SENDING HOME THE RICHES: INFORMAL RISK SHARING NETWORKS AND REMITTANCES

MELANIE MORTEN
MELANIE.MORTEN@YALE.EDU

Abstract. This paper asks the question: are remittances substitutes or complements to existing informal insurance provided by risk-sharing networks? Remittances may have two competing effects on informal risk-sharing networks: on one hand, remittances provides access to uncorrelated income processes which may insure the household and network against aggregate shocks. On the other hand, remittances may destroy social networks because the outside option of autarky becomes more attractive and a household who receives remittances may choose not to participate in a risk-sharing network. This is the question examined in this paper. I develop a theoretical model which generates a simple test based on the remittance response to exogenous aggregate and exogenous idiosyncratic shocks to identify whether a household who receives remittances is participating in a risk sharing network. I test this model on panel data from the ICRISAT villages in India, and find suggestive evidence that households who receive remittances participate in risk-sharing networks.
Keywords: Remittances, Risk-sharing, Panel model

1. Introduction

Farmers living in low-income countries face highly uncertain income realizations due to shocks, such as rainfall. Remittances, money sent to the household from either family or friends, are an important mechanism that may help a household to smooth income shocks. This paper asks the question: are remittances from migrants substitutes or complements to existing informal insurance provided by risk-sharing networks? Remittances may have two competing effects on informal risk-sharing networks: on one hand, remittances provides access to uncorrelated income processes which may be able to insure the household and network against aggregate shocks. On the other hand, the option of receiving remittances

Date: September 5, 2010.
Paper prepared for the 3rd International Conference on Migration and Development. Preliminary. Please do not cite. Thanks to Abhijit Banerjee, David McKenzie, Mark Rosenzweig, Chris Udry, and the participants at the Yale Development Lunch for helpful comments. Thanks also to Treb Allen, Camilo Dominguez, Snaebjorn Gunnsteinsson, and Yaniv Stopnitzky. Any remaining errors are of course my own.

may destroy social networks because the outside option of autarky becomes more attractive and a household who receives remittances may choose not to participate in a risk-sharing network. This is the trade-off analyzed in this paper. I develop a theoretical model which generates a simple test based on the remittance response to exogenous own income shocks and exogenous network shocks to identify, ex post, whether a household who receives remittances is participating in a risk sharing network. I test this model on panel data from the ICRISAT villages in India, and find suggestive evidence that households who receive remittances participate in risk-sharing networks.

Farmers living in low-income countries face highly uncertain income realizations due to shocks, such as rainfall. With standard assumptions on utility functions, households want to smooth consumption across periods and reduce consumption fluctuations. There is evidence that many individuals engage in informal risk-sharing networks, where transfers are given and received according to income realizations, to smooth income shocks. The first-best outcome is where each household receives a fixed proportion of total resources available in the network at one time: all idiosyncratic risk is pooled. However, if the risk-sharing network is geographically concentrated, such a network can smooth against idiosyncratic, but not aggregate, shocks. In empirical applications, less-than (but, close-to) full risk sharing is observed ([2], [11], [12]).

One way of gaining access to diversified income flows is for members of the household to migrate to another geographical area, and then send remittances back to the household in the village. In India, the main source of migration from villages is due to the migration of women due to marriage, which can be explained by risk-smoothing motives ([10]). Remittances have been shown in both India ([8]) and the Philippines ([13]) to respond to income shocks and have an insurance motive. If remittances to a household are then used to help the village or wider network smooth income shocks, remittances may be a way to increase the level of insurance against aggregate shocks for the network as a whole. However, it is possible that migration results in a break-down or reduction in insurance provided by informal risk-sharing networks: models of limited commitment ([6], [7]) predict that insurance decreases and informal insurance may be crowded out as the outside autarkic option of a household increases ([1]), which may be the case when the household has access to a stream of remittances.

