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CONSUMPTION SMOOTHING IN VILLAGE ECONOMIES: INTRA-TEMPORAL VERSUS INTER-TEMPORAL SMOOTHING MECHANISMS

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Consumption Smoothing in Village Economies: Intra-temporal Versus Inter-temporal Smoothing Mechanisms*

Edward J. Seiler†

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Abstract

This study examines the role of the various mechanisms that are employed to smooth consumption in village economies in less developed countries. Since intra-temporal remittances are only capable of smoothing the idiosyncratic component of risk, we include inter-temporal smoothing mechanisms into our analysis that are capable of smoothing the aggregate risk component. We develop a theoretical framework for our analysis that integrates two central strands of the village economy literature, risk sharing and buffer-stock saving. Using this framework we ask if transfers are targeted to liquidity constrained households, and we examine the relative use of the two types of mechanism by adding transaction costs in the use of intra-temporal remittances. We also analyze the relationship between remittances, household income and asset holdings using simulated data generated from the model. Our results suggest that within a risk sharing framework, remittances will be targeted to liquidity constrained households only under certain conditions; that there will be a positive relationship between asset accumulation and remittances; and that household income will be inversely related to remittances.

Keywords: Risk Sharing, Insurance, Saving, Consumption Smoothing, Liquidity Constraints, Transaction Costs, Village Economies.
JEL Classifications: O12, C61, D91.

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1 Introduction

In recent years there has been an increased interest in remittances in low-income economies in themselves and in order to explain various economic phenomena.[1] One of the ways to account for remittances is by assuming that migration decisions are not taken by individuals in isolation, but by larger economic units - primarily families and households. While some of the family members stay in the village, others migrate to urban areas or other villages where income is weakly correlated with that in the home village. This strategy means that households can diversify risk, in that they are able to send remittances between spatially separated family members to alleviate location specific negative shocks to income. This approach looks upon remittances as a form of informal insurance to help smooth consumption, often as a substitute for missing formal insurance markets.[2]

However, the diversification of risk that can be achieved through intra-temporal remittances is limited. They can only smooth idiosyncratic risk component facing the members of a transfer network, but are unable to account for the aggregate risk in it, and as such are often referred to as "limited insurance." Thus, additional inter-temporal smoothing mechanisms are needed to smooth consumption across time to account for the residual (aggregate) risk component.

In order to be more explicit about possible inter-temporal consumption smoothing mechanisms we turn to Townsend (1994) who notes that there are multiple risk-bearing institutions that can be used by low-income households. He mentions five - plot and crop diversification, grain storage, purchases and sales of assets, borrowing, and gifts and transfers in family networks. Morduch (1995) divides these mechanisms into two groups - income smoothing mechanisms (the first item on Townsend's list), and consumption smoothing items (the other four). Thus, leaving us with three inter-temporal consumption smoothing mechanisms - grain storage, purchases and sales of physical assets, and accumulation of financial assets (i.e. borrowing and saving). We follow Lim and Townsend (1998) and also add a fourth inter-temporal mechanism - the accumulation and running-down of currency stocks (that they are able to measure using the unique form of the ICRISAT data).[3]

Lim and Townsend (1998) also emphasize that it is not a trivial matter to evaluate the consumption smoothing mechanisms available to the households in rural villages. This difficulty in evaluation is further compounded by the fact that we have five mechanisms in total - both intra-temporal (remittances) and inter-temporal (the four mechanisms listed above). As such, questions about the use of the mechanisms (e.g. do they use them together, or is one used when the other is not available, or, is there no connection between them?) in effect require a model that is capable of uniting all the mechanisms in one framework in order to answer them.

This paper looks at remittances and inter-temporal mechanisms in order to address these points. First, we examine if remittances are used as an informal insurance mechanism to smooth consumption by examining summary data from three villages in India.[4] Second, we examine the theoretical relationship between remittances and inter-temporal smoothing mechanisms. This is an important contribution of this paper, in that we integrate into a unified framework two central strands of the village economy literature - the risk sharing literature (as in Townsend (1994, 1995)) and the buffer-stock literature (as in Deaton (1989,

[1] For example, Lucas and Stark (1985), Rosenzweig and Stark (1988).

[2] Remittances are defined here as resources sent between spatially separated locations. We can also include transfers sent and received within a village in this category, noting that "separate locations" is in fact referring to the possible existence of idiosyncratic shocks to a household's income (see Townsend (1994)).

[3] The International Crops Research Institute for the Semi-Arid Tropics.

[4] An accompanying paper (Seiler, (1998b)) examines these data in detail.

1991)). The model presented is also of importance in that it addresses all the consumption smoothing mechanisms mentioned above in one organized framework - giving us an opportunity to evaluate them in unison, which (as already mentioned) is not a trivial matter. Specifically, we ask if remittances correct for missing credit markets and are targeted towards liquidity constrained households, and we examine the relative use of the two types of mechanism by adding a friction (transaction costs) in the sending of remittances.

The targeting of remittances to liquidity constrained households is not a new question in the literature. For instance, Cox (1990) looks at this problem, extending the model from his previous (1987) paper. Using an overlapping generations framework to look at intergenerational transfers he determines that transfers are targeted towards liquidity constrained households. Guiso and Jappelli (1991) also ask this question, and determine if households are liquidity constrained by directly asking them if they have been turned down when asking for loans, or if they are discouraged borrowers (i.e. they did not attempt to ask for a loan because they felt that they would be turned down if they did so). Other studies also link transfers and liquidity constraints for less developed countries (for instance, Feder et al. (1991), Jacoby and Skoufias (1998)), but no study has specifically examined the targeting issue in a multi-period risk sharing model. We evaluate this question in our framework due to its important policy implications (as first raised by Barro (1974), and since examined by various authors, e.g. Cox and Jimenez (1992)).

The paper proceeds as follows. In the following section, Section 2, we carry out a preliminary analysis of the ICRISAT data with respect to remittances. We examine their size (relative to income), and the frequency in which they are sent and received. We show that remittances are received when income is low, and are sent when income is high (as may be expected in a risk sharing model). In Section 3 we build a multi-period risk sharing model that we label as the benchmark model. This model links transfers with liquidity constraints, income and asset accumulation. In Section 4 we investigate the model with the addition of transaction costs in sending remittances allowing us to examine the play-off between various smoothing mechanisms. We conclude the paper in Section 5.

2 Preliminary Data Analysis

In this section we briefly examine some of the characteristics of remittances in the ICRISAT villages to provide us with some salient facts that can aid us in building a theoretical framework for low-income village economies. We proceed as follows. After a brief introduction to the ICRISAT villages and data collection, we examine summary data for remittances. We note at this point however, that this section is brief, and interested readers should refer to Lim and Townsend (1998) and Seiler (1998a, 1998b) for details about consumption smoothing in the ICRISAT villages, and for a detailed empirical analysis of the various smoothing mechanisms that the villagers can use.[5]

The villages in the ICRISAT data are in the semi-arid tropics of southern India. Aurepalle is in Andrapadesh, a region with erratically distributed rainfall (both within and across years), and soils that have limited water storage capacities. Shirapur and Kanzara are in the Maharashtra region. Shirapur also suffers from erratic rainfall, but has soils with relatively good water storage capacities. Kanzara has low levels of rainfall, but the precipitation is more reliable. The soils in Kanzara have medium water storage capacities. All three economies are primarily agrarian economies with high risk and variability in income. They are all open economies.

[5] For more details concerning the ICRISAT data in general see Walker and Ryan (1990).

The ICRISAT data were collected over a ten year period, from 1975 to 1984. Initially there were forty households in each village sample. Ten of which were landless households, and ten households of small, medium and larger farmers respectively. Dropouts reduced the number of households to 36 in Aurepalle, 37 in Shirapur and 35 in Kanzara. For the use of this paper we follow Lim and Townsend (1998) who drop the last three years of data. This is due to an error in the measurement of certain consumption items during these three years, leading to an understatement in reported expenditures. We also follow Lim and Townsend and drop the first year of data due to concerns of measurement problems in consumption of own grain stocks. Thus, we examine 72 months of data.

The first things we look at are the size and frequency of the remittances by village. We also compare the size of the remittances relative to income to receive an idea of their importance. Income is calculated from the transaction schedules for the villages,[6] and includes the following categories: net income from plot production and sharecropping, net income from animal husbandry, handicrafts and trading and labor incomes. Note that it is net of remittances.

Table 1 shows the summary statistics for gross remittances, net remittances and incomes in Aurepalle, Shirapur and Kanzara. It shows three cases. The first is for all months in the sample, and the second for months in which the amount received was positive, and the third when the amount sent was positive. Looking first at Aurepalle, we notice that overall, gross remittances received are 3.75% of income (net of remittances). However, since the villagers are net senders of remittances (5.32% of income) we see that net receipts are negative.[7] The column for months with positive receipts shows that the mean income in these months is much lower (less than 70% of the amount for all months), and that gross receipts are 63.27% of income (they are 38.75% of gross income i.e. income with remittances included). Again the villagers are net senders of remittances.[8] It is also important to note that the trade of remittances is a very considerable factor in these months, the total amount transferred (received+sent) being 128.74% of net income. Regarding the frequency of remittances, we note that there is a positive receipt in households 8.52% of the time. Another interesting fact is that the amount sent is greater in months with positive gross receipts than overall. This may indicate that there are specific months when there are more active remittances in both directions. Finally, we see from the last column (months with positive remittances sent) that in these months income is higher (835 rupees on average) than overall.

In Shirapur we see that gross receipts are 9.41% of net income in the village. Net remittances received account for only 1.60%. However, note the importance of remittances in months with positive receipts. In these months net remittances received account for almost one-third of income. In Kanzara the net receipts compared to gross receipts are larger than in Shirapur, accounting for 3.39% of income. When we examine the months with positive receipts, we note that as opposed to the other two villages there is no decrease in average income, and while still being over a quarter of the size of net income, net remittances received do not constitute as large a percentage of income as in Shirapur. The frequencies of receipt of positive remittances is higher in Shirapur and Kanzara than in Aurepalle. They are 20.24% and 18.22% of the time respectively.

Two main facts stand out in Table 1. First, that remittances only make up a small proportion of overall income, but constitute a considerable percentage at specific times, and second, that they are generally

[6]See Lim and Townsend (1998) for details on the ICRISAT transaction data.

[7]This is driven by three very large transfers sent. Without these, the mean net receipt is 8.80 rupees.

[8]Again dropping the three largest transfers sent moves net receipts to be positive. They become 199.12 rupees, representing 52.45% of income.

received when income is low and sent when it is high. These both may indicate an insurance aspect to remittances. As such, we model remittances in a multi-period risk sharing model as opposed to a life cycle-model,[9] and it is this type of model to which we now turn our attention.

