^p \frac{\partial^2 x^p}{\partial k \partial q^p} - \delta_c^p \frac{\partial^2 x^c}{\partial k \partial q^c}\right)^2 \neq \left(\delta_p^p \frac{\partial^2 x^p}{\partial q^{p2}} + \delta_c^p \frac{\partial^2 x^c}{\partial q^{c2}}\right) \sum_i \delta_i^p \frac{\partial^2 x^i}{\partial k^2} + \delta_p^p \frac{\partial^2 x^p}{\partial q^{p2}} \delta_c^p \frac{\partial^2 x^c}{\partial q^{c2}}$$
$$-2\delta_p^p \frac{\partial^2 x^p}{\partial q^{p2}} \delta_c^p \frac{\partial^2 x^c}{\partial k \partial q^c} - 2\delta_c^p \frac{\partial^2 x^c}{\partial q^{c2}} \delta_p^p \frac{\partial^2 x^p}{\partial k \partial q^p}.$$

If this holds, we can apply the implicit function theorem. Assume $|J| \neq 0$ for the moment. By Cramer's rule, the impact of $\tilde{y}^p$ is summarized by

$$\begin{bmatrix} \frac{\partial k}{\partial \tilde{y}^p} \\ \frac{\partial q^c}{\partial \tilde{y}^p} \\ \frac{\partial q^p}{\partial \tilde{y}^p} \end{bmatrix} = J^{-1} \begin{bmatrix} -\frac{\partial F^1}{\partial \tilde{y}^p} \\ -\frac{\partial F^2}{\partial \tilde{y}^p} \\ -\frac{\partial F^3}{\partial \tilde{y}^p} \end{bmatrix} = J^{-1} \begin{bmatrix} -1 \\ -\delta_r^p \frac{\partial^2 x^r}{\partial k \partial q^r} \\ -\delta_r^p \frac{\partial^2 x^r}{\partial k \partial q^r} \end{bmatrix} = \frac{1}{|J|} \begin{bmatrix} |J_k| \\ |J_{q^c}| \\ |J_{q^p}| \end{bmatrix}$$

where

$$\begin{aligned}
|J_k| &= \begin{vmatrix} -1 & -1 & -1 \\ -\delta_r^p \frac{\partial^2 x^r}{\partial k \partial q^r} & -\delta_c^p \frac{\partial^2 x^c}{\partial k \partial q^c} & \delta_p^p \left(\frac{\partial^2 x^p}{\partial q^{p2}} - \frac{\partial^2 x^p}{\partial k \partial q^p}\right) \\ -\delta_r^p \frac{\partial^2 x^r}{\partial k \partial q^r} & \delta_c^p \left(\frac{\partial^2 x^c}{\partial q^{c2}} - \frac{\partial^2 x^c}{\partial k \partial q^c}\right) & -\delta_p^p \frac{\partial^2 x^p}{\partial k \partial q^p} \end{vmatrix} \\
&= -\begin{vmatrix} -\delta_c^p \frac{\partial^2 x^c}{\partial k \partial q^c} & \delta_p^p \left(\frac{\partial^2 x^p}{\partial q^{p2}} - \frac{\partial^2 x^p}{\partial k \partial q^p}\right) \\ \delta_c^p \left(\frac{\partial^2 x^c}{\partial q^{c2}} - \frac{\partial^2 x^c}{\partial k \partial q^c}\right) & -\delta_p^p \frac{\partial^2 x^p}{\partial k \partial q^p} \end{vmatrix} + \begin{vmatrix} -\delta_r^p \frac{\partial^2 x^r}{\partial k \partial q^r} & \delta_p^p \left(\frac{\partial^2 x^p}{\partial q^{p2}} - \frac{\partial^2 x^p}{\partial k \partial q^p}\right) \\ -\delta_r^p \frac{\partial^2 x^r}{\partial k \partial q^r} & -\delta_p^p \frac{\partial^2 x^p}{\partial k \partial q^p} \end{vmatrix} \\
&\quad - \begin{vmatrix} -\delta_r^p \frac{\partial^2 x^r}{\partial k \partial q^r} & -\delta_c^p \frac{\partial^2 x^c}{\partial k \partial q^c} \\ -\delta_r^p \frac{\partial^2 x^r}{\partial k \partial q^r} & \delta_c^p \left(\frac{\partial^2 x^c}{\partial q^{c2}} - \frac{\partial^2 x^c}{\partial k \partial q^c}\right) \end{vmatrix} \\
&= -\delta_c^p \frac{\partial^2 x^c}{\partial k \partial q^c} \delta_p^p \frac{\partial^2 x^p}{\partial k \partial q^p} + \delta_p^p \left(\frac{\partial^2 x^p}{\partial q^{p2}} - \frac{\partial^2 x^p}{\partial k \partial q^p}\right) \delta_c^p \left(\frac{\partial^2 x^c}{\partial q^{c2}} - \frac{\partial^2 x^c}{\partial k \partial q^c}\right) \\
&\quad + \delta_r^p \frac{\partial^2 x^r}{\partial k \partial q^r} \left[\delta_p^p \frac{\partial^2 x^p}{\partial k \partial q^p} + \delta_p^p \left(\frac{\partial^2 x^p}{\partial q^{p2}} - \frac{\partial^2 x^p}{\partial k \partial q^p}\right) + \delta_c^p \left(\frac{\partial^2 x^c}{\partial q^{c2}} - \frac{\partial^2 x^c}{\partial k \partial q^c}\right) + \delta_c^p \frac{\partial^2 x^c}{\partial k \partial q^c}\right] \\
&= \delta_r^p \frac{\partial^2 x^r}{\partial k \partial q^r} \left(\delta_p^p \frac{\partial^2 x^p}{\partial q^{p2}} + \delta_c^p \frac{\partial^2 x^c}{\partial q^{c2}}\right) - \delta_p^p \frac{\partial^2 x^p}{\partial q^{p2}} \delta_c^p \frac{\partial^2 x^c}{\partial k \partial q^c} - \delta_c^p \frac{\partial^2 x^c}{\partial q^{c2}} \delta_p^p \frac{\partial^2 x^p}{\partial k \partial q^p} + \delta_p^p \frac{\partial^2 x^p}{\partial q^{p2}} \delta_c^p \frac{\partial^2 x^c}{\partial q^{c2}}.
\end{aligned}$$

The first term represents the ceteris paribus effect via the impact on Relative's post-transfer income. This is negative because a ceteris paribus increase in $\tilde{y}^p$ translates into a decrease of the same magnitude in q^{r*}, and the marginal subutility that Relative gains from Parent's educational spending is increasing in q^{r*} by assumption. The remaining three terms in the last line constitute the ceteris paribus effect via the impact on Parent's household's post-transfer income. It is positive. At this stage of proof, the sign of $|J_k|$ is ambiguous. Next,