The contribution of this paper is to look at the interaction between remittances and informal risk-sharing networks. I want to examine the effect of remittances on risk sharing networks after any decision to migrate has been made and then examine the question of whether, ex post, the household participates in the risk-sharing network [1]. If a household is not sharing risk with the network, but is receiving remittance flows that have an insurance motive, then remittances should increase when the household faces an income shock. In particular, it should only be the magnitude of the shock, and not the source of the shock (i.e. whether the shock is idiosyncratic or aggregate in nature), that should affect the remittances received. However, if the household is participating in a risk-sharing network then remittances may provide insurance for a network against aggregate shocks. In this case, remittances should respond more to aggregate shocks than idiosyncratic shocks, as the household receiving the remittance will then make a transfer to the other households in the network, and the other households are also affected by the aggregate shock. I use this idea to test whether the household is participating in the risk-sharing network. I test this model on panel data from the ICRISAT villages in India, and find suggestive evidence that households who receive remittances participate in risk-sharing networks. The results also suggest that the appropriate network for risk-sharing is the caste or jati netwrk, rather than the village level network.

The remainder of this paper is structured as follows: Section Two presents the theoretical model of risk sharing between three agents (a migrant, a household, and the network) and derives the theoretical test. Section Three lays out the empirical strategy employed in the paper to implement the test used in the model. Section Four discusses the ICRISAT data, and Section Five undertakes the test of participation in risk sharing networks. The final section briefly concludes.

2. Model

This section develops a simple model of risk sharing between three agents: the migrant, the household who receives remittances from the migrant and the 'network' (which is modeled here as another household). I use this simple model to derive the empirical test to be used in the analysis. The intuition of the test is simple: if the household is sharing risk with the network, then full risk sharing means sharing all the income equally: an aggregate shock affects both the network and the household, so the remittance response to an

[1] That is, I take the decision to migrate as exogenous. Future work will extend this framework to analyze selection into migration

aggregate shock should be larger than that of an idiosyncratic shock if the household and network are sharing risk.

The economic environment is the following:

- The migrant receives a constant income each period, y_m each period
- The household and network receive income each period comprised of a common aggregate component, z, and an idiosyncratic component, $\{s_h, s_n\}$ for the household and network respectively: that is, the income realization for the household is $y_h = z + s_h$ and the income realization for the network is $y_n = z + s_n$

First, I consider the model where the migrant is altruistically linked to the household, and show that remittance sent by the migrant will respond to shocks to household income - in particular, remittances will have the same response to aggregate (z) shocks as idiosyncratic (s_h) shocks. I then consider the model if the household receiving remittances is participating in a risk sharing network with the village. [2] In this case, because total income is pooled between the three participants, and an aggregate shock affects both the household and the network, remittances should respond more to aggregate shocks than idiosyncratic shocks.

2.1. **No risk sharing between household and village.** A social planner finds the optimal remittance from migrant to HH: θ

$$\max_{\theta} u_m(y_m - \theta) + u_h(\underbrace{z + s_h}_{\text{HH income}} + \theta)$$

The first order conditions are :

$$\frac{u_m^{'}(c_m(\epsilon))}{u_h^{'}(c_h(\epsilon))} = 1$$

Then, assuming that HH and migrant have same preferences yields the following expression for the optimal transfer:

$$\theta = \frac{1}{2}[y_m - z - s_h]$$

[2] It is possible to show through an application of Becker's [3] 'rotten kid' theorem that the same theoretical result applies whether the migrant is a direct participant in the risk-sharing network and sends remittances to both the village and the household, or an indirect participant and only send remittances to the household. Given the equivalence of the two models, because transfers often involve transaction costs the rest of the paper assumes that the migrant participates indirectly i.e. only transfers money to one household, and therefore the remittance received by the household can be used to undertake the test.