3 A Multi-Period Risk Sharing Model

In this paper we solve two models of multi-period risk sharing in order to examine remittances and savings,[10] their characteristics, and the relationship between them. In particular, we are interested in investigating if remittances are targeted towards liquidity constrained households, how they depend on income, and their relationship to asset accumulation (i.e. their relationship to savings both into and out of a given period of time). We solve the models both analytically and by using simulations.

The first model that we solve (in this section) is a multi-period risk sharing model that shows the relationship between a household and its remittance partners. We label this model as the benchmark model. It is a specific version of the class of programming models reviewed by Townsend (1987), and used by Paulson (1994) for remittances.

In order to motivate the inclusion of savings into the conventional risk sharing model (as in Townsend (1994)) we note our preliminary data analysis in the previous section shows that households do not insure themselves completely against income shocks by just using transfers. Transfers make up only a relatively small percentage of income and can only smooth the idiosyncratic shocks realized by members of the remittance partner network. For this reason Lim (1992) refers to risk sharing as "limited insurance," since participating households cannot smooth aggregate shocks to the remittance network.[11] We therefore include savings and asset accumulation in our model as additional mechanisms that can be used to smooth consumption inter-temporally. As such, the model encompasses all the possible consumption smoothing mechanisms listed by Townsend (1994).

The first model gives implications about the relationship between remittances and savings, but it does *not* give a unique solution as to how much *each* household in the network should save. As such, we cannot determine the remittance amounts sent between network members, and we cannot determine if transfers will be targeted towards liquidity constrained households. However, this benchmark model is useful to compare to previous risk-sharing studies (e.g. Townsend (1994)), and to see what empirical implications it gives (before we add additional structure to it). In addition, we mention the important methodological use of the benchmark model that we develop as a way to link between the buffer-stock literature (e.g. Deaton (1991)) and the literature on risk-sharing via transfers.

In order to receive implications about the trade-off between savings and remittances, and to be able to uniquely determine the remittances and savings done by each household we need to add some extra structure to the benchmark model. There are various candidates for this purpose, for example: transaction

[9] Many papers look upon remittances as a mechanism to smooth consumption over the life cycle, often thinking of them as inter-generational transfers (e.g. Cox and Jimenez (1992), and Arcand, Boulila and Tritten (1995)). However, since we find possible evidence of an insurance aspect of remittances in the ICRISAT villages we choose to model them in a risk sharing environment. Moreover, we follow Deaton (1989) who argues that very few poor households in less developed countries smooth for life-cycle reasons (since all generations live together in a single household unit), but do so over agricultural crop seasons and other short term periods in order to alleviate high frequency income risk.

[10] We use the term "savings" as a generic term to denote inter-temporal smoothing mechanisms. To be more precise, we include the following mechanisms in it: financial assets, grain storage, physical asset holdings, and cash (as listed in the introduction).

[11] Various authors have used rainfall data in order control for idiosyncratic and aggregate shocks. For example, Paxson (1992), Paulson (1994) and, Jacoby and Skoufias (1998). However, we do not have information on the location and rainfall of the network partners, and as such we cannot determine the types of shocks realized by the remittance group.

costs and production economies.[12] In this paper we add friction to the benchmark model in that we assume that there are transaction costs involved in the sending of remittances. This is the second model we examine (in the next section).

3.1 The Benchmark Model

In order to understand the setup in the model, we start by describing the timing of the agricultural cycle in it. We assume that the start of each period t, is when farmers harvest their crops. Stochastic crop production Y_t, is realized (after the harvest), as are the independent crop incomes of the remittance partners. Each member of the remittance network also has savings s_t brought forward from the previous period at a risk-free interest rate r_t. Therefore in period t each of the farmers has total financial wealth W_t, consisting of stochastic crop income Y_t, and savings $(1+r_t)s_t$.[13] The farmers in the network then decide how much of their *aggregate* wealth to consume and how much to save into the next period. The consumption share of each household c_t, is determined by an ex-ante agreement. Thus, the remittances between households R_t, are received/sent in order to finance the gap between each household's financial wealth and the sum of their individual savings (into the next period) with household consumption, (i.e. $R_t = c_t + s_{t+1} - W_t$ for each household).

We assume at this point that there are no transaction costs in sending remittances, i.e. if a household sends one rupee, then one rupee is received by the recipient household. We further assume that the households are liquidity constrained in that they cannot consume more than their current financial wealth. This form of liquidity constraint is common in developing countries, (see Deaton (1989)), and in low income village economies (see Morduch (1993), and Chaudhuri and Paxson (1994)). It implies that households cannot borrow on future uncertain income but are able to save (this constraint appears to be stringent, but it can easily be relaxed by allowing households to borrow up to a certain positive amount).

We assume that the unit of observation in this model is the household. Suppose that household i's utility function is given by $v(c_{it})$, where v is concave and increasing in the household's consumption c_{it}. The household's consumption is determined by the following budget constraint:[14]

$$c_{it} = (1+r_t)s_{it} + Y(\mu_{it}) + R_{it} - s_{it+1} \tag{1}$$

where s_{it} is the household's savings from the last period invested with rate of return r_t, $Y(\mu_{it})$ its income realized at the start of period t, R_{it} the net remittances received, and s_{it+1} the amount saved for the next period. The income function is increasing in μ_{it}, i.e. a positive shock causes income to rise.

Suppose that household i has N remittance partners, each with identical utility functions $v(c_{nt})$, where c_{nt} is the consumption of household n in period t. The utility function is also assumed to be identical to the one for household i for simplicity. Thus each partner's consumption in period t is equal to the sum of its income (determined by its production shock μ_{nt}), net remittance receipts, and its net savings accumulation (i.e. those brought into the current period minus those taken into the next period):

$$c_{nt} = (1+r_t)s_{nt} + Y(\mu_{nt}) + R_{nt} - s_{nt+1} \quad \forall n \tag{2}$$

[12] By a production economy we mean an economy where households need savings in order to produce output in the following period.

[13] Deaton (1991) refers to this financial wealth as cash-on-hand.

[14] For details concerning the design of programs like this one see Townsend (1995).

We impose that transfers behave according to the following identity:

$$R_{it} + \sum_{n=1}^{N} R_{nt} = 0$$

i.e. that without loss of generality, the total amount of remittances sent is equal to the total amount received.[15] We also have an identity that the sum of the time invariant Pareto weights is equal to one, i.e.

$$\omega_i + \sum_{n=1}^{N} \omega_n = 1$$

where ω_j is the Pareto weight of household $j = i, n$.

Denoting the vector of household shocks in period t as μ_t, we write the history of shocks $(\mu_1, \mu_2, ..., \mu_t)$ as μ^t. Thus, the planner's problem is the following maximization problem (that we maximize with respect to consumption and savings):

$$\max \omega_i \sum_{t=1}^{T} \sum_{\mu^t} \text{prob}(\mu^t)\beta^t v[c_{it}(\mu^t)] + \sum_{n=1}^{N} \sum_{t=1}^{T} \sum_{\mu^t} \omega_n \text{prob}(\mu^t)\beta^t v[c_{nt}(\mu^t)] \tag{3}$$

$$\text{s.t.} \quad c_{it} = (1 + r_t)s_{it} + Y(\mu_{it}) + R_{it} - s_{it+1} \quad \forall t, \forall \mu^t \tag{4}$$

$$c_{nt} = (1 + r_t)s_{nt} + Y(\mu_{nt}) + R_{nt} - s_{nt+1} \quad \forall n, \forall t, \forall \mu^t \tag{5}$$

$$s_{jt} \geq 0 \quad j = i, n \quad t = 1, ..., T. \tag{6}$$

where β is the common (across households) discount factor, and the last constraint (6) (that savings is non-negative in each period for each household) is the liquidity constraint. The first order condition for consumption of household i in period t (assuming no binding corner constraints) is:

$$\omega_i \text{prob}(\mu^t)\beta^t v'[c_{it}(\mu^t)] = \lambda_t(\mu^t) \tag{7}$$

where $v'[c_{it}(\mu^t)]$ is the first derivative of the utility function with respect to consumption, and $\lambda_t(\mu^t)$ is the Lagrangian multiplier on the resource constraint.[16] Similarly we receive the following first order condition for the partner households

$$\omega_n \text{prob}(\mu^t)\beta^t v'[c_{nt}(\mu^t)] = \lambda_t(\mu^t) \tag{8}$$

These imply that

$$\omega_i v'[c_{it}(\mu^t)] = \omega_n v'[c_{nt}(\mu^t)] \tag{9}$$

i.e. that the weighted marginal utilities of consumption are equated across households. We will use this relationship in calculating the remittance function.[17]

We are also interested in the first order condition for the savings of the households at period t. Defining the Lagrange multiplier on the aggregate of the borrowing constraints in (6) as $\phi_t(\mu^t)$ we obtain the following first order condition:

$$\lambda_t(\mu^t) - \phi_t(\mu^t) = \sum_{\mu_{t+1}} \lambda_{t+1}(\mu^{t+1})(1 + r_{t+1}) \tag{10}$$

[15] This can easily be adjusted to allow for outside aid. For instance, if there is a net transfer into the network, the right hand side of the identity takes the value of this transfer.

[16] The sum of all the budget constraints across the households.

[17] If we had maximized the planner's problem with respect to remittances, then we would also receive (9). This is easy to see for the case where there is one household partner, i.e. $N = 1$.

Plugging this into the first order conditions for consumption (7) and (8) we obtain the following relationship:

$$\omega_j \text{prob}(\mu^t)\beta^t v'[c_{jt}(\mu^t)] - \phi_t(\mu^t) = \sum_{\mu_{t+1}} \omega_j \text{prob}(\mu^{t+1})\beta^{t+1} v'[c_{jt+1}(\mu^{t+1})](1 + r_{t+1}) \quad (11)$$

where $j = i, n$. By defining $\tilde{\phi} = \phi/(\omega_j \beta^t)$ we can rewrite this as:

$$\text{prob}(\mu^t)v'[c_{jt}(\mu^t)] = \sum_{\mu_{t+1}} \text{prob}(\mu^{t+1})\beta(1 + r_{t+1})v'[c_{jt+1}(\mu^{t+1})] + \tilde{\phi}_t(\mu^t) \quad (12)$$

where $\tilde{\phi}_t(\mu^t) = 0$ if the aggregate savings in the remittance network are positive, and $\tilde{\phi}_t(\mu^t) > 0$ if the aggregate savings in the network are zero. The interpretation of this equation is as follows: the marginal utility of consumption today for a member of the network is equal to the expected marginal utility in the next period if the aggregate borrowing constraint of the network does not bind, but is greater if it does bind.