$$
\begin{aligned}
|J_{q^c}| &= \begin{vmatrix} -1 & -1 & -1 \\ \delta^p_p \frac{\partial^2 x^p}{\partial q^p \partial k} - \sum_i \delta^p_i \frac{\partial^2 x^i}{\partial k^2} & -\delta^p_r \frac{\partial^2 x^r}{\partial k \partial q^r} & \delta^p_p \left(\frac{\partial^2 x^p}{\partial q^{p2}} - \frac{\partial^2 x^p}{\partial k \partial q^p} \right) \\ \delta^p_c \frac{\partial^2 x^c}{\partial q^c \partial k} - \sum_i \delta^p_i \frac{\partial^2 x^i}{\partial k^2} & -\delta^p_r \frac{\partial^2 x^r}{\partial k \partial q^r} & -\delta^p_p \frac{\partial^2 x^p}{\partial k \partial q^p} \end{vmatrix} \\
&= -\begin{vmatrix} -\delta^p_r \frac{\partial^2 x^r}{\partial k \partial q^r} & \delta^p_p \left(\frac{\partial^2 x^p}{\partial q^{p2}} - \frac{\partial^2 x^p}{\partial k \partial q^p} \right) \\ -\delta^p_r \frac{\partial^2 x^r}{\partial k \partial q^r} & -\delta^p_p \frac{\partial^2 x^p}{\partial k \partial q^p} \end{vmatrix} + \begin{vmatrix} \delta^p_p \frac{\partial^2 x^p}{\partial q^p \partial k} - \sum_i \delta^p_i \frac{\partial^2 x^i}{\partial k^2} & \delta^p_p \left(\frac{\partial^2 x^p}{\partial q^{p2}} - \frac{\partial^2 x^p}{\partial k \partial q^p} \right) \\ \delta^p_c \frac{\partial^2 x^c}{\partial q^c \partial k} - \sum_i \delta^p_i \frac{\partial^2 x^i}{\partial k^2} & -\delta^p_p \frac{\partial^2 x^p}{\partial k \partial q^p} \end{vmatrix} \\
&\quad - \begin{vmatrix} \delta^p_p \frac{\partial^2 x^p}{\partial q^p \partial k} - \sum_i \delta^p_i \frac{\partial^2 x^i}{\partial k^2} & -\delta^p_r \frac{\partial^2 x^r}{\partial k \partial q^r} \\ \delta^p_c \frac{\partial^2 x^c}{\partial q^c \partial k} - \sum_i \delta^p_i \frac{\partial^2 x^i}{\partial k^2} & -\delta^p_r \frac{\partial^2 x^r}{\partial k \partial q^r} \end{vmatrix} \\
&= -\delta^p_r \frac{\partial^2 x^r}{\partial k \partial q^r} \delta^p_p \frac{\partial^2 x^p}{\partial k \partial q^p} - \delta^p_p \left(\frac{\partial^2 x^p}{\partial q^{p2}} - \frac{\partial^2 x^p}{\partial k \partial q^p} \right) \delta^p_r \frac{\partial^2 x^r}{\partial k \partial q^r} \\
&\quad - \left(\delta^p_p \frac{\partial^2 x^p}{\partial q^p \partial k} - \sum_i \delta^p_i \frac{\partial^2 x^i}{\partial k^2} \right) \delta^p_p \frac{\partial^2 x^p}{\partial k \partial q^p} - \delta^p_p \left(\frac{\partial^2 x^p}{\partial q^{p2}} - \frac{\partial^2 x^p}{\partial k \partial q^p} \right) \left(\delta^p_c \frac{\partial^2 x^c}{\partial q^c \partial k} - \sum_i \delta^p_i \frac{\partial^2 x^i}{\partial k^2} \right) \\
&\quad + \left(\delta^p_p \frac{\partial^2 x^p}{\partial q^p \partial k} - \sum_i \delta^p_i \frac{\partial^2 x^i}{\partial k^2} \right) \delta^p_r \frac{\partial^2 x^r}{\partial k \partial q^r} - \delta^p_r \frac{\partial^2 x^r}{\partial k \partial q^r} \left(\delta^p_c \frac{\partial^2 x^c}{\partial q^c \partial k} - \sum_i \delta^p_i \frac{\partial^2 x^i}{\partial k^2} \right) \\
&= \delta^p_r \frac{\partial^2 x^r}{\partial k \partial q^r} \left(-\delta^p_p \frac{\partial^2 x^p}{\partial k \partial q^p} - \delta^p_p \frac{\partial^2 x^p}{\partial q^{p2}} + \delta^p_p \frac{\partial^2 x^p}{\partial k \partial q^p} + \delta^p_p \frac{\partial^2 x^p}{\partial q^p \partial k} - \sum_i \delta^p_i \frac{\partial^2 x^i}{\partial k^2} - \delta^p_c \frac{\partial^2 x^c}{\partial q^c \partial k} + \sum_i \delta^p_i \frac{\partial^2 x^i}{\partial k^2} \right) \\
&\quad - \left(\delta^p_p \frac{\partial^2 x^p}{\partial q^p \partial k} - \sum_i \delta^p_i \frac{\partial^2 x^i}{\partial k^2} \right) \delta^p_p \frac{\partial^2 x^p}{\partial k \partial q^p} - \delta^p_p \left(\frac{\partial^2 x^p}{\partial q^{p2}} - \frac{\partial^2 x^p}{\partial k \partial q^p} \right) \left(\delta^p_c \frac{\partial^2 x^c}{\partial q^c \partial k} - \sum_i \delta^p_i \frac{\partial^2 x^i}{\partial k^2} \right) \\
&= -\delta^p_r \frac{\partial^2 x^r}{\partial k \partial q^r} \left[\delta^p_p \left(\frac{\partial^2 x^p}{\partial q^{p2}} - \frac{\partial^2 x^p}{\partial q^p \partial k} \right) + \delta^p_c \frac{\partial^2 x^c}{\partial q^c \partial k} \right] \\
&\quad - \left(\delta^p_p \frac{\partial^2 x^p}{\partial q^p \partial k} \right)^2 - \delta^p_p \frac{\partial^2 x^p}{\partial q^{p2}} \left(\delta^p_c \frac{\partial^2 x^c}{\partial q^c \partial k} - \sum_i \delta^p_i \frac{\partial^2 x^i}{\partial k^2} \right) + \delta^p_p \frac{\partial^2 x^p}{\partial k \partial q^p} \delta^p_c \frac{\partial^2 x^c}{\partial q^c \partial k}
\end{aligned}
$$

where the first term again represents the effect via the impact on Relative's post-transfer income, and the other terms constitute the effect via the impact on Parent's household's post-transfer income. Since (10) implies that, holding $\tilde{y}^p$ fixed, q^c must rise to counterbalance the effect of q^{r*} on $\partial x^r / \partial k$. Thus, the first effect is positive, i.e.

$$\delta^p_c \frac{\partial^2 x^c}{\partial q^c \partial k} < \delta^p_p \left(\frac{\partial^2 x^p}{\partial q^p \partial k} - \frac{\partial^2 x^p}{\partial q^{p2}} \right). \tag{17}$$

In addition, we know that the second effect is also positive,

$$\left(\delta^p_p \frac{\partial^2 x^p}{\partial q^p \partial k} \right)^2 < \delta^p_p \frac{\partial^2 x^p}{\partial q^p \partial k} \delta^p_c \frac{\partial^2 x^c}{\partial q^c \partial k} - \delta^p_p \frac{\partial^2 x^p}{\partial q^{p2}} \left(\delta^p_c \frac{\partial^2 x^c}{\partial q^c \partial k} - \sum_i \delta^p_i \frac{\partial^2 x^i}{\partial k^2} \right). \tag{18}$$