And, in particular, remittances respond the same to aggregate shocks as idiosyncratic shocks:

$$\frac{\partial\theta}{\partial z} = \frac{1}{2} = \frac{\partial\theta}{\partial s_h}$$

2.2. **Incorporating risk sharing between the household and network.** First, assume that the migrant, household, and network are participating in a risk sharing network. The social planner finds the remittance from the migrant to the household (θ) and the net transfer ($\tilde{\tau}$) from the household to the network:

$$\max_{\tilde{\tau}\theta} u_m(y_m - \theta) + u_h(\underbrace{z + s_h}_{\text{HH income}} + \theta - \tilde{\tau}) + u_n(\underbrace{z + s_n}_{\text{Network income}} + \tilde{\tau})$$

The first order conditions are:

$$\frac{u_m^{'}(c_m(\epsilon))}{u_n^{'}(c_h(\epsilon))} = 1$$

$$\frac{u_h^{'}(c_m(\epsilon))}{u_n^{'}(c_h(\epsilon))} = 1$$

which implies

$$u_m^{'}(c_m(\tilde{\tau},\theta)) = u_h^{'}(c_h(\tilde{\tau},\theta)) = u_n^{'}(c_v(\tilde{\tau},\theta))$$

From the first order conditions, if all three agents have identical preferences this yields that optimal remittance flows from the migrant are:

$$\theta = \frac{1}{3}(2y_m - (2z + s_h + s_n))$$

And, in particular, remittances respond more to aggregate than idiosyncratic shocks

$$\frac{\partial\theta}{\partial z} = \frac{2}{3} > \frac{\partial\theta}{\partial s_h} = \frac{1}{3}$$

3. Empirical Strategy

The model developed yields an intuitive test for whether the household is participating in risk-sharing networks. The test looks at the response of remittances to total (pre-transfer) income. If the household is sharing risk with the network, remittances should respond more to aggregate shocks to income than idiosyncratic shocks to income. I test this restriction of the model in two ways: firstly, I compare the response directly of remittances to aggregate and idiosyncratic tests. Secondly, I examine an over-identification test of the model, similar in spirit to Townsend ([11]): if the migrant is fully participating in the network, then after controlling for network income, own income should be insignificant.

3.1. **Testing the response to aggregate vs idiosyncratic shocks.** There are two empirical concerns before the model can be tested. Firstly, income is endogenous, and so the empirical strategy needs to examine the remittance response to exogenous idiosyncratic and aggregate income shocks. The exogenous shock used in the empirical section is based on rainfall. Rainfall is interacted with a farmer's crop holdings and soil type to produce an exogenous measure of idiosyncratic income variation. The aggregate component of income is given by an appropriate network fixed effect, following Kazianga and Udry ([5]). That is, income Y_{int} of household i in network n at time t is given by:

$$Y_{int} = \alpha_1 X_{int} + \alpha_3 R_{nt} C_{int} + \gamma_{nt} + \gamma_i + \epsilon_{int}$$

where X_{int} is a vector of demographic characteristics, such as household size; R_{nt} is a vector of rainfall shocks, C_{int} is a vector of crop-specific and soil-specific land holdings, and γ_{nt} is a network-time fixed effect that captures the aggregate shock at time t to the network. From this equation, I can construct idiosyncratic and aggregate shocks:

$$\hat{Y}^{\text{idio}}_{int} = \hat{\alpha_3} R_{nt} C_{int}$$
$$\hat{Y}^{\text{agg}}_{int} = \hat{\gamma}_{nt}$$

The empirical test is then to consider the remittance response to each of these shocks: that is,

$$R_{int} = \beta_1 \hat{Y}^{\text{idio}}_{int} + \beta_2 \hat{Y}^{\text{agg}}_{int} + \epsilon_{int} \tag{1}$$

Which generates an alternative empirical test for participation of migrant HH in risk-sharing network:

$$H_0 : \beta_2 = \beta_1$$
$$H_A : \beta_2 > \beta_1$$

3.2. **Alternative: Over-identification test.** A second test is also possible from the model. This test has the opposite null hypothesis: that is, the test is a test with a null of participation in the risk-sharing network. The test is very similar to the standard

'Townsend'-style test of risk-sharing ([11]). From the theoretical section, we know that remittances under the null of participating in the risk sharing network are given by $\theta = \frac{1}{3}(2y_m - (2z + s_h + s_n))$. Note that the term $2z + s_h + s_n$ is the current income of the network. This can be directly expressed by a network-year fixed effect. That is, after controlling for network income, in the following regression:

$$R_{int} = \psi_1 Y_{int} + \gamma_{nt} + \gamma_t + \epsilon_{int} \tag{2}$$

an individual's own income should be insignificant in the following regression: $\psi_1 = 0$