We note at this point that equation (12) uses the aggregate borrowing constraint for the whole remittance network, and determines if the network as a whole is liquidity constrained. Suppose for a moment that at this optimum there is a household whose individual borrowing constraint is slack, i.e. it has positive savings, while a second household has a constraint that is at equality, and would like to borrow in order to smooth consumption. Technically the second household cannot borrow from sources outside the network, but the first household could borrow up to the value of its savings[18] and could then transfer these resources to the second household for consumption. This does not violate the terms of a lender outside the remittance network because the second household has positive savings and is not borrowing on uncertain future income. This is an important point since it basically says that if a household has individual liquidity constraints that are binding (in the sense of being a "buffer stock" household), but the network as a whole does not have binding constraints, then there is a possibility under certain conditions that transfers within the network will be allocated to the household that would have had binding constraints. (We will examine such conditions in the transaction cost model).

3.2 The remittance function.

The model solved above (without liquidity constraints, and often with savings markets missing) is standard in the risk sharing literature, and has been used by various authors (e.g. Townsend (1994, 1995)) to test for consumption smoothing and to describe village economies. One of the contributions of this paper is to use the risk sharing model to examine the use of remittances. Paulson (1994) also uses a risk sharing model to test for remittances in Thailand, however, this type of analysis has not been carried out for multi-period models with buffer stock savings. To investigate remittances we start by calculating a remittance function using the Euler condition (equation (9)) that equates weighted marginal utilities across households. This analytical examination is only capable of giving certain implications, and as such we next simulate the model to give a clearer picture of remittance behavior.

The remittance function is derived using equation (9). To facilitate in investigating the function we implement a parameterization of the utility function. In order to ensure that the problem will be Gorman aggregable (see Townsend (1987) for a discussion on the importance of Gorman aggregation in

[18]We use this terminology since households may borrow up to the value of collateral that they can post using other assets they own.

such programs), we work with a constant relative risk aversion (CRRA) utility function, i.e.

$$v(c_{it}(\mu^t)) = \frac{(c_{it}/F_{it})^{1-\alpha}}{1-\alpha}\exp(\theta_{it}) \tag{13}$$

where F_{it} is the adult equivalent size of the household, α is the coefficient of relative risk aversion, and θ_{it} is a taste shifter that includes the education, age, sex and marital status of the head of the household. We substitute this into (9) to obtain the following relationship:

$$\omega_i c_{it}^{-\alpha}(F_{it})^{\alpha-1}\exp(\theta_{it}) = \omega_n c_{nt}^{-\alpha}(F_{nt})^{\alpha-1}\exp(\theta_{nt}) \tag{14}$$

In order to simplify our calculations we define:

$$\xi_{jt} = [\omega_j(F_{jt})^{\alpha-1}\exp(\theta_{jt})]^{-1/\alpha} \tag{15}$$

for $j = i, n$. We can thus write the above relationship (14) as:

$$\xi_{it}c_{it} = \xi_{nt}c_{nt} \tag{16}$$

Substituting in the budget constraints (4) and (5) this becomes:

$$\xi_{it}[(1+r_t)s_{it} + Y(\mu_{it}) + R_{it} - s_{it+1}] = \xi_{nt}[(1+r_t)s_{nt} + Y(\mu_{nt}) + R_{nt} - s_{nt+1}] \tag{17}$$

Letting ξ_{nt} be equal for all partners, and summing over the above equation for all the N partners and dividing by N, we solve for remittances received by household i. This gives us:

$$\begin{aligned} R_{it} \quad = \quad & [\frac{\xi_{nt}}{N\xi_{it}+\xi_{nt}}]\sum_{n=1}^{N}[Y(\mu_{nt}) + (1+r_t)s_{nt} - s_{nt+1}] - \\ & -[\frac{N\xi_{it}}{N\xi_{it}+\xi_{nt}}][Y(\mu_{it}) + (1+r_t)s_{it} - s_{it+1}] \end{aligned} \tag{18}$$

We start our analytical inspection of equation (18) by looking at the cases where household i is a net receiver of remittances. It is straightforward to generalize to the case where the household is a net sender of remittances. First of all we note that the remittances received by household i are increasing in the average income received by the remittance partners, i.e. a "good" shock to a partner, *ceteris paribus*, increases the partner's income, and hence household i's remittance receipts increase. Second, a good shock to household i reduces the amount of remittances that it receives, other things equal.

We are also interested in looking at the interaction between remittances and asset accumulation (or savings coming in and going out of a period). From (18) we see that remittances received by household i will be increasing in the amount of savings going out of the period for household i, (s_{it+1}), and will be decreasing in the amount of its current saving s_{it}, other things equal. By defining asset accumulation for a period as the savings at the end of the period minus the savings brought into the period, it follows that remittances are positively related to the contemporaneous accumulation of household assets. The intuition of this result follows from the fact that the remittance network jointly decides on aggregate savings, i.e. if one household increases its savings the others will decrease them on average. The household that increases its saving into the next period it will require more remittances in order to close the gap between its financial wealth (W_t) and its outlays $(c_t + s_{it+1})$.

We also see from examining (18) that remittances received by household i in period t will be decreasing in the aggregate asset accumulation of its remittance partners in the network. The intuition behind this result is basically symmetric to the intuition above for household i's asset accumulation. If the savings accumulation of a partner household increases holding other households' savings constant, then this means that every household will consume less. Hence household i will receive fewer remittances since it will also consume less.

In order to investigate the effect of a change in the interest rate on remittances we differentiate (18) holding savings fixed. This gives us:

$$\frac{dR_{it}}{dr_t} = \frac{\xi_{nt}}{N\xi_{it} + \xi_{nt}} \sum_{n=1}^{N} s_{nt} - \frac{N\xi_{it}}{N\xi_{it} + \xi_{nt}} s_{it} \tag{19}$$

This expression is positive if $(\xi_{nt} \sum s_{nt} - N\xi_{it}s_{it}) > 0$. In other words, if the weighted average of partners savings is greater than the weighted savings of household i then an increase in the interest rate, other things equal, will increase the remittances received by household i in period t.

To see if a change in the number of remittance partners N increases or decreases the net remittances received by household i we differentiate (18) with respect to N again holding savings fixed. This gives us:

$$\begin{aligned} \frac{dR_{it}}{dN} &= \frac{\xi_{nt}}{N[N\xi_{it} + \xi_{nt}]^2} \{\xi_{nt} \sum_{n=1}^{N} [Y(\mu_{nt}) + (1 + r_t)s_{nt} - s_{nt+1}] - N\xi_{it}[Y(\mu_{it}) + (1 + r_t)s_{it} - s_{it+1}]\} \\ &= \frac{\xi_{nt}}{N[N\xi_{it} + \xi_{nt}]} R_{it} \end{aligned} \tag{20}$$

The sign of this expression is positive, since it is equal to a positive expression times the remittances received by household i (that are positive by assumption). Hence, remittances are increasing in the number of remittance partners in the network.

We now inspect the remittances function from the point of view of household demographics. Inspecting (15) we see that the function ξ_{it} includes three parts. The first of these is the Pareto weight of the household. We assume that this weight is constant over time, but is different for each household. The second component is the sex-age weighted family size, and the third is a taste shifter. As mentioned earlier we let this taste shifter θ_{it} be a function of the household head's age, education, sex and marital status.

In order to check these effects we differentiate (18) with respect to ξ_{it}, other things equal, to give:

$$\frac{dR_{it}}{d\xi_{it}} = \frac{-N\xi_{nt}}{[N\xi_{it} + \xi_{nt}]^2} \{\sum_{n=1}^{N} [Y(\mu_{nt}) + (1 + r_t)s_{nt} - s_{nt+1}] + [Y(\mu_{it}) + (1 + r_t)s_{it} - s_{it+1}]\} \tag{21}$$

The sign of this expression can be seen by substituting in the budget constraints (4) and (5), and is equal to the sign of $[-\sum_{n=1}^{N}[c_{nt} - R_{nt}] - c_{it} + R_{it}]$. Since we assume that the sum of remittances received is equal to those sent, this above expression is simply the negative of the sum of all consumption in the network. Hence, remittances received by household i are decreasing in ξ_{it}.

Furthermore, if we assume that α is positive, then as household i's Pareto weight increases we know that ξ_{it} decreases. Thus, remittances coming into household i are positively related to its Pareto weight, other things equal. We also know from inspecting ξ_{it} that remittances into i will decrease as F_{it} increases for $\alpha < 1$, and will increase as F_{it} increases for $\alpha \geq 1$, other things equal. Finally, remittances will increase as θ_{it} increases.

In order to see the effect of a change of the coefficient of relative risk aversion for one of the partners we simplify the remittance equation (18) by setting $N = 1$. Differentiating with respect to the coefficient for household i, other things equal (including the coefficient of household n), we receive:

$$\frac{dR_{it}}{d\alpha_i} = \frac{-\log[\omega_i F_{it}\exp(\theta_{it})]\xi_{it}\xi_{nt}}{\alpha^2[\xi_{it}+\xi_{nt}]^2}\{[Y(\mu_{it})+(1+r_t)s_{it}-s_{it+1}]+[Y(\mu_{nt})+(1+r_t)s_{nt}-s_{nt+1}]\} \quad (22)$$

This expression can further be simplified by substituting in the budget constraints (4) and (5), giving:

$$\frac{dR_{it}}{d\alpha_i} = \frac{\log[\omega_i F_{it}\exp(\theta_{it})]\xi_{it}\xi_{nt}}{\alpha^2[\xi_{it}+\xi_{nt}]^2}[c_{it}+c_{nt}]$$

This is ambiguous. If we assume that $\omega_i F_{it}\exp(\theta_{it}) > 1$, then it is positive, but otherwise it is negative. Thus, the remittances received by a household are either increasing or decreasing in the household's coefficient of relative risk aversion, depending on the household's demographic variables. By arguments of symmetry we also know that they are ambiguous in the partner's coefficient of relative risk aversion.

Summing up what we have till now, we see from this, the benchmark risk sharing model some important implications of the remittance function. It will be increasing in the household partners' positive shocks (to income), and decreasing in the household's own shocks; it will be increasing in future savings but decreasing in the current savings of the household (i.e. increasing in asset accumulation), and will be decreasing in partner households' asset accumulation; it will be increasing in the number of partner households in the network, and decreasing in the riskless exogenous interest rate if the weighted savings of the household are greater than the mean weighted savings of its partners; it will be ambiguous in the coefficient of relative risk aversion of the household, and in that of the partners; and finally, it will be increasing in the Pareto weight of the household, and the household size (if the coefficient of relative risk aversion is greater/equal to one).

So far we have received some implications of remittances received by a household in the risk sharing environment solving the model analytically. In order to increase our understanding of remittances in this environment we have to turn to numerical methods to solve the model. This is what we now turn our attention to.

