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Abstract

In this study we examine consumption smoothing in three low-income Indian villages by testing the empirical implications of a multi-period risk sharing framework with borrowing constraints. We investigate three main issues: the targeting of remittances to liquidity constrained households; the relationship between remittances and four types of asset accumulation (the purchase of physical assets, increased stock inventory, increased money holdings and the accumulation of financial assets); and the relationship between remittances and demographic variables, such as income, age, sex, marital status and education. Our results suggest that remittances are not particularly targeted to liquidity constrained households (except in the village of Aurepalle); that there is a positive relationship between asset accumulation and remittances - although this pattern differs across villages; and that household income is inversely related to remittances.
Keywords: Consumption Smoothing, Risk Sharing, Buffer Stocks, Liquidity Constraints, Village Economies.
JEL Classifications: O12, D12.

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1 Introduction

In recent years there has been an expanding body of literature in development economics devoted to the study of remittances in themselves, and in order to explain various economic phenomena (for example, Lucas and Stark (1985), Rosenzweig and Stark (1988), Paulson (1994)). 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 family members stay in the village, others migrate to areas 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.[1]

However, the diversification of risk that can be achieved through remittances is limited. They can only smooth the idiosyncratic risk component of the members of a remittance network, but are unable to account for the aggregate risk in it, and as such are often referred to as "limited insurance" (see Lim (1992)). Thus, other smoothing mechanisms are needed to smooth consumption across time to account for the aggregate (residual) risk component, for example, the accumulation and running-down of financial assets (i.e. borrowing and saving), the storage of crops, the purchase and sale of physical assets and livestock, and the use of currency holdings.

Although there are numerous models that address consumption smoothing, previous authors have generally abstained from building models that evaluate all the mechanisms in a unified framework, preferring to concentrate on *either* intra-temporal remittance network arrangements, testing for full insurance (as exemplified by the risk sharing models in Townsend (1994, 1995)), *or* inter-temporal mechanisms used by households in "autarky" (for example, Deaton (1989, 1991) who uses a buffer-stock framework, and Rosenzweig and Wolpin (1993) who examine the purchase and sale of physical assets and livestock by examining investments in bullocks and water pumps in India). This may be (in part) due to the fact, as Lim and Townsend (1998) note, that it is not a trivial matter to evaluate the consumption smoothing mechanisms available to households in rural villages. However, Lim and Townsend also emphasize the need for a comprehensive theoretical framework for such an evaluation. Therefore, Seiler (1998a, 1998b), develops a unifying theoretical framework that integrates the risk sharing literature and the buffer-stock literature in an attempt to carry out such an evaluation.

Seiler's framework is an extension to the family of models discussed in Townsend (1995) with the addition of liquidity constrained households, and transaction costs in the sending of remittances. The liquidity constraints he imposes are of the form that households cannot consume more than their current financial wealth (as in Deaton (1989), and used by Morduch (1993) and Chaudhuri and Paxson (1994) for low-income village economies). The addition of the transaction costs in his model is in order to "tie-down" the savings for the individual member households of remittance networks, and hence uniquely determine remittance amounts sent and received within the networks.

In this paper we implement the theoretical results of Seiler's model in order to test the characteristics of remittances in three villages in rural India. To do this we investigate three main issues. First, we ask if

[1] Remittances are defined here as resources sent between spatially separated locations. We can also include transfers between households 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)).

remittances correct for missing credit markets and are targeted towards liquidity constrained households in these villages. Second, we examine the relationship between remittances and four different types of asset accumulation (i.e. the relationship between the intra-temporal remittances and the inter-temporal mechanisms listed above), and third, we investigate the relationship between remittances and various household demographic variables, such as household income, and the age, sex, marital status and education of the head of a household.

The targeting of remittances to liquidity constrained households is not a new question in the literature, but we evaluate it due to its important policy implications (as first raised by Barro (1974), and since examined by various authors, e.g. Cox and Jimenez (1992)), and due to the fact that it has not been asked for a multi-period risk sharing setting in a less developed country and tested using panel data.[2] Past studies that address the targeting question include Cox (1990), and Guiso and Jappelli (1991) who use overlapping generations frameworks to look at intergenerational transfers, and find that transfers are allocated to liquidity constrained households. However, these studies differ from ours in that they are both empirically implemented using cross-sectional data from industrialized countries (USA and Italy) to study life-cycle models. Studies that have linked transfers and liquidity constraints for less developed countries include Feder et al. (1991), and Jacoby and Skoufias (1998), but they do not explicitly test for targeting of transfers to liquidity constrained households, and as such the targeting question is of importance in our present setting, in part due to its absence in the literature.

The data that we use in this paper to look at remittances together with inter-temporal mechanisms used to smooth consumption are the ICRISAT data.[3] The dataset has a panel structure that is needed to investigate the inter-temporal smoothing mechanisms and to perform the test developed by Zeldes (1989) to determine which households are liquidity constrained. The ICRISAT dataset is also very special in that the interviewers laboriously collected details of all the transactions that the households did over the ten years of data collection. From each village a sample of forty households was interviewed approximately every four weeks. These details were recorded in the transaction data records, that record (in principle) all purchases, sales, credit and gifts in three villages in southern India: Aurepalle, Kanzara and Shirapur. The transactions recorded are processed into different categories,[4] recording the date and (imputed) value of each transaction. As such, we have the opportunity to examine *all* the consumption smoothing mechanisms listed - including the unique ability to look at the use of currency as a smoothing mechanism. We are also able to examine the relationship of the smoothing mechanisms - in our case remittances - with household demographics such as income, age, sex and education.[5] Unfortunately there are also a few drawbacks in using the ICRISAT data for our purposes. There is no detailed information on transaction partners - for instance we do not know if the partner suffered a bad shock to income, or even his/her income level. We do not know the transaction partner's address or occupation, although there are some records that give the distance of the partner from the village. Another drawback is one that is common in the transfer literature, is that we do not observe intra-household transfers for household members living at the same address. However, the dataset remains a rich source for testing our hypotheses, albeit its drawbacks.

The paper proceeds as follows. The following section, Section 2 looks at the the empirical implications

[2] We discuss the data used for this paper in the next paragraph.

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

[4] For a more detailed explanation of the transaction schedule, examples of different types of transactions, and summary tables, see Lim and Townsend (1998).

[5] The relationship between remittances and income is important in that it provides a test for the risk-sharing hypothesis (see Paulson (1994)).

for remittances from Seiler's (1998b) multi-period risk sharing framework. In Section 3 there is a brief description of the villages and of the data. In this section we also look at the size of the remittances (in absolute terms and relative to income), and the frequency in which they are sent and received. In Section 4 we discuss the empirical implementation of the model. We discuss tests to determine which households are possibly liquidity constrained using methods developed by Zeldes (1989) and by Kaplan and Zingales (1997), and we expand on the structure of the remittance regressions we run. In Section 5 we look at the results of the empirical work, and finally conclude the paper in Section 6.

2 The Empirical Implications of a Multi-Period Risk Sharing Model

In this section we discuss the empirical implications of a multi-period risk sharing framework with borrowing constraints and transaction costs.[6] In particular, we expand on the relationship between the remittances received by a household in a full-information remittance network, and the mechanisms used for inter-temporal consumption smoothing. We discuss whether (and in what circumstances) remittances will be targeted towards liquidity constrained households, and report on the characteristics of remittances with respect to the demographics of the receiving households.

In order to help us to understand how the results are derived, we start by discussing the implications of a model without transaction costs (labeled the "benchmark model" by Seiler (1998b)), and then show what we gain by adding transaction costs to the benchmark model, and how the empirical implications are modified with this additional friction.

2.1 The Implications of the Benchmark Model

We start this subsection by summarizing the setup in Seiler's (1998b) framework (based on the agricultural cycle in rural villages). He assumes that at the start of each period, farmers harvest their crops and realize independent stochastic crop incomes. Each farmer's total financial wealth (or, "cash-in-hand") consists of his/her crop income and the assets he/she carried over from the previous period (that we label as "savings brought into the period"). 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 is determined by an ex-ante risk sharing agreement, and as such the remittances between households are received/sent in order to finance the gap between each household's financial wealth and its uses (individual savings into the next period and household consumption). Seiler (1998b) further assumes that 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, 1991)) and 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, as in Evans and Jovanovic (1989)). Previous authors have used this liquidity constraint for the ICRISAT villages, specifically Morduch (1993) and Chaudhuri and Paxson (1994).

