KINSHIP RELATED ALTRUISTIC PREFERENCES AND INTER-VIVOS TRANSFERS*

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ABSTRACT

Our aim is to study altruistically motivated inter-vivos transfers and their relation to the level of income. The concept of altruism we use is different from that typically used in economic research. Under our definition, individuals feel altruistically not only towards their descendants, but also towards other individuals genetically related to them. However, they only worry about them when their relatives' consumption falls below a certain level. We conclude that, within this framework, the number and amount of inter-vivos transfers is greater in poor than in rich countries, and greater among low-income families than among high-income families.

Keywords: altruistic preferences, poverty level, inter-vivos transfers, household behavior.

1 INTRODUCTION

In this paper we propose a new definition of altruism that we consider most appropriate to study inter-vivos transfers. In our framework, an individual would care more about relatives with a higher degree of consanguinity, but would care about all her relatives. However, she worries about a specific relative only if this relative's consumption falls below a certain threshold and assuming that her own consumption is above this threshold.

We classify transfers as either inter-vivos or bequest-type. We take the stand that some inter-vivos transfers (dowries or investment on human capital) should be considered as anticipated bequests. Bequest-type transfers and inter-vivos transfers respond to two different needs. While the first ones are meant to improve the recipients' welfare along the future, the second ones are meant to help the recipients overcome a present unpleasant situation. Bequests' recipients are usually descendants, whereas inter-vivos transfers' recipients are not necessarily so.[1] This paper focuses on inter-vivos transfers. Rosenzweig and Stark (1989) point that inter-vivos transfers among related households are an important source of income insurance in low-income countries. There is abundant anecdotal evidence showing that inter-vivos transfers, either in cash or in kind, are much more important in low-income countries than in high-income countries. This paper provides a rational for this fact.[2]

Our definition of altruism implies that there exists a perceived level of subsistence that triggers our altruistic feelings towards relatives. The concept of a subsistence level is intrinsically linked to that of poverty. What the World Bank defines as the absolute poverty level can be considered as the consumption level that guarantees subsistence. This subsistence level is the threshold below which agents in our framework worry about their relatives. However, as the World Bank (1990, p.30) says, "the perception of poverty

[1] These two classes of transferences correspond to what sociologists call the two main societal functions of families: the social placement function and the support function (see, for exmaple, Eichler 1983, p. 106-110).

[2] The literature, that so imitates life, gives us some examples of inter-vivos transfers in kind: in *The small house at Allington*, by Anthony Trollope, the widow Dale and her two daughters live in a house that belongs to her brother in law who also supplies the family with horses, produce and meat, clothes, etc. In *Bengal Nights*, by Mircea Eliade, in Mr. Sen's house live he, his wife, his two daughters, a poor relative and his two sisters, another poor relative and his wife plus the main character, a french who Mr. Sen wants to adopt.

has evolved historically and varies greatly from one culture to another". We will take this into consideration assuming that the threshold may change with the level of income per capita. The results will not change significantly.

The economic literature on inter/intra-family transfers began with Becker (1974). The key feature of Becker's altruism model is that the utility of the agent is related to the utility of the descendants, and it is assumed that the agent cares more for his children than his grandchildren, more for his grandchildren than his great-grandchildren, and so on. In his framework, altruistic transfers have the effect that consumption of each member of the spending unit is independent of the distribution of income across unit members.

We build a model in which individuals feel altruistically not only towards their descendants, but also towards other individuals genetically related to them, according to their degree of kinship. However, our concept of altruism differs from Becker's. In our framework, individuals become concerned about their relatives only if their relatives' consumption falls below a certain level (poverty line or subsistence minimum). As a consequence, transfers among members of families in which all members have an income above or below the threshold level are not observed. Thus, our concept of altruism is more restrictive than Becker's. Although Becker's concept seems adequate to analyze bequests and anticipated bequests, it does not seem suitable to analyze inter-vivos transfers purely directed to help our relatives to smooth consumption.[3] Our formulation seems better fitted to analyze the last type of transfers. Thus, this formulation of altruism is complementary to the most standard one. Nevertheless, as the above quotation from Adam Smith suggests, our concept is not entirely new in the economic literature.

There is a large literature on inter/intrafamily transfers. Some of this literature focuses on bequests (Becker 1974, Barro 1974, Laitner 1992, etc.) and some on inter-vivos transfers (Cox 1987, Lucas and Stark 1985, etc.). Our framework is related to inter-vivos transfers. Some of the literature in this area (for example, Altonji *et al.* 1992) reject altruism because a positive correlation between the amount transferred and the difference in income between donor and recipient is not observed, as the Becker's model implies. This is not an implication of our model. In our framework, altruistically

[3] Biologists predict altruistic behavior not only between parents and children but also among siblings and other close relatives. See, for instance, Dawkins (1976).

motivated transfers will take place but will not be correlated to the difference in income. This framework has a different implication: the number of inter-family transfers will be greater among low average-income families than in high average-income families. Likewise, the number of inter-family transfers will be greater in poor countries than in rich countries. Thus, our model opens a new line to investigate further the motivation of inter-vivos transfers. The importance of what motivates inter-vivos transfers can hardly be overstressed: the costs of setting public programs to fight poverty are directly related to the elasticity of substitution of public transfers by private transfers. This elasticity is greater when private transfers are altruistically motivated than when they are part of an exchange.. In other line, as Stark (1995) points out, the motivation of private transfers may well be crucial for the creation of financial markets. If transfers are altruistically motivated, their very existence tend to inhibit the appearance of markets. This does not occur when transfers are part of an exchange.

The rest of the paper is organized as follows: section 2 discusses the implications of our concept of altruism for the distribution of spending across members of a family, and compares them to the implications of the standard concept of altruism. Section 3 analyzes the strategic behavior of the members of the family when helping other members. In section 4 we study the relation between family income and number and amount of transfers. In section 5 we compare number and amount of transfers across countries. Section 6 concludes this paper.

2 IMPLICATIONS OF ALTRUISM FOR CONSUMPTION DISTRIBUTION WITHIN A FAMILY

Let us start by assuming that our extended family has two individuals[4], that we call mother and daughter for the sake of exposition. The concept of altruism we use differs from the standard concept used in the literature. The implications of altruism for distribution of spending across the members of a family are different depending on which concept of altruism we use. In the next subsection, we review the standard concept and illustrate

[4] Individuals may be understood as households.

its implications in a very simple example borrowed from Stark (1995). In subsection 2.2, we make explicit our concept of altruism and compare its implications to those of the standard model. Logarithmic preferences are used across this paper to illustrate some points.

2.1 "Intense" altruism

Mother and daughter value the consumption of a good, c, and each has an endowment of this good, I_i and I_j, respectively. Their utility functions are:

$$\begin{aligned} W_i(c_i, c_j) &= U(c_i) + \beta_i \cdot U(c_j), \\ W_j(c_i, c_j) &= U(c_j) + \beta_j \cdot U(c_i), \end{aligned} \tag{1}$$

where β_i and β_j are the discount factors that each individual applies to their relative's utility. This factor measures the intensity of altruism. They transfer income to each other. Thus, the mother's optimal transfer solves

$$\max \quad U\left(I_i - tr_{ij} + tr_{ji}\right) + \beta_i \cdot U\left(I_j - tr_{ji} + tr_{ij}\right) \tag{2}$$

where tr_{ij} denotes transfers from i to j. The first order condition for this problem, assuming logarithmic preferences, is

$$\left(I_i - tr_{ij} + tr_{ji}\right) = \beta_i \cdot \left(I_j - tr_{ji} + tr_{ij}\right). \tag{3}$$

In this case the net transfer is defined as

$$tr_{ij} - tr_{ji} = \frac{\beta_i \cdot I_i - I_j}{1 + \beta_i} \tag{4}$$

which implies the following levels of consumption

$$c_i = \tfrac{1}{1+\beta_i}\left(I_i + I_j\right), \quad c_j = \tfrac{\beta_i}{1+\beta_i}\left(I_i + I_j\right). \tag{5}$$

The optimal transfer for the daughter is

$$tr_{ij} - tr_{ji} = \frac{I_f - \beta_j \cdot I_s}{1 + \beta_j} \tag{6}$$

which implies the following levels of consumption

$$c_i = \frac{\beta_j}{1+\beta_j}\left(I_i + I_j\right), \quad c_j = \frac{1}{1+\beta_j}\left(I_i + I_j\right). \tag{7}$$

Let us assume that the mother controls the aggregate income. If $I_j < \beta_i I_i$, the mother will transfer to her daughter, and vice-versa. Same thing if it is the daughter who controls the aggregate income: If $I_j > \frac{I_i}{\beta_j}$, she transfers income to her mother and receives a transfer in the opposite case. In any case, the individual consumption does not depend on the individual income but on the aggregate income.