Hence $|J_{q^c}| > 0$. Similarly,

$$
\begin{aligned}
|J_{q^p}| &= \begin{vmatrix} -1 & -1 & -1 \\ \delta_p^p \frac{\partial^2 x^p}{\partial q^p \partial k} - \sum_i \delta_i^p \frac{\partial^2 x^i}{\partial k^2} & -\delta_c^p \frac{\partial^2 x^c}{\partial k \partial q^c} & -\delta_r^p \frac{\partial^2 x^r}{\partial k \partial q^r} \\ \delta_c^p \frac{\partial^2 x^c}{\partial q^c \partial k} - \sum_i \delta_i^p \frac{\partial^2 x^i}{\partial k^2} & \delta_c^p \left(\frac{\partial^2 x^c}{\partial q^{c2}} - \frac{\partial^2 x^c}{\partial k \partial q^c} \right) & -\delta_r^p \frac{\partial^2 x^r}{\partial k \partial q^r} \end{vmatrix} \\
&= -\begin{vmatrix} -\delta_c^p \frac{\partial^2 x^c}{\partial k \partial q^c} & -\delta_r^p \frac{\partial^2 x^r}{\partial k \partial q^r} \\ \delta_c^p \left(\frac{\partial^2 x^c}{\partial q^{c2}} - \frac{\partial^2 x^c}{\partial k \partial q^c} \right) & -\delta_r^p \frac{\partial^2 x^r}{\partial k \partial q^r} \end{vmatrix} + \begin{vmatrix} \delta_p^p \frac{\partial^2 x^p}{\partial q^p \partial k} - \sum_i \delta_i^p \frac{\partial^2 x^i}{\partial k^2} & -\delta_r^p \frac{\partial^2 x^r}{\partial k \partial q^r} \\ \delta_c^p \frac{\partial^2 x^c}{\partial q^c \partial k} - \sum_i \delta_i^p \frac{\partial^2 x^i}{\partial k^2} & -\delta_r^p \frac{\partial^2 x^r}{\partial k \partial q^r} \end{vmatrix} \\
&\quad - \begin{vmatrix} \delta_p^p \frac{\partial^2 x^p}{\partial q^p \partial k} - \sum_i \delta_i^p \frac{\partial^2 x^i}{\partial k^2} & -\delta_c^p \frac{\partial^2 x^c}{\partial k \partial q^c} \\ \delta_c^p \frac{\partial^2 x^c}{\partial q^c \partial k} - \sum_i \delta_i^p \frac{\partial^2 x^i}{\partial k^2} & \delta_c^p \left(\frac{\partial^2 x^c}{\partial q^{c2}} - \frac{\partial^2 x^c}{\partial k \partial q^c} \right) \end{vmatrix} \\
&= \delta_r^p \frac{\partial^2 x^r}{\partial k \partial q^r} \left(-\delta_c^p \frac{\partial^2 x^c}{\partial k \partial q^c} - \delta_c^p \frac{\partial^2 x^c}{\partial q^{c2}} + \delta_c^p \frac{\partial^2 x^c}{\partial k \partial q^c} - \delta_p^p \frac{\partial^2 x^p}{\partial q^p \partial k} + \sum_i \delta_i^p \frac{\partial^2 x^i}{\partial k^2} + \delta_c^p \frac{\partial^2 x^c}{\partial q^c \partial k} - \sum_i \delta_i^p \frac{\partial^2 x^i}{\partial k^2} \right) \\
&\quad - \left(\delta_p^p \frac{\partial^2 x^p}{\partial q^p \partial k} - \sum_i \delta_i^p \frac{\partial^2 x^i}{\partial k^2} \right) \delta_c^p \left(\frac{\partial^2 x^c}{\partial q^{c2}} - \frac{\partial^2 x^c}{\partial k \partial q^c} \right) - \delta_c^p \frac{\partial^2 x^c}{\partial k \partial q^c} \left(\delta_c^p \frac{\partial^2 x^c}{\partial q^c \partial k} - \sum_i \delta_i^p \frac{\partial^2 x^i}{\partial k^2} \right) \\
&= -\delta_r^p \frac{\partial^2 x^r}{\partial k \partial q^r} \left[\delta_c^p \left(\frac{\partial^2 x^c}{\partial q^{c2}} - \frac{\partial^2 x^c}{\partial q^c \partial k} \right) + \delta_p^p \frac{\partial^2 x^p}{\partial q^p \partial k} \right] \\
&\quad - \left(\delta_c^p \frac{\partial^2 x^c}{\partial q^c \partial k} \right)^2 - \delta_c^p \frac{\partial^2 x^c}{\partial q^{c2}} \left(\delta_p^p \frac{\partial^2 x^p}{\partial q^p \partial k} - \sum_i \delta_i^p \frac{\partial^2 x^i}{\partial k^2} \right) + \delta_c^p \frac{\partial^2 x^c}{\partial k \partial q^c} \delta_p^p \frac{\partial^2 x^p}{\partial q^p \partial k}
\end{aligned}
$$

where the first term again represents the effect through the impact on Relative's post-transfer income, and the remaining terms constitute the effect through the impact on Parent's household's post-transfer income. Again, (10) implies the first effect is positive, i.e.

$$\delta_p^p \frac{\partial^2 x^p}{\partial q^p \partial k} < \delta_c^p \left(\frac{\partial^2 x^c}{\partial q^c \partial k} - \frac{\partial^2 x^c}{\partial q^{c2}} \right), \tag{19}$$

and we know that the second effect is also positive,

$$\left(\delta_c^p \frac{\partial^2 x^c}{\partial q^c \partial k} \right)^2 < \delta_c^p \frac{\partial^2 x^c}{\partial q^c \partial k} \delta_p^p \frac{\partial^2 x^p}{\partial q^p \partial k} - \delta_c^p \frac{\partial^2 x^c}{\partial q^{c2}} \left(\delta_p^p \frac{\partial^2 x^p}{\partial q^p \partial k} - \sum_i \delta_i^p \frac{\partial^2 x^i}{\partial k^2} \right). \tag{20}$$

Thus, $|J_{q^p}| > 0$.

Note that adding (18) and (20) up gives

$$
\begin{aligned}
\left(\delta_p^p \frac{\partial^2 x^p}{\partial k \partial q^p} - \delta_c^p \frac{\partial^2 x^c}{\partial k \partial q^c} \right)^2 \quad < \quad & \left(\delta_p^p \frac{\partial^2 x^p}{\partial q^{p2}} + \delta_c^p \frac{\partial^2 x^c}{\partial q^{c2}} \right) \sum_i \delta_i^p \frac{\partial^2 x^i}{\partial k^2} \\
& - \delta_p^p \frac{\partial^2 x^p}{\partial q^{p2}} \delta_c^p \frac{\partial^2 x^c}{\partial k \partial q^c} - \delta_c^p \frac{\partial^2 x^c}{\partial q^{c2}} \delta_p^p \frac{\partial^2 x^p}{\partial k \partial q^p},
\end{aligned} \tag{21}
$$

which implies $|J| > 0$, i.e.

$$\left(\delta_p^p \frac{\partial^2 x^p}{\partial k \partial q^p} - \delta_c^p \frac{\partial^2 x^c}{\partial k \partial q^c}\right)^2 < \left(\delta_p^p \frac{\partial^2 x^p}{\partial q^{p2}} + \delta_c^p \frac{\partial^2 x^c}{\partial q^{c2}}\right) \sum_i \delta_i^p \frac{\partial^2 x^i}{\partial k^2} + \delta_p^p \frac{\partial^2 x^p}{\partial q^{p2}} \delta_c^p \frac{\partial^2 x^c}{\partial q^{c2}}$$
$$-2\delta_p^p \frac{\partial^2 x^p}{\partial q^{p2}} \delta_c^p \frac{\partial^2 x^c}{\partial k \partial q^c} - 2\delta_c^p \frac{\partial^2 x^c}{\partial q^{c2}} \delta_p^p \frac{\partial^2 x^p}{\partial k \partial q^p},$$

confirming that $\partial q^c / \partial \tilde{y}^p, \partial q^p / \partial \tilde{y}^p > 0$. Finally, by adding $|J_{q^c}|$ and $|J_{q^p}|$ up, we get

$$-\delta_r^p \frac{\partial^2 x^r}{\partial k \partial q^r} \left(\delta_p^p \frac{\partial^2 x^p}{\partial q^{p2}} + \delta_c^p \frac{\partial^2 x^c}{\partial q^{c2}}\right) > \left(\delta_p^p \frac{\partial^2 x^p}{\partial k \partial q^p} - \delta_c^p \frac{\partial^2 x^c}{\partial k \partial q^c}\right)^2 + \delta_p^p \frac{\partial^2 x^p}{\partial q^{p2}} \delta_c^p \frac{\partial^2 x^c}{\partial k \partial q^c} + \delta_c^p \frac{\partial^2 x^c}{\partial q^{c2}} \delta_p^p \frac{\partial^2 x^p}{\partial k \partial q^p}$$
$$-\left(\delta_p^p \frac{\partial^2 x^p}{\partial q^{p2}} + \delta_c^p \frac{\partial^2 x^c}{\partial q^{c2}}\right) \sum_i \delta_i^p \frac{\partial^2 x^i}{\partial k^2}.$$