The problem with this setup is that it does not give a unique solution to how much *each* household in the network should save. As such, we are unable to uniquely determine the remittance amounts sent between network members, and cannot determine if transfers will be targeted towards liquidity constrained

[6]Interested readers are encouraged to see Seiler (1998a, 1998b) for details of the setup and solution of such a model.

households. We discuss its empirical implications however, so that we can compare them to the transaction cost model (that, as we will see, can uniquely determine these quantities). We mention (as an aside) that in order to receive implications from this model Seiler (1998b) imposes exogenous saving rules. The rules he adopts are (at one extreme) that one of the households does all the network saving, and (at the other) that each household saves the same amount.

The first result of the model (that we discuss) is that the remittances received by a household are inversely related to the household's realized income that period, i.e. a "bad" income shock increases the household's remittance receipts, and vice-versa a "good" income shock reduces remittance receipts. This result is of importance since it provides a test for the risk sharing hypothesis (Paulson (1994)). The intuition behind it is as follows: if a household suffers a bad shock (with the other households' incomes unchanged), the total financial wealth of the network is decreased. The aggregate consumption in the present period will also be (weakly) decreased (by an amount up to the income loss). However, the household's partners transfer more remittances to it since they divide the *total* network consumption (ex-post) according to the ex-ante agreed sharing rule. By doing so they share the inherent risk in that their consumption amounts also decrease - hence the term "risk sharing."

Second, we look at the relationship between the remittances received by a household and the contemporaneous asset accumulation (defined as the savings taken into the next period minus those brought over from the previous one) of the household for physical assets and livestock, crop inventory stocks, cash balances, and savings in financial institutions. We are specifically interested in the relationship with these four forms of asset accumulation since the ICRISAT transaction data provide us with the unique ability to measure all of them.[7]

Seiler's model predicts that there will be a positive relationship between remittances received and asset accumulation, i.e. the more households add to their existing assets, the greater the remittances they receive. This result may seem counterintuitive in that we may think that the households accumulating assets are the ones who enjoyed good shocks, and as such should receive smaller remittances (if at all). However, we must emphasize the fact that the asset holdings of the remittance networks in this model are determined by the *aggregate* financial wealth, (as if by a "social planner") and not by individual households. Thus, if a specific household is appointed by the planner to save an extra unit of an asset into the next period (holding the aggregate savings fixed), it has to be compensated for the unit of consumption that it has moved into savings, and is thus transferred this unit via remittances from its network partners who are (in total) saving one unit less than before the change.

Third, we look at the implications of the benchmark model with respect to the demographics of a receiving household. We include in this category variables that we can measure using the ICRISAT data - the family size (weighted according to the age and sex of each family member in order to take into account different consumption requirements, for instance, calorie needs), and the age, education, marital status and sex of the head of the household.[8] The model predicts that the remittances received will be increasing

[7]There is also an associated set of stock files in the ICRISAT data, and as such we could have also examined the savings taken into and out of a period by using the relevant stock measure from the beginning of the crop year, and adding to it (or subtracting from it) the relevant transactions in the following time periods (except for the currency measure for which there is no stock file). However, there is a disturbing discrepancy in the data between the stock and transaction data files, and as such we have to decide which of the two measures to use. Since we are already using the transaction files for other measures, and are also able to measure the accumulation and running-down of cash holdings with them, we feel that it better to use them for all the asset measures, and we therefore do not use the stock files in this paper.

[8]Seiler (1998b) expands on some additional theoretical results for the remittances that a household receives that we do not test these in this paper due to the limitations of the data. He finds that the remittances received by a household will

in the weighted family size if the coefficient of relative risk aversion of a household's (constant relative risk aversion) utility function is greater or equal to one, but will be decreasing if it is less than one. It predicts that there will be a positive relationship between the remittances received by a household and an exogenous utility taste shifter (that Seiler (1998b) adds to the parameterized utility function in his model following Zeldes (1989). It is explained in detail in Section 4). Through this taste shifter we find that the remittances a household receives will be increasing in the age and education of the household head, will be increasing if the head is female, and if he/she is married.

2.2 The Implications of the Model with Transaction Costs

So far the results are ambiguous about one of our main questions - the targeting of remittances to liquidity constrained households. Seiler (1998b) adds transaction costs to the benchmark model in order to tie-down individual household savings, and hence, uniquely determines the remittance amounts sent and received by individual households in the network (that he is unable to determine in the benchmark model).[9] By doing so he finds that remittances are targeted to liquidity constrained households. In order to explain how the targeting result is obtained we summarize how he adds this additional friction, how household behavior changes with it, and also the intuition behind these observed changes.

Seiler (1998b) adds the transaction costs in the form of an "*ad valorem* tax" on the sending of remittances (i.e if a household sending remittances sends x rupees, then $x(1-t)$ will be received, where t is the transaction costs rate). He does this to take into account possible intermediaries that charge a percentage for the delivery of the remittances, and to allow us to think of these transaction costs as being relative to possible transaction costs in saving (which would be less intuitive if they were formulated as a fixed cost). The transaction costs in this model can also be thought of as being an expense in verifying the state of nature with respect to the partners' crop output - a way of incorporating possible informational problems into the setup.

The first result we discuss shows that when remittances are sent, they are decreasing in the stringency of the transaction costs. This result is important since it implies that alternative methods available to the household to smooth consumption (i.e. savings) are of increasing relative importance as transaction costs increase. The intuition behind this result is that remittances cause a loss of t to the resource constraint of the network for each rupee sent, and they will thus be reduced if the transaction costs are high, so as not to "throw away" network resources. In fact, if transaction costs are very large, we revert back to autarky, to a buffer-stock model.

One of the ways the network reduces its remittances relative to savings as transaction costs increase, is by allocating transfers to liquidity constrained households. Seiler (1998b) shows this point by proving that households that have sufficient own wealth (savings plus income) to finance their own consumption will do so, and will *only* receive remittances when they have insufficient financial wealth to finance their ex-ante determined consumption share. Thus, remittances are *only* transferred when individual liquidity constraints bind, and are transferred so as to ensure that a receiving household has enough cash-in-hand for contemporaneous consumption - it will however enter into the next period with zero assets. This means

be increasing in the number of network partners, will be increasing in the risk-free exogenous rate of return of a particular asset (if the weighted average value of the partners' saving into the period of that asset is greater than that of the receiving household), and in the Pareto weight of the household, but will be ambiguous in the coefficient of relative risk aversion of the household (using constant relative risk aversion preferences.

[9] We mention here that the results we discuss here are taken from a model in which there are two households in each remittance network (as in Seiler (1998b)).

that each household in the network does its own saving, that when remittances are sent the exact value received is known, and that they are only sent to liquidity constrained households.

We next discuss the other implications for the transaction cost model (i.e. for income, asset accumulation and household demographics). We find that the relationship between remittances and income, and between remittances and asset accumulation are in the same directions as those in the benchmark model, and as such have the same empirical implications. The conclusions from the benchmark model regarding household demographics are also unchanged: remittances received are decreasing in the family size if the coefficient of relative risk aversion is less than one, but are otherwise increasing, and they are increasing in the age and education of the household head, and are larger if the head is female or married.

Therefore, the characteristics of remittances with transaction costs are similar (with respect to their "comparative statics") to their characteristics without transaction costs. The important empirical implication we gain from adding this friction is that remittances will be targeted to liquidity constrained households, and that the asset holdings of *individual* households is determined (not only the aggregate). Finally, it is interesting to note from this result that if we find that remittances are *not* targeted to liquidity constrained households then this is synonymous to no significant transaction costs in the sending of these remittances (although 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).

