The Role of Destination, Gender, and Household Composition in Explaining Remittances:

An Analysis for the Dominican Sierra

by

Bénédicte de la Brière

The World Bank

Elisabeth Sadoulet and Alain de Janvry

University of California at Berkeley

and

Sylvie Lambert

Institut National de la Recherche Agronomique, Paris

July 2000

Abstract

Two contrasting hypotheses about what determines remittances sent by Dominican migrants to their rural parents in the Sierra are tested: (a) an insurance contract taken by parents with their migrant children and (b) an investment by migrants in potential bequests. Results show that the reason to remit is affected by destination (U.S. vs. cities in the Dominican Republic), gender, and household composition. The insurance function is mainly fulfilled by female migrants to the U.S. Only when a male is the sole migrant in his household does he play the role of insurer. Investment, by contrast, is pursued by both males and females, but only among those migrating to the U.S.

Key words: migration, remittances, insurance, inheritance.

JEL classification number: 8230.

Corresponding author: Alain de Janvry, Giannini Hall 207, University of California, Berkeley, CA 94720. E-mail: alain@are.berkeley.edu. Tel: 510-642-3348. Fax: 510-643-8911.

The Role of Destination, Gender, and Household Composition in Explaining Remittances:

An Analysis for the Dominican Sierra

I. Migration and remittances

For many rural households in developing countries, remittances sent by household members who migrated to urban centers or to more developed countries constitute a fundamental source of income, insurance, social security, and investment in productive assets. For this reason, the role of remittances has been a crucial element in explaining household strategies toward migration. The decision to send a migrant may thus be motivated by portfolio diversification where remittances offer a risk-return option to be weighted against local sources of income (Stark 1978; Stark and Lehvari, 1982), by insurance (Rosenzweig, 1988), or by the need for liquidity to invest in local income generation (Taylor and Wyatt, 1996).

However, in most models that use remittances to explain migration, the fact that the migrant will remit and the level of remittances are taken for granted, conditional on the expected risk and return achieved in migration. This is insufficient since migrants have control over the income which they earn through migration and hence are ultimately the ones in whom the decision to remit is vested. Understanding what motivates migrants to remit back to their families is important not only to explain how much they will remit, but the purpose for which they remit might also influence the way in which receiving households benefit from these remittances. It is the purposes sought by the migrant in remitting which we explore in this paper. We consider a situation where the decision to send a migrant and the destination of migration have already been taken, and ask what induces a particular migrant to remit at a certain level given his/her personal characteristics and economic status in the place of migration, the status and condition of his/her parents back in the home village, and eventual existence in the household of other migrants who may also be remitting.[1]

[1] This remittance behavior would be consistent with an incentive compatible contract between the household and the migrant about the joint decision to send a migrant and to remit given the choice of who will migrate. This is not done here because we do not have information on the household prior to sending the migrant that could help explain the migration decision. Similarly, we do not analyze the decision of where to migrate due to lack of information on the household at the time when this decision was taken. The paper consequently focuses on an analysis of the conditional remittance behavior of current migrants in their current locations.

The determinants of remittances have been analyzed from two different angles: the purposes of the transfer and its motives. In studying *purposes*, a number of studies have focused on the decision of migrants to remit in response to shortfalls in their parents' income. Two important occurrences are the provision of insurance, in which case the timing and magnitude of the remittances correspond to shocks afflicting the parent, and the provision of social security income at retirement age when the parent's capacity to generate income declines. Empirical evidence supports these two purposes. Lucas and Stark (1985) and Stark and Lucas (1988) show that remittances sent by migrants from Botswana respond to the severity of drought that has afflicted their parents, not only to shield parents from income loss but also to protect their drought sensitive assets. Cox and Jimenez (1998) show that the total transfer received by households in Colombia is function of their income risk. Using panel data on Indian rural households, Rosenzweig (1988) relates remittances to the size of the parent's income shock and evidences some risk sharing, although remittances only compensate for a small fraction of the income loss. In studies of transfers in the U.S. by Cox (1990) and in Peru by Cox and Jimenez (1992) and Cox, Eser, and Jimenez (1998), the social security purpose is revealed by the importance of the parent's age and income in determining remittances. Remittances can also be sent for the purpose of reimbursing the household for past expenditures such as schooling and costs directly related to migration (Stark and Lucas, 1988; Brown, 1997; Poirine, 1997), or of investing for the future either out of a concern for inheritance or as a way to maintain status and return home with social capital (Lucas and Stark, 1985; Ravelo and del Rosario, 1986; Hoddinott, 1992a, 1992b, and 1994; Guarnizo, 1993; Peralta, 1994; De La Cruz, 1995; Brown, 1997; Poirine, 1997). Note that there is no unique matching between any of the child's and the parent's purposes in the exchange. For example, school costs can be reimbursed independently of the parent's own needs according to a pure loan contract, or they can be reimbursed as social security payments, or as insurance transfers. Insurance can similarly be provided with the understanding that it ensures the child of a fair share in the parent's bequest.

The second angle in analyzing the determinants of remittances is to look for the child's *motives* when transfers are made in response to the parent's needs, such as insurance or social security. This transfer can be motivated by a mix of altruism and of self-interest in an exchange of service with the parent. Separating the relative importance of altruism and trade is difficult as pointed out by Hayashi *et al.* (1996) and by Altonji *et al.* (1992 and 1998). There are, however, circumstances under which this can be done. For example, Cox, Eser, and Jimenez

(1998) using Peruvian data have rejected pure altruism by showing that a child's social security transfers do not decline when the parent's pre-transfer income rises; Foster and Rosenzweig (1995) using data from India have rejected pure trade in showing that insurance transfers are more efficient among family members as altruism relaxes the constraint imposed by limited commitment. Our data do not allow such separation of motives in the case of transfers for insurance purposes, which can consequently come from either or both trade and altruism. In this paper, we consequently focus on the purposes sought in remitting, independently of motives.

Specific migrants have different purposes in remitting. In an analysis of attention provided to parents, Perozek (1998) shows that daughters and younger children pay more attention to their parent's welfare than sons and older children. Hoddinott (1992a) shows that sons' remittances respond to their parent's inheritable assets while those of daughters do not, and that the effect is more pronounced when there is more than one migrant son in the family. De La Cruz (1995) conducted a detailed case study of five Mexican families and their migrants in the United States. Her results indicate that men remit to invest while women do so to insure their family and assist siblings. We pursue the analysis in the same direction in showing that the determinants of remittances vary with the migrant's gender and destination, the structure of the household to which he or she belongs (number of heirs), and the eventual absence of other migrants in the household.

