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# Asymmetry of Information within Family Networks<sup>1</sup>

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## Abstract

This paper studies asymmetry of information and transfers within 712 extended family networks from Tanzania. Using cross-reports on asset holdings, we construct measures of mis-perception of living standards among households within the same network. We contrast altruism, pressure, exchange and risk sharing as motives to transfer in simple models with asymmetric information. Testing the model predictions in the data uncovers the active role played by recipients of transfers. Our findings suggest that recipients set the terms of the transfers, either by exerting pressure on donors or because they hold substantial bargaining power in their exchange relationships.

**JEL Classification Numbers:** O12, O15, D12

**Key Words:** Asymmetric Information, Transfers, Pressure, Exchange, Altruism.

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## I. INTRODUCTION

Private transfers among extended family members are pervasive in developing countries. A strand of the literature has investigated the determinants of these transfers (see, for example, Rapoport and Docquier 2006 and Cox and Fafchamps 2008). That literature has, however, typically assumed perfect information about one's income between family members. In contrast, a growing literature on migration suggests that there could be substantial asymmetry of information even among close relatives (McKenzie, Gibson, and Stillman 2013, Seshan and Zubrickas 2015 and Seror 2012).

Asymmetry of information may matter for private transfers. Using lab experiments in the field to vary the observability of gains, Jakiela and Ozier (2016), in the context of kin and neighbors in rural Kenyan villages, and Ambler (2015), in the context of migrants from El Salvador and their family members at home, show that subjects transfer more when their gains are made public. Seshan and Zubrickas (2017) finds that the more wives of Indian migrants working in Qatar underestimate the overseas income of their husbands, the lower the share of income sent home as annual remittances. Nyarko, Joseph, and Wang (2015) find remittances from workers in the UAE are strongly correlated with more easily observable variation in earnings. Batista and Narciso (2013) observe higher remittances from a sample of migrants in Ireland when they are offered free phone cards, arguing that it is due to improved information.

This paper uses a unique dataset of 712 extended family networks originating from the Kagera region in Tanzania to study the relationship between the asymmetry of information and private transfers within these networks. Making use of cross-reports on asset ownership among households belonging to the same extended family networks, we measure each household's misperceptions about the living standards of the other households in its network. We then explore

and contrast altruism, pressure, exchange and risk sharing as motives to transfer. Under these competing explanations, models of inter-household transfers with asymmetry of information yield predictions about the correlations between misperceptions and transfers after controlling for the income of the two parties, as well as the correlations between incomes and transfers after controlling for misperceptions. We refer to these as ‘partial’ correlations. Taking these predictions to the data, we find that transfers co-move with both the donor’s actual and perceived living standards, but not with the recipient’s actual or perceived living standards. This is consistent with a relationship where the recipients have power and request transfers from the donor, either using pressure to give or in exchange of services.

Our paper makes a number of contributions. First, our paper provides a coherent and generally applicable approach to measuring asymmetric information through surveys. In many environments of interest, household income is generated from smallholder farming or informal non-agricultural businesses and a large share of consumption is home-produced. In such contexts, measuring self-reported household income is problematic (Deaton 1997), so we should not expect to be able to measure perceptions of income by others. In contrast, questions on asset holdings are common in household surveys and provide an attractive indicator of medium term standards of living. Furthermore, eliciting beliefs from respondents about asset holdings of others can be done at low cost in linked surveys.

The question arises, though, of how to translate households’ beliefs about the various assets holding of others into measures of households’ beliefs regarding the living standards of others. We propose a measure of misperception that consists of a weighted sum of differences between believed and actual asset holdings. The weights are set depending on how these particular assets predict per capita consumption in the population. This, thus, captures the

percentage by which a household overestimates, or underestimates when negative, the per capita consumption of another household.

Our second contribution is descriptive. Applying this method to the data allows us to give a complete characterization of the asymmetry of information among the 712 Tanzanian extended family networks. Not surprisingly, we find a substantial level of asymmetry of information and show that it correlates positively with genetic, social and physical distance between households. However, there is no systematic underestimation or overestimation: perceptions are, on average, correct.

Our third contribution is to relate transfers to misperceptions by developing simple theoretical models of transfers with asymmetry of information regarding recipient and donor income. We develop static models that contrast three possible motives for transfers: altruism, in which the potential donor cares about the recipient; pressure, in which the recipient has some means of imposing a utility cost on the donor; and exchange, in which the transfer represents a payment for some good or service provided by the recipient.<sup>i</sup> Our model of altruism predicts a negative partial correlation of transfers with both the recipient's actual income and the donor's misperception of that income. A model of exchange in which the donor has all the bargaining power and risk-sharing motives also predict a negative partial correlation between the transfer and the recipient's income. In contrast, if the driving motivation is pressure or exchange in which the recipient has all the bargaining power, it is the donor's income and the recipient's misperception of the donor's income that matter and are positively correlated with the transfers. Note that these predictions capture not only the effect of information on transfers, but also the feedback mechanisms whereby transfers themselves, or the amount requested, are informative.

The data suggest that recipients of transfers play an active role in their relationship with donors. Rather than being passive, recipients seem to set the terms of transfers, either by exerting pressure to give on donors or by holding the bargaining power during an exchange of services. With respect to policy, this implies that we should probably worry less about possible crowding out effects of public transfers, and more about inefficiencies due to the cost of pressure and the moral hazard that can result from it (Alger and Weibull 2008).

This is consistent with the recent experimental evidence of Jakiela and Ozier (2016), Ambler (2015), Boltz, Marazyan, and Villar (2015) and Squires (2016), and the large ethnographic literature highlighting the importance of disapproval, shaming, ostracism and other means of pressure, as described and cited in Platteau (2014) and Chort, Gubert, and Senne 2012).

The rest of the paper is organized as follows. Section II presents the data on extended family networks in Tanzania that we use to build the measures of asymmetric information. These measures are defined and validated in Section III. Section IV presents competing models of transfers. Section V studies the correlations between transfers and misperceptions of income to examine the empirical validity of the models and Section VI concludes.

## II. DATA

This paper uses the 2010 wave of the Kagera Health and Development Survey (KHDS).<sup>ii</sup> Kagera, in the north-western part of Tanzania, has a population of 2.5 million people, the vast majority of whom engage in agriculture. The Kagera region is relatively isolated: it borders landlocked countries Uganda, Rwanda and Burundi and is 1,400 km away from the main port and commercial capital, Dar es Salaam. Using these data, De Weerdt (2010) and Beegle, De

Weerdt, and Dercon (2011) have shown that the diversification of income generating activities and migration are key household strategies for growth.

KHDS 2010 attempted to trace all individuals belonging to households that were surveyed in the original survey KHDS 1991-94. The latter interviewed 915 households in 52 villages' representative of the Kagera Region over four rounds from 1991 to 1994. KHDS 2010 searched for any individual listed in any household roster in KHDS 1991-94 and interviewed households in which these individuals were found residing in 2010. The survey attained very high recontact rates. Out of the original 915 households there are only 71 households (8%) where not a single individual was traced (excluding 26 households where all members had died). The interviewing team accounted, in 2010, for 88% of the 6,353 individuals listed on any KHDS 1991-94 roster: 68% of the original respondents were visited and surveyed, while 20% of respondents were confirmed to have died. 12% of individuals were not found. Out of the interviewed individuals 45% lived in the baseline village, 53% had migrated within the country, 2% to another East African country (primarily Uganda) and 0.3% had left East Africa.

Practically, we take advantage of this unique data structure to define a *split-off household* as any household that contains at least one member from the original roster (from KHDS 1991-94) and an *extended family network* as a network of split-off households, all originating from the same baseline household.<sup>iii</sup>

Note that the location of a household surveyed in 2010 depends strongly on the original member's role in the original household. We find that 58% of households who host the household head 18 years after baseline still live in the baseline village, as compared to only 22% of the other households in the family networks. The latter moved more frequently to nearby villages (17% of them versus 6% of households with former head) or to elsewhere in Kagera (41% of them versus 19% of households with former head). Moreover, split-off households with



daughters of the former head are less likely (21%) to live in baseline village than split-off households with sons (30%), a reflection of patrilocal marriage customs.

In addition to a detailed questionnaire regarding their own consumption<sup>iv</sup> and asset holdings, we designed survey questions regarding the asset holdings and relative standing of the other households in their network, as well as questions about the interactions and transfers between their household and each of the other households in their network. For example, if the original members have split into three different households, the network consists of these three households and each household is asked questions about the other two, giving us a data set of 6 dyadic observations. Having data on both sides of each pair of linked households in the networks allows us to contrast the beliefs held by one household about the other with the reality as recorded in the questionnaire.

After dropping households that did not split or have missing or incomplete interviews, our ‘large’ sample consists of 3,173 households from 712 extended family networks, yielding 13,808 unique within-family pairwise combinations of households. Some of the asymmetric information questions were skipped for split-off households residing in the same location as the respondent. Wherever the analysis below makes use of these skipped questions, we revert to our ‘small’ sample: a subsample of 9,032 dyads, all living in different locations, and encompassing 2,807 households within 613 extended family networks. Tables 11 and 12 in Appendix provide summary statistics on these samples.

The survey collected data on amounts remitted, both in-kind and cash. Over two thirds of households in our sample report remitting in the year preceding the survey. The average amount of cash remitted, among those who did, was USD 35, representing, on average, 7% of consumption per capita and 2% of total household consumption for the remitting households.