3 The ICRISAT Villages and Data

In this section we describe the ICRISAT villages and data collection, and we examine the summary data for remittances and income.[10] 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. Due to the seasonal rains - the monsoon season is from June through September - and differing irrigation and soil conditions in the three villages, there are differing seasonal crop incomes. In Aurepalle and Kanzara the main harvest is the Kharif crops that are planted in May or June and are harvested in the late fall. In Kanzara there is a longer duration of Kharif crops. There is a second harvest in March and May, consisting mainly of HYV paddy in Aurepalle. The second harvest is collected by "rich" farmers since they are the heavier users of irrigation. In Shirapur there is a single main harvest in the first three months of the year. The crops are planted after the monsoon since the soil holds the water (the source for this is 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

[10]This section is brief, and interested readers should refer to Lim and Townsend (1998) and Seiler (1998a) for details on other consumption smoothing mechanisms in the ICRISAT villages, and for the build of the transaction files for the villages. For more details concerning the ICRISAT data in general the interested reader should refer to Walker and Ryan (1990).

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 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.[11] 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.[12] 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 received when income is low and sent when it is high. These both may indicate an insurance aspect to remittances. We now turn to the empirical implementation of Seiler's (1998b) model so that we can test this insurance aspect of remittances in the ICRISAT data, and also examine their relationship to inter-temporal smoothing mechanisms and household demographics.

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

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

4 Empirical Implementation

The empirical implementation that we follow requires two steps. The first is to determine if an individual household (or a group of households) is liquidity constrained. We do this using three methods. The first follows Zeldes (1989) and Morduch (1993), using Euler conditions on saving to find which land classes are liquidity constrained. The second makes use of the transaction data to find which of the sample households are possibly financially constrained in each period. It is based on work by Kaplan and Zingales (1997) from the corporate finance literature, in which the extent to which firms are constrained is ranked using detailed firm reports. The third method uses the intersection of the first two, i.e. a household is constrained if it is found to be in both the previous methods. The second step uses these results together with the asset and household demographic data in order to study the characteristics of the remittances received by households in the three sample villages, and to determine if they are targeted towards liquidity constrained households.

4.1 Identifying Liquidity Constrained Households using Euler Conditions

The analysis that we follow is based upon the work of Zeldes (1989) who uses first order Euler conditions from a permanent income hypothesis (PIH) model with exogenous liquidity constraints as his point of departure. Zeldes' model is (in effect) very similar to the buffer stock model used by Deaton (1989), and as such, we can think of its specification as being a special case of the risk sharing model discussed above with the intra-temporal remittance markets between households closed down. Zeldes' test is suitable for our purposes since we are interested in determining if *individual* households are liquidity constrained (as in a buffer stock model) so that we can observe if members of remittance networks target transfers to these households.

Our point of departure is to write down (a modified version of) the Euler equation for saving with liquidity constraints as in Seiler (1998b). This equates the marginal utility of consumption for household i in period t, $v'(c_{it})$, with the expected discounted marginal utility of consumption in the following period, i.e.

$$v'(c_{it}) = \mathrm{E}_t\{\beta_i(1 + r_{it+1})v'(c_{it+1})\} + \phi_t \tag{1}$$

where β_i is the constant discount factor, r_{it+1} the discount rate (averaged over the different types of asset accumulation), and ϕ_t is the Lagrangian multiplier on the borrowing constraint that is equal to zero if household i's asset holdings are positive, but is positive if they are zero. The (familiar) interpretation of this equation is as follows: the marginal utility of consumption today for a member of the network is equal to the expected discounted marginal utility of in the next period if its borrowing constraint does not bind (i.e. consume the same in both periods), but is greater if it does bind (i.e. consume less today).

To facilitate in developing the test we parameterize the utility function using a constant relative risk aversion (CRRA) functional form with preferences over adult equivalent consumption that we write as:

$$v(c_{it}) = \frac{(c_{it}/F_{it})^{1-\alpha}}{1-\alpha}\exp(\theta_{it}) \tag{2}$$

Here 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 use this specific functional form in order to ensure that our problem will be Gorman aggregable (see Townsend (1987)), and to follow Zeldes' (1989) and Morduch's (1993) derivations. Normalizing the

Lagrangian multiplier for the liquidity constraints, and substituting in functional form (2) we rewrite the above Euler necessary condition (1) as:

$$\frac{c_{it+1}^{-\alpha}F_{it+1}^{\alpha-1}\exp(\theta_{it+1})\beta_i(1+r_{it})}{c_{it}^{-\alpha}F_{it}^{\alpha-1}\exp(\theta_{it})}(1+\Phi_{it}) = 1 + e_{it+1} \tag{3}$$

where the normalized Lagrangian multiplier Φ_{it}, is calculated so that it is equal to

$$\Phi_{it} = \frac{\phi_{it}}{[E_t v'_{it+1}\beta_i(1+r_{it+1})]} \tag{4}$$

and e_{it+1} is the expectations error. It is assumed to have mean zero and to be orthogonal to all variables known at t. In a similar fashion to Zeldes and Morduch, we specify the taste parameter to be:

$$\begin{aligned} \theta_{it} &= b_0\text{age}_{it} + b_1\text{age}_{it}^2 + b_2\text{education}_{it} + \\ &\quad + b_3\text{marital status}_{it} + b_4\text{sex}_{it} + \omega_i + \eta_t I_i + \epsilon_{it} \end{aligned} \tag{5}$$

where ω_i is a fixed household effect, η_t is a time effect common to all households in a given village, I_i is a village indicator, and ϵ_{it} is an orthoganol error term. Taking logs, substituting in for θ_{it} and capturing the effect of the constant parameter β_i in a household dummy k_i, leads to the following equation:[13]

$$\begin{aligned} \log(\frac{c_{it+1}}{c_{it}}) &= \frac{1}{\alpha}k_i + \frac{\alpha-1}{\alpha}\log(\frac{F_{it+1}}{F_{it}}) + \frac{1}{\alpha}[\log(1+r_{it}) + 2b_1\text{age}_{it} + \\ &\quad + (\eta_{t+1}-\eta_t)I_i + (\epsilon_{it+1}-\epsilon_{it}) + \log(1+\Phi_{it}) - \log(1+e_{it+1})] \end{aligned} \tag{6}$$

Finally, adding a village dummy k_t, to account for the difference $(\eta_{t+1}-\eta_t)$, and the log of income Y_{it} as a regressor, leads to the estimating equation:

$$\log(\frac{c_{it+1}}{c_{it}}) = k + \frac{1}{\alpha}k_i + k_t + \frac{\alpha-1}{\alpha}\log(\frac{F_{it+1}}{F_{it}}) + \frac{1}{\alpha}\log(1+r_{it}) + \frac{2b_1}{\alpha}\text{age}_{it} + \Omega\log(Y_{it}) + \nu_{it} \tag{7}$$

where

$$\nu_{it} = \frac{1}{\alpha}\log(1+\Phi_{it}) + \frac{1}{\alpha}[(\epsilon_{it+1}-\epsilon_{it}) - \log(1+e_{it+1}) - E_t[-\log(1+e_{it+1})]] \tag{8}$$

or, $\nu_{it} = \frac{1}{\alpha}\log(1+\Phi_{it}) + \frac{1}{\alpha}w_{it}$. Before continuing we need to discuss the inclusion of the log of income in our estimation equation. This is used as an overidentifying restriction in the test, and is based on Hall (1978) who incorporated Lucas' (1976) rational expectations argument that consumers utilize all available information when making consumption decisions. The basic argument (for our purposes) is as follows: if consumption at time t and other right-hand-side variables of equation (6) incorporate all information about the well being of households at that time, then inclusion of other period t variables should have no additional explanatory power. However, if we have liquidity constrained households it follows that consumption growth from t to $t+1$ will be affected by the income of the liquidity constrained households at time t, when a bad shock hits. Therefore, the coefficient on the log of income can be interpreted as a reflection of the measure of the borrowing constraints. Econometrically speaking, it will only be significant if it picks up the effects of the Lagrangian multiplier Φ. If household i is liquidity constrained, then $\Phi > 0$, *and,* the income for that period matters for consumption. Hence Y_{it} will be correlated with Φ

[13]In order to simplify the estimation equation we follow Morduch (1993) and assume that the education of the family head is completed before the sample period. We also assume that the marital status and age are constant for a given household head throughout the sample period.

which is in the error term ν_{it}, and as such Ω will be significant when this happens. When estimating (7), the log of income is interacted with dummies for the land class categories. This is done since we expect that households with higher amounts of land are less likely to be liquidity constrained. (This follows the methodology of Morduch (1993) to split the sample into groups that are more or less likely to be constrained). We also correct for heteroskedasticity when estimating (7) by using the White procedure of robust standard errors (see Greene (1993)).