The Sierra in the Northwestern mountains of the Dominican Republic is a poor region which has for many years sent a large contingent of migrants to Dominican cities and to the United States. Field observations through extensive case studies done by the authors suggest that insurance and investment are important among motives to remit. We, therefore, develop two models that focus on insurance for parents and investment by children as the two dominant reasons to remit, while stressing the role of migrant and household heterogeneity. These models are jointly tested with data we collected through a survey of Dominican Sierra households. Approximately 40% of these households have migrant children in urban zones of the Dominican Republic or the United States, and 52% of these migrants are sending remittances. Our results show that, among all migrant children, female migrants to the U.S. and male migrants to the U.S. with no migrant siblings are more likely to fulfill insurer roles for their parents; while male and female migrants to the U.S., but not to Dominican cities, are more likely to send remittances for the purpose of household investment and subsequent inheritance. The empirical analysis provides evidence that these results are robust to the econometric specification of the reduced form equation for remittances, notably concerning

the censoring of data, the choice of distribution assumptions for the error terms, and household effects influencing the remittance decisions of siblings.

In what follows, section II presents the insurance and investment models from which reduced forms are derived. Section III discusses the data and offers descriptive statistics on the migrants and their rural parent's households. Section IV gives the econometric specification of the equations to be estimated. Section V discusses the results obtained and section VI summarizes and concludes.

II. Insurance and investment as purposes to remit

2.1. Insurance

The first model specifies an insurance contract between the household and the migrant with the purpose of strict instantaneous risk-coping by the household. Because migrants' incomes are uncorrelated with their parent's, remittances can help smooth consumption when the rural household faces an income shock. An underlying assumption of the model is that remittances are not invested or that this is not taken into account by the migrant who therefore does not try to encourage risk-management behavior by his family. We specify the model in a simple principal agent framework where the parent, who is the main beneficiary of the transaction, is the principal. The parent assumes that the migrant is playing the role of an insurer and designs an optimal contract for such insurance.

Consider a risk-averse parent who receives income Y with known probability π and income $Y-\Delta$ with probability $1-\pi$, where $\Delta > 0$ represents a random income shock. The parent might want to enter an insurance contract with his risk-averse migrant child. If the parent was willing to pay a premium p (for example, any costs incurred by the parent on behalf of the migrant or alternatively the commitment to insure if the migrant faces a shock), the migrant will pay the parent $R = a\Delta$ when the shock hits, with $0 \le a \le 1$. We consider a model where the parent is the principal who chooses both the premium p and coverage a, taking into account his migrant child's preferences.

The parent chooses the terms of the contract that maximizes his utility *v,* subject to the participation constraint of the migrant:

$$\max_{a,\,p} \ \pi v(Y-p) + (1-\pi)v(Y-p-\Delta(1-a)),$$

$$\text{s.t.} \quad \pi u(y+p) + (1-\pi)u(y+p-a\Delta) \ge u(y),$$

where $u(.)$ is the utility function of the migrant child. The first order conditions of this problem give:

$$\frac{u'(y+p-a\Delta)}{u'(y+p)} = \frac{v'(Y-p-\Delta(1-a))}{v'(Y-p)}.$$

Taking a Taylor expansion around incomes $Y-p$ and $y+p$ gives:

$$\frac{a}{1-a} \approx \frac{\chi(Y-p)}{\xi(y+p)}, \tag{1}$$

where $\chi(.)$ and $\xi(.)$ are the parent's and migrant's absolute risk aversions at incomes $Y-p$ and $y+p$, respectively. This clearly shows that the optimal risk sharing level is essentially determined by the relative risk aversion of the two participants. Remittances received by the parent will thus be:

$$r = a\Delta = \frac{\xi(y+p)}{\xi(y+p)+\chi(Y-p)}\Delta. \tag{2}$$

However, to the extent that other variables influence the premium *p*, they also indirectly influence the risk aversions of migrant and parent, and thus remittances. A complete analytical solution of the model can be found by first solving a second-order Taylor expansion of the participation constraint for the premium *p*, substituting this expression in the parent's utility, and then solving the parent's optimization problem for *a*.[2]

This leads to the following solution:

$$a = \frac{1}{\sqrt{\Delta^2(1-\pi)\xi^{\circ 2} + 2\Delta(1-\pi)\xi^{\circ}\left(1+\frac{\xi^{\circ}}{\chi^{\circ}}\right) + \left(1+\frac{\xi^{\circ}}{\chi^{\circ}}\right)^2}} = a\left(-\Delta, -(1-\pi), +\chi^{\circ}, -\xi^{\circ}\right), \tag{1'}$$

where ξ° and χ° are the child's and parent's absolute risk-aversions at income *y* and *Y*, respectively.

With costly coverage, the parent will opt for a lower coverage if the size of the shocks and the incidence of shocks increase. He will want more coverage if he is more risk averse, but will obtain less coverage if the migrant is more risk averse as the cost of insurance rises. The reduced form equation for remittances received will thus be:

$$r = a\Delta = r\left(+\Delta, -(1-\pi), +\chi^{\circ}, -\xi^{\circ}\right). \tag{2'}$$

They increase with the size of the shock and the parent's level of risk aversion, and they decrease with the child's level of risk aversion. As absolute risk-aversion decreases with wealth, richer migrants will send more when a shock hits their parents and relatively poorer parents will receive larger remittances in times of shocks.

[2] The detail of these derivations can be seen on the authors' homepages such as http://are.Berkeley.edu/~alain/

2.2. Investment and inheritance

The second model specifies the decision to remit by a particular migrant as a contribution to investment in household assets later to be inherited. It is based on models found in the literature related to inter vivo transfers and bequests in developed (e.g., Becker, 1981; Bernheim *et al.*, 1985; Cox, 1987) and developing (Hoddinott, 1994; Subramanian, 1994) economies. Here again, the model framework depends on the assumed relationship between parents and children. The literature on the strategic bequest motive (Bernheim *et al.*, 1985; Perozek, 1998) focuses on the parent's behavior in holding the bequest and allocating it according to the children's relative attentions. In Hoddinott (1994), the focus is on the migrant who takes as given the parent's "reward" function and sends remittances to maximize his utility function. When attention to the parent is provided in time, total bequest is given, and the parent's strategic behavior is in the allocation of this bequest. When attention to the parent comes via remittances, it directly contributes to the wealth of the parent to be inherited. In the following model, we explicitly consider these different links.

Suppose that the migrant is maximizing the utility of an investment portfolio. He can choose between two assets: a safe asset (e.g., a savings account in the place of migration) and a risky asset (his potential bequest where the risk comes from the fact that the investment will only yield at the uncertain time of the parent's death). The migrant saves at a constant rate s. One unit of the safe asset yields $(1+i)$ in the next period. Investment in the bequest will yield in the next period only if the parent dies.