In the case in which each one controls her own income, there are three possible regions. When $I_j < \beta_i \cdot I_i$, the mother transfers to her daughter and the allocation is the one that maximizes the mother's utility. If $I_j > \frac{I_i}{\beta_j}$, the daughter transfers income and the daughter's optimal allocation is implemented. In the case in which $\beta_i \cdot I_i \leq I_j \leq \frac{I_i}{\beta_j}$ there is conflict.[5]

Let us assume that mother and daughter engage in Nash bargaining to choose the allocation of the good.[6] Let the disagreement point be the minimax,which in this case means that each one consumes her own income. Then, the problem they solve is

$$\begin{array}{ll} \max & [W_i(c_i, c_j) - W_i(I_i, I_j)] \cdot [W_j(c_i, c_j) - W_j(I_i, I_j)] \\ s.t. & \qquad\qquad c_i + c_j \leq I_i + I_j \end{array}$$

The solution to this problem depends on the disagreement point, which changes with the income distribution; therefore the solution depends on the income distribution. Thus, assuming that each agent controls her income, the consumption levels depend on the income distribution in the case in which incomes are not too different. In the other cases, consumption of each individual as fraction of aggregate income does not depend on income's distribution.

It is worth noting that more altruistic individuals might end up worse off than less altruistic ones. Let us assume that $I_j < \beta_i \cdot I_i$. In this case, the mother transfers income to her daughter. The consumption allocation is given in expression (5) and her indirect utility is

[5] One sided-altruism is included in this concept–we just need to assume that $\beta_j = 0$.

[6] This strategic dimension goes beyond altruism à la Becker, but we want to analyze the implications for the distribution of consumption across the members of the family.

$$W_i = \ln\left(\frac{I_i + I_j}{1+\beta_i}\right) + \beta_i \cdot \ln\left(\frac{\beta_i (I_i + I_j)}{1+\beta_i}\right). \tag{8}$$

If total income is low enough, W_i decreases with the intensity of altruism, measured by β_i. If $I_j > \frac{1}{\beta_j} I_i$, it is the daughter who transfers to her mother and, again, if total income is low enough, the daughter ends up worse off the stronger she feels towards her mother.[7]

2.2 "Restricted" altruism

In our framework, an individual has preferences such that she worries about her relative if the relative's consumption falls below a certain (subsistence) level and her own consumption is above it. Then, agent i's utility is

$$W_i(c_i, c_j) = \begin{cases} U(c_i) + \beta \cdot V(c_j) \ if \ c_i > c_s \\ U(c_i) \ if \ c_i \leq c_s \end{cases}$$

where $V(c_j) = \min\{U(c_s), U(c_j)\}$ and c_s is subsistence consumption.[8] There are three possible cases: both incomes are above the subsistence level, both incomes are below the subsistence level, and only one income falls below this level. In the first and second case there are no transfers. In the third case, assuming logarithmic preferences, the transfer will be

$$tr_{ij} = \min\left\{c_s - I_j, \frac{\beta \cdot I_i - I_j}{1+\beta}, I_i - c_s\right\}$$

if the mother is the one whose income is above the subsistence level. (Likewise, if the daughter is the one whose income is above this level.) Consumption allocations will be

$$c_i = \max\left\{I_i + I_j - c_s, \tfrac{I_i + I_j}{1+\beta}, c_s\right\}, \quad c_j = \min\left\{c_s, \tfrac{\beta \cdot (I_i + I_j)}{1+\beta}, I_i + I_j - c_s\right\}.$$

Notice that in most cases consumption allocations are not a proportion of total income.

[7]This paradox is well known in the literature. See, for instance, Bernheim and Stark (1988).

[8]The term subsistence is used by convenience and should not be understood as the agent dying if her consumption falls below this level.

Only in the case in which $tr_{ij} = \frac{\beta \cdot I_i - I_j}{1+\beta}$ a higher degree of altruism may imply that the donor ends up worse off. For this to be true,

$$I_i + I_j < \frac{e(1+\beta)}{1+\beta}.$$

However, in this case $(I_i + I_j) > (1+\beta) \cdot c_s$. Thus, a high enough subsistence level guarantees that a more altruistic donor does not end up worse off.

3 HOW ARE POOR RELATIVES HELPED?

In this section we discuss some issues related to our definition of altruism when there are more than two members in the same family. For convenience of exposition in this section we consider a family of three members. Then the agent's utility is

$$W_i(c_i, c_j, c_k) = \begin{cases} U(c_i) + \sum_{j=1,2} \beta^{d_{ij}} \cdot V(c_j) \ if \ c_i > c_s \\ U(c_i) \ if \ c_i \leq c_s; \end{cases}$$

i.e., β is raised to the d_{ij}, where d_{ij} is the degree of kinship between i and j. Relatives of first degree are parents, children and siblings. Relatives of second degree are grandparents, aunts and uncles, grandchildren, and nieces and nephews. Cousins are third degree relatives. Thus, the way in which the agent discounts her relative's utility is based in biologists' Hamilton's rule.[9]

There may be a situation in which all agents' incomes are above the subsistence level; another in which all incomes are below the subsistence level; a third in which only one relative's income is above this level; and the last in which one relative's income is below this level. In the first two cases each individual consumes his income. In the third one, the budget constraint and the following set of inequalities

$$\begin{aligned} U'(c_i) &\leq V'(I_j + tr_{ij}) \cdot \beta^{d_{rj}}, j = 1, 2, \\ tr_{ij} &\geq 0, \end{aligned}$$

[9] For an explanation of Hamilton's rule, see Bergstrom (1996).

where

$$V'(c_j) = \begin{cases} U'(c_j) \; if \; c_j \leq c_s \\ 0 \; if \; c_j > c_s, \end{cases}$$

characterize the solution, if $(1+\beta^{d_{i1}}+\beta^{d_{i2}}) \cdot c_s < I_i+I_1+I_2$. Otherwise, the person whose income is above the subsistence level consumes the subsistence level, and the other two consume

$$\frac{(I_i + I_1 + I_2 - c_s) \cdot \beta^{d_{ij}}}{\beta^{d_{i1}} + \beta^{d_{i2}}},$$

if these quantities are greater than income for both of them. Otherwise, they consume their own income.

In the fourth case, since both agents with income about subsistence level care above the level of consumption of the poor relative, consumption of the poor relative is a public good. We analyze in the following subsections efficient allocations, possible solutions to the allocation problem, and problems of these solutions.