3.3 Simulating the Benchmark Model

The methodology that we use to simulate the benchmark model links the buffer stock literature (as exemplified by Deaton (1991)), and the consumption smoothing literature (as in Townsend (1994)). We do this as follows: first, we use the Euler equation for savings (12) to determine the optimal aggregate consumption and savings for the remittance network. Second, we divide the total consumption for a given period according to Euler equation (9) that equates weighted marginal utilities across households. We therefore have the individual household consumption quantities and the aggregate saving of the network. However, we cannot "tie-down" the individual savings in the benchmark model, and as such we look at various cases where we exogenously fix the saving rules of the network in order to characterize remittances.

To determine the optimal aggregate consumption for the network we start by using the Euler equation for savings (12). By defining $\delta(C_t)$ as the marginal utility of aggregate consumption for the network we rewrite (12) in the following way:[19]

$$\delta(C_t) = \max\{\delta(x_t), \beta(1+r_{t+1})E_t[\delta(C_{t+1})]\} \quad (23)$$

where x_t is the aggregate wealth of the network (it is equal to the aggregate of household wealth, i.e. $x_t = W_{it} + \sum_{n=1}^{N} W_{nt}$). Following Deaton we term it as the "cash-on-hand" of the network. This

[19] We drop the shocks from the representation for clarity.

representation of the Euler equation for aggregate savings says that the network will consume all the cash-on-hand if the aggregate borrowing constraints bind (the first part on the right hand side), and will equate the marginal utility today to the expected discounted marginal utility if they do not bind (the second). It is important to note (as Zeldes (1989) emphasizes) that the expectation also takes into account future possible constraints.

We assume that the income processes of the network members are independently and identically distributed over time, and the aggregate income process is distributed with the cumulative distribution function $F(Y)$. We also bound the marginal utility from becoming infinite in the worst possible case by setting the minimal aggregate income Y_{min} such that $\delta(Y_{min}) < \infty$. Finally, we assume that the rate of time preference is greater than the rate of interest, such that we will not have a situation where the network accumulates wealth and the borrowing constraints have no effect (this means that $\beta(1 + r_{t+1}) < 1$).

The optimal rule for consumption follows $C_t = f(x_t)$, where $f(x_t)$ is the policy function. By defining the price of consumption equal to the marginal utility of cash-on-hand (i.e. $p(x_t) = \delta[f(x_t)]$) we can write aggregate consumption:

$$C_t = f(x_t) = \delta^{-1}[p(x_t)]$$

Hence, the stationary solution $p(x)$ satisfies:[20]

$$p(x) = \max\{\delta(x), \beta \int_{f(Y)} p\{(1 + r)(x - \delta^{-1}[p(x)]\} dF(Y)\} \tag{24}$$

The unique solution for this gives a threshold level of aggregate wealth x^*, such that

$$p(x) = \delta(x) \quad \text{if} \quad x \leq x^*$$

$$p(x) \geq \delta(x) \quad \text{if} \quad x \geq x^*$$

This means that for $x \leq x^*$ the network will consume all of its aggregate wealth, and for $x \geq x^*$ it will save a proportion of it.

In order to do the numerical calculations we make the following assumptions about income, preferences, the interest rate, and the discount rate. First, we assume that the income of each of the two farmers in a network follows a Bernoulli distribution with a 50% chance of high income (equal to 75), and a 50% chance of low income (equal to 25). The network thus has an income distribution so that with a 25% chance aggregate income equals 50, with 50% it equals 100, and with 25% it is 150. As such, the coefficient of variation of income (CV) is equal to 0.35. Second, we assume (for preferences) that the coefficient of relative risk aversion (CRRA) is equal to one (log utility). Finally, we choose $r = 0.05$ and $\beta = 1/1.1$

The consumption function computed (solid line) can be seen in Figure 1. Up to a cash-on-hand value of 84.6 the members consume their entire aggregate wealth. Beyond this threshold level however, the network carries savings into the following period (for convenience the 45-degree line is added in as a dot-dash line). The plot also shows the resulting consumption function when we change the income distribution such that with a 25% chance aggregate income equals 75, with 50% it equals 100, and with 25% it equals 125 (top dashed line) (i.e CV=0.18). We see that as the CV of income decreases the network saves less. This is due to the fact that savings are costly (recall $\beta(1 + r) < 1$), and with less income uncertainty the need for assets decreases (if the model had no income uncertainty, then savings would be zero each period). The bottom line shows the resulting consumption function when the CRRA=2 (dashed line). As relative risk

[20] Deaton and Laroque (1992) show that the stationary solution does exist and that it is unique.

aversion increases, we see that the network saves more for a given level of cash-on-hand. This is due to the fact that savings are used as a buffer stock in this model.

For the first case (CV=0.35, CRRA=1) we simulate 200 periods of aggregate income, consumption and asset holdings[21] for the two household network. These can be seen in Figure 2.[22] We note a couple of points: first, aggregate consumption is not symmetric - saving prevents it from being too high, but when assets are exhausted, a bad aggregate shock causes consumption to fall to 50 (equal to the low aggregate income). Second, despite the precautionary motive for saving, assets are not accumulated, but are kept at relatively low levels. This is due to the cost of holding savings in the model. For this income series asset holdings also bind about one-sixth of the time.

We calculate individual consumption for the time series by giving each of the two network members an equal Pareto weight, i.e. $c_{1t} = c_{2t} = 0.5C_t$. In order to look at the transfers in the network we consider three different savings rules: first, that each member saves half of the aggregate savings, second, that member one does all the saving, and third, that member two does.[23] For our analysis, we keep the series of consumption, income, savings and transfers (under these three rules) for one member of the two household network (household member one). This is done to create a simulated dataset that resembles data that only contains detailed information on the sampled village households but not on their transfer partners.[24] Also, in order to compare with autarky we calculate the consumption and savings of member one with the absence of transfers. This process is repeated 49 times so that we have a simulated panel data set with 50 households (each with independent income draws), 25 with CRRA=1 and 25 with CRRA=2, and a length of 200 periods. We now examine the empirical implications of the simulated data.

Table 2 presents summary statistics of the simulated data for an individual household under the three different savings rules. The first column shows the results for a household with log preferences where the CV of income for the network is 0.35. Thus, the consumption smoothing that can be achieved by intra-temporal insurance *alone* for the simulated data (ignoring inter-temporal smoothing mechanisms (such as borrowing and saving)) is equal to a reduction in the CV of income (and hence consumption) of 30% compared to autarky with no borrowing/saving (where the CV of income is 0.5). This accounts for idiosyncratic income shocks, but not for the aggregate shocks of the two member network.[25] With transfers *and* saving the CV of consumption is 0.22, and with saving *only* (autarky) the CV of consumption is 0.28.[26] If we compare the four outcomes for the CV of consumption to assess the contribution of each of the smoothing mechanisms, we see that buffer stock saving by itself reduces the CV by 44% (compare to 30% for insurance without saving). However, with both insurance and saving the household can reduce the CV of consumption by 56%.

When the saving rule is that each household saves half of the total assets, remittances are equal to half

[21]We remind the reader that asset holdings and savings are synonymous in this model. As such, we have simulated a series of income, consumption and savings data for the network.

[22]The other two cases were also simulated. We use the data from them, but the figures are not included since they are similar to those in Figure 2.

[23]The case where each household does its own saving is analyzed in the transaction cost model (in the next section).

[24]This is the general structure if household survey data in LDCs (for instance, the ICRISAT data inspected in the previous section.)

[25]As the number of network members increases, the amount of smoothing that can be achieved by intra-temporal transfers increases. For three members the reduction in the CV compared to autarky (without borrowing/saving) would be approximately 42%, and for a large number of network members it would approach 100%.

[26]Note that the consumption statistics reported are those that are observed, i.e. they include interest but do not account for preference discounting. In the case with discounting the consumption is 50.08, and in autarky is 48.87 (due to the cost of holding assets). Since asset holding is larger in autarky we are being "conservative," and actually under stating the importance of remittances.

the difference between the realized incomes. As such, the mean transfers converge to zero as the number of periods becomes large. This also implies that the remittances transferred are independent of the relative risk aversion (of the network) under this rule, but as we note from the table are increasing in the CV of income. The second saving rule (that the household holds all the assets) implies that remittances received by the household are the difference between the realized income and the consumption of the partner. The third rule (that the partner holds all assets) implies that the remittances received equal the difference between consumption and individual income realized. We note that the standard deviation for the first rule is smaller than the other two. That is, when each household does a positive proportion of the savings the remittances are smaller in magnitude. This will be of importance when we examine the economy when there are transaction costs in sending remittances.

Finally in examining Table 2, we note that as the CRRA increases, savings increase for a given level of cash-on-hand (see Figure 1), leading to a decrease in (discounted) consumption. The increase in relative risk aversion thus causes net remittances received in a period to increase in magnitude when we have a situation where the household does more than half the saving, but decrease in magnitude when it does less than half. This is of importance since it implies that if there are different groups within a village, we may observe different remittance behavior between them - depending not only on savings agreements within networks, but also on differing levels of risk aversion between them.

In order to receive more implications we run regressions based on the remittance equation (18). As mentioned above, the specification of the regressions we run only uses the information on one of the partners in the two household network so that we receive implications that can be tested using household survey data (that generally only contains this information). It is interesting to note that if we were to use the information on the two households in each network we would receive an exact relationship between the remittances received and the income and savings of the network. In order to derive the specification for our regressions we follow Lund and Fafchamps (1997) and assume that the information in the partners' savings and income can be approximated by network specific dummies (which are in effect household fixed effects for the households that we have data on), and time dummies. Since the relationship between the partners' income and savings is not an exact relationship to the household/time dummies we introduce an error term that we assume to be normal, with an independent and identical distribution across households and time, and with a zero mean. The regressions are run using the three different savings rules. However, since the third rule implies that the household's saving is identically zero, we change this so that the household saves 5% of the network's assets in this case. The results for the ordinary least square (OLS) and two stage least square (2SLS) (where savings into the next period are instrumented using assets held at the start of the current period, and the random numbers used to generate the income shock) regressions can be seen in Table 3.

The OLS regressions show that the coefficient for household income is negative and significant for all the savings rules. This is also the case for savings into the following period, except that the coefficients are positive. However, savings brought into the current period are not significant when the partner does 95% of the saving (the third saving rule). In order to see if savings accumulation is positive in the OLS regressions (as we will use them in the empirical section) we do Wald F-tests. These show that the asset accumulation is positive and significant for all three savings rules. The results for the two-stage least squares regressions give the same implications except for savings taken into the next period under the third savings rule, which is not significant. The Wald test for asset accumulation is also not significant for rule III in the 2SLS regression, but is for rules I and II.