The parent's assets increase with the following law of motion:

$$A_{t+1}^{p} = s^{p}\left(A_t^p\right)\left(A_t^p + Y_t + r_t\right)(1+i'),$$

where A_t^p are the parent's assets at time *t*, Y_t is the parent's autonomous income, r_t are remittances, i' is the rate of appreciation of the parent's assets, and $s^{p}\left(A_t^p\right)$ is the parent's saving rate, which increases at a decreasing rate with wealth.

If the parent dies, the child's inheritance is $\alpha\left(r_t, n_h\right)A_{t+1}^{p}$, where $\alpha\left(r_t, n_h\right)$ is the reward function, and n_h is the number of heirs. This reward function is the parent's decision on the allocation of his assets to his migrant child. In a neutral division of the bequest, α would be equal to the inverse of the number of heirs. However, as the parent uses this bequest to induce remittances, the reward increases with the migrant's remittances. The role of the number

of heirs is twofold. On the one hand, as heirs have to share the bequest, a larger number of heirs implies a smaller return to investment for anyone individual, a standard case of common property in building up the parent's wealth. On the other hand, as pointed out in the literature on the bequest motive, the threat of withholding the bequest is only credible if the parent has a good alternative to bestow his wealth (Hoddinott, 1992a). Hence, a larger number of heirs makes this threat more credible and reinforces the link between land assets and remittances. We can consequently postulate that $\frac{\partial \alpha}{\partial r_t} = \alpha_{r_t} \geq 0$, $\frac{\partial \alpha}{\partial n_h} \leq 0$, and $\frac{\partial^2 \alpha}{\partial n_h \partial r_t} \geq 0$.

The migrant maximizes the expected utility he derives from his portfolio:

$$\underset{r_t}{\text{Max}} \sum_t \delta^t \left[(1-\phi_{t+1}) u\left(A^m_{NI,t+1}\right) + \phi_{t+1} u\left(A^m_{I,t+1}\right) \right] ,$$

where ϕ_{t+1} is probability of inheriting at time $t+1$,

$A^m_{NI,t+1} = \left(s\left(A^m_t + y_t\right) - r_t\right)(1+i)$ is the migrant's asset position at $t+1$ if no inheritance,

$A^m_{I,t+1} = \left(s\left(A^m_t + y_t\right) - r_t\right)(1+i) + \alpha s^p \left(A^p_t + Y_t + r_t\right)(1+i')$ is the migrant's asset position if inheritance,

A^m_t is the migrant's asset position at t,

and y_t is the migrant's income at time t.

The first-order condition is then:

$$-(1-\phi_{t+1}) u'\left(A^m_{NI,t+1}\right)(1+i) + \phi_{t+1} u'\left(A^m_{I,t+1}\right)\left[-(1+i) + \alpha_{r_t} s^p \left(A^p_t + Y_t + r_t\right)(1+i') + \alpha s^p (1+i')\right] = 0 .$$

For the migrant, the marginal returns of the two assets are thus:

$(1+i)$ when investing in the safe asset,

$\phi_{t+1}\left[\alpha_{r_t} s^p \left(A^p_t + Y_t + r_t\right) + \alpha s^p\right](1+i')$ when investing in inheritance.

The optimal allocation between these two assets is given by the condition:

$$\frac{u'\left(A^m_{NI,t+1}\right)}{u'\left(A^m_{I,t+1}\right)} = \frac{\phi_{t+1}}{1-\phi_{t+1}} \left[-1 + \left[\alpha_{r_t} s^p \left(A^p_t + Y_t + r_t\right) + \alpha s^p\right] \frac{1+i'}{1+i} \right], \qquad (3)$$

which shows that if $\alpha_{r_t} = 0$, the portfolio composition is not affected by the parent's assets.

Applying the implicit function theorem to the first-order condition allows to determine how the optimal level of remittances, r_t , varies with parental assets, parental income, the probability of inheriting, the migrant's asset position, the migrant's income, and the migrant's level of risk aversion. The corresponding reduced form is:[3]

[3] The detail of these derivations can be seen on the authors' homepages such as http://are.Berkeley.edu/~alain/

$$r_t = r_t\left(+A_t^p, +Y_t, +\phi_{t+1}, +A_t^m, \pm n_h, +y_{t+1}, -\xi_I\right), \quad (4)$$

where ξ_I is the migrant's risk aversion at the level of assets A_I^m.

The positive effects of A_t^p and Y_t hold if ξ_I is less than a threshold ξ_A of risk aversion. The effect of the number of heirs is ambiguous. It contains two opposite effects. Sharing parent's assets with other heirs decreases inheritance and hence the return to investment in remittances, but competition among heirs can increase the parent's response to their child's transfers. We will see in the empirical analysis that the sharing effect dominates the competition effect.

We thus conclude that, if a migrant sends remittances to invest in inheritance, he will send more remittances when the parent's assets and income are higher if he is not too risk averse. He will also remit more if the probability of inheriting is higher, and if he is richer, wealthier, and less risk averse.

2.3. Summary of predictions

The results of the comparative statics experiments on the level of remittances derived from both models (equations 2´ and 4) are summarized as follows:

Variable	Insurance model	Investment model
Migrant's income (y) and assets (A^m)	No direct effect	Positive
Migrant's risk-aversion (ξ)	Negative	Negative
Parent's autonomous household income (Y)	No direct effect	Positive
Parent's risk-aversion (χ)	Positive	No direct effect
Shock on parent's income (Δ)	Positive	No direct effect
Parent's inheritable assets (A^p)	No direct effect	Positive
Number of heirs (n_h)	No direct effect	Negative/positive
Probability of inheriting (ϕ)	No direct effect	Positive

III. Data and descriptive statistics

In the summer of 1994, 400 farm households were surveyed by the authors in 20 randomly selected communities of the Dominican Sierra. Each community had a probability of being selected proportional to its

population size. Twenty households were then randomly drawn in each selected community, yielding 379 complete records. Information was gathered about production, assets, sources of income, and personal characteristics of household members above 12 years of age including all migrant children. Household heads were asked details about monetary remittances and their senders. No information was collected about out-transfers except for schooling purposes. In this regard, this data set is similar to the ones used by Knowles and Anker (1981), Stark and Lucas (1988), and Lucas and Stark (1985) where information is one-sided.[4]

The Sierra is a region of extensive poverty with a long tradition of migration to cities in the Dominican Republic and to the United States (Sambrook, 1992). A total of 76% of the households in the Sierra are linked to migration either because they receive remittances (49%), have migrant children (40%), or have siblings in the United States (57%).