That average masks a wide distribution, with the top decile remitting USD 160, or 8% of their total household consumption. Out of these transfers, 59% goes to recipients within the extended family network.

In empirical applications networks are typically self-defined, with questionnaires probing each respondent for a list of network partners in the sense of friendship or households to whom one can ask help or borrow money from. Our network definition is different as it is based on membership in a household 18 years ago. Our definition has the advantage of being objectively defined, not subject to recall and the definition of a link is not based on the existence of transfers. Attrition aside, we would have complete networks defined in this way alleviating econometric concerns related to sampled networks (Chandrasekhar and Lewis 2011). However, despite the tracking success of KHDS 2010 we have some attrition that is likely to be non random. The principal strategy for tracing people from the original KHDS household rosters was to obtain their contact details through interviewed relatives. Not surprisingly, attrition rates are higher among households that have infrequent contact with their family members. Thus, we are likely looking at a somewhat more connected set of family members.<sup>v</sup>

### **III. QUANTIFYING ASYMMETRY OF INFORMATION**

#### **A. Beliefs about Assets, Education and Employment**

We can measure the extent to which extended family members are (mis)informed about each other by cross-checking the beliefs of any household  $i$  about educational attainment, employment and asset ownership of household  $j$  with the information in household  $j$ 's questionnaire. We can do this over 8 different items listed in Table 1.<sup>vi</sup> Household  $i$  can underestimate, correctly estimate or overestimate the status of household  $j$ ; household  $i$  could

also answer that it does not know the educational attainment, employment status or assets owned by house-hold  $j$ . Table 1 gives frequencies of these cross-reports: most underestimates of assets occur with respect to land and phones, while most overestimates occur with respect to vehicles.

Educational attainment and employment have the most correct perceptions. Note, however, that very few people overestimate the employment position of their relatives, while relatively more underestimate (that is think their family members do not have a formal job, while in fact they do).

Ultimately, we are interested in measuring what  $i$ 's perception on these 8 items tells us about  $i$ 's perception of  $j$ 's standard of living, and to what extent and in which direction  $i$  misperceives  $j$ 's true standard of living. A naive measure of asymmetry of information would be the simple sum of perceptions on the 8 items above adding up overestimates (set to +1), underestimates (set to -1), correct responses (set to 0) and don't know responses (set to 0). However, this approach has a number of problems. First, it assumes that all items carry the same weight in the measure. Second, it assumes that the weight of each item is separable from the household's characteristics, and from other items. Third, it assumes that all items signal something positive about the individual's living standards. An example of a violation of these last two assumptions would be if livestock ownership signals high income for rural households, but low income for urban households. In the next section we alleviate these concerns with a novel measure of asymmetric information: a weighted sum of misperceptions and their interactions, with weights set according to the correlations of the perceived items with household per capita consumption in the population.

## B. Perceived Consumption and Misperceptions

Let  $\mathbf{A}_j$  denote the profile of actual ownership of assets, education and occupation for household  $j$ , including any relevant interaction effects among assets, education and occupation. This is the profile over which  $i$  expresses beliefs  $\mathbf{B}_{ij}$ . In addition, let  $\mathbf{X}_j$  be a vector of basic characteristics of household  $j$  that we would think are public knowledge among relatives.

Given  $i$ 's belief about the profile of ownership of  $j$ , what can we infer about  $i$ 's estimate of  $j$ 's consumption? The view that we take here is that by observing households around him,  $i$  has learned the joint distribution of ownership profiles  $\mathbf{A}_j$  and household per capita consumption  $c_j$  conditional on household characteristics  $\mathbf{X}_j$  and  $\mathbf{A}_j$ .

Hence, we first estimate a consumption regression among our households

$$(1) \quad \ln(c_j) = \alpha \mathbf{A}_j + \beta \mathbf{X}_j + \gamma \mathbf{A}_j \mathbf{X}_j + \epsilon_j$$

where  $c_j$  is the actual per capita consumption for household  $j$ . See Section III.C. for more information on how we estimate Equation (1).

Retrieving the coefficients estimated  $(\alpha, \beta, \gamma)$  from (1), we can then use the characteristics  $\mathbf{X}_j$  and  $i$ 's beliefs about  $j$ 's assets  $\mathbf{B}_{ij}$  to construct measures of  $i$ 's perception of  $j$ 's consumption. Let

$$(2) \quad \ln(C_{ij}) = \alpha \mathbf{B}_{ij} + \beta \mathbf{X}_j + \gamma \mathbf{B}_{ij} \mathbf{X}_j.$$

How does  $\ln(C_{ij})$  relate to  $i$ 's beliefs regarding  $j$ 's log per capita consumption? The answer depends on what knowledge  $i$  has of the unobservables  $\epsilon_j$  in Equation (1). We consider two extreme assumptions regarding  $i$ 's knowledge of  $\epsilon_j$  and use it to construct two alternative measures of  $i$ 's perception of  $j$ 's consumption. One benchmark is to think that households are much better informed than we are about all unobservable characteristics, including temporary

shocks, that affect the income of their relatives. Hence, at the one end of the spectrum, we can assume that  $j$ 's relatives are perfectly informed of  $\epsilon_j$ , in which case  $i$ 's perceived consumption for  $j$  is

$$P_{ij} = \ln(C_{ij}) + \epsilon_j.$$

In this case, if household  $i$  held perfect knowledge on household  $j$ 's assets then the predicted consumption would equal the actual consumption.

An alternative benchmark is to posit that household  $i$  uses only  $\mathbf{X}_j$  and her beliefs about  $j$ 's assets  $\mathbf{B}_{ij}$  in forming her estimate of household  $j$ 's per capita consumption  $\mathbf{C}_{ij}$ . This assumes that household  $i$  has no additional information about household  $j$ , over and above  $\mathbf{X}_j$ , so that  $i$ 's perceived consumption for  $j$  is

$$P'_{ij} = \ln(C_{ij}).$$

We believe that the truth lies somewhere in between these two estimates.

This method implicitly assumes that any information that  $i$  has received about  $j$  is captured in  $\epsilon_j$  or in  $\mathbf{B}_{ij}$ , and therefore does not have an independent effect on  $i$ 's perception of  $j$ 's consumption. For example, the transfers that  $j$  has given to  $i$  or the frequency with which  $j$  calls  $i$  can provide information to  $i$  regarding  $j$ 's standard of living. We assume that this information is fully reflected in  $i$ 's beliefs about  $j$ 's assets and therefore in  $i$ 's perception of  $j$ 's consumption. This approach accounts for the possibility that one could make a number of mistakes regarding a relative's assets and still have a fairly accurate estimate of his household per capita consumption. It is entirely possible that a person, when answering the survey questions about her relatives, reports beliefs on assets that are consistent with her perception of the relative's consumption. She

might report that her relative has a TV but no phone, while her relative has a phone but no TV, but if both asset ownership profiles correspond to similar lifestyle (per capita consumption) in the overall population it amounts to the same perceived consumption.

Using these two benchmarks, we can create the following two measures of misperceptions – the difference between  $i$ 's perceived consumption for  $j$  and  $j$ 's actual consumption:

$$(3) \quad \Omega_{ij} = P_{ij} - \ln(c_j) = (\mathbf{B}_{ij} - \mathbf{A}_j)\alpha + \gamma(\mathbf{B}_{ij} - \mathbf{A}_j)\mathbf{X}_j, \quad \text{and}$$

$$(4) \quad \Omega'_{ij} = P'_{ij} - \ln(c_j) = (\mathbf{B}_{ij} - \mathbf{A}_j)\alpha + \gamma(\mathbf{B}_{ij} - \mathbf{A}_j)\mathbf{X}_j - \epsilon_j.$$

Our measure of misperception  $\Omega_{ij}$  is a weighted sum of the difference in believed and actual occupation, education and assets. Thus, it is well suited to measure misperceptions of medium-term living standards, rather than asymmetry of information regarding temporary shocks. In contrast,  $\Omega'_{ij}$  might measure not only misperceptions on medium term living standards, but also be affected by beliefs regarding temporary shocks, which are part of  $\epsilon_j$ . For example, a temporary positive consumption shock to  $j$ ,  $\epsilon_j > 0$ , with constant  $\mathbf{A}_j$  will lower  $\Omega'_{ij}$  – making it more likely for us to conclude that  $i$  underestimates  $j$ 's lifestyle – but will not affect our measurement of  $\Omega_{ij}$ .

The log specification conveniently implies that  $\Omega_{ij}$  is a good approximation of the percentage by which  $i$  overestimates ( $\Omega_{ij} > 0$ ) or underestimates ( $\Omega_{ij} < 0$ )  $j$ 's consumption.

### C. Measuring Weights for Perceived Consumption

To determine which variables to consider for the weights we proceed as follows. There are 12 variables that we can reasonably assume to be known by other family members and therefore be part of  $\mathbf{X}_j$ . These are the gender, age and squared age of the household head, eight

indicator variables capturing the household's age-sex composition and a dummy indicating whether the household resides in rural or urban area. For  $\mathbf{A}_i$ , we consider in their level form the 8 asset variables for which we have beliefs questions: educational attainment, employment and the ownership of the six assets listed in Table 1. Then all 12 common knowledge variables are interacted with each other, all 8 asset variables are interacted with each other and all 12\*8 interactions across both sets are made. This gives us a total of 190 interactions and 20 level variables to consider.