The results of this estimating equation (7) will give us an estimate of which land classes in which villages (and also which land classes from the pooled sample) pass the PIH and which do not. Those that do not pass we assume to be liquidity constrained (see Hayashi (1987) for a discussion on this). It is also possible to determine which households are liquidity constrained, and in which periods. Morduch (1993) does this by estimating the consumption growth for households that belong to land classes that appear to have liquidity constraints that are *not* binding. Then using these coefficients he calculates the predicted value of consumption growth for the constrained households and subtracts this from their actual consumption growth. If the result is positive then the household is assumed to be constrained in that period. The intuition behind this exercise that Morduch performs is as follows: if we assume that a household is liquidity constrained in period t, then its consumption will be bounded from above by the amount of financial assets it owns. Therefore, c_{it} will be lower than if the household was not liquidity constrained. In the next period, after income is realized (after the harvest) consumption can return to the desired level, and we will see a large growth in consumption. Thus, if we see that the growth in actual consumption is greater than the growth in consumption using the estimates from the non-constrained land classes we determine that the household was borrowing constrained in period t.

We choose not to follow Morduch's procedure for two main reasons. First, Seiler (1998a) finds that there are different behavioral patterns between land classes, and imposing the results from one land class upon another may well include large errors that make our results non-realistic.[14] Second, in order to be able to run the above procedure Morduch takes steps to correct his data. Specifically, he uses instruments for his variable that captures the extent of the liquidity constraints. The instruments he uses are initial holdings of jewelry, consumer durable goods, buildings, stocks and land. We do not follow this instrumental variable procedure since we want to avoid using the stock data in this paper due to the transaction "flow" data not corresponding with the annual "stock" data (as discussed in an earlier footnote).[15]

4.2 Identifying Constrained Households using Transaction Data

The methodology used above ("Method I") to identify financially constrained households has a few drawbacks. First, we can only determine in a satisfactory fashion which land classes in the ICRISAT data are constrained, and as such we do not know which *individual* households are constrained, and in which periods. Second, there may be other reasons that the households do not pass the overidentifying restriction tests for the PIH (as discussed by Hayashi (1987)), and as such may not particularly be liquidity constrained. Therefore, we also follow a second methodology (labeled "Method II") to determine if a

[14] In fact we did run the above procedure but found some results that make us wonder if this theoretical procedure is what is really going on in the data. For example, for the pooled annual data we find that three out of four land classes are liquidity constrained by running (7), but by running the above procedure we find that we receive only one observation of a household being constrained.

[15] Other studies have shown (for example Cox and Jimenez (1992) who look at transfers in a developing country) that transfers are often targeted towards households with land and buildings, so without these discrepancies we may well have wanted to use this data in our empirical work.

household is constrained. This is based on Kaplan and Zingales (1997) who rank the extent to which firms are financially constrained by studying qualitative and quantitative information from annual firm reports and financial statements.

The detailed information that we examine (in Method II) comes from the household level data (as opposed to Kaplan and Zingales' firm level data) from the ICRISAT transaction files. Using these data we determine that a household is possibly constrained if it is running a deficit but does not borrow to finance it. The deficit measure we build for this purpose is similar to the one defined by Lim and Townsend (1998). It is defined as the gap between household expenditures and revenues in a given period, and is identically equal to the sum of the components that finance it in that period, i.e. the net sale of real capital assets, the net sale of crop inventory, the reduction of cash balances, net nominal borrowing and the net remittances received by a household.

This measure acts as an indication of possible constraints in that it includes households that do not borrow because they are unable to do so. However, these households only constitute a subset of those who do not borrow since we also include in this category households who freely choose not to borrow to finance their deficits, but instead, choose to finance them using the other available instruments. As such, we use this method (Method II) as a "broad" measure of liquidity constraints. In order to finesse it (or, "narrow it down"), we also define a third measure that is the intersection of the first two. That is, we define a household to be liquidity constrained in a specific time period if it belongs to a land class that is constrained according to the Euler overidentifying method, *and* is possibly constrained according to the broad measure using the second method. (We label this "narrow" measure "Method III").

4.3 Characterizing Remittances

We now describe how we implement the implications of Seiler's (1998b) risk sharing model that we discussed in Section 2. Our aim is to empirically examine the relationship between the remittances received by village households, with their income and asset accumulation, and their observable demographic characteristics that are available to us from the ICRISAT data. Unfortunately (as we mentioned in the introduction) we lack information on the households' remittance partners, so we cannot include their earnings and asset accumulation in our estimation equation. Following Lund and Fafchamps (1997) we account for these unobserved partner characteristics by including village/household and time dummies in the specification. Since the relationship between the unobserved partner characteristics and these dummies is not exact we thus introduce a source of error into the estimation.[16] Another possible source of error that is present is from the mis-measurement of the remittances received by a household in a given period. We assume that the error term in our regression specification is normally distributed with an independent and identical distribution across villages/households and time, and has a zero mean.

The first independent variable we include in our specification is d. This is used to indicate liquidity constraints, so that we can test if remittances are targeted towards liquidity constrained households. In the first set of regressions we run (that use the Zeldes (1989) methodology (Method I)) these are dummy variables equal to one for liquidity constrained *land classes*. In the second set of regressions (that use the Kaplan and Zingales (1997) methodology (Method II)) these are dummy variables equal to one if a

[16] Seiler (1998b) gives an exact theoretical relationship for the remittances received by a household that he calls "The Remittance Equation." However, this theoretical relationship includes information on *all* the network households, and thus, by replacing the partners' data with the village/household and time dummies we introduce the fore-mentioned estimation error.

household is running a deficit in a given month and does not use credit to finance its deficit. For the annual data these are aggregated up (over the months in that year) to give a measure of the number of months in the year that the household ran a deficit but did not borrow. In the third set of regressions (for Method III) we multiple the dummy variable values from the previous two methods together, receiving a narrow liquidity constraint dummy measure.[17]

The four categories for the asset accumulation - the net increase in stock inventory, the net increase in financial assets, the purchase of physical assets, and net increases of money holdings - are denoted in the matrix S. It is important to note at this point that the asset accumulation variables are endogenous, and as such we would like to be able to estimate their coefficients using instrumental variable methods. However, suitable instruments are not readily available.[18] We therefore make use of Seiler's (1998b) simulated data regression results, in which he uses the savings from the last period as well as the exogenous simulated shocks as instruments. The results for his ordinary least squares and two-stage least squares regressions are similar in that the signs and magnitudes of the coefficients are robust between the two regression procedures. Thus, we run the regressions in this paper without instruments, using the specification as Seiler's model dictates, with the knowledge that our worries about the endogeneity problems are reduced by the robustness of Seiler's simulated data results.

In order to complete the regression specification we include matrix H, that includes the age, age-squared, sex, education and marital status of the head, and an age-sex corrected measure of the size of the household. H also includes the income (net of remittances) of the household, and the village/household/time fixed effects mentioned above. We thus write our regression specification that we are to estimate as follows:

$$z = \beta d + \phi S + \gamma H + u \tag{9}$$

where z is an unobservable vector (that we will shortly explain), and u are the normally distributed disturbances, that we assume are independently and identically distributed with zero mean.

We run two cases of the regression: a probit and a tobit. The former determines the likelihood of receiving a transfer, and the latter the transfer amount. The tobit regression is the logical type of regression to run (versus ordinary least squares) since we may have observations where remittances are not sent due to the possible transaction costs involved, and as such are censored. Since we are interested in determining the characteristics of remittances received we censor the remittance observations left of zero.