In the analysis, we restrict our attention to migrant children of the household head because they are the main source of remittances, and information is available in the survey about their characteristics and remittances. Of these migrant children, 30% are in the United States (see mean values in Table 1), mostly New York and Florida. The average time spent in the location of migration is 5.4 years. Remarkable features of this migration pattern are the high proportion of migrants who are women (52%) and with dependent children (47%), suggesting a mature migration pattern with a well entrenched migrant community in the places of destination. There is a higher percentage of male migrants who remit (59%) compared to women (46%). However, among those who remit, higher levels of remittances are sent on average by female compared to male migrants (RD$4,871 vs. 3,234).[5] The place of migration also matters. 65% of migrants in the United States remit compared to 48% among migrants in Dominican cities. And there is a huge difference in the levels of remittances between the two groups, with migrants in the United States who remit sending on average RD$9147 compared to RD$1315 for migrants to Dominican cities.

Households with migrant children have on average 2.8 migrants, which leaves 6 persons living in the house. For these households, remittances (RD$3987) represent an important share of total income (15%), with other incomes coming from the imputed value of home-produced food (27%), the sale of farm products (24%),

[4] Hoddinott (1994) uses one of the few data sets where some of the migrants were also interviewed.
[5] Exchange rate: US$1.00 = RD$12.9 in the Summer 1994 in the Sierra.

agricultural wages (16%), and non-agricultural activities (14%). The potential land inheritance children might receive varies widely, both in terms of size and type, with an average of 14.5 hectares.

Exposure to health risks in the Sierra is important: 44% of the households reported illnesses of some income-earning household member during the last twelve months preceding the survey. On average, nearly a month of work (24.5 work days) was thus lost in a household, amounting to a loss of RD$720 to 960[6] while other costs (transportation to health centers, doctors' fees, and medicines) amounted to RD$5,250. Answers to the question as to how do parents cope with income shocks caused by illness show that households with migrant children are able to handle risk differently than those who do not have any connection to migrants. Those with migrants said that they cope with risk by using household savings and by calling on help from children in the United States. In contrast, households with no migrants must cope with risk by taking loans.

These descriptive statistics and the statements of opinion collected in the survey suggest that remittances play a role for asset accumulation and as a source of insurance. However, different categories of migrants may have different underlying purposes for sending remittances. We proceed to test which behavioral model and which combination of models best explain the observed remittances of each particular category of migrants.

IV. Econometric analysis

In both the insurance and investment-for-inheritance models, corner solutions are possible when migrants are not sending money to their parents. Half of the migrants actually do not remit. However, there is no compelling reason, neither theoretical nor empirical, for considering a selection process in which the decision to remit would be different from the decision on how much to remit. Observation of remittances in small amounts (11% of the positive remittances are of less than $10) suggests that there is no significant fixed cost in sending remittances. Remittances should, therefore, be treated as censored data. The problem introduced by censoring is that OLS results in biased estimators, and standard Tobit estimation relies heavily on the normality assumption for the residuals. The Tobit estimator is also biased if there is heteroscedasticity in the residuals. A second econometric issue is that our data set includes information from siblings. 78% of the 144 households with migrants have more than one migrant, and 41% of them receive remittances from more than one migrant. If migrants in a household are influenced by

[6] Computed using the value of the rural daily wage of RD$30 to 40.

some common unobservable, this results in residuals that are not independently distributed. Finally, as in many household data sets, we observe very large and small values. The mean positive remittance is RD$4,000, the largest value is 15 times higher, and 10% of the values are less than 5% of the mean.

To address these three potential problems, we perform four alternative estimations of the model that each provide some information on the determinants of remittances. First, we run an OLS ignoring the censoring problem. OLS may be a reasonable first approximation to analyze the effect of a given exogenous variable on the average remittance level, including the fact that remittances may be null. The standard deviations are computed taking into account the clustering effect of the presence of siblings from the same households. A second estimation procedure that accounts for the clustering effect of the siblings is the random-effect model. The model assumes that the residual term can be decomposed into a household random term and an individual error term. The standard Tobit model assumes a linear model for a latent variable and a censoring rule that sets remittances equal to the latent variable if it is positive and to 0 otherwise:

$$r^* = r\left(A^m, y, \xi, Y, \chi, \Delta, A^p, n_h, \phi, z^m\right) + u$$
$$r = r^* \text{ if } r^* > 0$$
$$r = 0 \text{ otherwise,}$$

where r is the observed remittance sent by a migrant, r^* is the corresponding latent variable, and u is a normal error with expectation 0 and a variance-covariance matrix that accounts for intra-cluster correlation among observations. Finally, we estimate the censored remittance model with Powell's Censored Least Absolute Deviations (CLAD) estimator. The CLAD estimator does not assume any specific distribution of the residuals u and gives consistent estimates even in the presence of heteroscedasticity and non-independent residuals. CLAD estimators are also less sensitive to outliers than OLS because they minimize the deviation around the median rather than the square of the deviation (around the mean). The algorithm for the CLAD estimation consists in estimating a median regression on the whole sample, and then, iteratively, re-estimating the median regression after having discarded the observations with predicted negative values. The final results obtained after convergence of the parameters are based on a sub-sample of the total initial sample. The standard deviations reported in the tables are obtained by a bootstrap procedure that reproduces the sampling design, i.e., where there is resampling of the households and inclusion of all children of the chosen households, and P-values are derived from the empirical distribution of values hereby obtained.

Given the shortcomings of each of these estimators and their complementarity, we will base the analysis of the determinants of remittances not so much on the particular parameters given by any individual estimator but on the results that seem robust across the four estimators.

Since information about migrants' income and asset position is not available in the data, we use a prediction function à la Mincer where:

$$\begin{pmatrix} y \\ A^m \end{pmatrix} = f\left(G, Age, Age^2, E, T, T^2, US, C\right),$$

where G is the migrant's gender, Age the migrant's age, E the schooling level expressed by four dummies corresponding to discrete levels of education (1 to 4 years of schooling, 4 to 8 years, some secondary schooling, and post-secondary schooling), with no schooling as the reference category, T the time spent at the migration location, US a dummy variable for living in the United States, and C a dummy variable for whether the migrant has dependent children in the place of migration as this is expected to create competition for the income from which remittances can be sent.

In the remittance equation, the parent's inheritable assets (A^p) only include land as land is by far the most important inheritable asset for the farm households surveyed. We used land owned in 1992 to correct for possible purchases in 1993-94 that would be directly correlated to remittances. In the inheritance model, the number of heirs enter as a modifier of the relationship between parent's inheritable assets and remittances. We therefore introduce the number of heirs in interaction with the parent's assets ($n_h A^p$). The shock on parental income (Δ) is proxied by the total number of working days lost in the year because of illnesses.[7] The migrant's and parent's levels of risk-aversion are proxied by their income levels. Hence, the sign of the income parameter in the remittance function reflects both the direct effect of this variable and its indirect effect through risk aversion. The probability of inheriting (ϕ) is proxied by the age of the household head. There is, nonetheless, a potential problem in so far as age captures both the increasing probability of death (positive effect on remittances) and the decreasing investment propensity of the father as his planning horizon declines (negative effect on remittances). A priori, the sign is ambiguous.