We want to remain agnostic about which of these 210 variables should enter the prediction regression and turn to approximately sparse regression models to ensure variables are selected with a view to good out-of-sample forecasts. In the Least Absolute Shrinkage and Selection Models (LASSO) of Frank and Friedman (1993) and Tibshirani (1996), the parameters are chosen in such a way to minimize the sum of least squares plus a term that penalizes additional variables. We use the post-LASSO estimator of Belloni et al. (2012), which proceeds in two steps. In a first step, the LASSO procedure is used to select all variables with non-zero weight. In a second step, the weights in the beliefs regression are determined by taking the coefficients from an OLS regression that uses only the variables selected in the first step.<sup>vii</sup>

Table 2 reports the final weights. Of the 8 candidate asset variables, only one, livestock ownership, did not get selected. In other words, livestock (by itself and in the various interacted forms it was considered) did not correlate sufficiently with per capita consumption once other variables were controlled for. Half of the 12 common knowledge variables were dropped in levels and only 5 interaction terms were retained. The final regression explains 57% of the total sample variation with 17 variables and a constant.

Note that when predicting household  $i$ 's beliefs about household  $j$ , we need to decide how to treat “don't know” (DK) answers to the assets, educational attainment and employment questions. We take the conservative approach of replacing DKs with location-specific sample means, depending on whether household  $j$  lives in an urban or rural area. We also control for the number of DK answers in the regressions in Sections III.D. and E.

Applying the weights from Table 2 to Equation (3) and (4), we can calculate  $\Omega$  and  $\Omega'$ , for each  $ij$  pair. Figure 1 shows kernel density estimations for both measures. The mean (standard deviation) is 0.006 (0.315) for  $\Omega$  and 0.002 (0.532) for  $\Omega'$ . Figure 1 also shows 95% confidence intervals around the sample means. These were obtained through the bootstrap procedure described in Appendix 1. They are  $[-0.013, 0.027]$  and  $[-0.020, 0.023]$  for  $\Omega$  and  $\Omega'$  respectively. This means that there is no indication of any systematic overestimation or underestimation of others' standards of living.

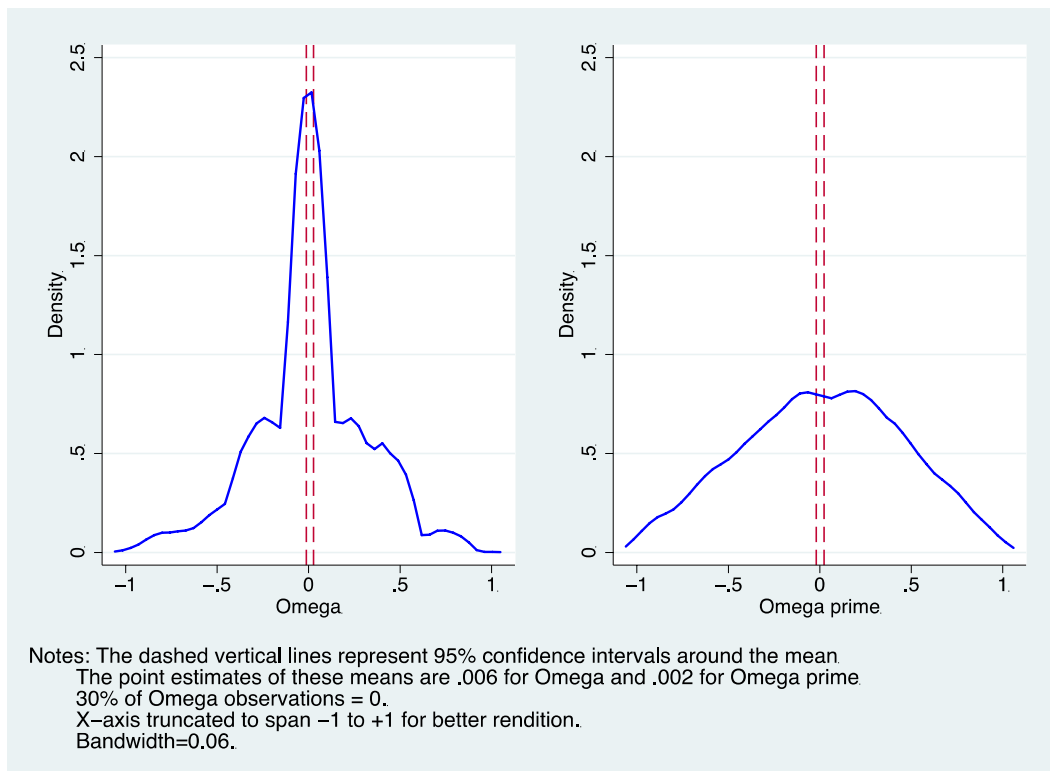


Figure 1: Distribution of  $\Omega$  and  $\Omega'$  (N=9,032)



However, there is significant asymmetry of information. The average of the absolute values of  $\Omega$  and  $\Omega'$  are 0.21 and 0.42, meaning that people are, on average, 21 and 42 per cent mistaken, respectively. The kernel smoother from Figure 1 obfuscates the fact that  $\Omega$  equals exactly zero in 30% of dyads, where all guesses were correct. The  $\Omega'$  distribution does not exhibit this lumping at zero because it subtracts the  $\epsilon_j$  term in its calculation. For the same reason the distribution of  $\Omega'$  has a much larger spread than that of  $\Omega$ .

#### **D. Validation**

We first validate  $\Omega$  and  $\Omega'$  by comparing them with a completely different measure of asymmetric information. For each of its network partners, any household  $i$  was asked to imagine a nine-step ladder where the top of the ladder, step 9, represents the best possible life and the bottom, step 1, represents the worst possible life. Household  $i$  was then asked to rank each household  $j$  in his network on the ladder. Table 3 shows that, using household  $i$  fixed effects, if household  $i$  places household  $j$  higher on the ladder, controlling for household  $j$ 's actual consumption, then  $\Omega_{ij}$  and  $\Omega'_{ij}$  are higher. That is, for 2 relatives with the same actual consumption, household  $i$ 's misperception of their standards of living is highly correlated with where he differentially places each on the ladder. The strong correlations between our misperception measures and these subjective perceptions give us confidence that  $\Omega$  and  $\Omega'$  are indeed capturing latent beliefs. When testing the model in Section V we will use the ladder as an alternative measure of misperceptions to verify the robustness of the results.

We further validate our misperception measures by verifying how they co-vary with variables that measure the fluidity of information flows between the two nodes. It is very natural

to expect individuals who are closer to each other, physically or socially, to have better information about each other. Table 4 relates misperceptions to a number of proximity variables through probit regressions. In the first column, the dependent variable is whether  $\Omega_{ij}$  is zero, which requires that all the beliefs of  $i$  regarding  $j$  are correct and occurs in 30% of all dyads. In the second column, the dummy is whether  $\Omega'_{ij}$ , which is never exactly zero, is close to 0 in the sense that it falls in  $[-0.5\sigma, +0.5\sigma]$  where  $\sigma = 0.532$  is the standard deviation of  $\Omega'$  (39% of all dyads).

In line with our expectations we see that the accuracy of perceptions, and in particular as measured by  $\Omega_{ij}$ , increases with proximity variables such as kilometers of geographic distance between the households, whether a parent-child link exists across the two households, whether they communicated in the past 2 years and whether they recently shared a meal together. This is also consistent with the findings of Alatas et al. (2016) in Indonesian networks. We also see that there is less accurate information about extended family members living in urban areas, controlling for distance travelled.

#### IV. MODEL OF MISPERCEPTIONS AND TRANSFERS

In this Section, we present simple models relating income, misperceptions of income and transfers. First, we model the three possible motivations for transfers in a static context: altruism, exchange and pressure. Then, we consider a dynamic model of risk sharing with asymmetry of information. For each model, we derive predictions regarding the correlations between income, misperceptions and transfers.

##### A. The Static Model

**Preferences and Income:** Consider two individuals, a recipient  $R$  and a donor  $D$ . A first possible motive for transfers is altruism: the donor cares not only about her own utility of consumption, but also about the recipient's. Denote by  $u_i(c)$  the utility of consumption of  $i \in \{R, D\}$ , with the usual properties that  $u' > 0$  and  $u'' < 0$ , and denote by  $\alpha_D \in [0, 1)$   $D$ 's altruism, that is the weight that the donor puts on the recipient's utility of consumption (following Becker 1974).<sup>viii</sup>

The recipient  $R$  and donor  $D$ 's utilities are then  $v_R = u_R(c_R)$  and

$$(5) \quad v_D = u_D(c_D) + \alpha_D \mathbb{E}_D u_R(\tilde{c}_R)$$

where  $\tilde{c}_R$  is  $R$ 's consumption as perceived by  $D$ . Note that we could easily assume that the recipient is also altruistic towards the donor.

**Income and Information:** We assume that  $R$  and  $D$ 's actual incomes are private information, though the following income distributions are common knowledge. The donor  $D$ 's income  $y$  is either low ( $L$ ) with a probability  $1 - q_D$  or high ( $H$ ) with a probability  $q_D$ ,  $L < H$  and  $q_D \in (0, 1)$ . The recipient  $R$ 's income  $x$  takes a low value ( $\ell$ ) with probability  $1 - q_R$  or a high value ( $h$ ) otherwise,  $\ell < h$  and  $q_R \in (0, 1)$ .