We first explain the probit regression for the above regression specification (9). In practice, z is unobservable. What we observe is a dummy variable t defined as follows:

$$\begin{aligned} t &= 1 \qquad \text{if } z > 0 \\ t &= 0 \qquad \text{otherwise} \end{aligned} \tag{10}$$

i.e. for a recipient, $t = 1$ if the net transfer received is positive, otherwise it is zero. Using this together with (9) it follows that:

$$Prob(t = 1) = Prob(u > -\beta d - \phi S - \gamma H) = 1 - F(-\beta d - \phi S - \gamma H) \tag{11}$$

[17] We call it a "narrow" measure since it has to satisfy *both* the previous two methods for being constrained in order to be considered so in this case.

[18] We have experimented using lagged asset accumulation, but the first stage regressions in the two-stage least square regressions have very small R-squared values, leading to very large standard errors in the second stage regressions. We are also skeptical about the use of the ICRISAT stock data (as already mentioned in our reluctance to follow Morduch's (1993) procedure for instrumental variables to determine which households are liquidity constrained).

where F is the normal cumulative distribution function for u. Thus, we can estimate the vector of parameters (β, ϕ and γ) upto a constant of proportionality using probit maximum likelihood estimation.

In order to look at transfer amounts we use a tobit regression since (as mentioned above) the transfer amount is censored at zero. For net recipients of transfers the tobit model is defined as follows:

$$\begin{aligned} T &= \beta d + \phi S + \gamma H + u \quad \text{if } z > 0 \\ T &= 0 \qquad\qquad\qquad\qquad \text{otherwise} \end{aligned} \tag{12}$$

Here T is the net amount received by the household.

In running the probit and tobit regressions we expect (using the results of the model) that if transfers are targeted towards liquidity constrained households then the coefficient β will be positive and significant. We also expect that the coefficient on income will be negative. A positive coefficient on any of the four forms of asset accumulation will indicate that households who are net remittance receivers are more likely to accumulate this particular asset over time (probit results), and increase accumulation as net remittance receipts increase (the tobit results).

5 Results

The results that we discuss are divided into two subsections. In the first of these we examine which households are liquidity constrained. We first report the results from the overidentifying restriction methodology (Method I), using the the growth in food consumption (following Zeldes (1989) and Morduch (1993)) as the dependent variable in our analysis. Following this, we discuss the results for Method II, that determines that a household is possibly constrained in a given time period if it runs a deficit during that period but does not borrow to finance it, and finally, we analyze the results for the intersection of the first two methods (Method III). In the second subsection we discuss the link between liquidity constraints, asset accumulation, observable characteristics and remittances. All the results are discussed for both annual and monthly data.

5.1 Identifying Liquidity Constrained Households

Method I: Annual Data. Using the specification of equation (7) we run ordinary least squares regressions with White standard errors. We do this both for the pooled sample (all three villages), and for the villages separately. The weighted interest rates are calculated as the average interest rate that a household has to pay for borrowing. These are weighted by the size of the loans taken. If a household did not take any loans during the crop year, we use the imputed value of the average interest rate for households in that land class and village. The interest rates are gross rates (i.e. one plus the interest rate). The results for the regressions can be seen in Table 2. As expected, all the signs for the overidentifying restriction - log income - are negative. The intuition for such a result is as follows: if there are liquidity constrained households within a land class at time t, an increase in contemporaneous income will relax the borrowing constraint *ceteris paribus*, and consumption will also increase in the current period (t). As a result consumption will grow less from t to $t+1$.

For the pooled sample we find that the landless laborers, small farmers and medium farmers appear to be constrained, but the large farmers are not. In Aurepalle and Shirapur only the landless are constrained (we also find that the large farmers are in Shirapur, at a 10% significance level). In Kanzara only the small farmers are. These results are not surprising in that we expect to find that the poorer land classes will be (in general) more likely to be liquidity constrained than the richer ones. In fact, this is the criterion that several authors have used in order to split their samples (e.g. Hayashi (1985) and Zeldes (1989)).[19]

Method I: Monthly Data. We also run the same regressions using the monthly data. We report the results in Table 3. We find that all the land classes are constrained for the pooled village sample, and for the village of Aurepalle. In Shirapur the landless laborers, the medium farmers and the large farmers are all constrained, but the small farming land class is not. In Kanzara only the small farmers are constrained at the 5% significance level, but the medium and large farmers are also constrained at the 10% significance level. We note that Lim and Townsend (1998) report that all the land classes are constrained in all the villages, and in the pooled sample.[20]

Since we are interested in empirically testing if transfers are targeted towards liquidity constrained households, we would be interested in obtaining some heterogeneity across the land classes in our results for the pooled village sample and for Aurepalle. We therefore perform an exercise where we limit ourselves by only using the data from the peak season months. The reasoning behind this strategy is as follows: Chaudhuri and Paxson (1994) find that due to the seasonal nature of the income in the ICRISAT villages, households are less likely to be liquidity constrained in the months with higher income (following the harvest), than during the months with relatively lower incomes. To carry out the exercise we follow Jacoby and Skoufias (1998) and define the peak season for the villages as October through March (the other six months - April through September - Jacoby and Skoufias label as "slack" months). The results for the exercise are interesting, even though we (unfortunately) do not obtain any heterogeneity across the land classes in the pooled sample or in Aurepalle (we note however that the small farmers were only constrained at a 4.8% significance level in Aurepalle). For Shirapur we now find that only the landless laborers are constrained - i.e. the medium and large land holding land classes that were constrained for the monthly data using the whole year are now not constrained for the peak season months. We also note that this result for Shirapur is the same as we received for the annual data. In Kanzara we now find that only the large farmers appear to be constrained versus the result that only the small farmers were constrained before.

Method II. The results for the whole sample with annual data show that on average, households are constrained for 3.98 months in the year (i.e. for almost one-third of the year). The village of Kanzara has the highest measure (4.19), although this is driven by the small land class households that are constrained for 4.45 months a year on average.[21] Overall, for the pooled sample, the large land class is constrained the least (3.78 months/year). The results for the monthly data show that 37.8% of households (on average)

[19]It is interesting to compare the results here with those of Morduch (1993). Morduch used ICRISAT prepared data files. We do not do this, but created income, consumption and interest rate data from the transaction and the credit and debt schedules. We obtain the same results regarding the significance of the land class income variables for the pooled sample. In Aurepalle, Morduch also found that the small and medium farmers were constrained, in Shirapur that the small were, and in Kanzara that no land class was. We also draw attention to the fact that Lim and Townsend (1998) report that all land classes are constrained in Shirapur, but none are in Aurepalle and Kanzara. The difference between Lim and Townsend and our results is that they use contemporaneous land classes whereas we follow Morduch and use the modal land classes. When we run our regressions with the contemporaneous land classes we receive the same results as Lim and Townsend. It is interesting to note the sensitivity of these results to the specification used.

[20]Again this difference arises from their use of the revised land class data, whereas we use the original land class data.

[21]It is interesting to note that this land class was also the only one constrained in Kanzara for the previous methodology (Method I).

are constrained in a given month. This is highest in Shirapur (39.5%) - driven by the medium land class (44.7%). Overall, for the pooled sample the landless laborers and the medium farmers are constrained the most (37.6% and 40.1% respectively).

Method III. The results for the whole sample with annual data show that on average, households are constrained 1.13 months in the year (this number represents the average number of months in a year that households are constrained *both* by Method I (27.6% of the households) and by Method II). For the monthly data we find that 26.5% of the households (on average) are constrained in a given month.

Our next stage is to make use of these results (pertaining to liquidity constrained households as reported in Tables 2 and 3 for Method I, and also those obtained with Method II and III) by including them in regressions that examine the characteristics of net transfer receipts in the ICRISAT villages.

5.2 Characteristics of Remittances

Annual Data. Using the whole sample pooled over the three villages we run probit and tobit regressions according to the specification discussed in Subsection 4.3. The results for these regressions can be seen in Table 4.

Looking at the probit regression for Method I we see that the coefficient on the liquidity constrained dummy is positive, i.e. the likelihood of receiving remittances in constrained households is greater than in non-constrained ones. However, the coefficient is not significant. This result is reversed is the probit regressions for Methods II and III in which the coefficient is both positive and significant. The coefficient on income (net of remittances) is negative and significant in all the probit regressions. This is expected under the informal insurance motivation for remittances, since we expect remittances to be sent to households who suffer negative shocks. Inspecting the effects of different types of household asset accumulation for the three probit regressions, we see that the coefficients for the accumulation of currency holdings (net of remittances received), physical assets purchased, financial savings are all positive. It is also interesting to note that the likelihood of receiving remittances has no effect on the accumulation of stock inventory saving. From the results of Seiler's (1998b) model we also expect to find a positive correlation between asset accumulation (overall) and remittances - which we do,[22] but the decomposition of the overall intertemporal consumption smoothing into the four types of accumulation that we are investigating is of central importance because it adds to our understanding of rural household behavior by uncovering very interesting patterns of behavior for the ICRISAT data.