[7] Transfers in response to working days lost due to illness are unlikely to be associated with an inheritance motive, i.e., to a link between illness and lower life expectancy. Lost working days do not indicate life threatening situations, only short run inabilities to work.

Following the methodology proposed by Smith and Blundell (1986) for a simultaneous equation Tobit model, we test for weak exogeneity of the parents' household income in the first three remittance regressions. This test consists in regressing the household income on the exogenous variables of the remittance equation and a set of valid instruments, and introducing the residual of this regression in the remittance equations. A sufficient condition for weak exogeneity is that the coefficient of the residual be equal to zero. The instruments are demographic variables (gender composition of the household and the percentages of adults that are illiterate, have some primary schooling, and have completed primary schooling), assets (ownership of a business, land in forest, and livestock), and the number of children in the U.S. The validity of these instruments is ensured by their joint significance in the income equation (with an F(8, 354) statistic equal to 14.1 and a corresponding p-value of 0.0000) and non-significance when added to the remittance equations (with p-values of 0.61 in the OLS, 0.77 in the OLS with random effects, and 0.63 in the Tobit). The residual then introduced as a covariate in the regression equations is non-significantly different from zero (with z-statistics of 0.8 in the OLS, 0.6 in the OLS with random effects, and 0.7 in the Tobit). Hence, weak exogeneity of household income in the remittance regressions cannot be rejected. We, therefore, pursue the analysis with the observed values of household income.

Based on the comparative statics derived from the models, the expected signs of the coefficients of the included variables are as follows:

Coefficients	**Insurance model**	**Investment model**
Migrant's asset and earnings function ($A^m, y, -\xi$)	+	+
Parents' household income ($Y, -\chi$)	–	+
Number of lost working days (Δ)	+	0
Age of household head (ϕ)	0	±
Parent's inheritable assets (A^p)	0	+
Number of heirs x Parent's inheritable assets ($n_h A^p$)	0	±

As discussed in Part I, the two models may hold simultaneously. The sign of the role of parents' household income on remittances will indicate which purpose has the dominant effect. The variables that support the insurance (number of lost working days) and the investment (age of household head and parent's inheritable assets) models can both be significant, indicating that a given transfer fulfills more than one function.

V. Econometric results

5.1. Determinants of remittances for all migrants

In a first step, we estimate a remittance function for all migrants (Table 1). As expected, parameters from the OLS fits are smaller, and generally significantly so, than the corresponding parameters for the censored regressions (Tobit and CLAD). With a small number of siblings per households, standard errors computed with the cluster design are large. Despite these shortcomings, some regularities can be extracted from these estimations. The expected level of remittances is significantly related to most migrants' asset and income variables, notably the time since they have migrated (with positive but decreasing returns until 9 to 10 years), their achievement of post-secondary education (stressing the importance of higher education for successful migration), and being a migrant in the U.S. compared to a Dominican city (adding RD$5880 or 23% to the average household income for a male migrant and 38% for a female migrant when using the Tobit results). Of all interaction terms between migrant characteristics and destination, the only significant one is with gender, with a negative sign indicating that male migrants in the U.S. remit less than gender and destination effects alone would imply.

The coefficient on the number of lost working days is positive and significant only in the CLAD, thus providing weak support for the insurance model. By contrast, inheritable land has a systematic positive effect on remittances, giving strong support to the inheritance model. This result is consistent with the theory of strategic bequests attracting transfers developed by Bernheim, Shleifer, and Summers (1985) as well as with empirical evidence that higher inheritable assets induce higher inter-generational transfers obtained by Hoddinott (1992b) for Kenya. We find that the average land asset of 14.5 hectares would induce remittances of RD$789 (Tobit result with the average number of heirs of 8.4), an important share of total remittances which average RD$2083 among all migrants.

The number of heirs interacts negatively with parent's land assets, indicating that having to share inheritance with a larger number of siblings reduces the attractiveness of inheritance as an investment. This result runs counter to Hoddinott's (1992b) finding that transfers increase with the number of heirs in response to the manipulative behavior of parents. Our result is consistent with a typical common property problem whereby sharing parents' assets induces under-provision as the one who remits externalizes positive benefits on his siblings. The size

of this externality increases with the number of heirs, creating a rising disincentive to transfer on each migrant. As a result, the inheritance purpose in remitting would be fully cancelled by the presence of 14 heirs.

We conclude from this estimation for all households that both insurance and investment objectives induce remittances, and the latter much more strongly than the former. The differential strength of these purposes may, however, be due to heterogeneity across households. To explore this, we proceed in what follows to contrast migrants by gender, destination, and household composition.

5.2. Purposes of remittances among different categories of migrants

Purposes to remit by an individual migrant are contrasted across genders in Table 2, destinations in Table 3, gender and destination in Table 4, and existence of other migrants in the household in Table 5. To sort out what induces different categories of migrants to remit, we use dummy variables that characterize specific migrant categories in interaction with the variables which provide tests for the insurance and investment models.[8] As reported in Tables 2 and 3, the model of Table 1 is rejected against the more general models with gender and destination interactive effects, showing the importance of accounting for heterogeneity among migrants in explaining the reasons to remit. Instead of discussing the results table by table, we analyze sequentially the roles of heterogeneity in explaining insurance and investment.

5.2.1. Insurance purpose

Results by gender (Table 2) show that remittances from female migrants respond strongly to the number of lost working days by parents, while male migrant remittances are unaffected, and the difference is significant in favor of women for three of the four fits. Insurance is thus a strong reason to remit for females. Female migrant on average send RD$15 to 21 per day lost, which represents about half of the loss in income. The weak role of insurance in explaining remittances in the overall population of migrants (Table 1) was thus the consequence of gender heterogeneity.

[8] Estimations were also performed by splitting the sample in the different categories but these do not provide a straightforward test of the behavioral models at play and, as sub-samples get smaller, the reliability of the estimates is put in question.

The insurance function of remittances may also be associated with migrant destination. Results in Table 3 show that the insurance function is principally fulfilled by U.S. migrants. In all four estimations, U.S. migrants respond significantly to lost working days when only one estimation (CLAD) supports a similar response by migrants to Dominican cities. The difference in responses is significant in favor of U.S. migrants. Like gender (female), destination (U.S.) is a significant determinant of heterogenous behavior.