Then, if $|J_k| > 0$, we must have

$$\delta_p^p \frac{\partial^2 x^p}{\partial q^{p2}} \delta_c^p \frac{\partial^2 x^c}{\partial q^{c2}} - \delta_p^p \frac{\partial^2 x^p}{\partial q^{p2}} \delta_c^p \frac{\partial^2 x^c}{\partial k \partial q^c} - \delta_c^p \frac{\partial^2 x^c}{\partial q^{c2}} \delta_p^p \frac{\partial^2 x^p}{\partial k \partial q^p} > \left(\delta_p^p \frac{\partial^2 x^p}{\partial k \partial q^p} - \delta_c^p \frac{\partial^2 x^c}{\partial k \partial q^c}\right)^2 + \delta_p^p \frac{\partial^2 x^p}{\partial q^{p2}} \delta_c^p \frac{\partial^2 x^c}{\partial k \partial q^c}$$
$$+\delta_c^p \frac{\partial^2 x^c}{\partial q^{c2}} \delta_p^p \frac{\partial^2 x^p}{\partial k \partial q^p} - \left(\delta_p^p \frac{\partial^2 x^p}{\partial q^{p2}} + \delta_c^p \frac{\partial^2 x^c}{\partial q^{c2}}\right) \sum_i \delta_i^p \frac{\partial^2 x^i}{\partial k^2},$$

or

$$\left(\delta_p^p \frac{\partial^2 x^p}{\partial k \partial q^p} - \delta_c^p \frac{\partial^2 x^c}{\partial k \partial q^c}\right)^2 < \left(\delta_p^p \frac{\partial^2 x^p}{\partial q^{p2}} + \delta_c^p \frac{\partial^2 x^c}{\partial q^{c2}}\right) \sum_i \delta_i^p \frac{\partial^2 x^i}{\partial k^2} + \delta_p^p \frac{\partial^2 x^p}{\partial q^{p2}} \delta_c^p \frac{\partial^2 x^c}{\partial q^{c2}}$$
$$-2\delta_p^p \frac{\partial^2 x^p}{\partial q^{p2}} \delta_c^p \frac{\partial^2 x^c}{\partial k \partial q^c} - 2\delta_c^p \frac{\partial^2 x^c}{\partial q^{c2}} \delta_p^p \frac{\partial^2 x^p}{\partial k \partial q^p}.$$

But this is the same condition for $|J| > 0$ and is true, as implied by (21). Hence $|J_k| > 0$. QED.

Since we know that

$$\frac{\partial k^*}{\partial \tilde{y}^p} + \frac{\partial q^{c*}}{\partial \tilde{y}^p} + \frac{\partial q^{p*}}{\partial \tilde{y}^p} = 1,$$

we have

$$|J_k| + |J_{q^c}| + |J_{q^p}| = |J|.$$

Also note that (17) and (19) together suggest

$$\delta_c^p \frac{\partial^2 x^c}{\partial q^c \partial k} + \delta_p^p \frac{\partial^2 x^p}{\partial q^{p2}} < \delta_p^p \frac{\partial^2 x^p}{\partial q^p \partial k} < \delta_c^p \frac{\partial^2 x^c}{\partial q^c \partial k} - \delta_c^p \frac{\partial^2 x^c}{\partial q^{c2}}. \tag{22}$$

C. Possible equilibrium transfers

The following 13 equilibrium situations are possible.

Case 1: Mine first. Each of them cares about his own household sufficiently more than the other's such that

$$\tilde{y}^{pP} > \frac{Y}{2} > \tilde{y}^{pR}.$$

(a) If $\tilde{y}^{pP} > y^p$ and $\tilde{y}^{rR} = Y - \tilde{y}^{pR} > y^r$, no transfer takes place, and neither player achieves his most preferred division of Y between the two households, i.e.

$$\begin{aligned} q^{r*} &= y^r, \\ q^{p*} &= q^{p*}\left(\tilde{y}^p = y^p\right), \\ q^{c*} &= q^{c*}\left(\tilde{y}^p = y^p\right), \\ k^* &= k^*\left(\tilde{y}^p = y^p\right). \end{aligned}$$

(b) If $\tilde{y}^{pP} < y^p$, then $\tilde{y}^{rR} > y^r$, and we have $(\tau^{pr*}, \tau^{rp*}) = \left(y^p - \tilde{y}^{pP}, 0\right)$. As a result, Parent's optimum is achieved, i.e.

$$\begin{aligned} q^{r*} &= \tilde{y}^{rP} = Y - \tilde{y}^{pP}, \\ q^{p*} &= q^{pP} = q^{p*}\left(\tilde{y}^p = \tilde{y}^{pP}\right), \\ q^{c*} &= q^{cP} = q^{c*}\left(\tilde{y}^p = \tilde{y}^{pP}\right), \\ k^* &= k^P = k^*\left(\tilde{y}^p = \tilde{y}^{pP}\right). \end{aligned}$$

(c) If $\tilde{y}^{rR} < y^r$, then $\tilde{y}^{pP} > y^p$, and we have $(\tau^{pr*}, \tau^{rp*}) = \left(0, y^r - \tilde{y}^{rR}\right)$. Consequently, Relative's ideal is achieved, i.e.

$$\begin{aligned} q^{r*} &= \tilde{y}^{rR} = Y - \tilde{y}^{pR}, \\ q^{p*} &= q^{pR} = q^{p*}\left(\tilde{y}^p = \tilde{y}^{pR}\right), \\ q^{c*} &= q^{cR} = q^{c*}\left(\tilde{y}^p = \tilde{y}^{pR}\right), \\ k^* &= k^R = k^*\left(\tilde{y}^p = \tilde{y}^{pR}\right). \end{aligned}$$

Case 2: Yours first. Each cares about the other's household sufficiently more than his own such that

$$\tilde{y}^{pP} < \frac{Y}{2} < \tilde{y}^{pR}.$$

(a) If $\tilde{y}^{pP} < y^p$ and $\tilde{y}^{rR} < y^r$, then each player wants to transfer to the other. As they are assumed to behave noncooperatively, I assume $(\tau^{pr*}, \tau^{rp*}) = \left(y^p - \tilde{y}^{pP}, y^r - \tilde{y}^{rR}\right)$ under this circumstance. Accordingly, neither player achieves his most preferred division of Y between the two households, i.e.

$$\begin{aligned} q^{r*} &= \tilde{y}^{rR} + y^p - \tilde{y}^{pP}, \\ q^{p*} &= q^{p*}\left(\tilde{y}^p = \tilde{y}^{pP} + y^r - \tilde{y}^{rR}\right), \\ q^{c*} &= q^{c*}\left(\tilde{y}^p = \tilde{y}^{pP} + y^r - \tilde{y}^{rR}\right), \\ k^* &= k^*\left(\tilde{y}^p = \tilde{y}^{pP} + y^r - \tilde{y}^{rR}\right). \end{aligned}$$