4. Data

This section outlines the ICRISAT data, collected in 10 villages in semi-arid India over the period 1975-1984. The survey data contains comprehensive measures of financial transactions within the household, farm activity, and inventories of goods. Following Foster and Rosenzweig ([4]) I use data from 5 villages where relatively complete data is available on the partner code for transactions. I define remittances as transfers that have a partner code of either relative, friend, landlord, or missing, that originate outside the village. I define in-village transfers as those with the same partner code, but originating within the village. Net transfers are defined as the sum of out-of-village and within-village transfers. I do not include transfers made for marriage purposes. I drop the households who do not have any land-holdings, as land-holdings are interacted with the rainfall shock to provide the measure of the idiosyncratic income shock. This leaves 169 households, and a total of 1088 household-year observations [3]

Table 1 breaks down the source of income for the households, both overall and by village. Crop income comprises 45% of income, and is the dominant source of income. Labor income is 37% of the total. Net transfer income and net remittance income comprise a small proportion of total income (and are negative in some cases), however, this is because in transfers and out transfers are almost balanced, and so close to zero in net terms. Table 2 explores this further by breaking down remittance and transfer in and out flows. This is consistent with Foster and Rosenzweig ([4]) that households both make and receive transfers, consistent with models of risk-sharing when transfers depend on income realizations. However, remittances are still small in magnitude: mean remittance inflows are 2.3% of

[3] I clean the data by dropping the following: any households where the absolute value of net transfers in one year is more than two times total non-transfer income; and the top/bottom 1% of values of total non-transfer income to remove outliers

total income, and mean remittance outflows 3% of total income.

To create the income shock measures I use measures of rainfall, an exogenous shock to income processes. To create the idiosyncratic shock I utilize variation in crop holdings by the household, and that different crops are planted and harvested at different times of the year, and hence affected differentially by rainfall realizations each month. Tables 3 and 4 show the distribution of crops by village for each of the seasons. For example, Sorghum is planted during April to August during the Kharif cropping season, while Castor is planted between June and July, so any rainfall occurring before June will affect those farmers who have planted Sorghum planted but not those who have planted Castor. Table 5 shows the distribution of soil type by village. To create an idiosyncratic shock, I interact mean monthly rainfall with crop-specific land cultivated, and soil-specific land cultivated variables [4] The idiosyncratic rainfall instruments are strong instruments for predicting total non transfer income: the F statistic for the null that the set of variables are jointly equal to zero is 6.605, which is strongly rejected at the 1% level of significance. The first stage results are given by type of income in Table Six.

5. Results

The section presents the results of the risk-sharing. I consider three potential definitions of the relevant risk-sharing network: the village, the caste (using a caste-ranking system that groups castes into seven hierarchical groups), and the sub-caste (jati). Firstly, I show that remittances are responding to household shocks and so provide some insurance motive. I then perform the tests developed in Section 2 to distinguish participation in the risk-sharing network. I find slight evidence that remittances contribute to risk-sharing within networks, especially at the caste and jati definition of network. I then perform a final consumption-based test of risk sharing which suggests that those who do not receive remittances receive less insurance from the network that those who do receive remittances, which is consistent with the role of remittances found. However, the estimated coefficients

[4] An earlier version of this paper aimed to construct aggregate rainfall shocks directly, following Rosenzweig and Binswanger ([9]) - the number of days late (after 1 June) the monsoon started; the average monthly rainfall; and the number of days each month with non-zero rainfall. However, once controlling for the idiosyncratic rainfall shocks these aggregate level variables were no longer statistically significant. In addition, defining aggregate variables in this way does not not easily extend to alternative considerations of the network type.

are small in magnitude and these results should be interpreted with caution.