Let  $i \in \{R, D\}$  be one party and  $j \neq i \in \{R, D\}$  be the other. Individual  $i$ 's beliefs about  $j$ 's income are based on  $j$ 's actual probability of having a high income, but will also reflect any information about the actual realization of  $j$ 's income that  $i$  receives. Assume that  $i$  receives a signal  $s_j \in (0, 1)$  about  $j$ 's income  $m$  drawn from the conditional distribution  $f_j(s|m)$ . The realization of the signals is common knowledge. We assume that the conditional distributions satisfy the monotonic

likelihood property, so that high values of the signal are relatively more likely when income is higher, but also that at the extreme, these signals are almost perfectly informative:

$$[S1] \quad \frac{f_R(s|h)}{f_R(s|\ell)} \text{ and } \frac{f_D(s|H)}{f_D(s|L)} \text{ are strictly increasing in } s,$$

$$[S2] \quad \lim_{s \uparrow 1} \frac{f_R(s|\ell)}{f_R(s|h)} = \lim_{s \uparrow 1} \frac{f_D(s|L)}{f_D(s|H)} = 0 \text{ and } \lim_{s \downarrow 0} \frac{f_R(s|h)}{f_R(s|\ell)} = \lim_{s \downarrow 0} \frac{f_D(s|H)}{f_D(s|L)} = 0.$$

After using the signals and Bayes rule to update their beliefs, the posterior beliefs that the recipient and the donor hold about each other are given by

$$\pi_{s_R}^R = \frac{q_R f_R(s_R|h)}{q_R f_R(s_R|h) + (1-q_R) f_R(s_R|\ell)} \quad \text{and}$$

$$\pi_{s_D}^D = \frac{q_D f_D(s_D|H)}{q_D f_D(s_D|H) + (1-q_D) f_D(s_D|L)}$$

where  $\pi_s^j$  is the probability that the other party assigns to  $j$  having a high income after observing signal  $s$ .

**Pressure:** There is a large literature describing the pressure under which many households in developing countries find themselves to transfer to relatives (see Chort, Gubert, and Senne 2012 and Platteau 2014 among others).

To model this pressure motive, we assume that  $R$  can commit on imposing a punishment, a utility cost  $p \in [0, P]$ , on  $D$ . The nature of this punishment is likely to differ from household to household. There may be ways in which retaliation or feelings of guilt or shame can be directly meted out to someone who does not transfer enough. Similar punishments, but also loss of social status could be imposed indirectly through the community (see Cox and Fafchamps 2008).

Pressure might be available only at certain times, for instance when the recipient has a well-known need (such as suffering from some observable shock, or because school fees are due).

**Exchange:** Finally, another possible motive for transfers, in particular for migrants, is quid-pro-quo. As discussed by Cox and Fafchamps (2008) and Rapoport and Docquier (2006), private transfers might be given in exchange for goods or services provided by the recipient. This could be help with young children, old-age support or maintaining property rights for migrants. Assume that, at times, the recipient is in position to provide a service of utility value  $v$  to the donor at a utility cost  $c$ .

## B. Altruism

Consider first a situation in which altruism is driving the transfers:  $\alpha_D > 0$ ,  $P = 0$  and  $v = 0$ . The recipient  $R$  has no credible way to signal her income. Hence, for a given realization of her income  $y$  and the signal  $s_R = s$ ,  $D$  chooses to make a transfer  $t$  to  $R$  that maximizes

$$(6) \quad u_D(y - t) + \alpha_D [\pi_s^R u_R(h + t) + (1 - \pi_s^R) u_R(\ell + t)].$$

If interior,  $D$ 's choice of transfer  $t^*$  strictly increase on his own income  $y$  and decreases in  $\pi_s^R$ , his posterior beliefs regarding  $R$ 's income. Hence, the altruism model predicts a positive correlation between transfers and the donor's actual income, and a negative correlation between transfers and the donor's perception of the recipient's income. The latter implies a negative correlation between transfers and the donor's misperception of the recipient income controlling for the actual income and a negative correlation between transfers and the recipient's income controlling for the donor's misperception. Since there is a one-to-one correspondence between the donor's income and the transfer that she chooses when a positive transfer is made, upon receiving a transfer,  $R$  would know  $D$ 's realized income. Hence, no correlation is predicted between the transfers and the recipient's misperception of the donor's income.<sup>ix</sup>

### C. Pressure

Now, let's study the case without altruism  $\alpha_D = 0$  and without services  $v = 0$ , but in which transfers are driven by the possibility of pressure:  $P > 0$ . Since the cost for  $D$  of making a given transfer is decreasing in her income,  $R$  can make use of pressure not only to receive a transfer but also to get  $D$  to reveal her real income.

Indeed, given his income  $x$ ,  $R$  offers a menu to  $D$  of transfers  $t$  and contingent pressure  $p(t)$ :

- a transfer of  $T_H$  or more implies no pressure;
- a transfer of  $T_L$  implies pressure  $\underline{p}$ ; and
- any other transfer is associated with pressure  $\bar{p}$ .

The offer is designed so that the donor chooses to give  $T_H$  and faces no pressure when her income is high, while she chooses to give  $T_L$  and faces pressure  $\underline{p}$  when her income is low.

**Incentive constraints:** To simplify notation, denote by  $V_y(T)$   $D$ 's utility if her income is  $y$  and she makes a transfer  $T$ :

$$(7) \quad V_y(T) = u_D(y - T).$$

The incentive constraints for both type  $H$  and type  $L$  to comply with the offered menu are

$$(8) \quad V_H(T_H) \geq \max_t \{V_H(t) - p(t)\}$$

$$(9) \quad V_L(T_L) - \underline{p} \geq \max_t \{V_L(t) - p(t)\}$$

where  $p(t)$  is the pressure triggered by the scheme.  $D$ 's preferred transfer to  $R$  is 0 while  $R$  would like to receive as much as possible. Hence,  $R$  uses the highest pressure as a threat  $\bar{p} = P$  and, if  $D$  has a low income, her preferred deviation would be to make no transfer.

It follows that the incentive constraint for type  $L$  in (9) becomes,

$$(10) \quad V_L(T_L) - \underline{p} \geq V_L(0) - P.$$

Now, for type  $H$ , the relevant constraint ensures that  $H$  does not want to pretend to be  $L$ :<sup>x</sup>

$$(11) \quad V_H(T_H) \geq V_H(T_L) - \underline{p}.$$

Given his income  $x$  and a signal  $s$ , the recipient  $R$  chooses  $p$ ,  $T_H$  and  $T_L$  to maximize

$$(12) \quad \pi_s^D u_R(x + T_H) + (1 - \pi_s^D) u_R(x + T_L) \quad -$$

subject to (10) and (11).

The following two types of offer (or contracts) are possible:

*Pooling:*  $R$  asks  $D$  to transfer at least  $t^p$  in which case no pressure is applied  $\underline{p}=0$ , otherwise the maximal pressure  $\bar{p} = P$  would be applied. Hence,  $D$  makes the same transfer irrespective of her income  $T_L = T_H = t^p$ . Beliefs are therefore not updated and  $R$  never learns  $D$ 's real income. The transfer  $t^p$  is such that a type  $L$  donor is indifferent between giving  $t^p$  and receiving the maximum amount of pressure, that is  $u_D(L - t^p) = u_D(L) - P$  ;

or

*Separating:*  $R$  demands from  $D$  either a transfer of  $T_H$  in exchange for no pressure, or a lower transfer  $T_L (< T_H)$  but with some pressure  $\underline{p} > 0$ . Any other transfer would result in maximal pressure.  $D$  chooses to transfer more when her income is high  $T_H > T_L$  but she is subject to pressure  $\underline{p} > 0$  when her income (and transfer) is lower. Since  $D$ 's transfer varies with her income,  $R$  updates his beliefs and has full information ex-post. The exact values  $T_H$ ,  $T_L$  and  $\underline{p}$  depend on the probabilities  $\pi_s^D$  and on  $x$ .

The higher  $R$ 's belief that  $D$  has a high income, the more likely he is to offer a separating contract. This intuition is formalized in Proposition 1 whose proof is in Appendix 2.

**Proposition 1** *There is a cutoff value of the signal  $\tilde{s} \in (0,1)$  such that  $R$  offers a pooling contract if  $s_D \leq \tilde{s}$  and  $R$  offers a separating contract if  $s_D > \tilde{s}$  with  $T_H$  ( $T_L$ ) increasing (decreasing) in  $s$ .*

Proposition 1 tells us that either:

- (i)  $s_D > \tilde{s}$  and  $R$  offers a separating contract, in which case  $D$  gives a low transfer if her actual income is low but is subject to pressure while she gives a high transfer and receive no pressure if her actual income is high.  $R$ 's beliefs are correct ex-post; or
- (ii)  $s_D \leq \tilde{s}$  and  $R$  offers a pooling contract with transfer  $t^p > T_L$ , in which case  $R$  overestimates (underestimates)  $D$ 's income ex-post if  $D$  was low (high).

Table 5 illustrates these findings. First, there is a positive correlation between  $D$ 's actual income and her transfer to  $R$ . Second, for a given income level of  $D$  (H or L) there exists a positive correlation between the perception of  $D$ 's income by  $R$  ( $\pi^D$ ) and the transfer from  $D$  to  $R$ : the more  $R$  thinks  $D$  has, the higher the transfer from  $D$  to  $R$  is.

In terms of the recipient's income, whether a higher  $x$  affects the contract offered and, if so, whether it encourages separating or pooling depends on the utility function. In any case the correlation between the recipient's income and the transfers is small and unlikely to be significant.<sup>xi</sup> Finally, controlling for the recipient's income, and therefore the actual offer, variation in the donor's ex-post beliefs about the recipient stems from receiving different signals



under a pooling offer. This has no bearing on transfers so that, controlling for incomes, there is no correlation between transfers and the donor's misperceptions.