The tobit regressions show similar results for transfer amounts, i.e. that they are sent more to liquidity constrained households for Methods II and III but not for Method I, that they are inversely related to income, and that they are positively related to the accumulation of currency, physical assets, and financial assets. The tobit regressions also show that the weighted family size measure is positive and significant. This is of interest since it implies that the coefficient of relative risk aversion is greater than one in the ICRISAT villages (using the setup of Seiler's (1998b) model), a finding that is of importance for the theoretical modeling of village economies.

In Table 5 we see the results of the regressions for Aurepalle. We observe that remittances appear to be

[22]The Chi-square value (with 4 degrees of freedom) to test that the asset accumulation (overall) is positive for the Method I probit is 39.77 (p-value=0.0000) and for the Method II and III probits we also receive p-values equal to 0.0000.

targeted towards liquidity constrained households in this village for all the Methods (I, II and III). That is, as opposed to the pooled sample we find clear evidence (versus mixed evidence) of remittances being targeted to liquidity constrained households for the annual data in Aurepalle. We also see that remittances are negatively related to income, and positively related to money and physical asset accumulation both for the probit and tobit estimation methods. The interesting difference to the pooled sample is that financial asset accumulation is not significant in the tobit regressions, i.e. there is no significant correlation between this type of asset accumulation and net transfer amounts received. However, we see that inventory stock accumulation is positively and significantly correlated to transfer amounts in Methods I and III. We also see that households with married heads are more likely to receive remittances (for all three methodologies). Finally, for Methods II and III we see that as education levels increase, the likelihood of receiving remittances decreases.

Finally, we briefly summarize the results for Shirapur and Kanzara. In Shirapur (as opposed to Aurepalle) we find there is no evidence of transfers being targeted towards liquidity constrained households for any of the three methods. We find that the income variable is negative and significant in all the regressions. With respect to asset accumulation, we find that all of the asset accumulation mechanisms have positive and significant coefficients *except* for stock inventory that is significant neither in the probit nor in the tobit regressions. We find that education is positive and significant in the tobit regressions (for Method II at 10% only), and that the weighted household size is positive and significant in all the regressions. Thus, we can say that the coefficient of relative risk aversion is greater than one in this village (that we cannot do for Aurepalle). In Kanzara the coefficients on the liquidity constraint variables are not significant. We find that transfers are negatively related to income, and are the likelihood of receiving them is positively related to money holding accumulation. The other three forms of asset accumulation are not found to be significant in the probits. This is interesting because we see a clear difference in the correlations between remittance receipts and asset accumulation patterns across the three villages. The net remittance amounts (i.e. from the tobit regressions) received are positively corellated to all the four types of asset accumulation.

Summing up the annual data results we find the following: First, that there is no conclusive evidence that transfers are targeted towards liquidity constrained households, except in Aurepalle (in the pooled sample we find mixed evidence - that there is targeting for Methods II and III but not for Method I). Second, as predicted by the risk sharing model, remittances are inversely related to household income. Third, as predicted by the theory, remittances are positively related to asset accumulations in all three villages. However these differ across villages, but we see that positive money holding accumulation is significant in all the villages, and inventory stock accumulation is only significant when related to remittance amounts in Aurepalle and Kanzara.

Monthly Data. We implement the same methodology for the monthly data as for the annual data, examining the results for the pooled sample first, and afterwards discussing the results for Aurepalle, Shirapur and Kanzara separately. The results for the pooled village sample can be seen in Table 6. Since we did not receive any heterogeneity across the land classes regarding liquidity constraints in the overidentifying restriction regressions (for the pooled sample) we run the regressions without this regressor for Method I. This also means that the liquidity constraint regressor is identical for Methods II and III (since III is the intersect of Methods I and II), and therefore, so are the regression specifications for them.

As such, we report their results jointly in the table. For Method II (and hence III) we see that the liquidity constraint dummy variables are positive and significant. The results also show that income is inversely related to remittances. In reference to asset accumulation, for the probits we receive the same results as for the annual data for the pooled village sample. These are that the likelihood of receiving net remittances is positively related to the accumulation of currency holdings, physical assets and financial assets, but are not related to the build up of stock inventory. The tobit regressions give us that all four types of asset accumulation are positive and significant. Examining the household characteristic variables, we see that net remittances are being received by households with better educated heads, and remittance amounts received increase in larger families.

Table 7 shows the results for Shirapur.[23] We note three things. First, we see that net remittances are not particularly allocated to constrained households for Method I, but are for Methods II and III (recall that we found no evidence of targeting for the annual data). Second, we see that remittances are positively related to asset accumulation for all four components in the probits and also in the tobits, and third, with regard to household characteristics, we see that income is inversely related to remittances, the likelihood of remittances being received is positively related to the age and education of the household head, and negatively related to the age-squared, the sex and the marital status of the head,[24] and that remittance amounts have the same characteristics as the likelihoods regarding demographics, except we add that age-squared is only significant at 10% for Methods I and III.

In Aurepalle (running the regressions without the liquidity constraint regressors for Method I) we see that remittances are targeted to liquidity constrained households (for Methods II and III) for the probit but not for the tobit. We also see that income is negatively related to remittances received, that the accumulation of currency, financial assets and physical assets are positively related to remittances, and that the weighted household size is positively related to them in all the regressions. The regressions for Kanzara show that the liquidity constraint dummy variable is significant only for the tobit regression for Method II, the coefficients on income are negative and significant, the coefficients on all the assets are positive and significant, as are the coefficients on the education of the head variable. The tobits also show that households with married heads receive higher net remittances.

We also rerun the regressions for Shirapur and Kanzara (for Method I only) using the land classes that were found to be liquidity constrained, restricting ourselves to the peak season months. The results are similar to those described above, except we note the important result that remittances are allocated to liquidity constrained households in Kanzara.

Thus, summing up the results for the monthly data we find that there is mixed evidence that remittances are targeted towards liquidity constrained households. It appears that they may be in Aurepalle (although we do not have results - either for or against - for Method I)and in Shirapur (for Methods II and III, but not for I). They are not targeted to liquidity constrained households in Kanzara. We also see a positive relationship between various types of asset accumulation and remittances (as in the annual data), but the patterns vary across the villages. Finally, we note that remittances are positively related to the education level of the head in Shirapur and Kanzara.

[23]We show Shirapur in detail (as opposed to Aurepalle as in the annual data) since we do not receive heterogeneity across land classes regarding liquidity constraints in Aurepalle for Method I.

[24]That is, they are allocated to households with female and non-married heads.

6 Conclusions

In this paper we have examined the importance of remittances in the ICRISAT villages from a risk sharing perspective (that is, as an intra-temporal mechanism to smooth consumption) by implementing the empirical implications of Seiler's (1998b) framework (that integrates the risk sharing and buffer-stock literatures). Specifically, we have examined the relationships between remittances and inter-temporal smoothing mechanisms (i.e. financial assets and liabilities (borrowing and saving), money holdings, stock inventory, and purchase and sale of physical assets), and between remittances and observable household demographic characteristics, and have also investigated whether remittances are targeted within networks of remittance partners to liquidity constrained households.

Our results show that there is a negative relationship between remittances and income in all the villages, thus lending support to the risk sharing hypothesis. However, the results are less decisive and suggest mixed evidence as to whether remittances are targeted to liquidity constrained households. We find evidence that they are targeted in Aurepalle, are not in Kanzara, but are unable to infer if they are in Shirapur or for the pooled sample (i.e. for all three villages together) since we find evidence both for and against in these cases. These results differ from those for developed countries (e.g. Cox's (1990) sample for households in the United States) for which authors have generally found evidence of targeting, and thus they suggest that we may need to think about transfer targeting issues in a different light for less developed countries (LDC). One possible way to do this is to employ "high frequency smoothing" agricultural cycle models (as Seiler (1998b) does) instead of lower frequency life-cycle models (more suited to developed countries), following Deaton's (1989) recommendations concerning the analysis of LDC household saving and consumption behavior. Our findings are also of importance due to their policy implications. For instance, credit agencies that can target loans to liquidity constrained households may not particularly "crowd out" informal loans and remittances in Kanzara, but may well do so in Aurepalle.