3.1 Efficient allocations

As stated above, the problem of the consumption of the poor relative is a typical public good problem–the amount of public good to be provided and the distribution of the cost of the public good are the components of the problem that need to be solved. In our case the components of the public good problem are the level of consumption of the poor relative and how to share the cost of this level of consumption among the two relatives whose income is above the subsistence level. Thus, efficient solutions to this problem are solutions to the maximization of

$$\sum_{i=1,2} \alpha_i \cdot W_i(c_i, c_j)$$

$$\text{subject to} \quad \begin{array}{c} c_i + tr_{ij} \leq I_i, \\ c_i \geq c_s, \\ tr_{ij} \geq 0, \end{array} \quad i = 1, 2$$

$$\text{and } c_j \leq I_j + tr_{1j} + tr_{2j}.$$

With logarithmic preferences, the constraints and the following set of inequalities

$$\frac{\alpha_i}{c_i} \leq V'\left(I_j + \sum_{r=1,2} tr_{rj}\right) \cdot \sum_{r=1,2} \alpha_r \cdot \beta^{d_{rj}}, i = 1, 2 \tag{9}$$

characterize the efficient solutions if $(1 + \alpha_1 \cdot \beta^{d_{1j}} + \alpha_2 \cdot \beta^{d_{2j}}) \cdot c_s < \alpha_i \cdot (I_j + I_1 + I_2)$ for $i = 1, 2$. If the poor relative receives less than the subsistence minimum, a solution is characterized by the following relation $c_j/c_i = \sum_{k=1,2} \alpha_k \cdot \beta^{d_{kj}}/\alpha_i, i = 1, 2$, and transfers are proportional to weights α. If the poor relative receives the subsistence minimum, transfers are also proportional to the weights α.

If $(1 + \alpha_1 \cdot \beta^{d_{1j}} + \alpha_2 \cdot \beta^{d_{2j}}) \cdot c_s \geq \alpha_i \cdot (I_j + I_1 + I_2)$ for one of the two individuals whose income is above the subsistence level, let us say $i = 1$, this person consumes c_s and transfers her remaining income to the poor relative. Then the other individual whose income is above the subsistence level, $i = 2$, transfers the following amount

$$\frac{\beta^{d_{2j}} \cdot I_2 - I_j}{1 + \beta^{d_{2j}}}.$$

3.2 Nash equilibrium

Although cooperation seems natural within our framework, we want to explore the noncooperative solutions, of which the Nash equilibrium is the most common one. We know that the Nash equilibrium is not an efficient solution to the public good problem. In this case the Nash noncooperative solution, as we show in this subsection, has an added problem: it presents multiple equilibria.

Consider agent i's problem which is the maximization of

$$W_i(c_i, c_j)$$

$$\begin{array}{rc} \text{subject to} & c_i + tr_{ij} \leq I, \\ \text{and} & c_j \leq I_j + tr_{1j} + tr_{2j}. \end{array}$$

With logarithmic preferences,

$$tr_{ij} = \min\left\{c_s - I_j - tr_{kj}, \frac{\beta^{d_{ij}} \cdot I_i - I_j - tr_{kj}}{1+\beta^{d_{ij}}}, I_i - c_s\right\}$$

where tr_{kj} denotes the transfer from the third relative. There are three different cases: for both of them $(c_s - I_j) \leq (\beta^{d_{ij}} \cdot I_i - I_j)/(1+\beta^{d_{ij}})$; for one of them the opposite is true; and for both of them the opposite is true. There are multiple Nash equilibria in the first and second cases. In the third multiple equilibria might exist or might not (see appendix 1). In this case there is under-provision of the public good.

3.3 The Lindahl equilibrium

A decentralized solution that can implement an efficient allocation is the Lindahl equilibrium. Let us assume that income is observable, as is the degree of kinship. In this environment this assumption seems intuitive: close relatives are able to estimate income with a fair degree of accuracy. The Lindahl problem can be posed as the maximization of $W_i(c_i, c_j)$ subject to $c_i + \alpha_i \cdot (c_j - I_j) = I_i$, for $i = 1, 2$. It should also be true that $\sum_{i=1,2} \alpha_i = 1$. The proportion that agent i contributes to consumption of relative j can be understood by the price faced by agent i of the public good c_j. With logarithmic preferences, the demand of agent i of this public good is

$$\min\left\{c_s, \frac{\beta^{d_{ij}\cdot} \cdot (I_i + \alpha_i \cdot I_j)}{\alpha_i \cdot (1+\beta^{d_{ij}})}, \frac{I_i + \alpha_i \cdot I_j - c_s}{\alpha_i}\right\}.$$

The existence of a kink in the objective function poses problems similar to those of the subscription (Nash) solution[10]. There may exist indeterminacy of equilibrium. Again, there are three different cases: for both of the relatives $i = 1, 2$, $c_s < \beta^{d_{ij}} \cdot (I_i + I_j)/(1+\beta^{d_{ij}})$; for one of them the opposite is true; and for both of them the opposite is true. There are multiple equilibria in the first and second cases. In the third one there may or may not be(see appendix 2).

[10] Notice that, when $\alpha_i = 1$, the demand coincides with the solution to the agent's maximization problem in the Nash equilibrium when the other agent's transfer is zero.

If there is an interior solution, the Lindahl equilibrium implies a determined set of proportions, for each relative $i = 1, 2$, of the total contribution to poor relatives. Then, in the case of indeterminacy these same proportions could be applied to raise the necessary total contribution, $c_s - I_j$, to the poor relative j. Thus, at first sight, problems of indeterminacy do not seem so serious using the Lindahl solution.

The Lindahl equilibrium supposes that somebody acts as the state in the usual public good problem. In certain cases, the oldest relative, the patriarch, might seem as the obvious candidate for this role. However, in certain cases this patriarch might be the person who needs to be helped. The Lindahl solution could be implemented as the result of an agreement between the agents. Modified in this way, though, this solution is just one of many cooperative solutions. As we will show, other cooperative solutions are simpler, both to implement and to treat analytically.

3.4 Nash bargaining

As we have shown, the decentralized solutions present problems of indeterminacy. Cooperative solutions do not have this problem. Furthermore, they seem natural in our environment. Nash bargaining would be the first obvious candidate. Let the disagreement point be the minimax value for each player (Myerson 1991, p. 376). In this case, then, the disagreement point would be no transfers to the poor relative from any of both players. Then, the Nash Bargaining solution is the maximization of

$$[W_1(c_1, c_j) - W_1(I_1, I_j)] \cdot [W_2(c_2, c_j) - W_2(I_2, c_j)]$$

subject to

$$c_1 + tr_{1j} \leq I_1$$

$$c_2 + tr_{2j} \leq I_2$$

$$c_j \leq I_j + tr_{1j} + tr_{2j}.$$

If c_s is small enough, an interior solution is characterized by

$$\frac{U'(c_1)}{U'(c_2)} = \frac{U(c_1) + \beta^{d_{1j}} \cdot V(c_j) - U(I_1) - \beta^{d_j} \cdot V(I_j)}{U(c_2) + \beta^{d_{2j}} \cdot V(c_j) - U(I_2) - \beta^{d_{2j}} \cdot V(I_j)} \tag{10}$$

$$V'(c_j)\left(\frac{\beta^{d_{1j}}}{U'(c_1)} + \frac{\beta^{d_{2j}}}{U'(c_2)}\right) = 1$$

and the binding budget constraints[11]. A corner solution is characterized by (10), the first two binding constraints and

$$c_s = I_j + tr_{1j} + tr_{2j}.$$

Although this solution is well characterized, it is not very tractable. Therefore, let us look at other cooperative solutions.

3.5 Allocation rules

Since there are no problems with truthful revelations, any of the efficient solutions to the allocation of the public good problem can be implemented as a cooperative solution through a certain allocation rule. The following seems a natural allocation rule: make the weights in the efficient allocations problem proportional to the individuals' incomes[12]. In the rest of the text

[11] Otherwise, the player k with the smaller income receives c_s, and the consumption of the other player i and the poor relative j are characterized for the following equations

$$c_i + c_j = I_i + I_k + I_j - c_s$$

$$V'(c_j) \cdot \left[\beta^{d_{ij}} \cdot \omega_i + \beta^{d_{kj}} \cdot \omega_k\right] = U'(c_i) \cdot \omega_k$$

where

$$\omega_k = U(c_s) + \beta^{d_{kj}} \cdot V(c_j) - U(I_k) - \beta^{d_{kj}} \cdot V(I_j)$$

and

$$\omega_i = U(c_i) + \beta^{d_{ij}} \cdot V(c_j) - U(I_i) - \beta^{d_{ki}} \cdot V(I_j).$$

[12] Weights in the planner's problem can be made proportional to degrees of kinship, or incomes weighted by degrees of kinship, with similar results.

this rule is called the "transfers proportional to income" allocation rule. This proportional rule is anonymous, efficient by construction, and, as noticed, there are not truthful revelation problems. Furthermore, the allocation rule seems analytically tractable, when compared with other solutions to the public good problem.