#### D. Exchange

To study the exchange motive, assume that there is no pressure ( $P = 0$ ) nor altruism ( $\alpha_D = 0$ ), but that the recipient can provide a service of utility value  $v$  to the donor at a utility cost  $c$ ,  $c < v$ . The price of that service, the transfer, clearly depends on their relative bargaining power.

Denote as  $\underline{t}(x)$ , the lowest transfer that the recipient would accept to provide the service, given his income  $x$ :

$$(13) \quad u_R(x + \underline{t}(x)) - u_R(x) = c,$$

and as  $\bar{t}(y)$ , the highest transfer that a donor with income  $y$  would pay for the service:

$$(14) \quad u_D(y) - u_D(y - \bar{t}(y)) = v.$$

We assume that the relative value of the service ( $v/c$ ) is sufficient that the exchange is socially optimal:  $\bar{t}(L) > \underline{t}(h)$ . We follow Cox and Fafchamps (2008) and Rapoport and Docquier (2006) and consider in turn the two extremes: the case where the donor has all the bargaining power and the case where the recipient has all the bargaining power.

**Exchange-D: Donor has the bargaining power:** Assume that  $D$  gets to make a take-it-or-leave-it offer to  $R$ . This recipient's reservation price  $\underline{t}(x)$  is clearly increasing in his income  $x$ . Hence,  $D$  essentially chooses between a) offering  $\underline{t}(h)$  for the service, an offer that  $R$  always accepts, or b) offering a lower transfer  $\underline{t}(\ell)$  that  $R$  accepts only when his income is low. Other

offers are dominated. The optimal choice depends on  $D$ 's income  $y$  and her beliefs regarding  $R$ 's income  $\pi_s^R$ .  $D$  chooses a) if

$$u_D(y - \underline{t}(h)) + v \geq \pi_s^R u_D(y) + (1 - \pi_s^R) (u_D(y - \underline{t}(\ell)) + v) \quad \Leftrightarrow$$

$$(15) \quad v \geq [u_D(y) - u_D(y - \underline{t}(h))] + \frac{1 - \pi_s^R}{\pi_s^R} [u_D(y - \underline{t}(\ell)) - u_D(y - \underline{t}(h))]$$

and chooses b) otherwise. Higher  $\pi_s^R$  makes this inequality more likely to hold. For low values of the signal  $s_R$ ,  $\pi_s^R$  is close to 0 and Inequality (15) cannot hold, while for high values of the signal  $s_R$ ,  $\pi_s^R$  is close to 1 and (15) is necessarily satisfied.

**Proposition 2** *There is a cutoff value of the signal  $\bar{s} \in (0,1)$  such that  $D$  offers  $\underline{t}(\ell)$  if  $s_R \leq \bar{s}$  and  $D$  offers  $\underline{t}(h)$  if  $s_R > \bar{s}$ .*

$D$  offers  $\underline{t}(\ell)$  when she receives a signal that the recipient's income is likely to be low ( $s_R \leq \bar{s}$ ), and she offers  $\underline{t}(h)$  when the signal indicates that recipient's income is likely to be high ( $s_R > \bar{s}$ ). Table 6 illustrates these findings.

Controlling for  $D$ 's perception of  $R$ 's income, the actual transfer is negatively correlated with  $R$ 's actual income. And controlling for the actual realization of  $R$ 's income ( $x$ ), the correlation between the transfer and  $D$ 's perception of  $R$ 's income ( $\pi^R$ ) is ambiguous: it is positive for low values of  $x$  and negative for high values of  $x$ .

What about the donor's income  $y$ ? A higher income makes inequality (15) more likely to hold. Richer donors are more likely to offer the high price  $\underline{t}(h)$  so that the threshold  $\bar{s}$  is smaller for richer donors. This implies a positive correlation between transfers and donor's income. This correlation is likely to be small as it comes only from the realization of the signal that reveals  $y$ 's income: the realizations of the signal  $s_R$  that lies between the threshold  $\bar{s}$  for  $y = H$  and the threshold  $\bar{s}$  for  $y = L$ . Controlling for the actual income of the donor, only the signal that the

recipient receives affects his beliefs about the donor's income so that there is no correlation with the transfers.

**Exchange-R: Recipient has the bargaining power:** Now, assume that the recipient gets to make a take-it-or-leave-it offer to the donor. It is easy to check that the donor's reservation price  $\bar{t}(y)$  too is increasing in her income. Hence,  $R$  essentially chooses between two options: a) demanding  $\bar{t}(L)$  for the service, an offer that  $D$  always accepts, or b) demanding a higher transfer  $\bar{t}(H)$  that  $D$  rejects when her income is low but accepts when her income is high. Other demands would be dominated by one of these two options.  $R$ 's chosen option depends on his income  $x$  and his beliefs about  $D$ 's income  $\pi_s^D$ .  $R$  chooses a) if

$$(16) \quad \begin{aligned} u_R(x - \bar{t}(L)) - c &\geq \pi_s^D [u_R(x - \bar{t}(H)) - c] + (1 - \pi_s^D)u_R(x) \Leftrightarrow \\ [u_R(x - \bar{t}(L)) - u_R(x)] - c &\geq \frac{\pi_s^D}{1 - \pi_s^D} [u_R(x - \bar{t}(H)) - u_R(x - \bar{t}(L))] \end{aligned}$$

and chooses b) otherwise. We see that when  $\pi_s^D$  is close to 0, inequality (16) is satisfied while it fails for value of  $\pi_s^D$  close to 1. The higher  $\pi_s^D$  is the more likely  $R$  is to ask  $\bar{t}(H)$ .

**Proposition 3** *There is a cutoff value of the signal  $s^* \in (0, 1)$  such that  $R$  asks  $\bar{t}(L)$  if  $s_D \leq s^*$  and  $R$  asks  $\bar{t}(H)$  if  $s_D > s^*$ .*

$R$  asks  $\bar{t}(L)$  when he receives a signal that the donor's income is likely to be low, and he offers  $\bar{t}(H)$  when the signal indicates that donor's income is likely to be high. Controlling for  $D$ 's income ( $y$ ), the transfer is positively correlated with  $R$ 's perception of  $D$ 's income ( $\pi_s^D$ ) and, controlling for  $R$ 's perception of  $D$ 's income, the transfer is positively correlated with  $D$ 's income. Table 7 illustrates these findings.

Again, there will be a correlation between the recipient's income  $x$  and the transfers only for the signal values for which it affects the scenario that  $R$  chooses. Hence, this effect should be small. As a higher income for the recipient could make him more or less likely to select a) depending on the values of  $\bar{t}(L)$  and  $\bar{t}(H)$  and on his utility function, this correlation, if there is one, could go in any direction. Controlling for  $R$ 's actual income  $x$ , only the signal about it causes variation in  $D$ 's beliefs about  $R$ 's income and this is uncorrelated with the transfers.

### E. Risk Sharing

So far, we have considered only static models of transfers. That focus is, to some extent, due to the KHDS data on which our empirics are built. We do not have repeated data on consumption per capita for our households and we measure misperceptions through cross-reports on assets. It is nevertheless worth briefly discussing risk sharing.

Imagine that our two individuals draw an income realization in each period. For simplicity, assume away the signal. Instead individuals send messages to each other regarding the realization of their income. The prescribed transfers depend on these reports as well as the history of previous reports. Under the constrained optimal risk sharing scheme (see Cole and Kocherlakota 1999, Attanasio and Pavoni 2011, Cole and Kocherlakota 1999, Kinnan 2009 and Hauser and Hopenhayn 2008 among others), the prescribed transfers and continuation utilities must be such that individuals truthfully reveal their income and there are no misperceptions left. Although the prescribed transfer from a donor to a recipient is history dependent,<sup>xii</sup> transfers are increasing in the income realization of the donor and decreasing in the income realization of the recipient. Assuming that the effect of the difference in average income between these individuals (see Genicot 2006) is small – this effect is absent for instance in the case of log utility – the

prediction that transfers are increasing in the income realization of the donor and decreasing in the income realization of the recipient would hold even without controlling for the average income of the individual.

## F. Predictions

Table 8 summarizes the predicted *partial* correlations between transfers, donor's and recipient's income, and misperception under the four motives. That is, it shows the predicted correlations between the transfers and the donor's (recipient's) misperception controlling for the income realizations and the other's misperception, and the predicted partial correlation between the transfers and the donor's (recipient's) income controlling for the misperceptions and the other's income. These correspond to the predictions regarding the regression coefficients in the next section. Importantly, the misperceptions concern ex-post beliefs, so that these correlations take into account the feedback mechanisms through which transfers influence beliefs.

We made two decisions for the table. First, some misperceptions in the data are likely due to measurement errors/noise. Hence, when the model predicts no misperception at all and therefore no correlation could be calculated, we enter 0. If the misperceptions are just due to noise then one would expect a zero correlation. Second, recall that in the pressure and exchange- $R$  models, the partial correlation between the transfers and  $R$ 's income are likely to be small as it exists only when the type of contract chosen by  $R$  changes with his income, and in addition the overall effect averages some positive and negative effects.<sup>xiii</sup> Hence, we enter  $\epsilon$  in Table 8 for these effects.