5.1. **Test A: Do Remittances respond more to aggregate than idiosyncratic shocks?** Table 7 presents the results of estimating equation 1. The sign on own income shock is negative, as expected, for all three potential networks considered. All networks are subsets of the village network, so the expected coefficient on the aggregate shock is also negative. This is the case for the caste and jati network, but not the village network. The test for equality of coefficients on the aggregate and idiosyncratic coefficients is only rejected for the jati network.

5.2. **Test B: Overidentification test of remittances.** Table 8 presents the second test by estimating equation 2. The table shows the coefficient for own income, with the appropriate fixed effect included in the regression but not reported in the table. The overidentification test, in the vein of Townsend, is that after controlling for total resources in the network the coefficient on own income is zero. This is only rejected for the village definition of network, but not for the caste or jati network. This evidence is consistent with the results above, that remittances are used to contribute to a risk sharing network.

Finally, Table 9 presents the standard Townsend test for consumption. If remittances were being used as part of a risk sharing network, then it would be consistent that after all transfers/remittances were conducted, consumption patterns should be consistent: that is, consumption should not depend on own income. This is rejected for all the definitions of networks considered. However, an interaction with a dummy variable that indicates the household had zero net remittances in the year is significant. This shows that own income is a larger component of consumption for households that didn't receive remittances, suggests that households who didn't receive remittances have less insurance from the relevant network. However, this result is only suggestive and should be interpreted with caution, as selection into receiving remittances is endogenous.

6. Conclusion

This paper developed a simple model of risk sharing to answer the question: are remittances substitutes or complements to existing informal insurance provided by risk-sharing networks? Remittances may have two competing effects on informal risk-sharing networks: on one hand, remittances provide access to uncorrelated income processes which may be able to insure the household and network against aggregate shocks. On the other hand, remittances may destroy social networks because the outside option of autarky becomes more attractive and a household who receives remittances may choose not to participate in a risk-sharing network. The intuition of the test developed is simple: if the household is sharing risk with the network, then full risk sharing means sharing all the income equally: an aggregate shock affects both the network and the household, so the remittance response to an aggregate shock should be larger than that of an idiosyncratic shock if the household and village are sharing risk.

I undertook two empirical tests of this hypothesis using the panel ICRISAT data from village economies in India, utilizing exogenous income shocks in the form of crop-specific rainfall shocks. The results are suggestive that remittances contribute to risk-sharing with a network, especially a network that is either caste-based or jati-based rather than the whole village. However, the magnitude of the results are very small and should be interpreted accordingly. The framework used in this paper looks at the effect of remittances after the migration decision has been made. Future work will explore the selection into migration, and the interaction of risk sharing networks for this decision.

References

[1] P. Albarran and O. Attanasio. Limited commitment and crowding out of private transfers: Evidence from a randomised experiment. *Economic Journal*, Jan 2003.

[2] J. Altonji, F. Hayashi, and L. Kotlikoff. Is the extended family altruistically linked? direct tests using micro data. *The American Economic Review*, Jan 1992.

[3] G. Becker. A theory of social interactions. *Journal of Political Economy*, Jan 1974.

[4] A. Foster and M. Rosenzweig. Imperfect commitment, altruism, and the family: evidence from transfer behavior in low-income rural .... *Review of Economics and Statistics*, Jan 2001.

[5] H. Kazianga and C. Udry. Consumption smoothing? livestock, insurance and drought in rural burkina faso journal of development .... *Journal of Development Economics*, Jan 2006.

[6] N. Kocherlakota. Implications of efficient risk sharing without commitment. *Review of Economic Studies*, Jan 1996.

[7] E. Ligon, J. Thomas, and T. Worrall. Informal insurance arrangements with limited commitment: Theory and evidence from village economies. *The Review of Economic Studies*, 69(1):209–244, Jan 2002.

[8] M. Rosenzweig. Risk, implicit contracts and the family in rural areas of low-income countries. *The Economic Journal*, Jan 1988.

[9] M. Rosenzweig and H. Binswanger. Wealth, weather risk and the composition and profitability of agricultural investments. *The Economic Journal*, Jan 1993.