(b) If $\tilde{y}^{pP} < y^p$ and $\tilde{y}^{rR} \geq y^r$, then $(\tau^{pr*}, \tau^{rp*}) = \left(y^p - \tilde{y}^{pP}, 0\right)$. As a result, Parent achieves his optimum, i.e.

$$\begin{aligned} q^{r*} &= \tilde{y}^{rP} = Y - \tilde{y}^{pP}, \\ q^{p*} &= q^{pP} = q^{p*}\left(\tilde{y}^p = \tilde{y}^{pP}\right), \\ q^{c*} &= q^{cP} = q^{c*}\left(\tilde{y}^p = \tilde{y}^{pP}\right), \\ k^* &= k^P = k^*\left(\tilde{y}^p = \tilde{y}^{pP}\right). \end{aligned}$$

(c) If $\tilde{y}^{pP} \geq y^p$ and $\tilde{y}^{rR} < y^r$, then $(\tau^{pr*}, \tau^{rp*}) = \left(0, y^r - \tilde{y}^{rR}\right)$. Subsequently, Relative achieves his most preferred division of Y between the two households, i.e.

$$\begin{aligned} q^{r*} &= \tilde{y}^{rR} = Y - \tilde{y}^{pR}, \\ q^{p*} &= q^{pR} = q^{p*}\left(\tilde{y}^p = \tilde{y}^{pR}\right), \\ q^{c*} &= q^{cR} = q^{c*}\left(\tilde{y}^p = \tilde{y}^{pR}\right), \\ k^* &= k^R = k^*\left(\tilde{y}^p = \tilde{y}^{pR}\right). \end{aligned}$$

Case 3: Only one of them cares about the other's so much. If only Parent cares about Relative's household so much, then

$$\tilde{y}^{pP} < \frac{Y}{2} < \tilde{y}^{rR}.$$

In this case, $\tilde{y}^{pR} < Y/2 < \tilde{y}^{rP}$. If instead only Relative cares about Parent's so much, then

$$\tilde{y}^{pP} > \frac{Y}{2} > \tilde{y}^{rR}.$$

In this case, $\tilde{y}^{pR} > Y/2 > \tilde{y}^{rP}$. In either situation, one of the following four cases applies.

(a) If $y^p \leq \tilde{y}^{pP} < \tilde{y}^{pR}$ or $y^p < \tilde{y}^{pR} \leq \tilde{y}^{pP}$, then $(\tau^{pr*}, \tau^{rp*}) = \left(0, y^r - \tilde{y}^{rR}\right)$, and Relative achieves his ideal, i.e.

$$\begin{aligned}
q^{r*} &= \tilde{y}^{rR} = Y - \tilde{y}^{pR}, \\
q^{p*} &= q^{pR} = q^{p*}\left(\tilde{y}^{p} = \tilde{y}^{pR}\right), \\
q^{c*} &= q^{cR} = q^{c*}\left(\tilde{y}^{p} = \tilde{y}^{pR}\right), \\
k^{*} &= k^{R} = k^{*}\left(\tilde{y}^{p} = \tilde{y}^{pR}\right).
\end{aligned}$$

(b) If $\tilde{y}^{pP} < y^{p} < \tilde{y}^{pR}$, then we have $(\tau^{pr*}, \tau^{rp*}) = \left(y^{p} - \tilde{y}^{pP}, y^{r} - \tilde{y}^{rR}\right)$. Here, neither player can achieve his most preferred outcome, i.e.

$$\begin{aligned}
q^{r*} &= \tilde{y}^{rR} + y^{p} - \tilde{y}^{pP}, \\
q^{p*} &= q^{p*}\left(\tilde{y}^{p} = \tilde{y}^{pP} + y^{r} - \tilde{y}^{rR}\right), \\
q^{c*} &= q^{c*}\left(\tilde{y}^{p} = \tilde{y}^{pP} + y^{r} - \tilde{y}^{rR}\right), \\
k^{*} &= k^{*}\left(\tilde{y}^{p} = \tilde{y}^{pP} + y^{r} - \tilde{y}^{rR}\right).
\end{aligned}$$

(c) If $\tilde{y}^{pR} \leq y^{p} \leq \tilde{y}^{pP}$, then $(\tau^{pr*}, \tau^{rp*}) = (0, 0)$. Again, neither player can achieve his most preferred outcome, i.e.

$$\begin{aligned}
q^{r*} &= y^{r}, \\
q^{p*} &= q^{p*}\left(\tilde{y}^{p} = y^{p}\right), \\
q^{c*} &= q^{c*}\left(\tilde{y}^{p} = y^{p}\right), \\
k^{*} &= k^{*}\left(\tilde{y}^{p} = y^{p}\right).
\end{aligned}$$

(d) If $\tilde{y}^{pP} < \tilde{y}^{pR} \leq y^{p}$ or $\tilde{y}^{pR} \leq \tilde{y}^{pP} < y^{p}$, then $(\tau^{pr*}, \tau^{rp*}) = \left(y^{p} - \tilde{y}^{pP}, 0\right)$, and Parent's ideal allocation of Y is achieved, i.e.

$$\begin{aligned}
q^{r*} &= \tilde{y}^{rP} = Y - \tilde{y}^{pP}, \\
q^{p*} &= q^{pP} = q^{p*}\left(\tilde{y}^{p} = \tilde{y}^{pP}\right), \\
q^{c*} &= q^{cP} = q^{c*}\left(\tilde{y}^{p} = \tilde{y}^{pP}\right), \\
k^{*} &= k^{P} = k^{*}\left(\tilde{y}^{p} = \tilde{y}^{pP}\right).
\end{aligned}$$

Case 4: Coincidence. Each of them cares about his own household and the other's equally, i.e.

$$\begin{aligned}\tilde{y}^{pP} &= \tilde{y}^{rP}, \\ \tilde{y}^{pR} &= \tilde{y}^{rR}.\end{aligned}$$

Each household will then have $Y/2$ after transfers, and both players achieve their most preferred outcomes, i.e.

$$\begin{aligned}q^{r*} &= \tilde{y}^{rP} = \tilde{y}^{rR} = \tilde{y}^{pR} = \tilde{y}^{pP} = Y/2, \\ q^{p*} &= q^{pP} = q^{pR} = q^{p*}\left(\tilde{y}^{p} = \tilde{y}^{r} = Y/2\right), \\ q^{c*} &= q^{cP} = q^{cR} = q^{c*}\left(\tilde{y}^{p} = \tilde{y}^{r} = Y/2\right), \\ k^{*} &= k^{P} = k^{R} = k^{*}\left(\tilde{y}^{p} = \tilde{y}^{r} = Y/2\right).\end{aligned}$$

(a) If $\tilde{y}^{pP} = y^p \Leftrightarrow \tilde{y}^{rR} = y^r$, then $(\tau^{pr*}, \tau^{rp*}) = (0, 0)$. Each player's most preferred income allocation will coincide with the existing income distribution.

(b) If $\tilde{y}^{pP} < y^p \Leftrightarrow \tilde{y}^{rR} > y^r$, then we have $(\tau^{pr*}, \tau^{rp*}) = \left(y^p - \tilde{y}^{pP}, 0\right)$.

(c) If $\tilde{y}^{rR} < y^r \Leftrightarrow \tilde{y}^{pP} > y^p$, then $(\tau^{pr*}, \tau^{rp*}) = \left(0, y^r - \tilde{y}^{rR}\right)$.