The question of how a family helps relatives going through a rough period remains open to inquiry. It may very well be that the answer is specific to every family or to the situation. In some families, parents might always be the first to help. In others, it may be the sibling living closer to the poor relative. In some, everybody may want to help, according to their means, as a matter of pride. In others, it may be just the relative with the highest income. In the case of a sibling having problems, parents might suggest to other siblings how to help. However, siblings seem to decide jointly how to help parents in their old age. While the question is answered, and throughout this paper, we use what we have called the "transfers proportional to income" rule.

4 FAMILY INCOME AND TRANFERS

In this section we study how inter-vivos transfers vary with income across families within the same country. Suppose that each family is composed of a grandparent, who has N children, who in turn have N children. Therefore, the family has $1+N+N^2$ members and each member worries about $N+N^2$ relatives[13]. This is a static model and usually three generations coexist at the same point in time. Income of a member g of the first generation is denoted I_g and I is the average income for this generation. The members of the second generation have an income dependant on their parents' income and an idiosyncratic shock. Income of a member p of this generation is I_p. Income of a member c of the third generation is I_c, which also depends on their parents' income and a shock.

If the intergenerational correlation of income is high enough and the distribution of the shock is symmetric of mean zero, each generation has an income distribution similar to the previous one and so does the aggregation of

[13] That the first and the second generation have the same number of children is not essential in any way.

the three generations. However, according to Solon (1992) and Zimmerman (1992), the correlation between parents' and children's income, as deviation from the mean of their generation, in the US economy is roughly 0.4[14]. This means that, to preserve an income distribution similar to a Lorenz curve, a shock that is skewed is needed; i.e., if your parents enjoy a high income, the probability of becoming richer than your parents is lower than that of becoming poorer than them–there exists regression to the mean. In this paper we assume a uniform distribution of the shock, $\epsilon \sim u(0, 2\sigma)$[15], but then, and to preserve the income distribution, we assume that an individual income depends also on average income I. So, $I_p = \rho \cdot I_g + (1-\rho) \cdot I + \epsilon$ and $I_c = \rho \cdot I_p + (1-\rho) \cdot I + \epsilon$. In this way, there is regression to the mean as well.

4.1 Average Family Income and Expected Number of Transfers

Suppose the income of the grandparent is I_g. Expected average family income is then

$$\frac{I_g \cdot (1+\rho+\rho^2) + I \cdot (2-\rho-\rho^2)}{3},$$

equal to I_g when $\rho = 1$. Since there is a simple relation between expected family income and grandparent's income, and since it is easier to relate expected number of transfers to grandparent's income rather than to expected family income, we do so.

The probability $\Phi_p(I_g)$ of a member of the second generation being poor is $\Phi_p(I_g) = P(\rho \cdot I_g + (1-\rho) \cdot I + \epsilon) \leq c_s$, or $\Phi_p(I_g) = P(\epsilon) \leq c_s - \rho \cdot I_g - (1-\rho) \cdot I$. If the distribution function of ϵ is $f(\epsilon)$, then $\Phi_p(I_g) = \int_{-\infty}^{c_s - \rho \cdot I_g - (1-\rho) \cdot I} f(\epsilon) \cdot d\epsilon$. With this uniform distribution,

$$\Phi_p(I_g) = \min\left\{\max\left\{\frac{c_s - \rho \cdot I_g - (1-\rho) \cdot I + \sigma}{2\sigma}, 0\right\}, 1\right\}.$$

[14]Previous estimates (for example, Behrman and Taubman 1985) place this correlation around 0.2. Both Solon and Zimmerman argue that these estimates are too low and intergenerational earnings mobility is lower than previously thought.

[15]This distribution is truncated at low levels of income since income cannot be less than zero.

Then, the probability of m members of the second generation being poor is a binomial function $\binom{N}{m} \cdot (\Phi_p(I_g))^m \cdot (1 - \Phi_p(I_g))^{N-m}$. So the expected number of poor persons in the second generation is $N \cdot \Phi_p(I_g)$.

The conditional probability of a member of the third generation being poor given the parent shock ϵ_p, $P(I_c \leq c_s \mid \epsilon_p)$, equals $\int_{-\infty}^{c_s-\rho^2 \cdot I_g-(1-\rho^2)\cdot I-\rho\cdot\epsilon_p} f(\epsilon_c) \cdot d\epsilon_c$, where ϵ_c is the shock for the third generation. Therefore, the probability of a member of the third generation being poor is
$\Phi_c(I_g) = \int_{-\infty}^{\infty} \int_{-\infty}^{c_s-\rho^2 \cdot I_g-(1-\rho^2)\cdot I-\rho\cdot\epsilon_p} f(\epsilon_c) \cdot d\epsilon_c \cdot d\epsilon_p$. With the proposed uniform distribution,

$$\Phi_c(I_g) = \min\left\{\max\left\{\frac{c_s - \rho^2 \cdot I_g - (1-\rho^2) \cdot I + \sigma}{2\sigma}, 0\right\}, 1\right\}.$$

Thus, the probability of m members of the third generation being poor is the binomial function $\binom{N^2}{m} \cdot (\Phi_c(I_g))^m \cdot (1 - \Phi_c(I_g))^{N^2-m}$. The expected number of poor people in the third generation is $N^2 \cdot \Phi_c(I_g)$.

The expected number of poor relatives, Enp, inside a family, given the grandparent's income, is

$$Enp(I_g) = N \cdot \Phi_p(I_g) + N^2 \cdot \Phi_c(I_g). \tag{11}$$

The expected number of poor relatives depends positively on the number of members in each generation and on the subsistence level, and negatively on grandparent's income. It depends positively on the degree of correlation ρ if the grandparent's income is below the mean and negatively otherwise.

The effect of changes in the standard deviation depends on the level of grandparent's income relative to the difference between the subsistence level and a certain proportion of income per capita. If the grandparent's income is low enough, an increase in volatility can only increase the number of individuals whose income is above the subsistence level. Likewise, if the grandparent's income is sufficiently high, an increase in volatility increases the expected number of poor relatives.[16] Since the effect depends on the difference between the subsistence level and a proportion of income per capita,

[16] If $I_g < \min\left\{\frac{c_s-(1-\rho)\cdot I}{\rho}, \frac{c_s-(1-\rho^2)\cdot I}{\rho^2}\right\}$ then, $\frac{\partial Enp(I_g)}{\partial \sigma} \leq 0$. If

if the latter is high enough the expected number of poor relatives increases (or does not change) with volatility for any level of grandparent's income.