Our results also imply that there is a positive relationship between the remittances received by a household and its contemporaneous accumulation of assets, although the patterns differ from village to village. We find that all villages accumulate cash holdings (net of the remittances), but there is a smaller effect of remittances on the accumulation of stock inventory. Savings have long been associated with transfers and hence remittances (as in Barro (1974)), and in light of our findings for the ICRISAT villages, we suggest that the *type* of saving may also be of importance due to the differing patterns we find. As such, the effect of saving and credit programs in LDCs on *each* saving vehicle should taken into account when such programs are designed and implemented.

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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. Euler Equation Estimates for Crop Years 1976 to 1981, using Annual Data.

Independent Variable	All Villages	Aurepalle	Shirapur	Kanzara
Log Laborer Income	-0.694	-0.705	-0.564	-0.016
	(-5.688)**	(-4.405)**	(-3.120)**	(-0.104)
Log Small Farm Income	-0.201	-0.205	-0.173	-0.164
	(-3.110)**	(-1.324)	(-1.346)	(-2.604)**
Log Med. Farm Income	-0.136	-0.045	-0.184	-0.034
	(-2.041)**	(-0.659)	(-1.481)	(-0.210)
Log Large Farm Income	-0.258	-0.030	-1.316	-0.024
	(-1.610)	(-0.300)	(-1.963)*	(-0.175)
Growth of Adult Equivalent Family Size	0.323 (1.955)*	0.119 (0.673)	0.385 (0.998)	0.349 (1.519)
Age of Household Head	-0.3e-3	0.003	-0.081	-0.028
	(-0.073)	(1.024)	(-2.074)**	(-1.386)
Log Weighted Interest Rate	-0.052 (-2.739)**	-0.053 (-0.718)	0.015 (0.282)	-0.025 (-0.628)
Constant	2.643	1.814	8.698	1.652
	(5.076)**	(2.680)**	(3.425)**	(1.500)
Observations	383	146	126	111
R-squared	0.29	0.48	0.43	0.61

Notes: The dependent variable is the growth in food consumption.

Equations are estimated with household and time fixed effects.

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

Table 3. Euler Equation Estimates using Monthly Data.

Independent Variable	All Villages	Aurepalle	Shirapur	Kanzara
Log Laborer Income	-0.302 (-7.144)**	-0.298 (-4.135)**	-0.243 (-4.326)**	-0.117 (-1.590)
Log Small Farm Income	-0.149 (-4.840)**	-0.171 (-2.673)**	-0.060 (-1.384)	-0.124 (-2.408)**
Log Med. Farm Income	-0.157 (-5.637)**	-0.241 (-5.118)**	-0.102 (-2.260)**	-0.071 (-1.705)*
Log Large Farm Income	-0.196 (-6.611)**	-0.277 (-5.259)**	-0.195 (-3.710)**	-0.060 (-1.660)*
Growth of Adult Equivalent Family Size	0.337 (2.939)**	-0.002 (-0.011)	0.250 (1.082)	1.009 (4.828)**
Age of Household Head	0.001 (0.300)	0.001 (0.133)	0.545 (6.930)**	-0.353 (-6.542)**
Log Weighted Interest Rate	-0.006 (-0.407)	-0.074 (-1.545)	0.036 (1.282)	0.012 (0.309)
Constant	1.149 (3.653)**	1.530 (4.394)**	-26.132 (-6.750)**	16.529 (6.934)**
Observations	3820	1450	1229	1141
R-squared	0.14	0.20	0.20	0.26

Notes: The dependent variable is the growth in food consumption.

Equations are estimated with household and time fixed effects.

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

Table 4. Probit and Tobit Estimates of Net Transfers Received in Whole Sample using Annual Data.

Independent Variable	Method I Probit	Method I Tobit	Method II Probit	Method II Tobit	Method III Probit	Method III Tobit
Liquidity Constrained	0.163	174.068	0.116	117.870	0.089	80.168
	(0.691)	(0.845)	(3.152)**	(3.884)**	(2.638)**	(2.825)**
Income	-0.2e-3	-0.205	-0.2e-3	-0.202	-0.2e-3	-0.199
	(-5.172)**	(-10.134)**	(-5.223)**	(-10.795)**	(-4.910)**	(-10.473)**
Currency Accumulation	0.5e-3	0.723	0.5e-3	0.722	0.5e-3	0.732
	(6.195)**	(19.426)**	(6.109)**	(19.833)**	(6.018)**	(19.710)**
Financial Accumulation	0.3e-3	0.586	0.3e-3	0.578	0.3e-3	0.593
	(4.326)**	(16.641)**	(4.112)**	(16.774)**	(4.254)**	(16.902)**
Inventory Accumulation	0.6e-4	0.011	0.7e-4	0.011	0.6e-4	0.012
	(1.418)	(1.434)	(1.468)	(1.560)	(1.443)	(1.578)
Phys Asset Accumulation	0.3e-3	0.573	0.4e-3	0.577	0.3e-3	0.581
	(5.147)**	(15.644)**	(5.022)**	(16.075)**	(4.977)**	(15.939)**
Age	0.046	12.267	0.044	5.717	0.036	2.267
	(0.800)	(0.270)	(0.748)	(0.129)	(0.627)	(0.050)
Age-Squared	-0.3e-3	0.013	-0.3e-3	0.068	-0.2e-3	0.114
	(-0.601)	(0.030)	(-0.560)	(0.155)	(-0.427)	(0.257)
Sex	-0.390	59.96	-0.221	156.867	-0.196	154.890
	(-0.773)	(0.137)	(-0.446)	(0.369)	(-0.393)	(0.355)
Education	0.019	115.133	-0.014	69.640	-0.027	112.859
	(0.231)	(1.761)*	(-0.161)	(1.099)	(-0.320)	(1.771)*
Married	-0.374	-100.653	-0.229	1.506	-0.264	43.215
	(-0.904)	(-0.287)	(-0.556)	(0.004)	(-0.646)	(-0.125)
Weighted Family Size	0.059	135.887	0.046	121.202	0.058	135.220
	(1.193)	(3.563)**	(0.940)	(3.245)**	(1.178)	(3.583)**
Constant	-0.938	-1408.895	-1.090	-1366.099	-0.500	-614.853
	(-0.676)	(-1.273)	(-0.757)	(-1.276)	(-0.364)	(-0.562)
Recipients	192	192	192	192	192	192
Observations	395	395	395	395	395	395
R-squared	0.31	0.09	0.33	0.09	0.32	0.09

Notes:

1. The dependent variable in the probits is 1 if the net transfers received is positive, otherwise it is 0. In the tobits it is the amount when the net amount received is positive, otherwise it is zero.
2. Equations are estimated with village and time fixed effects.
3. T-values are in parentheses. A star indicates significant at 10%, two stars at 5%.
4. For the sex variable, male=0 and female=1.

Table 5. Probit and Tobit Estimates of Net Transfers Received in Aurepalle using Annual Data.