Table 1. Summary statistics (means) of cross-wave changes and first-wave levels

N = 2,731 children	Net transfer increased? Yes N = 662	Net transfer increased? No N = 2,069	p-value for rejecting H_0: the difference is not different from 0
Dependent var.			
Household spending for educating the child (VN$'000) [Δ]	248.78	161.69	.00
Controlled var.			
Individual level			
Male*	.51	.51	.84
Age (months) [W1]	117.63	117.17	.63
Seriously ill* [Δ]	.00	.00	.71
Co-residing members			
# older members below 70 [Δ]	-.53	-.49	.34
# younger members [Δ]	.14	.23	.00
Household level			
Net transfer (VN$ mil) [Δ]	1.12	-.48	.00
Wealth			
Dwelling value (VN$ mil) [W1]	15.98	10.92	.00
Durable goods (VN$ mil) [Δ]	2.88	1.88	.00
[W1]	2.25	1.61	.00
Self-managed business			
Agriculture* [Δ]	-.03	-.01	.11
[W1]	.84	.89	.00
Non-agri. biz* [Δ]	.01	-.02	.21
[W1]	.47	.47	.98
# members aged 70 or more [Δ]	-.01	-.00	.65
Head's characteristics			
Male*	.80	.87	.00
Age (months) [W1]	481.97	480.16	.64
Ethnic minority*	.11	.16	.00
Religion [W1]			
None*	.63	.63	.98
Buddhist*	.26	.25	.72
Catholic*	.09	.09	.95
Protestant*	.01	.01	.70
Other*	.02	.02	.54
Highest educ. Attainment [W1]			
None*	.28	.37	.00
Primary school*	.25	.26	.73
Lower secondary school*	.29	.27	.26
Upper secondary school*	.06	.05	.33
Technical school/college*	.08	.05	.00
University*	.04	.01	.00
Have a spouse at home* [Δ]	.03	-.00	.00
[W1]	.88	.94	.00
Seriously ill* [Δ]	.00	.00	.31

(Table 1 continued)

Location			
North Vietnam*	.51	.50	.69
Rural area*	.79	.88	.00
12/97-06/98 drought-hit area*	.35	.40	.05
Instruments for Δ(Net transfer)			
If located outside drought-hit regions			
At least one relative inside* [W2]	.06	.04	.08
# Relatives inside [W2]	.12	.09	.24
If located inside drought-hit regions			
At least one relative outside* [W2]	.04	.03	.34
# Relatives outside [W2]	.07	.04	.05

Sources: VLSS 1992-1993 & 1997-1998

Notes: Dummy variables are indicated by *. Cross-wave changes are indicated by Δ, first-wave levels by W1, and second-wave levels by W2. All monetary figures are adjusted to both temporal and spatial price level differences and are expressed at the January 1993 national average price level. GNI per capita was VN$2,268,708 in 1993 when US$1 ≈ VN$10,641, according to the World Bank (http://databank.worldbank.org).

The dependent variable refers to the 12-month period prior to the interview. So does the amount of net interhousehold transfers. The cross-wave change in the dwelling value is not provided due to many missing observations in the second wave. Durable goods refer to those purchased more than 12 months ago, and the value of each goods is the price that the owner thought could be charged in the market at the time of interview. "Seriously ill" indicates the person was so ill that her/his anthropometric information could not be collected when the surveyor visited the household. The areas affected by the 12/97-06/98 drought are rural communes of Uplands, North Central Coast, South Central Coast, and Central Highlands.

Table 2. Instrumented first-difference analysis of the impact of the net interhousehold transfer on household spending for educating the child (2SLS)

N = 2,731 children Dependent var.	First stage Net transfer [Δ]		Main eq. ln(Ed spending) [Δ]	
Explanatory var. of interest				
Relative in drought-hit area but not itself*	+.47**	(1.97)	..	
Net transfer [Δ]	..		-1.20	[1.53]
M&P's coverage-corrected *p*-value (nonrobust)			.01	
Other explanatory var.				
Household characteristics				
Located in Drought-hit area*	-.27**	(2.12)	-.24	[.79]
North Vietnam*	+.20	(1.42)	+.46*	[1.81]
Rural area*	+.21	(1.04)	+.37	[1.24]
Dwelling value [W1]	+.00	(.58)	+.01	[.64]
Durable goods value [W1]	+.04	(.90)	+.09	[1.62]
[Δ]	-.03	(.82)	-.01	[.29]
Own self-managed biz in Agriculture* [W1]	+.04	(.14)	+.01	[.02]
[Δ]	+.14	(.65)	+.15	[.46]
Non-agricu.* [W1]	-.16	(1.65)	-.16	[.84]
[Δ]	-.01	(.03)	+.07	[.31]
# members aged 70 or more [Δ]	+.23	(.62)	+.18	[.35]
Household head's characteristics				
Male*	-.20	(1.27)	-.74**	[2.57]
Ethnic minority*	-.05	(.54)	+.40**	[2.15]
Age in months [W1]	+.01**	(1.97)	+.02*	[1.75]
Age in months squared [W1]	-.00**	(2.18)	-.00*	[1.74]
Edu [W1: Ref, None] is Primary sch.*	-.17	(1.24)	-.09	[.36]
Lower secondary sch.*	-.41***	(3.36)	+.12	[.33]
Upper secondary sch.*	-.22	(.66)	+.56	[1.24]
Technical sch/college*	-.47**	(2.31)	+.27	[.58]
University*	+1.98**	(2.43)	+3.23**	[2.07]
Religion [W1: Ref, None] is Buddhism*	+.02	(.18)	-.27*	[1.66]
Catholicism*	-.96**	(2.26)	-1.08	[1.21]
Protestantism*	+.04	(.14)	+.78	[1.52]
Other belief*	-.21	(1.40)	-.54	[1.22]
Have a spouse* [W1]	+.08	(.31)	+.74*	[1.95]
[Δ]	+1.57**	(2.40)	+2.17	[1.36]
Seriously ill* [Δ]	-.81	(1.50)	+.03	[.03]
Child's characteristics				
Male*	+.05	(.45)	+.43***	[2.67]
Age in years [W1: Ref, 7]: 8	+.04	(.34)	-.46**	[2.34]
9	-.24	(1.06)	-1.23***	[3.72]
10	-.11	(.58)	-1.73***	[5.82]
11	-.05	(.35)	-2.16***	[9.33]
12	-.01	(.06)	-2.69***	[9.60]
13	-.69	(1.16)	-2.92***	[2.87]
Seriously ill* [Δ]	+.52	(1.63)	+1.03	[.54]
# Younger members [Δ]	-.14*	(1.95)	-.25*	[1.66]
# Older members below 70 [Δ]	+.10	(1.17)	+.12	[1.06]
Robust F(1, 2,692) for H0: The excluded is not different from zero			3.89	
p-value for rejecting the null			.05	
Partial R^2 between Δ(Net transfer) and the excluded			.00	
p-value for rejecting H_0: Δ(Net transfer) is not endogenous				
Based on robust score $chi^2(1)$			.02	
Based on robust regression F(1, 2,691)			.02	
OLS-estimated coefficient on non-instrumented Δ(Net transfer)			-.02**	(2.23)

Notes: Starred variables are dummies. Starred estimates are statistically significant at 1%(***), 5%(**), 10%(*). Following each estimate, heteroskedasticity-robust *t*-statistic in brackets and *z*-statistic in square brackets. M&P's stands Mikusheva and Poi's (2006) conditional likelihood-ratio test. To deal with a small number (5% of the estimation sample) of children for whose education Δ(Ed spending) was zero, 1 dong was added to all observations before taking log.