Finally, note that if the opportunity presents itself, households might hide some of their income. Access to a hiding technology would result in an increase in the precision of a high signal and reduce the prediction of a low signal. Hence, the existence of a

(partial) hiding technology would not affect our main predictions, though it would attenuate some of the effects. Similarly, access to a costly monitoring would not affect the predicted correlations.<sup>xiv</sup>

## V. ASYMMETRIC INFORMATION AND TRANSFERS

This section tests the predictions from Table 8 regarding the partial correlations between transfers ( $T_{RD}$ ) received by any household  $R$  in the family network from any other family  $D$  in the same network and (i) the degree of misperceptions of the recipient about the donor ( $\Omega_{RD}$  or  $\Omega'_{RD}$ ), (ii) the degree of misperceptions of the donor about the recipient ( $\Omega_{DR}$  or  $\Omega'_{DR}$ ), (iii) the donor's living standards ( $I_D$ ) and (iv) the recipient's living standards ( $I_R$ ). Living standards are proxied by log consumption per capita.

We estimate these partial correlations through dyadic regressions of  $T_{RD}$ , whether or not  $D$  reported giving transfers to  $R$  in the year preceding the survey,<sup>xv</sup> on the four correlates that we are interested in. This brings with it a number of econometric challenges. The first is that we need to condition the correlations on the correct variables in order to get unbiased estimates. In the model, we assume everything constant across both donor and recipient. We can implement this empirically by using a two-way fixed effect model, which includes a fixed effect for  $R$  and  $D$ ,  $\alpha_R$  and  $\alpha_D$ , respectively.<sup>xvi</sup> While this does not capture any dyadic specific heterogeneity that may cloud these correlations, we also control for a set of observable dyadic characteristics describing the relationship between donor and recipient households to minimize such concerns.

Our preferred regression then is:

$$(17) \quad T_{RD} = \beta_1 \Omega_{RD} + \beta_2 \Omega_{DR} + \mathbf{P}_{RD} \gamma_1 + \alpha_R + \alpha_D + \epsilon_{RD}$$

where  $\epsilon_{RD}$  is an error term and  $\mathbf{P}_{RD}$  is a vector of variables describing the relationship between the  $R$ - $D$  household pair. This includes whether the heads of both households share the same religion or tribe, whether a child or parent relationship links both households, the geographic distance between the two households and the number of DK responses to the asymmetric information questions each side of the dyad gave.

A second econometric issue arises from the fact that  $\Omega$  and  $\Omega'$  are predicted values, which means that standard parametric approaches will overstate the precision with which they are measured. We therefore present bootstrapped standard errors, calculated through the two-step procedure described in the online Appendix 1.

One of the variables of interest from the model predictions in Table 8 is  $D$ 's standard of living  $I_D$ , which is subsumed in the fixed effect  $\alpha_D$ . To retrieve an estimate of the coefficient of  $I_D$ , we drop  $\alpha_D$  in Equation (17) and replace it with the natural logarithm of  $D$ 's consumption and other characteristics of  $D$ . We estimate:

$$(18) \quad T_{RD} = \beta_1 \Omega_{RD} + \beta_2 \Omega_{DR} + \beta_3 I_D + \mathbf{P}_{RD} \gamma_1 + \mathbf{Z}_D \gamma_2 + \alpha_R + \epsilon_{RD}$$

where  $\mathbf{Z}_D$  is a vector of household  $D$  characteristics including the sex, age and years of education of the household head, whether the household owns a phone or a motorized vehicle (as these may serve to lower the cost of transfers), as well as the number of household members that fall in each of eight exclusive and exhaustive age-sex categories (this controls for household size).

Similarly, to retrieve an estimate on the  $I_R$  variable we drop  $\alpha_R$  in Equation (17) and replace it with  $R$ 's consumption and other characteristics:

$$(19) \quad T_{RD} = \beta_1 \Omega_{RD} + \beta_2 \Omega_{DR} + \beta_4 I_R + \mathbf{P}_{RD} \gamma_1 + \mathbf{Z}_R \gamma_2 + \alpha_D + \epsilon_{RD}.$$

We can determine  $T_{RD}$  in two ways. First, we can use what  $R$  reports receiving from  $D$  in the incoming gifts section of his questionnaire. Alternatively, we can use what  $D$  reports giving to  $R$

in the outgoing gifts section of her questionnaire. When we run the two-way fixed effects regressions, we report the results both ways. When we omit one of the fixed effects, we use the report from the questionnaire of whoever's fixed effect is still included, that is when we drop the donor fixed effect, we use the recipient's report of transfers in. The advantage of this approach is that the controls  $Z$  are measured independently from the transfer measure used on the left hand side of the equation since they are sourced from a different questionnaire. Each regression table will show in the heading not only which equation is being estimated, but also whether the transfers used on the left hand side are from the questionnaire of  $R$  or  $D$ .

It is worth recalling that we do not attach a causal interpretation to these coefficients. In fact, the model explicitly allows for feedback mechanisms between the level of transfers and perceptions. For example, in a separating equilibrium, a high  $T_{RD}$  will cause beliefs  $\Omega_{RD}$  to be revised upwards. We use the dyadic regression set-up as a convenient way to retrieve the partial correlations, measured by  $\beta_1$ ,  $\beta_2$ ,  $\beta_3$  and  $\beta_4$ , in order to compare their signs to the predictions from Table 8.

We estimate Equations (18) and (19) separately for both  $\Omega$  and  $\Omega'$  Equation (17) is only reported for  $\Omega$ , since, as can be seen from Equations (3) and (4) above, the difference between  $\Omega$  and  $\Omega'$  is subsumed in the double fixed effect and, in consequence, the regression results for both measures are identical. All equations are estimated using linear probability models.

The picture that emerges from this table is clearly that  $\beta_1 > 0$ ,  $\beta_2 = 0$ ,  $\beta_3 > 0$  and  $\beta_4 = 0$ , which is consistent with either pressure or exchange-R in Table 8.<sup>xvii</sup> From the first and second columns we see that when  $\Omega_{RD}$  goes up with one standard deviation ( $=0.315$ ), then, depending on the specification, the likelihood of a transfer goes up by two to three percentage points, which represents 11% to 14% of the prevalence of transfers among dyads. The absence of a negative



coefficient on the the recipient's income,  $\beta_4$ , allows us to reject both altruism and exchange-D as motives of transfers. We can also reject the hypothesis that  $\beta_2$ , the coefficient on  $\Omega_{DR}$ , is smaller than zero, thus rejecting a second prediction of the altruism model.

The absence of negative correlation between transfers and the recipient's income is consistent with the finding of Lucas and Stark (1985) and Cox, Eser, and Jimenez (1998) who reject altruism as a motive for remittances among migrants in Botswana and as a motive for transfers in Peru. In contrast, Kazianga (2006) finds some support for the altruistic motive among the middle income class in Burkina Faso, but not for low income levels, and in the US, Altonji, Hayashi, and Kotlikoff (1997) finds a negative correlation between in-vivo transfers and the recipient's income in support of the altruism remittance motive.

We can check that our findings are unaltered if we use different measures of the perceptions of standard of living, coming from the ladder questions described in Section III.D. We run slightly different versions of Equations (17), (18) and (19), where we include a measure for whether  $i$  places  $j$  on the lowest steps 1, 2 or 3 of the ladder,  $\underline{L}_{ij}$ , or the highest steps 7, 8, 9 of the ladder,  $\bar{L}_{ij}$ . Furthermore, the variables measuring the number of don't know responses to asymmetric information questions are replaced by two dummy variables indicating that don't know responses were given to the ladder questions by the donor or the recipient, respectively. The two way fixed-effects version then becomes:

$$(20) \quad T_{RD} = \delta_1 \underline{L}_{RD} + \delta_2 \bar{L}_{RD} + \delta_3 \underline{L}_{DR} + \delta_4 \bar{L}_{DR} + \mathbf{P}_{RD} \gamma_1 + \alpha_R + \alpha_D + \epsilon_{RD}.$$

Unlike the  $\Omega$  variables, these ladder questions are not predicted values, but are directly reported in the questionnaire. We do not bootstrap the standard errors here, but still need to allow for correlations between transfers received by the same recipient or sent by the same donor to

avoid biased estimates of the standard errors. We use the non-nested two-way clustering approach developed by Cameron, Gelbach, and Miller (2011) and implemented in Stata by Baum, Shaffer, and Stillman (2007)<sup>xviii</sup> with clustering on both  $R$  and  $D$ .