To conclude the reasoning on insurance, we analyze in Table 4 the effect of the double gender-destination contrast on the insurance variables. This contrast confirms that remittances from migrants to Dominican cities, whatever their gender, do not respond to the number of lost working days by their parents due to illness. By contrast, female migrants to the U.S. respond to parents' illnesses by sending more remittances. Men migrants to the U.S. respond negatively, a behavior that is not explained by the insurance model. The test of insurance behavior for female migrants is systematically in favor of those in the U.S. compared to those in Dominican cities. We thus conclude that there is strong empirical support in associating insurance behavior in remitting with female migrants to the United States over the other three combinations of gender and destination.

We can go one step further in analyzing insurance behavior by asking whether sibling composition affects the decision to assume the role of insurer for one's parents. A hypothesis is that when a male is the only migrant in his household, he may have to assume the role of insurer because there are no others available to do this. We analyze this in Table 5 by contrasting males according to whether they are the sole migrant in their household, or whether they have migrant siblings. Results show that male migrants with migrant siblings do not insure, but that male migrants who are the only migrant in their family do respond to parents' illnesses. Their behavior is significantly different from that of male migrants with sibling migrants in three of the four estimations. As before, female migrants do show strong insurance behavior in all estimations.

We conclude that migrant heterogeneity is important in explaining insurance behavior. Female migrants to the United States are the ones whose remittances respond to parents' lost working days due to illness. Male migrants only fulfill this insurance function when they are the sole migrant in their family.

5.2.2. Investment purpose

The second purpose to remit is to invest in parents' assets toward inheritance. Results in Table 1 indicated that investment is a strong overall purpose to remit. We now explore whether migrant heterogeneity has a role in explaining this behavior.

Results in Table 2 show that there is no gender contrast in investment. Both males and females respond to parents' land asset position, and there is no significant difference in their responses. In the Dominican Republic, inheritance law follows the Napoleonic Code with equality between heirs, irrespective of order and gender, as the default option. In interviews, most parents claim that assets will be distributed equally between all descendants. In spite of this, it is well known that there are differences in the assets effectively transferred to specific heirs, justifying the investment-toward-inheritance model we propose in the paper as inspired from the work of others. Results show that remittances do respond to the inheritable asset position of parents but that there is no systematic gender difference. We see again that a larger number of heirs tends to deter sending remittances in response to the asset position of parents, with no difference between male and female migrants (OLS, random effects).

If there is no gender differentiation, does destination play a role? Results in Table 3 show that it is only migrants to the U.S. who remit in response to their parents' asset position. Remittances from U.S. migrants respond significantly to parents' land assets in three of the four estimations, and their response is significantly different from that of migrants to Dominican cities in two of the estimations. The remittances sent by these U.S. migrants for investment decline as the number of heirs increases, suggesting a common property disincentive effect.

We thus conclude that sending remittances as an investment toward inheriting parents' land assets is a purpose sought by both males and females. Heterogeneity of behavior is in terms of the destination of migration: only migrants to the U.S. are able or willing to remit as an investment toward inheritance.

VI. Conclusions

In this paper, we started from the premise that migrants have control over remittances and examined two types of purposes for migrant children to send remittances to their farming parents in the Dominican Sierra that can hold jointly or separately: insurance in response to health shocks to parent's work capacity, and investment toward increasing future inheritance. By constructing decision making models to capture these two purposes, we establish that how data on remittances can be used to identify them econometrically. Taking into account the heterogeneous

nature of household migrants by destination, gender, and family composition, the results show clear contrasts in the reasons to remit. Insurance is the main purpose to remit for female migrants to the United States. Only when a male is the sole migrant in his household does he feel compelled to remit as an insurer when his parents are subject to health shocks. Investment toward inheritance is, by contrast, gender neutral. However, only migrants to the United States are in a position to (or feel compelled to) invest toward this purpose. Common property problems reduce this incentive to remit as the number of heirs in the migrant's household increases.

Identifying the reasons why migrants decide to remit allows to better understand why remittances matter in household strategies beyond constituting an additional source of income for the household. By having control over the decision to remit, migrants send remittances for specific purposes which give them a differential value (positive or negative) for parents compared to unconditional transfers. If women remit largely for insurance, the timing of their transfers gives parents a risk coping instrument that allows them to reduce costly risk management in generating autonomous income. This reason to remit enhances the welfare value of the money transferred. If males and female migrants to the United States remit for their parents to invest in inheritable assets, this may induce parents to invest the remittances received in order to increase the flow of transfers from abroad, possibly constraining the welfare value of the cash transfers away from consumption.

Policies targeted at favoring the successful migration of different classes of migrants to different destinations will thus have differential effects on household welfare according to their reasons to remit. In particular, little has been done to help women migrate successfully to the United States in terms of education and language. Since they are differentially entrusted with insuring their parents and siblings, consolidating their success in international migration may serve as an effective source of risk coping, with direct welfare effects and indirect efficiency consequences for households in the emitting areas.

References

Altonji, H., F. Hayashi, and L. Kotlikoff. 1992. "Is the Extended Family Altruistically Linked? Direct Tests Using Micro-Data." *American Economic Review*, 82(5): 1177-98.

Altonji, H., F. Hayashi, and L. Kotlikoff. 1998. "Parental Altruism and Inter Vivos Transfers: Theory and Evidence" *Journal of Political Economy*, 105(6): 1121-1166.

Becker, G. 1981. *A Treatise on the Family.* Cambridge, MA: Harvard University Press.

Bernheim, B.D., A. Schleifer, and L. Summers. 1985. "The Strategic Bequest Motive." *Journal of Political Economy*, 93(6): 1045-76.

Brown, R.P.C. 1997. "Estimating Remittance Functions for Pacific Island Migrants" *World Development*, 25(4): 613-626.

Cox, D. 1987. "Motives for Private Income Transfers." *Journal of Political Economy*, 95(3): 508-46.

Cox, D. 1990. "Intergenerational Transfers and Liquidity Constraints." *Quarterly Journal of Economics*, 105(1): 187-217.

Cox, D. and E. Jimenez. 1992. "Social Security and Private Transfers in a Developing Country: The Case of Peru." *The World Bank Economic Review*, 6(1): 155-69.

Cox, D. and E. Jimenez. 1998. "Risk Sharing and Private Transfers: What about Urban Households?." *Economic Development and Cultural Change*, 46(3): 621-637.

Cox, D., Z. Eser, and E. Jimenez. 1998. "Motives for Private Transfers over the Life Cycle: An Analytical Framework and Evidence from Peru." *Journal of Development Economics*, 55(1): 57-81.

De La Cruz, B. E. 1995. "The Socioeconomic Dimensions of Remittances: Case Studies of Five Mexican Families." *The Berkeley McNair Journal*, 3: 1-10.

Foster, Andrew, and Mark Rosenzweig. 1995. "Imperfect Commitment, Altruism, and the Family: Evidence From Transfer Behavior in Low-Income Rural Areas". Department of Economics, University of Pennsylvania. Mimeo, 35pp.