Summarizing the implications that we receive from the numerical solution of the model, we see that the amount of savings for the network is sensitive to the coefficient of variation of income and to the relative risk aversion of the network. Up to a certain threshold point of aggregate wealth, the network does not save, but only smoothes consumption using remittances. These are capable of only smoothing a limited proportion of the income uncertainty, i.e. the idiosyncratic shocks to the network but not the aggregate ones. (In our example of a two household network, the smoothing achieved by remittances alone is less than one-third. However, as the number of households in the network increases, the smoothing that can be achieved by remittances (without inter-temporal mechanisms) increases). Beyond the threshold level the households can use both intra- and inter-temporal smoothing mechanisms. We find that as a household holds more assets coming into the period, the remittances received decrease (this is true at least for the first two savings rules we examine). Similarly, as a household holds more assets leaving the period, the remittances it receives increase (for the first two saving rules only). The results from the simulated data therefore suggest that remittances will be increasing in asset accumulation. We also find that income is negatively related to the remittances a household receives.[27]

In the next section we add transaction costs in sending remittances to the benchmark model. We include this friction in order to try and tie-down the individual savings amounts of the households in the network that is missing in the model in this section. We do this to investigate if remittances are targeted to liquidity constrained households, and to further investigate the relation between remittances and saving.

4 A Risk Sharing Model with Transaction Costs

In this section we add transaction costs in sending remittances to incorporate some important aspects that are lacking in the benchmark model. Specifically, we are interested in determining individual savings of the member households in the network in order to investigate whether remittances are targeted to liquidity constrained households, and to examine the relationship between remittances and individual asset accumulation. We adapt our model in two ways to add this friction. First, we assume (for simplicity) that there are only two households in the network. Second, suppose that household one receives remittances R_{1t} if household two sends $(1+\gamma)R_{1t}$, and vice-versa, that household two receives R_{2t} if household one sends $(1+\gamma)R_{2t}$.[28] We assume that $\gamma \geq 0$ (note that if γ is equal to zero then we have no transaction costs, and we have the special case examined so far).[29] If γ is very large (approaching infinity) then in effect we shut down remittances, and return to the buffer stock set of models where households are in autarky.

The budget constraints for the households are now

$$c_{1t} = (1+r_t)s_{1t} + Y(\mu_{1t}) - s_{1t+1} + R_{1t} - (1+\gamma)R_{2t} \tag{25}$$

[27]Thus, the main results of the comparative static exercises in the previous subsection are confirmed in the dynamic numerical solution of the model.

[28]We add the transaction costs in this way since we want to take into account possible intermediaries that charge a percentage amount of the remittances to deliver them. Alternatively, we could have formulated them as a fixed cost, i.e. if a household sends R_{it} then $R_{it} - \gamma$ (where $0 < \gamma < R_{it}$) is received. Another reason for formulating the transaction costs as we have is to allow us to think of them as being relative to possible transaction costs in saving.

[29]Throughout the paper by assuming that $\gamma \geq 0$ we are thus assuming that transaction costs are relatively greater for remittances than for saving.

and

$$c_{2t} = (1+r_t)s_{2t} + Y(\mu_{2t}) - s_{2t+1} + R_{2t} - (1+\gamma)R_{1t} \tag{26}$$

We assume that either one of the remittance values (R_{1t} or R_{2t}) is zero, or that both are, i.e. only one of the households at most is sending remittances. In this example we set $R_{2t} = 0$. Therefore, the resource constraint of the network is:

$$c_{1t} + c_{2t} = (1+r_t)(s_{1t} + s_{2t}) + Y(\mu_{1t}) + Y(\mu_{2t}) - (s_{1t+1} + s_{2t+1}) - \gamma R_{1t} \tag{27}$$

i.e. if remittances in the amount $(1+\gamma)R_{1t}$ are sent by household two, then the network loses γR_{1t} of its resources.

Solving the maximization problem (3) for two households but using the modified budget constraints ((25) and (26)) we obtain first order conditions for consumption and remittances that include the transaction costs (if remittances are sent). With the parameterization (13) from before we write the FOCs as:

$$(1+\gamma)^{1/\alpha}\xi_{1t}c_{1t} = \xi_{2t}c_{2t} \quad \text{if} \quad R_{1t} > 0 \tag{28}$$

$$\xi_{1t}c_{1t} = \xi_{2t}c_{2t} \quad \text{if} \quad R_{1t} = 0 \tag{29}$$

We interpret these conditions as follows: if there are no remittances sent then the transaction costs do not change the distribution of consumption that we get when $\gamma = 0$. However, when remittances are sent, the transaction costs behave like a "tax" and drive a wedge between the relative consumption levels of the sending and receiving households.

The Euler equations for saving are also different than those in the benchmark model. They differ in that the Lagrangian multiplier on the network's borrowing constraint differs across the households. Household two's multiplier is the same as in the benchmark model, but the multiplier for household one is normalized by $(1+\gamma)$. We write the FOCs for saving (without the parameterization used above) as follows:

$$\text{prob}(\mu^t)v'[c_{it}(\mu^t)] = \sum_{\mu_{t+1}} \text{prob}(\mu^{t+1})\beta(1+r_{t+1})v'[c_{it+1}(\mu^{t+1})] + \tilde{\phi}_{it}(\mu^t) \tag{30}$$

where $i = 1, 2$. $\tilde{\phi}_{it}(\mu^t) = 0$ if the aggregate savings in the remittance network are positive, and $\tilde{\phi}_{it}(\mu^t) > 0$ if the aggregate savings in the network are zero. The implications of (30) are that households equate their marginal utility of consumption in the current period to their expected marginal utility in the next period if the aggregate borrowing constraint of the network does not bind, but their marginal utility is larger today if it does bind.

We derive the remittance identity using the same method as for (18), and as such, remittances received by household one are given by (again using the parameterization):

$$\begin{aligned} R_{1t} \quad = \quad & [\frac{\xi_{2t}}{\xi_{1t}(1+\gamma)^{1/\alpha} + \xi_{2t}(1+\gamma)}][Y(\mu_{2t}) + (1+r_t)s_{2t} - s_{2t+1}] - \\ & -[\frac{\xi_{1t}(1+\gamma)^{1/\alpha}}{\xi_{1t}(1+\gamma)^{1/\alpha} + \xi_{2t}(1+\gamma)}][Y(\mu_{1t}) + (1+r_t)s_{1t} - s_{1t+1}] \end{aligned} \tag{31}$$

Note that this remittance function reduces to the one in the benchmark model (18) (for two households) when $\gamma = 0$.

We now show that when remittances are sent that they will be decreasing in the stringency of the transaction costs (i.e. $\frac{dR_{1t}}{d\gamma} < 0$). This result is important since it implies that alternative methods available to the household to smooth consumption (i.e. savings) are of increasing importance as transaction costs increase. To show that $\frac{dR_{1t}}{d\gamma} < 0$ we differentiate (31) to get:

$$\begin{aligned}
\frac{dR_{1t}}{d\gamma} &= D^{-2}\{\xi_{1t}X_{1t}[(1+\gamma)^{\frac{1}{\alpha}}\xi_{2t} + \frac{1}{\alpha}(1+\gamma)^{\frac{1-\alpha}{\alpha}}\xi_{1t} - \frac{1}{\alpha}(1+\gamma)^{\frac{1-\alpha}{\alpha}}D] - \\
&\quad -\xi_{2t}X_{2t}[\xi_{2t} + \frac{1}{\alpha}(1+\gamma)^{\frac{1-\alpha}{\alpha}}\xi_{1t}]\} \\
&= D^{-2}\{(\xi_{1t}X_{1t} - \xi_{2t}X_{2t})\frac{\delta\xi_{1t}}{\alpha(1+\gamma)} + (\delta\xi_{1t}X_{1t} - \xi_{2t}X_{2t})\xi_{2t} - \frac{\delta\xi_{1t}X_{1t}}{\alpha(1+\gamma)}D\} \qquad (32)
\end{aligned}$$

where we define $D \equiv [\xi_{1t}(1+\gamma)^{1/\alpha} + \xi_{2t}(1+\gamma)]$, $X_{it} \equiv [Y(\mu_{it}) + (1+r_t)s_{it} - s_{it+1}]$ for $i = 1, 2$, and $\delta \equiv (1+\gamma)^{\frac{1}{\alpha}}$.

By definition $R_{1t} > 0$, hence $[\xi_{2t}X_{2t} - \delta\xi_{1t}X_{1t}] > 0$ (since this is the numerator of equation (31) for R_{1t}). Also following from $R_{1t} > 0$, we have $[\xi_{2t}X_{2t} - \xi_{1t}X_{1t}] > 0$ because $\delta > 1$ and $X_{2t} > 0$ (since $c_{2t} > 0$ and $X_{2t} \equiv c_{2t} + (1+\gamma)R_{1t})$). Therefore, the sign of (32) is negative.[30] The intuition behind this result is that transfers cause a loss to the resource constraint (27) of γ for each rupee transferred, and as such transfers will be reduced if the transaction costs are high, so as not to "throw away" network resources.

With this result in mind, we now want to show that one of the ways the network will reduce its remittances relative to savings as transaction costs increase, is by allocating transfers to liquidity constrained households. We show this by arguing that households that have sufficient own wealth (savings plus income) to satisfy first order condition (29) will do so, rather than having remittances sent so as to satisfy (28) for the network. To prove this we label the value of wealth at period t to the network as $V(x_t)$, where x_t is equal to the network savings from the last period plus the sum of contemporaneous household incomes ("cash-on-hand"). We assume for simplicity that $\xi_{1t} = \xi_{2t}$, and that each household has the same Pareto weight. Thus, the two household network problem can be written as the following Bellman equation:[31]

$$V(x_t) = v(c_{1t}) + v(c_{2t}) + E_t\beta V(x_{t+1}) \qquad (33)$$

We now compare the situation where remittances are sent to household one, to the situation where no remittances are sent. The value function without remittances is greater than the value function with remittances if:

$$\begin{aligned}
v(c_{1t}) + v(f(x_t) - c_{1t}) \quad &+ \quad E_t\beta V[x_t - f(x_t) + Y_{t+1}] > \\
&v(\tilde{c}_{1t}) + v(f(\tilde{x})_t - \tilde{c}_{1t}) + E_t\beta V[\tilde{x}_t - f(\tilde{x}_t) + Y_{t+1}] \qquad (34)
\end{aligned}$$

where $f(x_t)$ is total network consumption when no remittances are sent, $f(\tilde{x}_t)$ is total network consumption with remittances, c_{1t} is household one's consumption without remittances, $\tilde{c}_{1t}$ with, and Y_{t+1} is the total income of the network in the next period. In order to prove that inequality (34) holds we first show that

$$E_t\beta V[x_t - f(x_t) + Y_{t+1}] \geq E_t\beta V[\tilde{x}_t - f(\tilde{x}_t) + Y_{t+1}] \qquad (35)$$

and then that

$$v(c_{1t}) + v(f(x_t) - c_{1t}) > v(\tilde{c}_{1t}) + v(f(\tilde{x}_t - \tilde{c}_{1t}) \qquad (36)$$

[30] This argument assumes that $X_{1t} > 0$. However, this is reasonable since even in the simulations (in the last section) where we "load the dice" for the remittances received to be high, (i.e. where the household does all the saving in the network and for the larger coefficient of variation of income and coefficient of relative risk aversion), we still see that consumption is greater than remittances received for every period in every household. Also, for the ICRISAT data we have seen that remittances only make up a small proportion of income, and we also see that consumption is greater than remittances received in the data (see Table 1).