If all relatives whose income is above the subsistence level transfer some income, even a small amount, to those whose income is below the subsistence level, the expected number of transfers equals

$$\begin{aligned}(1+N+N^2-Enp(I_g))\cdot Enp(I_g) \text{ if } I_g &\geq c_s,\\ (N+N^2-Enp(I_g))\cdot(Enp(I_g)+1) \text{ if } I_g &< c_s.\end{aligned}$$[17]

The expected number of transfers is maximized at the level of income I_g that satisfies

$$\begin{aligned}Enp(I_g) &= \frac{1+N+N^2}{2} \text{ if this } I_g \geq c_s, \text{ or}\\ Enp(I_g) &= \frac{N+N^2-1}{2} \text{ if this } I_g < c_s.\end{aligned}$$

The function $Enp(I_g)$ is strictly decreasing and, assuming that $c_s \leq \sigma$, $Enp(c_s) < \frac{1+N+N^2}{2}$.[18] Therefore, the expected number of transfers inside a family is maximized when

$$I_g = \min\left\{c_s, \frac{N\cdot(1+N)\cdot c_s+\sigma-[N\cdot(1-\rho)+N^2\cdot(1-\rho^2)]\cdot I}{N\cdot\rho\cdot(1+N\cdot\rho)}\right\},$$

i.e., when I_g is at or below the subsistence level. That is, the expected number of transfers inside a family is maximized at very low levels of income. That the number of transfers is maximized around the subsistence level is intuitive, since the number of transfers is maximized when half of the family members have an income above and half of them have an income below the subsistence level. This is most likely to occur when the grandparent's income is around the subsistence level. This result is independent of the income distribution across members of the first generation.

$I_g > \max\left\{\frac{c_s-(1-\rho)\cdot I}{\rho}, \frac{c_s-(1-\rho^2)\cdot I}{\rho^2}\right\}$ then, $\frac{\partial Enp(I_g)}{\partial\sigma} \geq 0$. In the middle range the effect on expected number of poor individuals in second and third generation may have different signs and the net effect depends on the number of individuals in each generation.

[18] The condition $c_s \leq \sigma$ is sufficient but not necessary. As we will see, σ is likely to be greater than c_s.

4.2 Average Family Income and Expected Amount of Transfers

In this subsection we use the "transfers proportional to income" allocation rule to study the relation between income level and amount of transfers inside the same country. We compute an example and we find that the expected amount of transfers behaves in a similar way to the expected number of transfers. In this case, and for computational simplicity, N equals 1; i.e., each family has three members–the grandparent, the parent, and the child. According to the World Bank (1990) the absolute poverty threshold is 370 annual 1985 purchasing power parity adjusted US dollars. Therefore, c_s is set at this level. The country's per capita income for this simulation is set equal to \$3000, the per capita income of an upper-middle-income country in 1988 (see World Bank 1990).

We assume that there is a continuum of families. Income for the first generation is distributed according to $I_g = (1+n) \cdot g^n \cdot I$, $g \in [0,1]$. This function implies an income distribution similar to a Lorenz curve. In this simulations we set $n = 1.08$, which implies a Gini coefficient of 0.35. This was the decade average of the Gini coefficient for the industrial countries in the 1960s (see Deininger and Squire 1996).

Recall that the discount factor between relatives equals $\beta^{d_{ij}}$ where d_{ij} equals the degree of consanguinity between them. Thus β can be considered the basic degree of altruism which, for this simulation, is set to 0.5. Changing the degree of altruism does not change the results much, since the degree of altruism only affects the amount of transfers at very low levels of income. At higher levels of income, when the other relatives are sufficiently rich, the total transfer received by the poor relative is the difference between the subsistence level and his income and does not depend on the intensity of altruism.

According to Kremer (1997), a child's educational attainment can be expressed as 0.39 times the educational attainment of the parents, plus 0.15 times the average educational attainment of the neighborhood in which the child grew up, plus an intercept, plus an error term with a standard deviation of 1.79 years. Across countries, a regression between mean years of schooling of people 25 years and older in 1992 and GNP per capita, measured in purchasing power adjusted dollars, in 1991 (according to the *Human Development Report 1994*) suggests than an extra year of schooling increases income by \$375. Thus, 1.79 years of schooling would represent \$675, a figure that we use as a benchmark. For this simulation we use a standard deviation of \$700.

Figure 1 shows the relation between the expected amount of transfers within a family and the grandparent's income for the parameters aforementioned. For very low levels of income per capita, the relation between grandparent's income and expected amount of transfers is non-monotonic (figure 1a). When the grandparent's income is below the subsistence level, the most likely situation is that only a member of the family has an income above c_s. In this case, the larger the income of the other members, the smaller the transfer. This is what happens in figure 1a as grandparent's income increases. Once the grandparent's income is above c_s, in most cases there are two members whose income is above the subsistence level. Nevertheless, the transfer received by the poor relative is less than the amount he needs to consume c_s. As the grandparent's income increases, the amount transferred increases too, as can be seen in figure 1a. If grandparent's income were to increase further, the poor relative eventually would receive the necessary transfer to consume c_s. The larger the grandparent's income, the richer this poor relative would be likely to be and, thus, the smaller the transfer. In richer countries, even at very low levels of grandparent's income, because of the regression toward the mean in income, the most likely situation is that there is just one poor relative in the family and the other two can afford the necessary transfer for him to consume c_s. That is why the expected amount of transfers decreases with the average family income, once the income per capita in the country reaches a certain level (figure 1b).[19]

It can be argued that the perception of poverty, of what is considered a "primary necessity" varies with income. However, it is unlikely that the perceived poverty level changes rapidly with income within a country, although it may change across societies and we discuss this in the following section. The way in which the perception of poverty varies with income within the same society should be the study of further empirical investigation. In the meanwhile and in this section, we run a simulation in which the subsistence level across families changes with the level of income in the following way: $c_s(I_g) = 370 + a \cdot I_g$. For $a = 0.1$ there was not any substantial difference.[20]

[19] The levels of income chosen in figure 1 correspond to the mean income per capita for low income and lower-middle countries, respectively, in 1988, according to the *World Development Report 1990*.

[20] The implications for consumption of our formulation are equivalent to those of Becker's

5 INCOME PER CAPITA AND TRANSFERS: A COMPARISON ACROSS COUNTRIES

In this section we study how transfers vary across countries within this framework. The first subsection studies how the number of transfers varies across countries and the second subsection studies how the amount of transfers changes from one country to another. Countries are characterized by their level of income per capita I. We keep the family size constant across countries although the number of family members in poor and rich countries is unlikely to be the same because we know that the number of transfers increases with family size. Likewise, we keep income distribution constant across countries. We know that, at the same level of income per capita, the more unequal the income distribution the larger the proportion of families whose average income falls below the subsistence level and, therefore, the larger the number of transfers. We want to abstract from these two effects. We conclude that our definition of altruism implies that both the number and the amount of transfers are higher the lower the per capita income of the country.

5.1 Income per capita and expected number of transfers

As long as all relatives whose income is above the subsistence level transfer some income to those whose income is below this level, results in this section do not depend on the solution chosen to the public good problem considered in section 3. Since we have assumed that there is a continuum of families g inside each country, for each country we integrate over g the expected number of transfers inside a family to obtain the expected total number of transfers per country,

$$\begin{aligned} ENT(I) &= \int_0^{gc} (N^2 + N - Enp(I_g)) \cdot (Enp(I_g) + 1) \cdot dg + \\ &\quad \int_{gc}^1 (N^2 + N + 1 - Enp(I_g)) \cdot Enp(I_g) \cdot dg. \end{aligned}$$

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if c_s changes with average family income in a certain way. For instance, consider the model in section 2 with just two members. We just need $c_s = \frac{2\beta \bar{I}}{1+\beta}$ where $\bar{I}$ is average family income.

Since $g \in [0,1]$, results are normalized and can be understood as expected total number of transfers per family. The term gc denotes the family whose grandparent has an income of exactly c_s. It also denotes the proportion of families whose grandparent's income is below the subsistence level.

For countries for which $I \leq \frac{c_s - \sigma}{1+n\cdot\rho}$, income per capita is so low that all members in all families in the country are poor and so there are no transfers—$ENT(I) = 0$. For countries for which $\frac{c_s-\sigma}{1+n\cdot\rho} \leq I$, there are transfers inside the country, $ENT(I) > 0$. For countries for which $I \geq \frac{(N+N^2)\cdot(c_s+\sigma)}{N\cdot(1-\rho)+N^2\cdot(1-\rho^2)}$, $ENT(I)$ is strictly decreasing with the level of income per capita I—the higher the income per capita, the larger the fraction of families rich enough not to have transfers and, thus, the smaller the number of transfers per family. Thus, $ENT(I)$ is 0 for low levels of income per capita, then increases with the level of income per capita, and finally decreases, and it reaches a maximum for some for some relatively low level of income per capita.