Guarnizo, L. E. 1993. *Going Home: Class, Gender and Household Transformation Among Dominican Return Migrants.* Report prepared for the Commission for Hemispheric Migration and Refugee Policy, Georgetown University. Mimeo, 55p.

Hayashi, F., J. Altonji, and L. Summers. 1996. "Risk-Sharing Between and Within Families." *Econometrica*, 64(2): 261-294.

Hoddinott, J. 1992a. "Modeling Remittance Flows in Kenya." *Journal of African Economies*, 1(2): 206-32.

Hoddinott, J. 1992b. "Rotten Kids or Manipulative Parents: Are Children Old Age Security in Western Kenya?" *Economic Development and Cultural Change*, 40(3): 545-65.

Hoddinott, J. 1994. "A Model of Migration and Remittances Applied to Western Kenya." *Oxford Economic Papers*, 46(3): 459-476.

Knowles, J. C. and R. Anker. 1981. "An Analysis of Income Transfers in a Developing Country: The Case of Kenya." *Journal of Development Economics*, 8: 205-26.

Lucas, R. and O. Stark. 1985. "Motivations to Remit: Evidence from Botswana." *Journal of Political Economy*, 93(5): 901-18.

Peralta, L. E. 1994. *Evolution of Slash and Burn Agriculture and Cattle Raising in Los Corrales: A Community of La Sierra Region in the Dominican Republic.* Unpublished Master's thesis, University of Florida, Center for Latin American Studies.

Perozek, M. G. 1998. "A Reexamination of the Strategic Bequest Motive." *Journal of Political Economy*, 106(2): 423-445.

Poirine, B. 1997. "A Theory of Remittances as an Implicit Family Loan Arrangement." *World Development*, 25(4): 589-612.

Ravelo, S. and P. del Rosario. 1986. "Impacto de los Dominicanos Ausentes en el Financiamiento Rural." Mimeo, Pontifica Universidad Católica Madre y Maestra, Santiago de los Caballeros, Dominican Republic.

Rosenzweig, M. R. 1988. "Risk, Implicit Contracts and the Family in Rural Areas of Low-Income Countries." *Economic Journal*, 98(393): 1148-70.

Sambrook, R. A. 1992. *Population Pressure, Deforestation, Land Degradation and Population Redistribution in the Plan Sierra Region of the Cordillera Central, Dominican Republic.* Ph. D. dissertation, Department of Geography, University of Michigan, Ann Arbor, Michigan.

Smith, R. and R. Blundell. 1986. "An Exogeneity Test for the Simultaneous Tobit Model with an Application to Labor Supply." *Econometrica*, 54(3): 679-86.

Stark, O. 1978. *Economic Demographic Interactions in Agricultural Development: The Case of Rural-to-Urban Migration,* Bar Ilan University, Israel.

Stark, O. and D. Lehvari. 1982. "On Migration and Risk in LDCs." *Economic Development and Cultural Change,* 31(1): 191-6

Stark, O. and R. Lucas. 1988. "Migration, Remittances and the Family." *Economic Development and Cultural Change,* 36(3): 465-481.

Subramanian, R. 1994. A Theory of Remittances. CRIEFF, Working Paper No. 9406, Department of Economics, University of St. Andrews, Scotland.

Taylor, J. E. and T. J. Wyatt. 1996. "The Shadow Value of Migrant Remittances, Income, and Inequality in a Household Farm Economy." *Journal of Development Studies,* 32(6): 899-912.

Appendix[9]
Derivation of the Insurance and Investment Models

I. Insurance model

The migrant's participation constraint is such that:

$$\pi u(y+p)+(1-\pi)u(y+p-a\Delta)\geq u(y), \tag{1}$$

where u is his utility function and y his income.

At the reservation utility level, equation (1) is an equality. A second-order Taylor expansion of the left-hand side around y yields:

$$u'(y)\left[p-a\Delta(1-\pi)\right]+\frac{1}{2}u''(y)\left[\pi p^2+(1-\pi)(p-a\Delta)^2\right]\approx 0$$

from which we obtain

$$-\frac{u''(y)}{u'(y)}\approx\frac{2\left(p-a\Delta(1-\pi)\right)}{\left[\pi p^2+(1-\pi)(p-a\Delta)^2\right]}.$$

Let $\xi=-\dfrac{u''(y)}{u'(y)}$ be the child's absolute risk-aversion. The above equation can be rewritten as:

$$\xi p^2-2\left[a\xi\Delta(1-\pi)+1\right]p+(1-\pi)a\Delta(\xi\Delta a+2)\approx 0. \tag{2}$$

This equation has two positive roots, both greater than $a\Delta(1-\pi)$:

$$p(a)=a\Delta(1-\pi)+\frac{1}{\xi}\pm\frac{\sqrt{1-\pi(1-\pi)\xi^2a^2\Delta^2}}{\xi}.$$

The largest root is greater than $a\Delta$ and therefore not acceptable.[10] The only feasible premium level for the child to participate in the contract is therefore:

$$p(a)=a\Delta(1-\pi)+\frac{1}{\xi}-\frac{\sqrt{1-\pi(1-\pi)\xi^2a^2\Delta^2}}{\xi}, \text{ given in the text.} \tag{3}$$

We now solve the parent's utility maximization problem, taking into account his migrant child's reservation utility. The parent's problem is to solve:

$$\max_a\left\{\pi v\left[Y-a\Delta(1-\pi)-\frac{1}{\xi}+\frac{\sqrt{1-\pi(1-\pi)\xi^2a^2\Delta^2}}{\xi}\right]+(1-\pi)v\left[Y+\Delta(-1+\pi a)-\frac{1}{\xi}+\frac{\sqrt{1-\pi(1-\pi)\xi^2a^2\Delta^2}}{\xi}\right]\right\}.$$

Let us denote $A=1-\pi(1-\pi)\xi^2a^2\Delta^2$. The first-order condition for this maximization problem is:

$$-\left[1+\frac{\pi\xi a\Delta}{\sqrt{A}}\right]v'\left(Y-a\Delta(1-\pi)-\frac{1}{\xi}+\frac{\sqrt{A}}{\xi}\right)+\left[1-\frac{(1-\pi)\xi a\Delta}{\sqrt{A}}\right]v'\left(Y+\Delta(-1+\pi a)-\frac{1}{\xi}+\frac{\sqrt{A}}{\xi}\right)=0.$$

Using a first-order Taylor expansion around Y, the first-order condition reduces to:

$$-\frac{\xi a\Delta}{\sqrt{A}}v'(Y)+\left[-\Delta+\frac{\xi\Delta^2}{\sqrt{A}}(1-\pi)a+\frac{\Delta a}{\sqrt{A}}\right]v''(Y)\approx 0.$$

---

[9] Note: We suggest that this appendix be placed on the homepage of one of the authors to be readily accessible to readers on the Internet.