[31] Dropping the shocks from the notation for clarity.

The first part of the proof (to show that (35) holds) uses two pieces of information that we can see in Figure 1. First, that f (the policy function) is increasing in x, and second, that the slope of f is less or equal to one (it is equal to one upto the threshold level where no savings take place, and is less than one above this level once the network starts saving). With transaction costs γ we know (from (27)) that the cash on hand of the network will be $\tilde{x}_t = x_t - \gamma R_{it}$, and thus, $\tilde{x}_t < x_t$. Using the first piece of information above, this means that $f(\tilde{x}_t) < f(x_t)$, and using the second we know that $f(x_t) - f(\tilde{x}_t) < x_t - \tilde{x}_t$. Therefore,

$$x_t - f(x_t) \geq \tilde{x}_t - f(\tilde{x}_t)$$

and hence $E_t\beta V[x_t - f(x_t) + Y_{t+1}] \geq E_t\beta V[\tilde{x}_t - f(\tilde{x}_t) + Y_{t+1}]$ as we wanted to show.

We now turn to the second part of the proof (i.e. that (36) holds). Using the following three pieces of information: $c_{1t} + c_{2t} = f(x_t)$, $\tilde{c}_{1t} + \tilde{c}_{2t} = f(\tilde{x}_t)$, and $f(x_t) > f(\tilde{x}_t)$, we know that

$$c_{1t} + c_{2t} > \tilde{c}_{1t} + \tilde{c}_{2t} \tag{37}$$

We also know from $c_{1t} = c_{2t}$ (29) that $c_{1t} = f(x_t)/2$, and from $\delta\tilde{c}_{1t} = \tilde{c}_{2t}$ (28) that $\tilde{c}_{1t} = f(\tilde{x}_t)/(1+\delta)$. Since $\delta > 1$ we receive that $\tilde{c}_{1t} < c_{1t}$.

From (37) we know that the total current consumption decreases when remittances are sent, and we have shown that the current consumption of household one will also decrease. Thus, for household two there are two possibilities for its current consumption. Either (i) $\tilde{c}_{2t} \leq c_{2t}$, or, (ii) $\tilde{c}_{2t} > c_{2t}$. If (i) holds then it is easy to see that (36) is satisfied, and if (ii) holds, then by the concavity of the utility function and property (37) (that total current consumption decreases with remittances) we get that (36) is satisfied due to the increasing inequality of current consumption.

Hence, we have shown that both (35) and (36) are satisfied, and thus, so is (34) (as we set out to prove). This result means that transfers will only be sent to households when their savings are sufficiently low such that they cannot satisfy condition (29), and the loss of utility to household one of not receiving remittances is very large. If they are able to satisfy it, then (as we have shown) no remittances will be received. This result also means that transfers will be allocated to liquidity constrained households in the presence of transaction costs. It is important to reiterate that if $\gamma = 0$ we may see that transfers are not specifically targeted towards households with low savings, but are allocated so as to preserve an agreed distribution of savings across the households in the network (as in the benchmark model simulations). This result also ties-down the individual saving of each household in the remittance network since it can be interpreted that although savings are determined by the network as a whole, each household does its own saving.

We simulate the transaction cost model in the next subsection to obtain a numerical solution, and hence a clearer picture of the effects of this added friction. Before we do this however, we discuss the analogous comparative statics to the benchmark model by examining the remittance equation (31). First, note that the remittances received by household one are increasing in household two's income and decreasing in its own income (other things equal). Second, household one's remittances are increasing in its own asset accumulation (that is, increasing in savings into the next period and decreasing in those brought into the current period) and decreasing in household two's, *ceteris paribus*. The results for income and asset accumulation are the same directions as those in the benchmark model, and as such have the same empirical implications. Regarding the effect of the change of interest rate we differentiate (31) with respect to r_t, other things equal. This gives us:

$$\frac{dR_{1t}}{dr_t} = \frac{\xi_{2t}}{D}s_{2t} - \frac{\delta\xi_{1t}}{D}s_{1t} \tag{38}$$

This expression is positive if $\xi_{2t}s_{2t} > \delta\xi_{1t}s_{1t}$. In other words, if the weighted savings of the sending household are greater than those of the receiving household multiplied by a factor greater than one (reflecting the transaction costs and the coefficient of relative risk aversion), then remittances will be increasing in the interest rate, other things equal. This is similar to the result without transaction costs, except as transaction costs are higher, it is more likely that the remittances received will decrease with an increase in the interest rate on savings.

To inspect the remittance function with respect to household demographics we differentiate (31) with respect to ξ_{1t}, other things equal, to give:

$$\frac{dR_{1t}}{d\xi_{1t}} = \frac{-\delta\xi_{2t}}{D^2}[(1+\gamma)c_{1t} + c_{2t}] \tag{39}$$

This expression is clearly negative. Thus, the conclusions from the benchmark model regarding household demographics are unchanged: remittances received are increasing in the Pareto weight of the household and in θ_{1t}, and are decreasing in the family size if $\alpha < 1$, but are increasing in family size if $\alpha \geq 1$.

Thus, the remittance function with transaction costs gives very similar comparative static results to the remittance function without transaction costs. However, the analytical solution to the model differs from the benchmark model in that transfers will be targeted to liquidity constrained households, and that the asset holding of individual households is determined (not only the aggregate). In order to study the transaction cost model in greater detail, comparing it to the benchmark model, we now turn to its numerical solution.

4.1 Simulating the Transaction Cost Model

The method for solving the transaction cost model is similar to that of the benchmark model in that we make use of the Euler equations for consumption (28) and (29), and savings (30), together with the remittances equation (31). However, we must differentiate between the periods when remittances are sent with those when they are not.

The algorithm that we use to solve the problem is as follows. First, we solve for the policy function $f(x_t)$ as in the benchmark model. Thus, for a given amount of "cash on hand" we know how much the network would like to save. Since (as we proved in the last subsection) there will be no transfers if each of the households has enough savings to satisfy their own consumption share, we next calculate the consumption each household would be allocated in the absence of remittances. This is done by taking the (given) aggregate wealth of the network x_t, and from the policy function $f(x_t)$ calculating the aggregate consumption and saving of the network. Individual consumption is calculated using the Euler equation (29) - and since we assume that $\xi_{1t} = \xi_{2t}$, it is equal to half the aggregate consumption. Next we compare the individual consumption allocations to the individual wealth of each household. If both households are capable of financing their own consumption, then this is done. However, if one (or both) households are unable to do so, then we must calculate remittances, consumption, and savings for these cases.

We elaborate on the algorithm for the case where household one is unable to finance its own consumption. If household two sends remittances in the amount R_{1t}, then the aggregate wealth of the network $\tilde{x}_t$

is equal to $x_t - \gamma R_{1t}$ (from the resource constraint (27)). Remittances are given by equation (31), and substituting this into the above equation for $\tilde{x}_t$ we get:

$$\tilde{x}_t = x_t - \frac{\gamma}{\delta + (1+\gamma)}\{Y(\mu_{2t}) + (1+r_t)s_{2t} - \delta[Y(\mu_{1t}) + (1+r_t)s_{1t}] - s_{2t+1}\} \tag{40}$$

Note that s_{1t+1} does not appear in the above equation since household one does not save in this case, so as to minimize the resources lost. We solve (40) simultaneously with the saving/consumption identity:

$$\tilde{x}_t = f(\tilde{x}_t) + s_{2t+1} \tag{41}$$

in order to receive $\tilde{x}_t$, and the aggregate consumption and savings for the network. We can calculate R_{1t} from this using (31), and can calculate the individual consumptions from (28).

Table 4 presents the summary statistics of the simulated data for an individual household. We examine the data using four different values for γ, and for two values of the coefficient of relative risk aversion (CRRA). The first column (where $\gamma = 0$) shows the values for the case where there are no transaction costs and each household does its own saving. We see that savings are increasing in the CRRA, and total remittances are decreasing. However, when remittances are sent, their value is larger on average, but they are sent less frequently. As the transaction costs become larger we see that remittances decrease (both in size and in frequency). However, as γ increases we also see that savings increase.[32] This is important since it confirms the comparative static result - that as the transaction costs in sending remittances increase, the use of remittances decreases as a smoothing mechanism in favor of alternative inter-temporal smoothing mechanisms.

In order to see the targeting result more clearly we show a plot of remittances received by partner household one (for all fifty networks simulated, when remittances are not sent by household one) against household saving. This can be seen in Figure 3. The main thing to note from this graph is that no remittances are received at higher levels of saving (i.e. above 30.70 (or just above a quarter of the maximum savings when remittances are not sent)). This confirms that remittances are targeted towards households with lower savings that are liquidity constrained.

Finally, to receive more implications we run regressions similar to those in the benchmark model. These are based on the remittance equation (31) using a value for γ of 0.25. In order to check if remittances are targeted towards liquidity constrained households we add a dummy variable that is equal to zero if a household can finance its consumption share from its individual cash-on-hand, and equal to one if it cannot. The results presented for the ordinary least square and two stage least square (where the instruments used are the same as in the benchmark model) regressions can be seen in Table 5.

The first (left-most) ordinary least square regression shows that remittances are targeted to liquidity constrained households, they are negatively related to income and savings into the period, and are positively related to savings out. We carry out a Wald F-test to see if asset accumulation (savings out minus savings in) is significant in this regression. It is found to be so with a p-value of 0.0000. The corresponding (left-most) two stage least square regression gives the same signs as the ordinary least squares regression, but none of the coefficients are significant, and neither is the Wald F-statistic for asset accumulation. We also show the regressions where we include asset accumulation as a regressor instead of savings in and out of the period. The interesting thing that comes out is, that the 2SLS regression gives significant coefficients, with the same implications as the OLS regressions.

[32]If we look at the case where $\gamma = 10$ for CRRA=1 (not in the table), we see that there are no remittances sent and the household saves 21.83. This is approaching the value for savings in autarky (24.63).