If the value of σ is greater than the value of c_s, the first group of countries does not exist. If this is the case, the number of transfers are higher in countries with low income than in countries with higher income. Now, recall that according to the World Bank calculations the absolute poverty threshold is 370 1985 US dollars, a figure lower than the benchmark above calculated for σ (\$675). Therefore, the number of transfers are higher in countries with low income than in countries with higher income.

Figure 2 shows the relation between expected number of transfers per family and level of per capita income for different values of c_s. The level of income at which the number of transfers peaks moves with the value of c_s. Figure 3 shows that the shape of this relation does not change with the value of the standard deviation. In this figure we have set c_s equal to 370 dollars; as it can be seen, transfers peak at this level. In 1988 there were 23 countries with income per capita below 370 dollars; i.e., basically, the number of transfers decreases with the level of income.[21]

According to the World Bank (1990, p.30)

[21] These countries are: Mozambique, Ethiopia, Chad, Tanzania, Bangladesh, Malawi, Somalia, Zaire, Bhutan, Lao, Nepal, Madagascar, Burkina Faso, Mali, Burundi, Uganda, Nigeria, Zambia, Niger, Rwanda, China, India, and Pakistan (World Bank 1990).

> A consumption-based poverty line can be thought of as comprising two
> elements: the expenditure necessary to buy a minimum standard of
> nutrition and other basic necessities and a further amount that varies
> from country to country, reflecting the cost of participating in the
> everyday life of society. The first part is relatively straightforward.
> The cost of minimum adequate caloric intakes and other necessities can be calculated by looking at the prices of the foods that make up the diets
> of the poor. The second part is far more subjective; in some countries
> indoor plumbing is a luxury, but in others is a "necessity."

The figure above mentioned of \$370 is what the Bank considers to be the amount needed to acquire primary necessities. To account for the second part, we use the following formula

$$c_s = \min\left\{370, (1+n)\cdot 0.2^n \cdot I\right\}; \tag{12}$$

i.e., with this definition, in countries sufficiently rich, the poorest quintile income falls below the subsistence level. This definition is loosely based on the way in which Canada calculates the poverty level for welfare purposes.[22] With this modification, as can be seen in figure 4, the expected number of transfers stabilizes at a certain level instead of tending to 0.

Changes in the degree of persistence ρ do not affect the expected number of transfers when there is regression to the mean. Inside a family, the effect of ρ depends on the grandparents income being above or below the mean. For families with income above the mean, a decrease in the degree of

[22] United Nations considers the poverty level in a country to be half of the income per capita (United Nations, p. 196). This means that the lowest quartile of the population falls below the poverty level.

persistence ρ increases the expected number of poor relatives. The opposite is true for families with income below the mean. On average, as can be seen by integrating equation (11) the expected number of poor people does not change with ρ when there is regression to the mean. Thus, the expected number of transfers per family does not change much either.

5.2 Income per capita and expected amount of transfers

In this subsection we use again the transfers proportional to income allocation rule. For each country, we integrate over g the expected amount of transfers per family to obtain the expected total amount of transfers. As in the previous subsection, results are normalized and can be understood as expected total amount of transfers per family. We assume $N = 1$ for simplicity. The results are similar to those obtained in subsection 5.1.

Figure 5 shows the relation between expected amount of transfers per family and level of per capita income. The shape is similar to that of figure 2. When we allow the poverty level to change with the level of per capita income, according to formula (12), the expected amount of transfers, expressed as a percentage of per capita income, stabilizes at a certain positive level instead of tending to 0 (figure 6).

6 CONCLUDING REMARKS

In this paper we propose a definition of altruism that we consider most appropriate to study inter-vivos transfers; i.e., transfers that are meant to help acquaintances out of luck. We take the stand that some inter-vivos transfers (dowries or investment on human capital) should be considered as anticipated bequests. Bequest-type transfers and inter-vivos transfers respond to two different needs. While the first ones are meant to improve the recipients' welfare along the future, the second ones are meant to help the recipients overcome a present unpleasant situation. In the first case the recipients are usually descendants, whereas in the second case, they are not confined to be so. Although Becker's concept seems adequate to model altruism towards descendants and study bequest-type transfers, it does not seem suitable to study inter-vivos transfers or to model altruism towards other relatives.

In our framework, individuals become concerned about their relatives only if their relatives' consumption falls below a certain level (poverty line or subsistence minimum). As a consequence, transfers among members of families in which all members have an income above the threshold level are not observed. We conclude that, within this framework and as a general rule, the number and relative amount of inter-vivos transfers are greater in poor than in rich countries, and greater among low-income families than among high-income families.

This paper opens three questions to empirical investigation. The first one is whether the number and relative amount of inter-vivos transfers varies in a systematic way with income, both across families and across countries, as our model implies. The second question concerns the relation between the perception of poverty and income across countries and across families. Finally, the third question pertains to the manner in which families decide to help relatives who are going through a rough period. All these questions we consider worthwhile investigating.

There is an ongoing discussion about the impact of public programs on the level of public transfers. If transfers are altruistically motivated, public transfers crowd out private transfers one-to-one, provided that the recipient's income is below the subsistence consumption. If among the very poor transfers are altruistically motivated, a decrease in public programs increase transfers and it should decrease savings, which contributes to perpetuate poverty.

APPENDIX 1

In this appendix we illustrate the possibility of multiple equilibria with the Nash solution. Recall that with this solution and logarithmic preferences,

$$tr_{ij} = \min\left\{c_s - I_j - tr_{kj}, \frac{\beta^{d_{ij}} \cdot I_i - I_j - tr_{kj}}{1 + \beta^{d_{ij}}}, I_i - c_s\right\},$$

i.e., each individual decides her transfer taking as given the other relative's transfer. Then her transfer is a reaction function of the other transfer. Let us assume for this illustration that $(1+\beta) \cdot c_s < (I_i + I_j)$, for $i = 1, 2$, which implies that $(I_i - c_s)$ is always greater than the function $(\beta^{d_{ij}} \cdot I_i - I_j - tr_{kj})/(1 + \beta^{d_{ij}})$. Then, figure A1 shows these reaction functions for both individuals in the three cases.

In the first case for both of them $(c_s - I_j) \leq (\beta^{d_{ij}} \cdot I_i - I_j)/(1 + \beta^{d_{ij}})$. The reaction for both of them is

$$tr_i = c_s - I_j - tr_k,$$

where j denotes the poor relative and k denotes the third relative. Thus, any pair $(tr_i, c_s - I_j - tr_k)$ constitutes a solution.

In the second case, $(c_s - I_j) \leq (\beta^{d_{2j}} \cdot I_2 - I_j)/(1 + \beta^{d_{2j}})$ while $(c_s - I_j) > (\beta^{d_{i1}} \cdot I_1 - I_j)/(1 + \beta^{d_{i1}})$. Thus the reaction function for agent 2 is the same as in the first case, while for agent 1 the reaction function is

$$tr_1 = \min\left\{c_s - I_j - tr_2, \frac{\beta^{d_{i1}} \cdot I_1 - I_j - tr_2}{1 + \beta^{d_{i1}}}\right\}.$$

Thus, any pair

$$(c_s - I_j - tr_2, tr_2) \text{ for } tr_2 \in \left[c_s - I_j, \frac{(1 + \beta^{d_{1j}}) \cdot c_s - \beta^{d_{1j}} \cdot (I_j + I_1)}{\beta^{d_{1j}}}\right]$$

constitutes a solution. Similarly, if $(c_s - I_j) > (\beta^{d_{2j}} \cdot I_2 - I_j)/(1 + \beta^{d_{2j}})$ while $(c_s - I_j) \leq (\beta^{d_{i1}} \cdot I_1 - I_j)/(1 + \beta^{d_{i1}})$.