[10] $p_h(a)=a\Delta(1-\pi)+\dfrac{1}{\xi}+\dfrac{\sqrt{1-\pi(1-\pi)\xi^2a^2\Delta^2}}{\xi}>a\Delta \Rightarrow a<\dfrac{2}{\xi\Delta}$.
This is always true since $a\leq\dfrac{1}{\xi\Delta\sqrt{1-\pi(1-\pi)}}$ and $\pi(1-\pi)<\dfrac{1}{4}$.

Let us call $\chi = -\frac{v''(Y)}{v'(Y)}$ the parent's absolute risk aversion and replace A by its expression. We then obtain:

$$\chi\sqrt{1-\pi(1-\pi)\xi^2 a^2\Delta^2} = a\left[\xi + \chi + \xi\chi\Delta(1-\pi)\right].$$

Taking squares on both sides and solving for a positive yields the optimal a.

The optimal level of coverage is then $a = \frac{1}{\sqrt{\Delta^2(1-\pi)\xi^2 + 2\Delta(1-\pi)\xi\left(1+\frac{\xi}{\chi}\right) + \left(1+\frac{\xi}{\chi}\right)^2}}$.

II. Investment and inheritance

The migrant maximizes the utility he derives from his portfolio

$$\underset{r_t}{\text{Max}} \sum_t \delta^t\left[(1-\phi_{t+1})u\left(A^m_{NI,t+1}\right) + \phi_{t+1}u\left(A^m_{I,t+1}\right)\right],$$

where ϕ_{t+1} is probability of inheriting at time $t+1$,

$A^m_{NI,t+1} = \left(s\left(A^m_t + y_t\right) - r_t\right)(1+i)$ is migrant's asset position at $t+1$ if no inheritance,

$A^m_{I,t+1} = \left(s\left(A^m_t + y_t\right) - r_t\right)(1+i) + \alpha s^p\left(A^p_t + Y_t + r_t\right)(1+i')$ is migrant's asset position if inheritance,

A^m_t is migrant's asset position at t

and y_t is migrant's income at time t.

The first-order condition:

$$-(1-\phi_{t+1})u'\left(A^m_{NI,t+1}\right)(1+i) + \phi_{t+1}u'\left(A^m_{I,t+1}\right)\left[-(1+i) + \alpha_{r_t}s^p\left(A^p_t + Y_t + r_t\right)(1+i') + \alpha s^p(1+i')\right] = 0. \quad (4)$$

can be written as: $F\left(r_t, A^m_t, Y_t, A^p_t; \phi_{t+1}, z^p\right) = 0$. (4')

We assume the utility functions is a concave function, therefore $\frac{dF}{dr_t} < 0$. By the implicit function theorem, the sign of $\frac{dr_t}{dx}$ will thus be the same as the sign of $\frac{dF}{dx}$.

1. Remittances and parental assets and income:

$$\frac{dF}{dY_t} = \frac{dF}{dA^p_t} = \phi_{t+1}(1+i')\left\{\left[\alpha_{r_t}s^p_{A^p_t}\left(A^p_t + Y_t + r_t\right) + \alpha_{r_t}s^p + \alpha s^p_{A^p_t}\right]u'\left(A^m_{I,t+1}\right) + \right.$$
$$\left.\left[-(1+i) + \alpha_{r_t}s^p\left(A^p_t + Y_t + r_t\right)(1+i') + \alpha s^p(1+i')\right]\left[\alpha s^p + \alpha s^p_{A^p_t}\left(A^p_t + Y_t + r_t\right)\right]u''\left(A^m_{I,t+1}\right)\right\},$$

so: $\frac{dF}{dA^p_t} > 0$ if $\xi < \xi_A = \frac{\alpha_{r_t}s^p_{A^p_t}\left(A^p_t + Y_t + r_t\right) + \alpha_{r_t}s^p + \alpha s^p_{A^p_t}}{\left[-(1+i) + \alpha_{r_t}s^p\left(A^p_t + Y_t + r_t\right)(1+i') + \alpha s^p(1+i')\right]\left[\alpha s^p + \alpha s^p_{A^p_t}\left(A^p_t + Y_t + r_t\right)\right]}$

2. Remittances and number of heirs:

$$\frac{dF}{dn_h} = \phi_{t+1}(1+i')\left\{\left[\alpha_{r_t n_h}s^p\left(A^p_t + Y_t + r_t\right) + \alpha_{n_h}s^p\right]u'\left(A^m_{I,t+1}\right) + \right.$$
$$\left.\left[-(1+i) + \alpha_{r_t}s^p\left(A^p_t + Y_t + r_t\right)(1+i') + \alpha s^p(1+i')\right]\alpha_{n_h}s^p\left(A^p_t + Y_t + r_t\right)u''\left(A^m_{I,t+1}\right)\right\},$$

so: $\frac{dF}{dn_h} > 0$ if $\xi < \xi_n = \frac{\alpha_{r_t n_h}\left(A_t^p + Y_t + r_t\right) + \alpha_{n_h}}{\left[-(1+i) + \alpha_{r_t} s^p\left(A_t^p + Y_t + r_t\right)(1+i') + \alpha s^p(1+i')\right]\alpha_{n_h}\left(A_t^p + Y_t + r_t\right)}$

The negative derivative α_{n_h} characterizes the negative effect sharing with other heirs has on the return to investment through remittances, while the second derivative $\alpha_{r_t n_h}$ is expected to be positive to express the competition among heirs in attracting their parents' favor. The overall can be either positive or negative.

3. Remittances and probability of inheritance:

$$\frac{dF}{d\phi_{t+1}} = (1+i)u'\left(A^m_{NI,t+1}\right) + \left[-(1+i) + \alpha_{r_t} s^p\left(A_t^p + Y_t + r_t\right)(1+i') + \alpha s^p(1+i')\right]u'\left(A^m_{I,t+1}\right) > 0$$

as $\left[\alpha_{r_t} s^p\left(A_t^p + Y_t + r_t\right) + \alpha s^p\right](1+i') > 1+i$.

4. Remittances and migrant's assets:

$$\frac{dF}{dA_t^m} = s(1+i)\left\{-(1-\phi_{t+1})(1+i)u''\left(A^m_{NI,t+1}\right) + \phi_{t+1}\left[-(1+i) + \alpha_{r_t} s^p\left(A_t^p + Y_t + r_t\right)(1+i') + \alpha s^p(1+i')\right]u''\left(A^m_{I,t+1}\right)\right\}.$$

The term in curly brackets is similar to the first-order condition, except that we are now considering the second-order derivatives of the utility function.

If the absolute risk-aversion is decreasing with income, then $\frac{dF}{dA_t^m} > 0$.