Table 3. Using alternative instruments

N = 2,731 children Dependent var.	First stage Net transfer [Δ]	Main eq. ln(Ed spend) [Δ]
(a) Remove the dummy "Located in drought-hit area" from the main equation & Introduce an additional instrument "Located in drought-hit area and have a relative outside the affected area" (LIML)		
Have relative inside drought-hit area*	+.51** (2.16)	..
Have relative outside it*	-.87** (1.96)	..
Net transfer [Δ]	..	-.51 [1.25]
M&P's coverage-corrected *p*-value (nonrobust)		.07
Robust F(2, 2,692) for H_0: The excluded aren't different from zero		4.40
p-value for rejecting the null		.01
Partial R^2 between Δ(Net transfer) and the excluded		.00
p-value for rejecting H_0: Both IVs are valid & should be excluded		.06
p-value for rejecting H_0: Δ(Net transfer) is not endogenous		
Based on 2SLS robust score $chi^2(1)$		.14
Based on 2SLS robust regression F(1, 2,692)		.14
(b) Do not remove "Located in drought-hit area" from the main equation & Replace the indicator instrument with "# Relatives inside the affected area if the household is located outside it" (2SLS)		
# Relatives inside drought-hit area	+.14** (2.10)	..
Net transfer [Δ]	..	-1.35 [1.64]
M&P's coverage-corrected p-value (nonrobust)		.01
Robust F(1, 2,692) for H_0: The excluded aren't different from zero		4.40
p-value for rejecting the null		.04
Partial R^2 between Δ(Net transfer) and the excluded		.00
p-value for rejecting H_0: Δ(Net transfer) is not endogenous		
Based on robust score $chi^2(1)$		.01
Based on robust regression F(1, 2,691)		.01
(c) Replace the indicator instrument with "# Relatives inside the affected area if the household is located outside it" & Remove the dummy "Located in drought-hit area" from the main equation & Introduce an additional instrument "# Relatives outside the affected area if the household is located inside it" (LIML)		
# Relatives inside drought-hit area	+.15** (2.17)	..
# Relatives outside it	-.49 (1.50)	..
Net transfer [Δ]	..	-.64 [1.00]
M&P's coverage-corrected p-value (nonrobust)		.06
Robust F(2, 2,692) for H_0: The excluded aren't different from zero		3.61
p-value for rejecting the null		.03
Partial R^2 between Δ(Net transfer) and the excluded		.00
p-value for rejecting H_0: Both IVs are valid & should be excluded		.05
p-value for rejecting H_0: Δ(Net transfer) is not endogenous		
Based on 2SLS robust score $chi^2(1)$		.16
Based on 2SLS robust regression F(1, 2,692)		.18

Notes: The test of overidentifying restrictions is based on 2SLS robust score chi^2(#IVs - 1). See the notes for Table 2.

Table A1. Cross-sectional summary statistics (means): From 7 up to 18 year olds

	Wave 1			Wave 2		
	Net transferrer household?			Net transferrer household?		
	Yes N = 757	No N = 4,511	*p*-value for rejecting H_0: the difference is not different from 0	Yes N = 801	No N = 4,045	*p*-value for rejecting H_0: the difference is not different from 0
Dependent var.						
Household spending for the child's ed (VN$'000)	100.44	74.70	.00	286.52	199.48	.00
Controlled var.						
Individual level						
Male*	.51	.50	.74	.51	.50	.53
Age (months)	147.14	146.55	.69	152.15	150.85	.37
Seriously ill*	.00	.00	.15	0	.00	.44
Co-residing members						
# Older members below 70	3.63	3.51	.05	3.31	3.40	.11
# Younger members	1.54	1.70	.00	1.20	1.35	.00
Household level						
Net transfer (VN$ mil)	.34	-.27	.00	.86	-.48	.00
Wealth						
Dwelling value (VN$ mil)	16.00	13.37	.04	28.28	21.41	.00
Durable goods (VN$ mil)	3.00	1.75	.00	5.74	3.10	.00
Self-managed business						
Agriculture*	.83	.88	.00	.86	.88	.13
Non-agri. biz*	.59	.47	.00	.52	.45	.00
# Members aged 70 or more	.11	.11	.92	.08	.10	.04
Head unchanged*	.94	.95	.33	.97	.96	.25

(Table A1 continued)

Head's characteristics						
Male*	.86	.82	.03	.85	.85	.86
Age (months)	520.63	519.18	.71	516.64	512.83	.28
Ethnic minority*	.08	.16	.00	.13	.18	.00
Religion						
None*	.65	.62	.08	.74	.72	.14
Buddhist*	.23	.27	.03	.16	.16	.67
Catholic*	.10	.08	.25	.07	.09	.01
Protestant*	.01	.01	.43	.01	.01	.97
Other*	.02	.02	.36	.02	.02	.47
Highest educ. attainment						
None*	.31	.40	.00	.19	.32	.00
Primary sch.*	.30	.25	.00	.23	.24	.79
Lower secondary sch.*	.25	.23	.29	.29	.28	.38
Upper secondary sch.*	.04	.04	.88	.08	.06	.02
Technical sch./college*	.08	.06	.06	.17	.10	.00
University*	.01	.01	.79	.04	.01	.00
Have a spouse at home*	.96	.90	.00	.98	.95	.00
Seriously ill*	0	.00	.68	0	.00	.21
Location						
North Vietnam*	.47	.48	.71	.58	.53	.04
Rural area*	.79	.86	.00	.85	.88	.05
12/97-06/98 drought-hit area*	.35	.38	.11	.44	.41	.11
<u>Instruments for Net transfer</u>						
If located outside 12/97-06/98 drought-hit area						
# Relatives inside the affected area	n.a.	n.a.	n.a.	.11	.07	.06
Have at least one relative inside the area*	n.a.	n.a.	n.a.	.05	.03	.03
If located inside 12/97-06/98 drought-hit area						
# Relatives outside the affected area	n.a.	n.a.	n.a.	.05	.04	.27
Have at least one relative outside the area*	n.a.	n.a.	n.a.	.03	.03	.62