In this section we have increased our understanding of remittance behavior and how it is linked to inter-temporal smoothing mechanisms. We find that there is a trade-off between one mechanism to another as transaction costs on the first make it more "expensive" to use. We find that the implications of this model are similar to those derived in the benchmark model, except we also find that remittances are targeted to liquidity constrained households in the presence of transaction costs. Finally, it is interesting to note that remittances that are *not* targeted to liquidity constrained households can be looked upon as being synonymous to no significant transaction costs in the sending of these remittances. However, we also add that the opposite is not true, i.e. if remittances are targeted to liquidity constrained households it does not mean that there are transaction costs involved.

5 Conclusions

In this paper we have examined the importance of remittances as an intra-temporal mechanism used to smooth consumption, and their relationship to inter-temporal smoothing mechanisms (specifically, financial assets and liabilities, money holdings, stock inventory, and purchase and sale of physical assets). We ask if transfers are targeted within networks of remittance partners to liquidity constrained households, and in doing so have linked together two important literatures on village economies - the risk-sharing insurance literature, and the buffer-stock saving literature. These have generally been examined separately, the former only looking at the intra-temporal aspects of smoothing, and the latter at households in autarky. Thus, this paper provides an important step in modeling both aspects of low-income village smoothing behavior together.

The framework used to examine the relationship between remittances, asset accumulation, and household demographics is a multi-period risk sharing model with borrowing constraints. Although this model suffers from its inability to tie down individual savings within a remittance network, we solved it as a benchmark before adding an additional friction to determine individual savings. The benchmark model provides implications, for example, that net remittances received are inversely related to household income, and positively related to asset accumulation. With the added friction of transaction costs, the second model we solved gives the same implications as the benchmark model, with the added feature that we see targeting of remittances to liquidity constrained households. We were also able to examine (in this second model) the relative use of remittances and inter-temporal smoothing mechanisms, and the trade-off between them, by changing the size of the transaction costs when simulating the model.

Apart from the theoretical importance of this paper, we also receive some important empirical implications that are tested in a companion paper (Seiler (1998b)). One of the implications found is that remittances will be targeted to liquidity constrained households in a risk sharing network if there are transaction costs in sending remittances, but not necessarily so if there are not. This is an important finding with policy implications. For instance, credit agencies that can target loans to liquidity constrained households will not necessarily "crowd out" informal insurance agreements in village economies without prevailing transaction costs in sending remittances, but may well do so if there are.

We also find that households who receive remittances accumulate more savings. This is of interest since various saving programs are often associated with the crowding out of transfers (a classic example being in Barro (1974)). Thus, we must also ask, in light of our findings here, if such programs would also crowd out other forms of saving, and significantly change the overall asset accumulation in rural low-income village economies.

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Table 1. Summary Statistics (Means and Standard Deviations) of Remittances and Incomes in the ICRISAT Villages

Village	Variable	All Months	Months with Positive Gross Receipts	Months with Positive Remittances Sent
Aurepalle	Gross Receipts	20.46	240.19	88.87
		(453.37)	(1540.66)	(1100.70)
	Amount Sent	29.03	248.56	180.78
		(488.53)	(1655.83)	(1209.38)
	Net Receipts	-8.57	-8.36	-91.90
		(647.90)	(2221.04)	(1595.74)
	Income	546.09	379.63	835.37
		(871.06)	(615.22)	(1192.40)
	Observations	1949	166	313
	Gross Receipts/Income	3.75	63.27	10.64
	Amount Sent/Income	5.32	65.47	21.64
Shirapur	Gross Receipts	58.05	286.79	134.13
		(308.87)	(637.50)	(476.33)
	Amount Sent	48.19	132.02	142.84
		(423.74)	(891.65)	(720.54)
	Net Receipts	9.86	154.77	-8.71
		(469.69)	(990.28)	(778.83)
	Income	617.04	508.73	653.70
		(935.90)	(1134.54)	(1084.18)
	Observations	2238	453	755
	Gross Receipts/Income	9.41	56.37	20.52
	Amount Sent/Income	7.80	25.95	21.85
Kanzara	Gross Receipts	41.34	226.93	131.76
		(498.50)	(1129.58)	(988.22)
	Amount Sent	15.73	21.50	67.85
		(66.22)	(81.89)	(124.09)
	Net Receipts	25.61	205.43	63.91
		(475.06)	(1088.37)	(961.86)
	Income	754.95	774.62	994.14
		(1532.91)	(1502.40)	(1574.71)
	Observations	2053	374	476
	Gross Receipts/Income	5.47	29.30	13.25
	Amount Sent/Income	2.08	2.78	6.82

Notes:

1. All values are in rupees per month.
2. Standard deviations are in parentheses.
3. Gross receipts divided by income are given as a %, as is amount sent divided by income.

Table 2. Summary Statistics (Means and Standard Deviations) for an Individual Household using Simulated Data.

Variable	CV=0.35,CRRA=1	CV=0.18,CRRA=1	CV=0.35,CRRA=2
Income	50.5	50.25	50.5
	(25.06)	(12.52)	(25.06)
Consumption	51.22	50.49	51.29
	(11.14)	(6.81)	(9.88)
Savings (save half)	11.39	2.30	14.95
	(9.70)	(3.04)	(13.42)
Savings (save all)	22.78	4.61	29.89
	(19.39)	(6.07)	(26.84)
Savings (save none)	0	0	0
	(0)	(0)	(0)
Remittances (save half)	0.38	0.19	0.38
	(18.16)	(9.08)	(18.16)
Remittances (save all)	0.03	0.13	-0.04
	(20.42)	(9.62)	(21.31)
Remittances (save none)	0.72	0.24	0.79
	(20.47)	(9.65)	(21.39)
Consumption (autarky)	51.33	50.49	52.17
	(14.61)	(8.42)	(10.09)
Savings (autarky)	24.63	7.33	59.59
	(20.24)	(7.08)	(48.11)

Notes:

1. The summary statistics are for 200 periods.

2. Standard deviations are in parentheses.

Table 3. Regression Analysis using the Simulated Data.

Variable	OLS Rule I	OLS Rule II	OLS Rule III
Income	-0.89	-0.89	-0.89
	(-288.0)**	(-288.0)**	(-288.1)**
Savings in	-0.89	-0.95	0.06
	(-132.6)**	(-280.8)**	(0.84)
Savings out	1.61	1.30	7.06
	(192.9)**	(313.0)**	(84.8)**
Constant	37.88	37.88	37.88
	(88.5)**	(88.4)**	(88.5)**
Observations	9950	9950	9950
R-squared	0.90	0.92	0.92
Variable	**2SLS Rule I**	**2SLS Rule II**	**2SLS Rule III**
Income	-0.88	-0.88	-0.88
	(-5.09)**	(-5.09)**	(-5.09)**
Savings in	-0.86	-0.93	0.42
	(-2.16)**	(-4.68)**	(0.11)
Savings out	1.54	1.27	6.42
	(2.22)**	(3.66)**	(0.93)
Constant	37.71	37.71	37.71
	(7.88)**	(7.88)**	(7.88)**
Observations	9950	9950	9950
R-squared	0.90	0.92	0.92

Notes:

1. The dependent variable in all regressions is remittances received.

2. Equations are estimated with household specific dummies and time dummies.

3. T-values are in parentheses. A star indicates significance at 10%, two stars at 5%.

4. In Wald tests to determine if asset accumulation (i.e. savings out minus savings in) is significant the $F(1,9699)$ values for the OLS regressions under rules I, II and III are 32217, 104337 and 2527 respectively (all with p-values 0.0000). For the 2SLS regressions they are 4.84, 16.26 and 0.3 respectively (with p-values 0.0279, 0.0010 and 0.5825).

Table 4. Summary Statistics for a Household (with Transaction Costs).

Variable	CRRA=1			
	$\gamma = 0$	$\gamma = 0.1$	$\gamma = 0.25$	$\gamma = 1$
Consumption	51.22	50.76	50.43	50.34
	(11.13)	(11.37)	(12.03)	(15.20)
Remittances Received	5.39	4.45	3.38	0.99
(all observations)	(9.11)	(7.82)	(6.32)	(2.39)
Remittances Sent	4.98	4.09	3.02	0.79
(all observations)	(8.62)	(7.34)	(5.79)	(2.13)
Remittances Received	15.18	14.12	11.87	5.83
(when > 0)	(9.23)	(7.56)	(6.27)	(2.34)
Number Times Received	71	63	57	34
Remittances Sent	15.32	13.64	10.22	5.10
(when > 0)	(8.38)	(7.01)	(6.32)	(2.73)
Number Times Sent	65	60	59	31
Savings Out	11.45	11.48	11.50	14.44
	(13.37)	(13.39)	(13.39)	(15.35)

Variable	CRRA=2			
	$\gamma = 0$	$\gamma = 0.1$	$\gamma = 0.25$	$\gamma = 1$
Consumption	51.28	50.87	50.52	50.43
	(9.89)	(10.16)	(10.81)	(13.68)
Remittances Received	5.11	4.20	3.18	0.95
(all observations)	(9.11)	(7.82)	(6.30)	(2.45)
Remittances Sent	4.70	3.82	2.84	0.78
(all observations)	(8.51)	(7.27)	(5.78)	(2.20)
Remittances Received	16.74	14.24	11.79	6.13
(when > 0)	(8.79)	(8.02)	(6.74)	(2.62)
Number Times Received	61	59	54	31
Remittances Sent	15.40	13.66	10.94	5.81
(when > 0)	(8.54)	(7.37)	(6.34)	(2.65)
Number Times Sent	61	56	52	27
Savings Out	15.19	15.31	15.63	19.62
	(17.56)	(17.64)	(17.82)	(20.39)

Notes:

1. The summary statistics are for 200 periods.

2. Standard deviations are in parentheses.

3. Remittances sent are the amounts received by the household's partner - to obtain the actual amount sent multiply by $(1 + \gamma)$.

Table 5. Regression Analysis using the Simulated Data (with Transaction Costs).

Variable	Ordinary Least Squares	Ordinary Least Squares	Two Stage Least Squares	Two Stage Least Squares
Liquidity Constrained	7.10 (47.36)**	6.67 (40.29)**	5.50 (1.36)	9.51 (49.37)**
Income	-0.40 (-88.84)**	-0.29 (-68.02)**	-0.56 (-1.36)	-0.15 (-26.80)**
Savings in	-0.43 (-83.39)**		-0.62 (-1.34)	
Savings out	0.66 (87.73)**		1.00 (1.18)	
Asset Accumulation		0.40 (70.29)**		0.16 (19.13)**
Constant	15.29 (64.03)**	12.87 (49.84)**	22.26 (1.28)	5.03 (14.78)**
Observations	9950	9950	9950	9950
R-squared	0.72	0.66	0.66	0.60

Notes:

1. The dependent variable in all regressions is remittances received.

2. Equations are estimated with household specific and time dummies.

3. T-values are in parentheses. A star indicates significance at 10%, two stars at 5%.

4. In Wald tests to determine if asset accumulation (i.e. savings out minus savings in) is significant the F-value for the left-most OLS regression is 8286.72 (p-value 0.0000). For the left-most 2SLS regression it is 1.54 (p-value 0.2151).