In the third case, for both of them $(c_s - I_j) > (\beta^{d_{ij}} \cdot I_i - I_j)/(1 + \beta^{d_{ij}})$. There may be a situation like the one shown in $3a$, in which there is multiplicity of equilibria, or a situation like the one depicted in $3b$, in which there is a unique interior solution. In the case of an interior solution, consumption allocations are

$$c_j = \frac{\beta^{d_{1j}} \cdot \beta^{d_{2j}} \cdot (I_1 + I_2 + I_j)}{\beta^{d_{1j}} + \beta^{d_{2j}} + \beta^{d_{1j}} \cdot \beta^{d_{2j}}}$$

and

$$c_i = \frac{\beta^{d_{ij}} \cdot (I_1 + I_2 + I_j)}{\beta^{d_{1j}} + \beta^{d_{2j}} + \beta^{d_{1j}} \cdot \beta^{d_{2j}}}, \ i = 1, 2.$$

Thus, $c_j/c_i = \beta^{d_{ij}} \leq (\alpha_1 \cdot \beta^{d_{1j}} + \alpha_2 \cdot \beta^{d_{2j}})/\alpha_i$, i.e., the solution is nonefficient, as Nash solutions are known to be.

APPENDIX 2

As we have shown, with logarithmic preferences, the demand of agent i of the public good in the Lindahl solution is

$$\min \left\{ c_s, \frac{\beta^{d_{ij}} \cdot (I_i + \alpha_i \cdot I_j)}{\alpha_i \cdot (1 + \beta^{d_{ij}})}, \frac{I_i + \alpha_i \cdot I_j - c_s}{\alpha_i} \right\}.$$

Again, for the purpose of this illustration let us assume $(1 + \beta) \cdot c_s < I_i$, for $i = 1, 2$. With this condition the function $(I_i + \alpha_i \cdot I_j - c_s)/\alpha_i$ always lies above the function $\beta^{d_{ij}} \cdot (I_i + \alpha_i \cdot I_j)/(\alpha_i \cdot (1 + \beta^{d_{ij}}))$ and, thus, becomes irrelevant. Figure A2 shows the demand functions in the three cases. Demand for individual 1 is shown in the left-hand axes. Demand for individual 2 is shown in the right-hand axes. In the X-axis, α_1 is represented from the left-hand corner and $\alpha_2 = 1 - \alpha_1$ is represented from the right-hand corner.

In the first case, for both of them $c_s < \beta^{d_{ij}} \cdot (I_i + I_j)/(1 + \beta^{d_{ij}})$. The curves show the functions $\beta^{d_{ij}} \cdot (I_i + \alpha_i \cdot I_j)/(\alpha_i \cdot (1 + \beta^{d_{ij}}))$. Since in this case c_s lies always below these functions, the demand equals c_s for every α_i. Then any par $(\alpha_1, 1 - \alpha_1)$ constitutes a solution.

In the second case this inequality holds just for one of the agents. Figure 2 shows the case in which the inequality holds for agent 1 but not for agent 2. The other case would be symmetric. Then any pair

$$(1-\alpha_2, \alpha_2) \text{ for } \alpha_2 \in \left[0, \frac{\beta^{d_{2j}} \cdot I_2}{c_s \cdot \left(1+\beta^{d_{2j}}\right) - \beta^{d_{2j}} \cdot I_j}\right]$$

constitutes a Lindahl solution.

In the third case, for both of them $c_s > \beta^{d_{ij}} \cdot (I_i + I_j)/(1+\beta^{d_{ij}})$. In this case there may be a situation like the one shown in $3a$, in which there are multiple Lindahl solutions, or a situation like the one shown in $3b$ in which the Lindahl solution is unique.

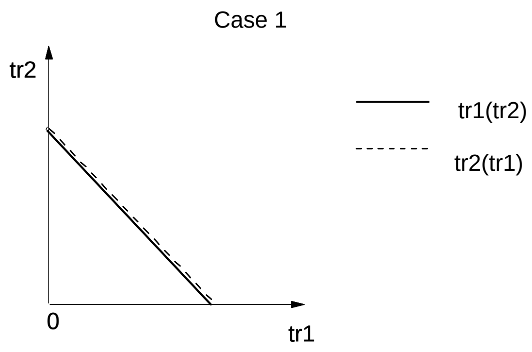

Figure 1:

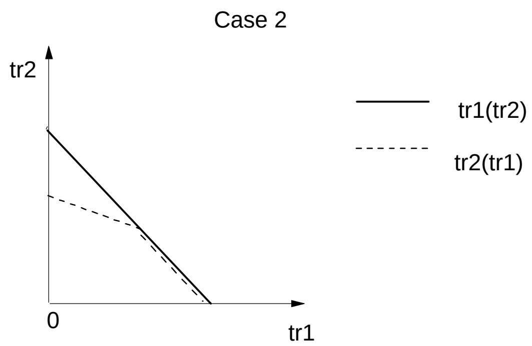

Figure 2:

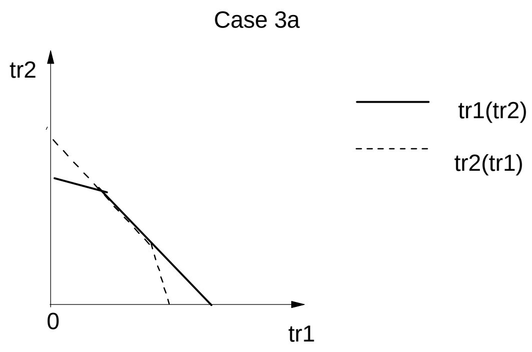

Figure 3:

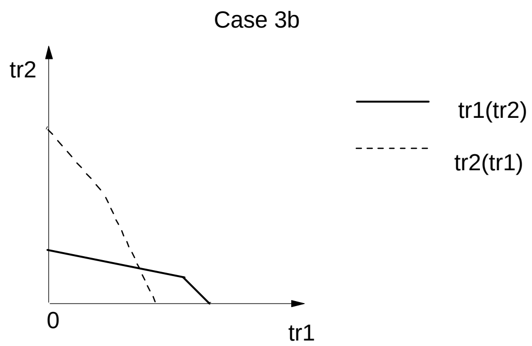

Figure 4:

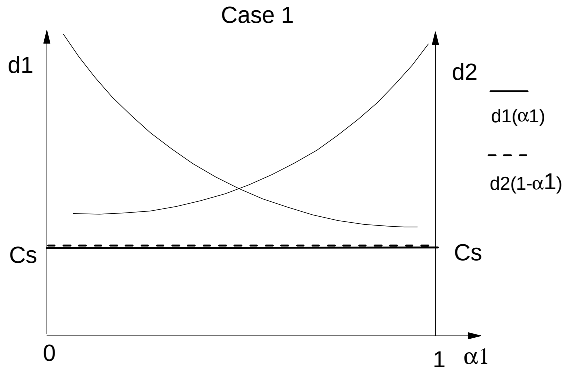

Figure 5:

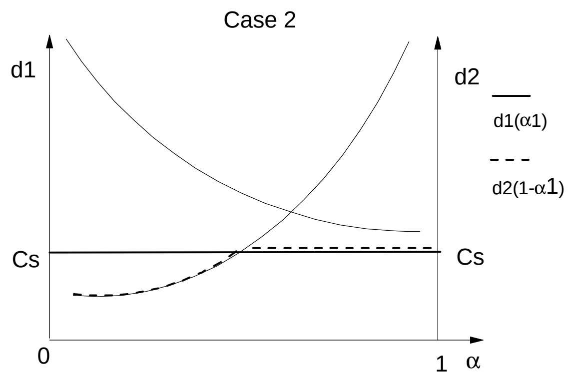

Figure 6:

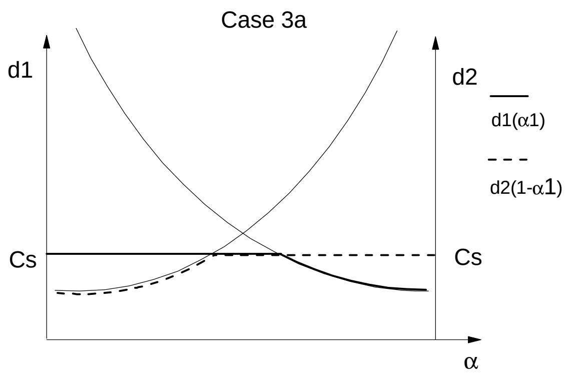

Figure 7:

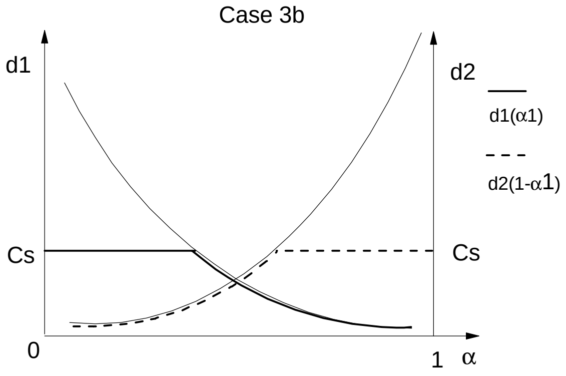

Figure 8:

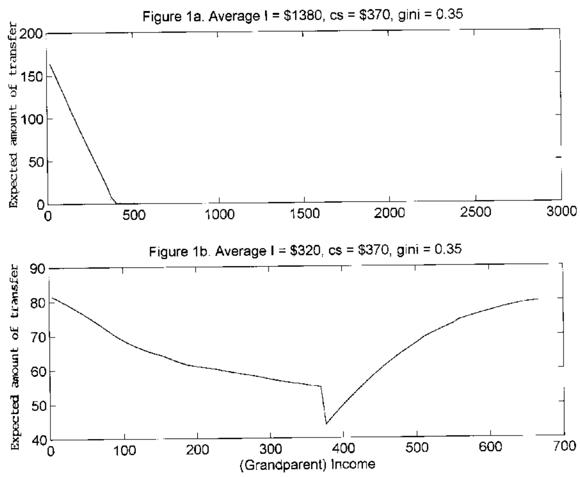
Figure 1a. Average I = $1380, cs = $370, gini = 0.35
Expected amount of transfer
200
150
100
50
0
0
500
1000
1500
2000
2500
3000
Figure 1b. Average I = $320, cs = $370, gini = 0.35
Expected amount of transfer
90
80
70
60
50
40
0
100
200
300
400
500
600
700
(Grandparent) Income

Figure 9:

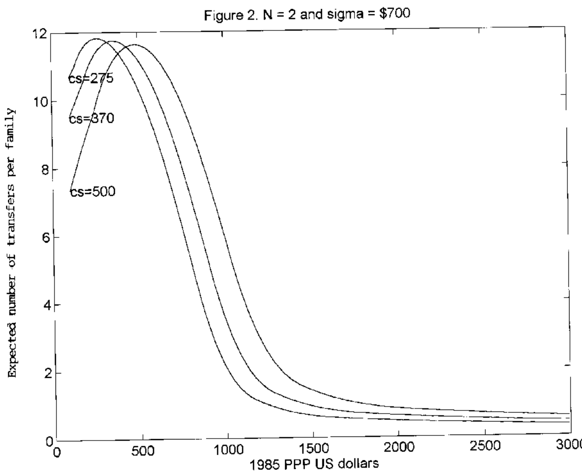

Figure 2. N = 2 and sigma = $700
Expected number of transfers per family
1985 PPP US dollars
cs=275
cs=370
cs=500
0
2
4
6
8
10
12
0
500
1000
1500
2000
2500
3000

Figure 10:

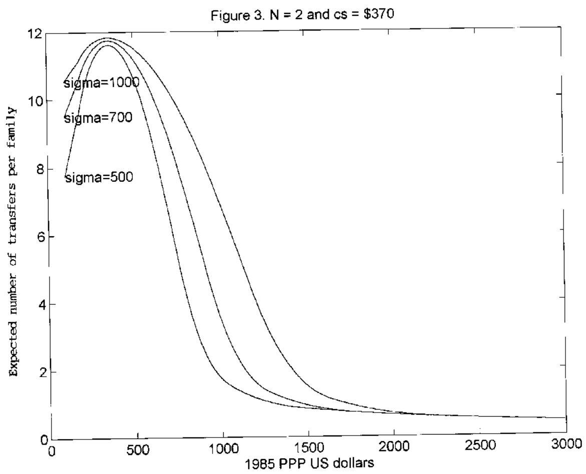
Figure 3. N = 2 and cs = $370
sigma=1000
sigma=700
sigma=500
Expected number of transfers per family
1985 PPP US dollars
0
2
4
6
8
10
12
0
500
1000
1500
2000
2500
3000

Figure 11:

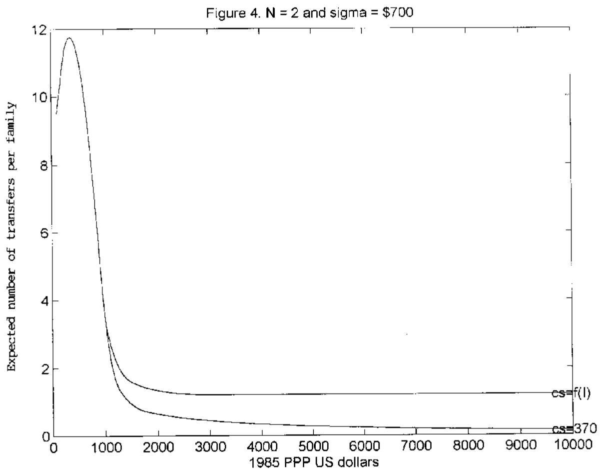

Figure 12:

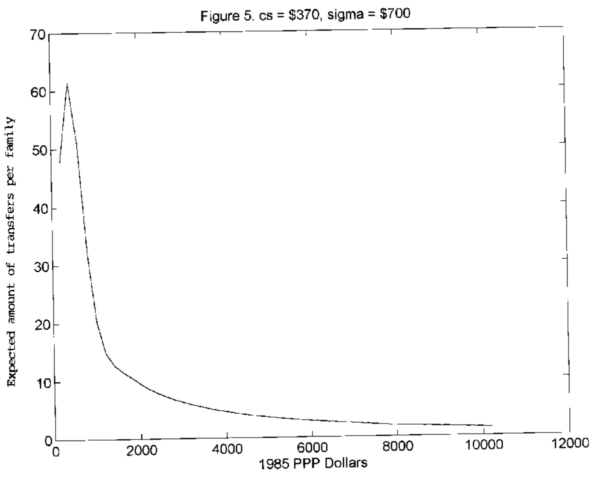

Figure 13:

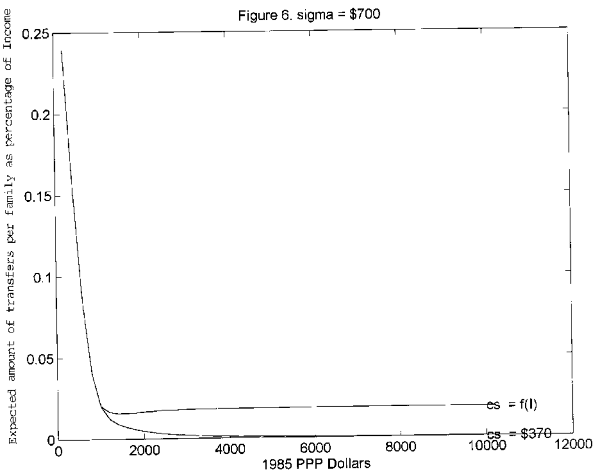

Figure 14:

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