Independent Variable	Method I Probit	Method I Tobit	Method II Probit	Method II Tobit	Method III Probit	Method III Tobit
Liquidity Constrained	1.316	155.739	0.288	40.559	0.581	38.154
	(3.199)**	(2.638)**	(2.523)**	(3.655)**	(5.635)**	(3.719)**
Income	-0.3e-3	-0.058	-0.4e-3	-0.066	-0.3e-3	-0.061
	(-2.641)**	(-2.696)**	(-3.898)**	(-3.096)**	(-2.510)**	(-2.890)**
Currency Accumulation	0.6e-3	0.136	0.8e-3	0.166	0.6e-3	0.143
	(2.569)**	(3.214)**	(2.715)**	(3.774)**	(2.513)**	(3.429)**
Financial Accumulation	0.4e-3	0.037	0.6e-3	0.063	0.5e-3	0.044
	(2.165)**	(1.012)	(2.210)**	(1.657)*	(2.150)**	(1.209)
Inventory Accumulation	0.2e-4	0.036	0.2e-3	0.032	0.2e-3	0.041
	(1.658)*	(2.132)**	(1.684)*	(1.956)*	(1.903)*	(2.445)**
Phys Asset Accumulation	0.6e-3	0.107	0.8e-3	0.130	0.7e-3	0.114
	(2.634)**	(2.262)**	(2.372)**	(2.695)**	(2.568)**	(2.388)**
Age	0.7e-3	10.768	0.012	5.884	0.074	10.698
	(0.005)	(0.537)	(0.094)	(0.307)	(0.454)	(0.551)
Age-Squared	-0.2e-3	-0.105	-0.2e-3	-0.054	-0.001	-0.107
	(-0.180)	(-0.566)	(-0.217)	(-0.303)	(-0.718)	(-0.592)
Sex	0.611	36.317	1.410	137.463	2.587	134.389
	(0.683)	(0.229)	(1.577)	(0.907)	(2.621)**	(0.861)
Education	-0.355	-48.479	-0.614	-82.120	-0.365	-49.926
	(-1.509)	(-1.008)	(-2.221)**	(-1.757)*	(-1.476)**	(-1.087)
Married	1.526	237.673	1.421	219.282	3.459	301.675
	(2.289)**	(1.716)*	(2.301)**	(1.743)*	(4.843)**	(2.230)**
Weighted Family Size	0.180	21.205	0.101	12.336	0.136	14.147
	(1.537)	(1.179)	(0.382)	(0.712)	(0.950)	(0.810)
Constant	1.045	-302.745	0.590	-223.140	-5.228	-666.770
	(0.276)	(-0.607)	(0.189)	(-0.475)	(-1.253)	(-1.376)
Recipients	54	54	54	54	54	54
Observations	145	145	145	145	145	145
R-squared	0.59	0.19	0.58	0.20	0.66	0.20

Notes:

1. The dependent variable in the probits is 1 if the net transfers received is positive, otherwise it is 0. In the tobits it is the amount when the net amount received is positive, otherwise it is zero.

2. Equations are estimated with village and time fixed effects.

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

4. For the sex variable, male=0 and female=1.

Table 6. Probit and Tobit Estimates of Net Transfers Received in the Pooled Sample using Monthly Data.

Independent Variable	Method I Probit	Method I Tobit	Method II/III Probit	Method II/III Tobit
Liquidity Constrained			0.272	104.322
			(4.470)**	(3.656)**
Income	-0.9e-3	-0.469	-0.9e-3	-0.463
	(-5.743)**	(-29.523)**	(-5.613)**	(-29.056)**
Currency Accumulation	1.4e-3	0.796	1.4e-3	0.793
	(6.339)**	(62.848)**	(6.276)**	(62.464)**
Financial Accumulation	1.4e-3	0.757	1.3e-3	0.752
	(6.013)**	(53.709)**	(5.941)**	(53.106)**
Inventory Accumulation	0.2e-4	0.015	0.3e-4	0.019
	(1.230)	(2.134)**	(1.533)	(2.750)**
Phys Asset Accumulation	1.4e-3	0.752	1.3e-3	0.749
	(6.154)**	(47.037)**	(6.096)**	(46.794)**
Age	0.001	-3.476	0.8e-3	-3.691
	(0.059)	(-0.429)	(0.037)	(-0.455)
Age-Squared	-0.6e-4	0.074	0.6e-4	0.075
	(-0.229)	(0.917)	(0.309)	(0.927)
Sex	-0.149	-37.806	-0.118	-23.010
	(-0.713)	(-0.409)	(-0.557)	(-0.247)
Education	0.118	47.233	0.113	45.142
	(4.237)**	(3.819)**	(4.041)**	(3.633)**
Married	-0.119	-47.686	-0.081	-32.244
	(-0.674)	(-0.635)	(-0.459)	(-0.427)
Weighted Family Size	0.022	20.191	0.019	19.346
	(1.368)	(2.729)**	(1.161)	(2.605)**
Constant	-1.304	-549.991	-1.407	-587.151
	(-2.457)**	(-2.700)**	(-2.646)**	(-2.877)**
Recipients	467	467	467	467
Observations	3932	3932	3932	3932
R-squared	0.22	0.16	0.23	0.16

Notes:

1. The dependent variable in the probits is 1 if the net transfers received is positive, otherwise it is 0. In the tobits it is the amount when the net amount received is positive, otherwise it is zero.
2. Equations are estimated with village and time fixed effects.
3. T-values are in parentheses. A star indicates significant at 10%, two stars at 5%.
4. For the sex variable, male=0 and female=1.
5. Method II and Method III are identical for these regressions, and as such are displayed in the same columns.

Table 7. Probit and Tobit Estimates of Net Transfers Received in Shirapur using Monthly Data.

Independent Variable	Method I Probit	Method I Tobit	Method II Probit	Method II Tobit	Method III Probit	Method III Tobit
Liquidity Constrained	0.079	23.808	0.388	92.893	0.301	72.724
	(0.615)	(0.608)	(3.499)**	(2.926)**	(2.694)**	(2.243)**
Income	-0.7e-3	-0.293	-0.6e-3	-0.283	-0.7e-3	-0.286
	(-4.438)**	(-14.078)**	(-4.181)**	(-13.461)**	(-4.235)**	(-13.587)**
Currency Accumulation	1.7e-3	0.662	1.7e-3	0.658	1.7e-3	0.659
	(6.863)**	(32.561)**	(6.935)**	(32.465)**	(6.877)**	(32.386)**
Financial Accumulation	1.3e-3	0.512	1.2e-3	0.500	1.2e-3	0.503
	(4.477)**	(24.002)**	(4.500)**	(23.167)**	(4.450)**	(23.250)**
Inventory Accumulation	0.4e-4	0.013	0.5e-4	0.015	0.5e-4	0.015
	(2.407)**	(2.515)**	(2.647)**	(2.934)**	(2.594)**	(2.834)**
Phys Asset Accumulation	1.3e-3	0.522	1.3e-3	0.513	1.3e-3	0.514
	(4.843)**	(26.113)**	(4.888)**	(25.529)**	(4.830)**	(25.526)**
Age	0.165	39.582	0.168	40.315	0.160	38.531
	(2.735)**	(2.178)**	(2.769)**	(2.203)**	(2.682)**	(2.117)**
Age-Squared	-1.4e-3	-0.336	-0.001	-0.348	-0.001	-0.327
	(-2.500)**	(-1.929)*	(-2.562)**	(-1.986)**	(-2.451)**	(-1.880)*
Sex	-1.141	-305.802	-1.045	-281.713	-1.015	-276.818
	(-2.391)**	(-2.352)**	(-2.153)**	(-2.164)**	(-2.093)**	(-2.119)**
Education	0.208	53.329	0.197	50.133	0.205	52.133
	(4.747)**	(4.282)**	(4.437)**	(4.006)**	(4.640)**	(4.173)**
Married	-1.266	-333.463	-1.151	-306.571	-1.138	-304.964
	(-2.868)**	(-2.879)**	(-2.552)**	(-2.648)**	(-2.537)**	(-2.627)**
Weighted Family Size	-0.013	4.322	-0.010	5.287	-0.018	3.278
	(-0.370)	(0.420)	(-0.299)	(0.533)	(-0.551)	(0.327)
Constant	-4.693	-1086.288	-5.053	-1093.082	-4.688	-1083.330
	(-3.487)**	(-2.709)**	(-3.753)**	(-2.693)**	(-3.525)**	(-2.698)**
Recipients	196	196	196	196	196	196
Observations	1238	1238	1238	1238	1238	1238
R-squared	0.30	0.17	0.31	0.17	0.30	0.17

Notes:

1. The dependent variable in the probits is 1 if the net transfers received is positive, otherwise it is 0. In the tobits it is the amount when the net amount received is positive, otherwise it is zero.

2. Equations are estimated with village and time fixed effects.

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

4. For the sex variable, male=0 and female=1.

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