Figure 1: Consumption Functions as Computed by Euler Equation

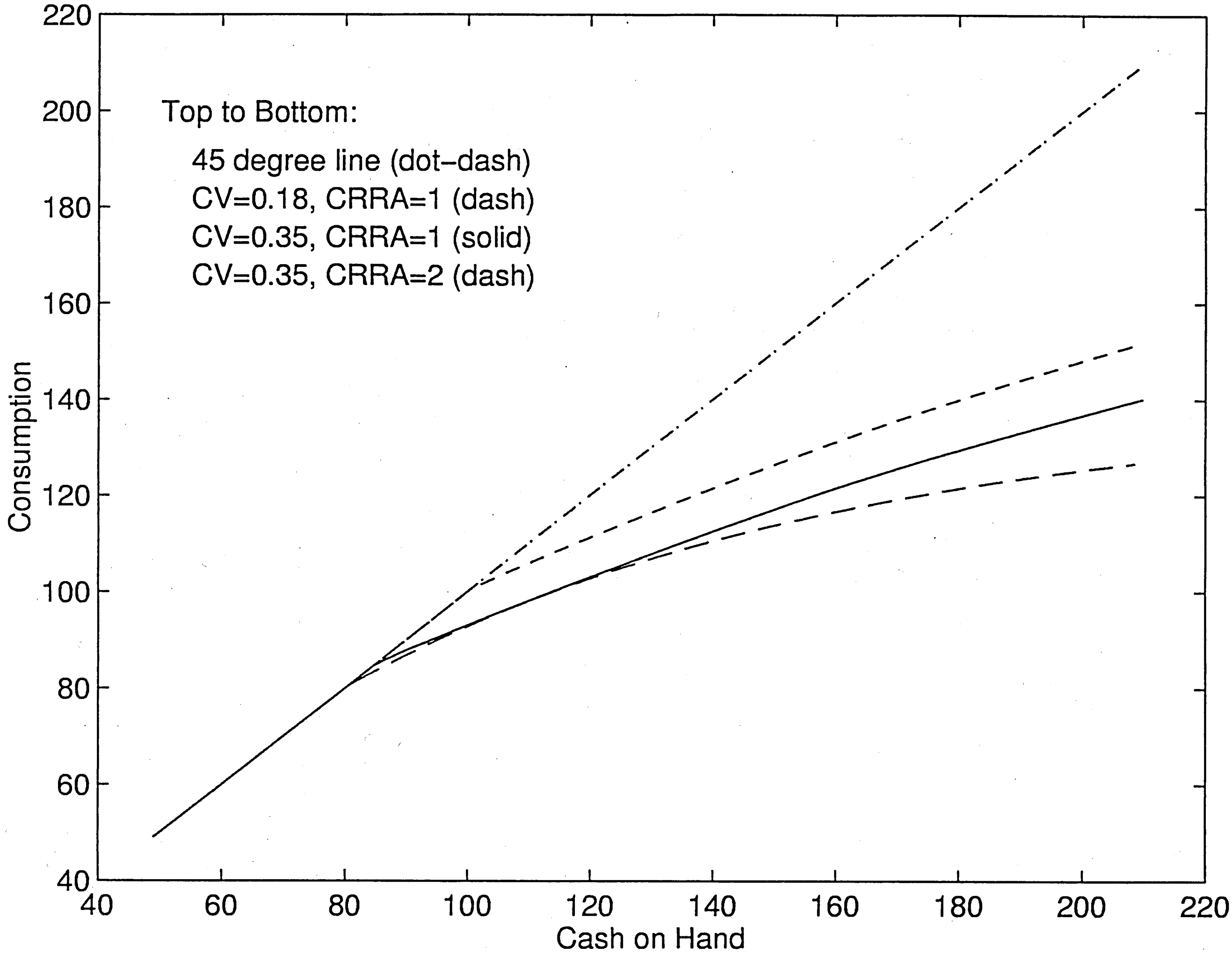
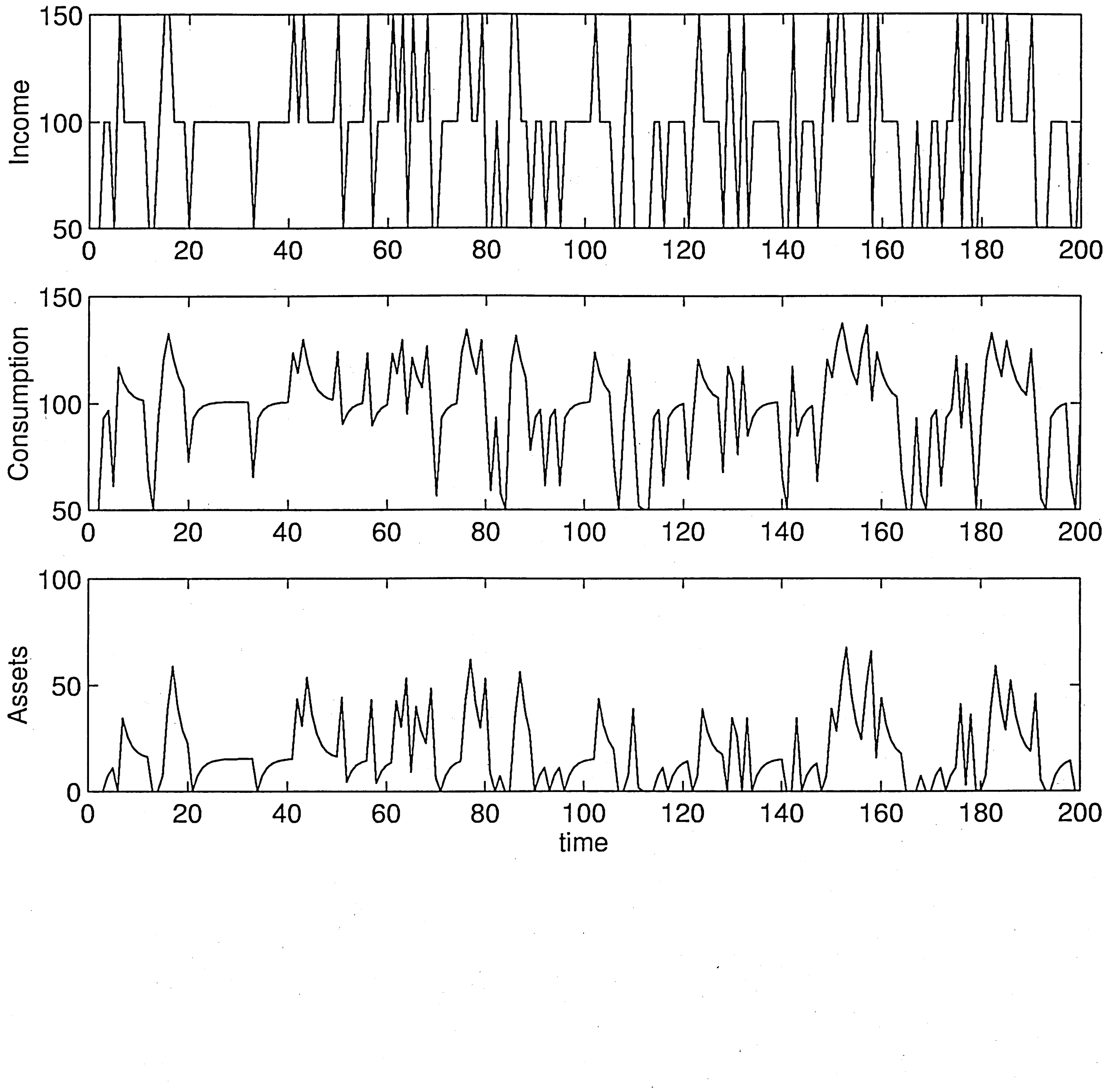


Figure 2: 200 Period Simulation of Income, Consumption and Assets



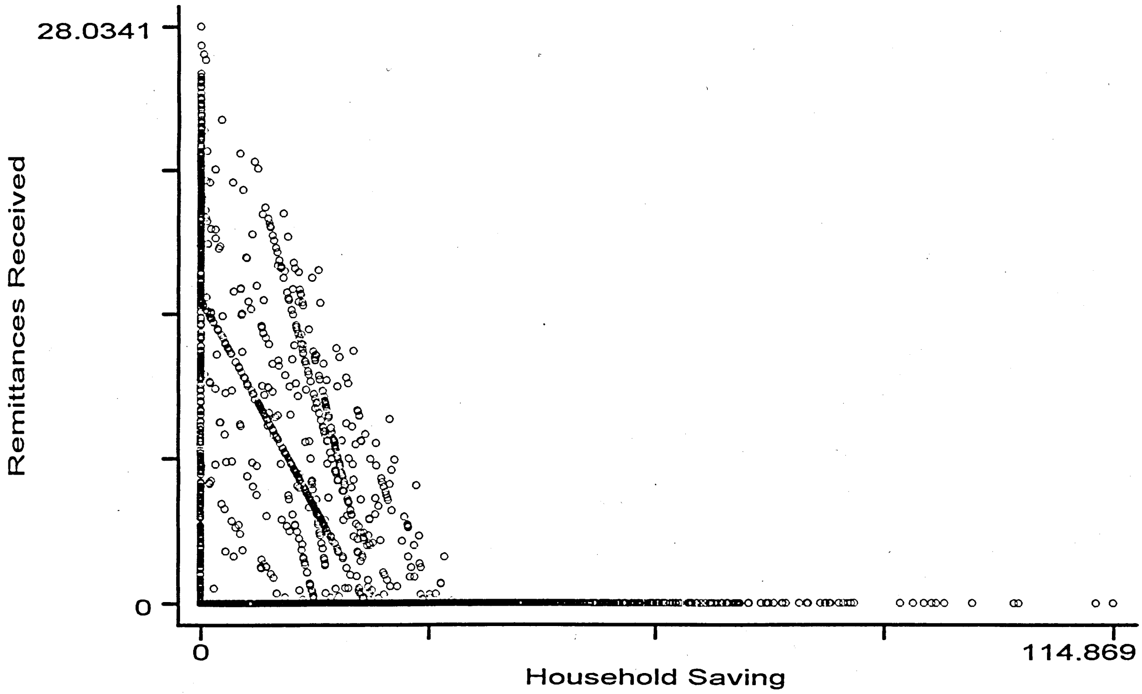


Figure 3: Remittances Received versus Savings

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