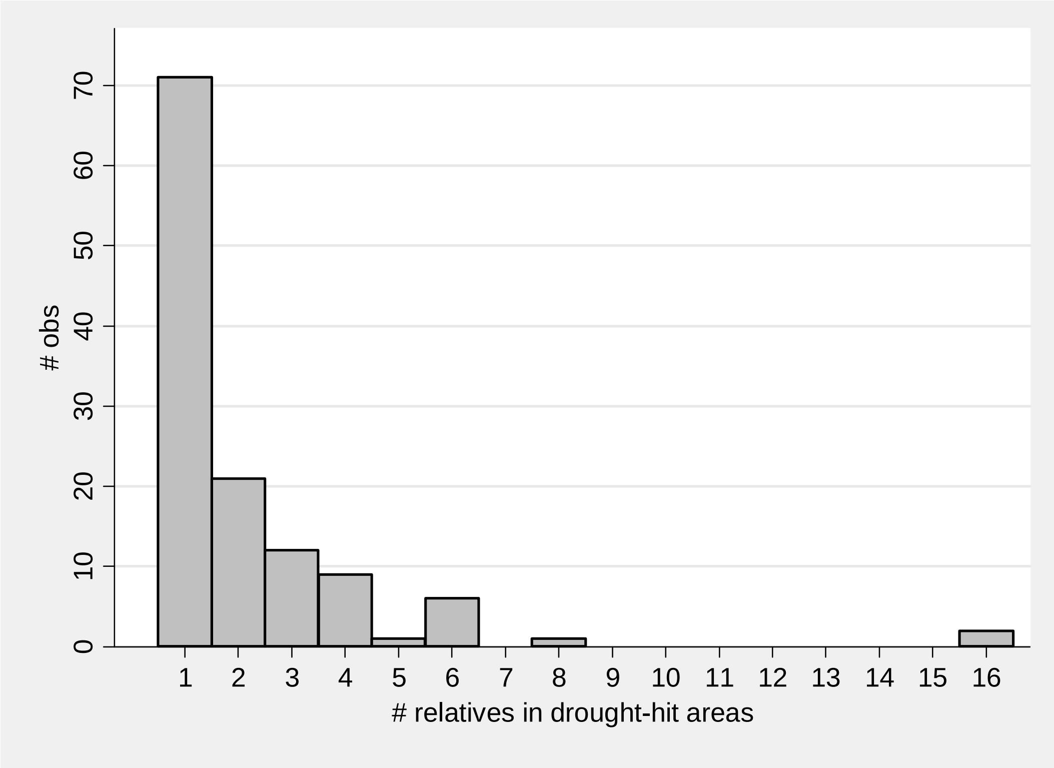
Sources: VLSS 1992-1993 & 1997-1998

Notes: Dummy variables are indicated by *. The dependent variable refers to the 12-month period prior to the interview. So does the amount of the net interhousehold transfer. All monetary figures are adjusted to both temporal and spatial price level differences and are expressed at the January 1993 national average price level. "Seriously ill" indicates the person was so ill that her/his anthropometric information could not be collected when the surveyor visited the household. The areas affected by the drought are rural communes of Uplands, North Central Coast, South Central Coast, and Central Highlands. The instruments are relevant only for Wave 2, as # Relatives in the affected areas refers to information collected during the second wave interview.

Table A2. Instrumented cross-sectional analysis of the impact of the net interhousehold transfer on household spending for educating the child, using W2 data (LIML)

N = 4,846 children	First stage		Main eq.	
Dependent var.	Net transfer		Ln(Ed spending)	
Explanatory var. of interest				
Relative in drought-hit area but not itself*	+.42***	(3.76)	..	
Household in the area but relative outside it*	-1.51***	(3.66)	..	
Net transfer	..		-.07	[.70]
M&P's coverage-corrected *p*-value (nonrobust)			.49	
Other explanatory var.				
Household characteristics				
Located in North Vietnam*	+.32***	(3.41)	-.31***	[4.44]
Rural area*	+.42***	(2.77)	-.54***	[5.04]
Dwelling value	-.01	(1.61)	+.01***	[3.65]
Durable goods value	-.01	(.33)	+.02***	[3.89]
Own self-managed biz in Agriculture*	+.18	(1.08)	+.02	[.14]
Non-agriculture*	+.05	(.55)	+.15***	[2.64]
# members aged 70 or more	-.15	(1.46)	+.08	[1.00]
Household head's characteristics				
Male*	-.08	(.52)	-.19**	[2.11]
Ethnic minority*	-.26***	(4.63)	-.37***	[5.02]
Age in months	+.00	(.13)	+.00	[1.21]
Age in months squared	-.00	(.20)	-.00*	[1.66]
Edu [Ref, None] is Primary school*	-.23*	(1.95)	+.48***	[5.69]
Lower secondary school*	-.36***	(4.25)	+.82***	[9.12]
Upper secondary school*	-.47**	(2.13)	+1.04***	[8.88]
Technical school/college*	+.03	(.22)	+1.01***	[9.84]
University*	+.38	(1.11)	+1.42***	[7.74]
Religion [Ref, None] is Buddhism*	+.20***	(2.62)	-.03	[.41]
Catholicism*	-1.32***	(3.67)	+.14	[.90]
Protestantism*	+.05	(.30)	+.40	[1.61]
Other belief*	+.03	(.32)	+.34	[1.45]
Have a spouse*	+.49**	(2.22)	+.48***	[2.81]
Seriously ill*	+.12	(.32)	+.80**	[2.09]
Child's characteristics				
Male*	-.08	(.90)	+.23***	[4.41]
Age in years [Ref, 7]: 8	+.15	(.54)	+.23***	[3.20]
9	+.31	(1.21)	+.28***	[3.44]
10	+.32	(1.28)	+.43***	[5.27]
11	+.05	(.15)	+.52***	[6.41]
12	+.31	(1.14)	+.39***	[3.93]
13	+.47*	(1.75)	+.32***	[2.84]
14	+.24	(.82)	+.22*	[1.83]
15	+.31	(.98)	-.23	[1.63]
16	+.15	(.46)	-.81***	[5.34]
17	+.38	(1.19)	-1.32***	[7.48]
Seriously ill*	+.21	(1.20)	-2.36***	[4.71]
# Younger members	+.02	(.47)	-.23***	[8.07]
# Older members below 70	+.10**	(2.55)	+.00	[.15]
Robust F(2, 4,807) for H0: The excluded are not different from zero			13.69	
p-value for rejecting the null			.00	
Partial R^2 between Net transfer and the excluded			.01	
p-value for rejecting H_0: Both IVs are valid & should be excluded			.56	
p-value for rejecting H_0: Net transfer is not endogenous				
Based on robust score $chi^2(1)$			.58	
Based on robust regression F(1, 4,807)			.58	
OLS-estimated coefficient on non-instrumented Net transfer			-.01**	(2.17)

Note: See the notes for Tables 2 and 3.



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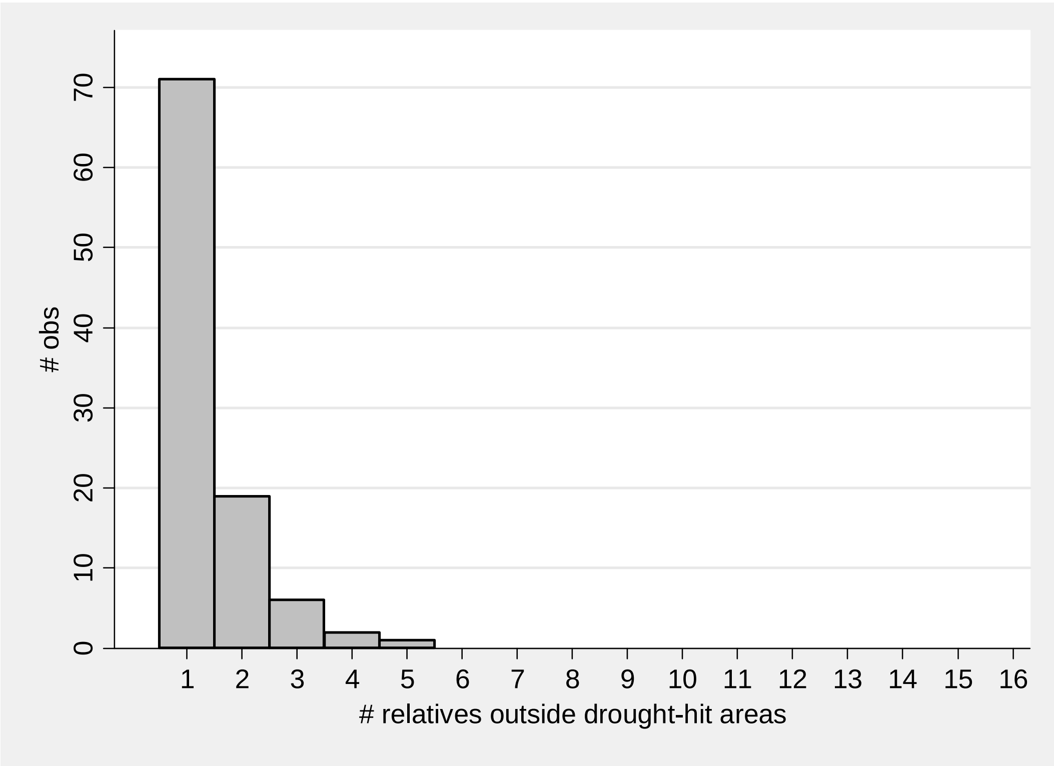
relatives in drought-hit areas

Fig. 1



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relatives outside drought-hit areas

Fig. 2