The FE specification allow us to capture any fixed unobserved characteristic of the recipient or of the donor, which may systematically affect their relative perceptions of the positions of other households in their family network. As above, to retrieve estimates of the coefficients on  $I_D$  and  $I_R$ , we estimate

$$(21) \quad T_{RD} = \delta_1 \underline{L}_{RD} + \delta_2 \bar{L}_{RD} + \delta_3 \underline{L}_{DR} + \delta_4 \bar{L}_{DR} + \mathbf{P}_{RD}\gamma_1 + \beta_3 I_D + \mathbf{Z}_D\gamma_2 + \alpha_R + \epsilon_{RD}$$

and

$$(22) \quad T_{RD} = \delta_1 \underline{L}_{RD} + \delta_2 \bar{L}_{RD} + \delta_3 \underline{L}_{DR} + \delta_4 \bar{L}_{DR} + \mathbf{P}_{RD}\gamma_1 + \beta_4 I_R + \mathbf{Z}_R\gamma_2 + \alpha_D + \epsilon_{RD}.$$

Table 10 shows the estimates of these three equations. As above we use the transfer report from the questionnaire of whoever's fixed effect is still included. We show results both ways for the double fixed effect. To be consistent with the results above, we would expect to see that, controlling for  $D$ 's actual consumption (through either  $\alpha_D$  or  $I_D$ ), lower perceptions of  $R$  about  $D$ 's standard of living are correlated with a lower likelihood of transfers from  $D$  to  $R$ , which implies  $\delta_1 < 0$  and, symmetrically, that higher perceptions of  $R$  about  $D$ 's standard of living are correlated with a higher likelihood of transfers from  $D$  to  $R$ , that is  $\delta_2 > 0$ . As before, we expect  $\delta_3 = 0$ ,  $\delta_4 = 0$ ,  $\beta_3 > 0$  and  $\beta_4 = 0$ . Table 10 does yield this pattern, except for the estimated coefficients  $\delta_2$  which turn out to be largely not significantly different from zero at conventional levels. This anomaly could be attributed to the fact that this category holds only 5% of the

observations. However expanding the boundaries does not make a difference. Taken together, these results support the main results indicating that the power in the gift-giving relationship lies with the recipient of the transfer, consistent with either a pressure model or an exchange model in which the recipient holds the bargaining power.<sup>xix</sup>

## VI. CONCLUSION

This article analyzed how private transfers between linked households relate to actual and perceived living standards. To do this, we built novel measures of asymmetric information that compare actual to perceived asset holdings. We applied these measures to original survey data on households belonging to 712 extended family networks in Tanzania. Using rich information on their relationships and characteristics, we validated our measures of misperceptions of living standards and showed that the degree of misperception increases with genetic, social and physical distance between households. We found, on the one hand, substantial asymmetry of information within our extended family network, but on the other hand that perceptions are correct on average.

We then developed simple static models to predict the correlations between income, misperceptions of income and transfers depending on whether it is altruism, exchange or pressure that is the main driver of transfers. We showed that the predictions of these models differ. In particular, when the recipient plays an active role (either in a model of pressure to give or in a model of exchange in which the recipient holds all the bargaining power), transfers have a positive partial correlation to the donor's actual income and to the recipient's misperception of that income (a positive value of misperceptions indicating over-estimation of income). In contrast, when transfers are motivated by pure altruism of the donor, their partial correlation to

the income of the recipient and to the misperception of it by the donor are negative. Finally, the recipient's income is negatively correlated to transfers under an exchange model in which the donor holds the bargaining power.

Our data support a model of pressure to give or a model of exchange in which the recipient holds substantial bargaining power. These results highlight the active role played by recipients of transfers in our setting and show that it is possible to disentangle some motives of transfers using cross-sectional household survey data on linked households.

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**Table 1**  
Asymmetric information

	Underestimate	Spot-on	Overestimate	DK
Completed O'level	0.029	0.920	0.022	0.029
Has formal job	0.054	0.872	0.008	0.066
Owens house	0.088	0.748	0.095	0.068
Owens land	0.120	0.761	0.048	0.071
Owens livestock	0.059	0.745	0.072	0.123
Owens phone	0.096	0.725	0.075	0.105
Owens TV	0.080	0.720	0.044	0.156
Owens motorized vehic	0.040	0.667	0.142	0.151

Notes: Comparing actual realizations to beliefs held by extended family members. Cells indicate the proportion of observations. Completed O'level means having completed the first four (out of six) years of secondary education. N=9,032.

**Table 2**  
Weights in  $\Omega$

	Coefficient
Completed O'level	0.161** (2.190)
Has formal job	0.185*** (5.620)
Owns house	-0.264*** (-4.223)
Owns phone	0.300*** (15.492)
Owns TV	0.240** (2.060)
Owns vehicle	0.272*** (3.833)
Owns phone * Completed O'level	0.079 (0.996)
Owns TV * Owns phone	0.085 (0.716)

Owens vehicle * Owens house	0.207*** (2.716)
Age of hh head * Owens house	0.004*** (2.764)
Age of hh head * Owens land	0.001 (0.847)
Urban	0.160*** (7.701)
Age of hh head	-0.009*** (-5.423)
Males 0-5 years	-0.216*** (-17.926)
Males 6-15 years	-0.103*** (-10.459)
Females 0-5 years	-0.214*** (-17.632)
Females 6-15 years	-0.099*** (-9.862)
Constant	13.466*** (237.160)
Adjusted R-squared	0.565
N	3,173

Notes: Final weights in  $\Omega$  Variables selected with LASSO.  $t$  statistics between brackets under the coefficient. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

**Table 3**  
Comparing  $\Omega$  to subjective perceptions

	$\Omega_{ij}$	$\Omega'_{ij}$
$i$ places $j$ on bottom 3 rungs of 9-step ladder	-0.071*** (-7.016)	-0.108*** (-8.903)
$i$ places $j$ on top 3 rungs of 9-step ladder	0.101*** (4.993)	0.225*** (9.264)
$i$ gives DK answer to ladder question regarding $j$	-0.041** (-2.327)	-0.064*** (-3.037)
log of $j$ 's actual consumption per capita	-0.130*** (-21.878)	-0.582*** (-81.738)
Constant	1.758*** (22.274)	7.722*** (81.602)
N	9,032	9,032

Notes: Household  $i$  fixed effect regression of  $\Omega$  and  $\Omega'$  on 3 ladder dummies indicating where household  $i$  places household  $j$  on a 9-step ladder. Regressions control for the number of don't know responses to the asymmetric information questions that each side of the dyad gave.

**Table 4**

Correct expectations and distance

	$\Omega_{ij} = 0$	$\Omega'_{ij} \approx 0$
		-
Distance between HHs (100 km)	-0.0089*** (-7.916)	0.0040** (-2.413)
<i>j</i> located in urban area	-0.0708*** (-10.221)	-0.0176 (-1.549)
Parent-child link	0.0178** (2.207)	0.0008 (0.055)
<i>i</i> and <i>j</i> communicated in the past 2 years	0.0214** (2.165)	-0.0161 (-0.967)
Number of years since <i>i</i> and <i>j</i> last lived together	0.0013** (2.314)	0.0017* (1.691)
Shared at least one meal in the past month	0.0091 (0.995)	0.0401** (2.326)
N	9,032	9,032
Percent of observations with LHS = 1	27%	39%

Notes: Probit regressions of correct expectations. Marginal effect reported.  $t$  statistics in brackets under the coefficient. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Regressions also control for the number of don't know responses to the asymmetric information questions that each side of the dyad gave and an indicator variable for 36 missing km distance observations.

**Table 5**  
Summary of the Pressure Model

$D$ 's income	Signal	Contract to $D$	Transfers to $R^*$	$\Omega_{RD}$
L	$s_D > \tilde{s}$	separating	low ( $T_L$ )	= 0 (correct)
	$s_D \leq \tilde{s}$	pooling	medium ( $t^P$ )	> 0 (overestimate)
H	$s_D > \tilde{s}$	separating	high ( $T_H$ )	= 0 (correct)
	$s_D \leq \tilde{s}$	pooling	medium ( $t^P$ )	< 0 (underestimate)

\*  $T_L < t^P < T_H$

**Table 6**  
Summary of Exchange-D scenario [3]

$R$ 's income	Signal	Offer to R	Transfers to $R^*$	$\Omega_{RD}$
$\ell$	$s_R > \bar{s}$	$\underline{t}(h)$	$\underline{t}(h)$	$> 0$ (overestimate)
	$s_R \leq \bar{s}$	$\underline{t}(\ell)$	$\underline{t}(\ell)$	$= 0$ (correct)
$h$	$s_R > \bar{s}$	$\underline{t}(h)$	$\underline{t}(h)$	$< 0$ (underestimate)
	$s_R \leq \bar{s}$	$\underline{t}(\ell)$	$0$	$= 0$ (correct)

**Table 7**

Summary of Exchange-R scenario [3]

$D$ 's income	Signal	Demand to D	Transfers to $R^*$	$\Omega_{RD}$
L	$s_D > s^*$	$\bar{t}(H)$	0	= 0 (correct)
	$s_D \leq s^*$	$\bar{t}(L)$	$\bar{t}(L)$	> 0 (overestimate)
H	$s_D > s^*$	$\bar{t}(H)$	$\bar{t}(H)$	= 0 (correct)
	$s_D \leq s^*$	$\bar{t}(L)$	$\bar{t}(L)$	< 0 (underestimate)

**Table 8**  
Predictions

Partial correlation between transfer and: Model	$\Omega_{RD}$	$\Omega_{DR}$	$D$ 's income	$R$ 's income
Altruism	0	—	+	—
Pressure	+	0	+	$\epsilon_+$
Exchange-D	0	$A$	+	—
Exchange-R	+	0	+	$\epsilon$
Risk Sharing	0	0	+	—

Notes:  $A$ =ambiguous;  $\epsilon_+$  small non negative effect;  $\epsilon$  small ambiguous effect.



**Table 9**Main Results, Partial correlations with transfers:  $\Omega$  and income

Equation No.	(17)	(17)	(18)	(19)	(18)	(19)
Transfer report	$R$	$D$	$R$	$R$	$D$	$D$
$\Omega_{RD}$	0.075*** (0.029)	0.090*** (0.030)	0.081*** (0.020)		0.056*** (0.020)	
$\Omega_{DR}$	0.036 (0.028)	0.011 (0.030)	0.033 (0.021)		0.026 (0.019)	
$\Omega'_{RD}$				0.118*** (0.018)		0.056*** (0.020)
$\Omega'_{DR}$				0.032 (0.021)		0.012 (0.017)
$I_D$			0.040*** (0.011)	0.141*** (0.019)		
$I_R$					0.007 (0.010)	0.017 (0.018)
$R^2$	0.72	0.72	0.09	0.10	0.11	0.11
$N$	9,032	9,032	9,032	9,032	9,032	9,032

Notes: Fixed effect linear probability models with bootstrapped standard errors in parentheses under the coefficient. Each column heading indicates, in brackets, the equation being estimated and below that, italicized, whether the left-hand side transfer variable is reported by *R* or *D*. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .  $N=9032$ .

**Table 10**  
Partial correlations with transfers: ladder and income

Equation No.	(20)	(20)	(21)	(22)
Transfer report	<i>R</i>	<i>D</i>	<i>R</i>	<i>D</i>
R places D low on ladder ( $\underline{L}_{RD}$ )	-0.052*** (0.016)	-0.025* (0.015)	-0.082*** (0.011)	-0.015* (0.009)
R places D high on ladder ( $\bar{L}_{RD}$ )	-0.006 (0.034)	-0.033 (0.032)	0.043* (0.025)	-0.019 (0.020)
D places R low on ladder ( $\underline{L}_{DR}$ )	-0.015 (0.016)	0.000 (0.015)	-0.005 (0.010)	0.005 (0.011)
D places R high on ladder ( $\bar{L}_{DR}$ )	-0.003 (0.030)	-0.040 (0.035)	-0.013 (0.019)	-0.029 (0.022)
$I_D$			0.034*** (0.009)	
$I_R$				0.005 (0.009)
$R^2$	0.64	0.64	0.09	0.10

Notes: Fixed Effect Linear probability models. Cluster-robust standard errors are in parentheses under the coefficient, with clustering on both *R* and *D*. Each column heading indicates, in brackets, the equation being estimated and below that, italicized, whether the left-hand side transfer variable is reported by *R* or *D*. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .  $N = 13,808$ .

## APPENDIX : SUMMARY STATISTICS

**Table A1**  
Summary Statistics of Household Variables

	Mean	SD
Log consumption per capita	13.12	0.70
Urban	0.34	0.47
Completed O'level	0.13	0.33
Has formal job	0.09	0.28
Owens house	0.75	0.43
Owens land	0.87	0.34
Owens livestock	0.12	0.33
Owens phone	0.60	0.49
Owens TV	0.19	0.39
Owens vehicle	0.09	0.29
Head is male	0.80	0.40
Age of hh head	41.04	15.14
Males 0-5 years	0.50	0.71

Males 6-15 years	0.60	0.87
Males 16-60 years	1.07	0.73
Males 61+ years	0.08	0.27
Females 0-5 years	0.49	0.70
Females 6-15 years	0.61	0.86
Females 16-60 years	1.11	0.74
Females 61+ years	0.11	0.33

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Notes: N = 3,173.

**Table A2**  
Summary Statistics of Dyadic Variables

	Sample N = 9,032		Sample N = 13,808	
	Mean	SD	Mean	SD
D reports giving gift to R in past 12 months	0.20	0.40	0.24	0.42
$\Omega_{RD}$	0.01	0.32	0.01	0.31
$\Omega_{DR}$	0.01	0.32	0.01	0.31
$\Omega'_{RD}$	0.00	0.53	-0.00	0.53
$\Omega'_{DR}$	0.00	0.53	-0.00	0.53
R places D low on ladder ( $\underline{L}_{RD}$ )	0.41	0.49	0.42	0.49
R places D high on ladder ( $\bar{L}_{RD}$ )	0.05	0.21	0.04	0.21
R answers DK on ladder question about D	0.11	0.31	0.09	0.28
D places R low on ladder ( $\underline{L}_{DR}$ )	0.41	0.49	0.42	0.49
D places R high on ladder ( $\bar{L}_{DR}$ )	0.05	0.21	0.04	0.21
D answers DK on ladder question about R	0.11	0.31	0.09	0.28
$I_R$	13.19	0.72	13.13	0.69
R HH head is male	0.82	0.39	0.81	0.39
R HH head age	39.93	14.22	40.51	14.77
R HH head years education	6.74	3.27	6.40	3.23
R HH No. Males 0-5 years	0.49	0.69	0.51	0.71
R HH No. Males 6-15 years	0.60	0.87	0.62	0.89
R HH No. Males 16-60 years	1.08	0.74	1.07	0.71
R HH No. Males 61+ years	0.06	0.25	0.07	0.26
R HH No. Females 0-5 years	0.49	0.69	0.50	0.70
R HH No. Females 6-15 years	0.60	0.86	0.62	0.87
R HH No. Females 16-60 years	1.12	0.74	1.12	0.75
R HH No. Females 61+ years	0.10	0.31	0.11	0.32
i has phone	0.66	0.47	0.61	0.49
i has vehicle	0.12	0.32	0.11	0.31
Parent-child link	0.17	0.38	0.22	0.41
km distance	214.07	339.40	150.51	295.71

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<sup>i</sup> In addition, we consider the implications of a dynamic risk sharing model with asymmetry of information. However, since our measures of misperception are based on assets, it is better suited to capture asymmetry of information regarding medium term standard of living, rather than asymmetry of information regarding short term income shocks.

<sup>ii</sup> The field work was implemented in 2010 by Economic Development Initiatives (EDI). A full description of the fieldwork and data can be found in De Weerd et al. (2012).

<sup>iii</sup> De Weerd and Hirvonen (2015) study how consumption co-moves across linked nodes in these networks.

<sup>iv</sup> The questionnaire included extensive food and non-food consumption modules. The final consumption aggregate includes purchased and home-produced food, as well as food eaten outside of the household. It contains 51 food items and 27 non-food items. The aggregates are temporally and spatially deflated using data from a price questionnaire included in the survey. Consumption is expressed in annual per capita terms using 2010 Tanzanian shillings. A full description of the consumption aggregate is available at [http : //www.edi-africa.com/research/khds/introduction.htm](http://www.edi-africa.com/research/khds/introduction.htm).

<sup>v</sup> Out of all dyads in our larger sample 53% communicated at least once in the month preceding the survey, while for 5% the last communication was over 5 years ago (within the smaller sample 41% of dyads communicated within the past month and 7% within the past year). By contrast, the reports from interviewed households about untraced households (which constitute dyads that are dropped from the analysis) show that only 26% of such pairs communicated within the last month and 23% over 5 years ago. Our main empirical results also hold for dyads that did not

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communicate recently, giving some credence that attrition - in as far as it relates to the strength of communication between network members - is not a major concern.

<sup>vi</sup> Perceptions of educational attainment and occupation were collected for each original panel member (that is individuals who were member of the baseline household) currently member of  $j$ . The perceptions on the 6 assets were asked at the  $j$ -household level.

<sup>vii</sup> We implemented the procedure using the LassoShooting ado file made available by Christian Hansen on his homepage here <http://faculty.chicagobooth.edu/christian.hansen/research/>.

<sup>viii</sup> See also Stark(1995).

<sup>ix</sup> The same predictions would apply if the recipient was also altruistic towards the donor. This is also the finding of Barczyk and Kredler (2014) in a dynamic and continuous time context. In addition, if they care about each other's total utility (and not just each other's utility of consumption) then an interesting signaling game among donors arise as shown in Genicot (2016). However, if the degree of altruism of the donor was not known to the recipient, then there could be a positive correlation between the transfers and the recipient's misperception of the donor's income controlling for the donor's income.

<sup>x</sup> As usual, (10) and (11) imply that  $V_H(T_H) - \underline{p} \geq V_H(0) - P$ . This is shown in the online Appendix 2.

<sup>xi</sup> If the recipient utility function exhibits diminishing risk aversion then the recipient may be more likely to offer a separating contract when his income is high ( $\tilde{s}$  decreases) and, for any given signal  $s_D$  above the threshold, R may ask a higher  $T_H$  and a lower  $T_L$  when his income is high. Since a higher spread between  $T_L$  and  $T_H$  must come with a slightly higher mean transfer, this could imply a small positive correlation between the transfers and the recipient's income.

<sup>xii</sup> Incentive compatibility requires the transfer to decrease with recent claims from the recipient.

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<sup>xiii</sup> Under decreasing risk aversion, though small the overall effect would be positive under the pressure model but ambiguous in the exchange-R model.

<sup>xiv</sup> See de Laat (2014) for evidence of split household members engaging in costly monitoring.

<sup>xv</sup> 25% of dyads have  $T_{RD}=1$

<sup>xvi</sup> These models have been discussed by Mittag (2012), with De Weerdt (2004) providing an early application of two-way fixed effects in dyadic regressions for network analysis.

<sup>xvii</sup> To identify dyads with potentially larger means of pressure or bargaining power in the hands of the recipient, we also interacted the income of the Donor and the perceptions of the donor income with an indicator of whether the donor household hosts a child of Recipient household. The interaction with Donor's income is significant and positive, suggesting extra power of the recipient household in this type of parent-child relationship.

<sup>xviii</sup> An alternative method is provided by Fafchamps and Gubert (2007)

<sup>xix</sup> The online Appendix 3 shows that these results remain robust under a number of alternative specifications such as using the intensive margin of transfers (value), using proxies for pre-transfer incomes, including dyads living in the same location (large sample) and using discrete choice modelling to relax the assumptions underlying the linear probability model.