[10] M. Rosenzweig and O. Stark. Consumption smoothing, migration, and marriage: evidence from rural india. *The Journal of Political Economy*, Jan 1989.

[11] R. Townsend. Risk and insurance in village india. *Econometrica*, 62(3):539–591, May 1994.

[12] C. Udry. Risk and insurance in a rural credit market: An empirical investigation in northern nigeria. *The Review of Economic Studies*, 61(3):495–526, Jul 1994.

[13] D. Yang and H. Choi. Are remittances insurance? evidence from rainfall shocks in the philippines. *The World Bank Economic Review*, 21(2):219–248, Jun 2007.

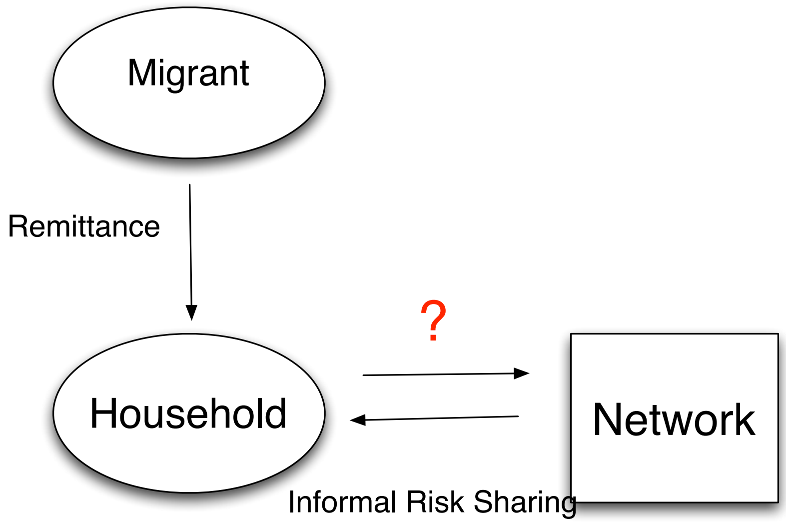

FIGURE 1. Research Question: Do households receiving remittances participate in informal risk sharing networks with the village?

Table 1. Sources of Income, by village

	All mean	village1 mean	village3 mean	village5 mean	village7 mean	village8 mean
Crop Income	0.45	0.56	0.37	0.54	0.24	0.35
Livestock Income	0.10	0.03	0.22	-0.01	0.27	0.06
Labor Income	0.37	0.25	0.36	0.36	0.37	0.70
Trade Income	0.07	0.16	0.01	0.05	0.09	0.02
Total Transfer Income	0.01	-0.00	0.04	0.06	0.03	-0.13
Remittance Income	0.02	0.03	0.00	0.00	0.06	0.01
Number Obs	1088	289	269	298	110	122
No HH	169	38	37	35	28	31

Tables show mean percentage, for all households and by whether the household received remittances (defined as transfers originating from outside the village) that year. Remittance and Transfer income are net values, hence may be negative

Table 2. Sources of Remittances, by village

	All mean	village1 mean	village3 mean	village5 mean	village7 mean	village8 mean
Total Income	5839.49	5084.66	5452.95	7043.61	3103.31	8005.69
Net Transfer	-62.59	-207.22	-4.44	53.91	90.91	-271.20
Net In Village Trans	-23.26	-65.38	-27.67	-31.86	176.74	-73.03
Inflow In V	225.21	140.81	212.11	68.87	281.70	784.99
Outflow In V	248.47	206.19	239.78	100.73	104.96	858.03
Net Remittance	-39.34	-141.84	23.23	85.77	-85.83	-198.17
Remittance In	136.46	104.63	136.95	133.93	214.03	147.06
Remittance Out	175.80	246.47	113.72	48.15	299.86	345.23
Number Obs	1088	289	269	298	110	122
No HH	169	38	37	35	28	31

Tables show mean percentage, for all households and by whether the household received remittances (defined as transfers originating from outside the village) that year. Remittance and Transfer income are net values, hence may be negative

Table 3. Kharif (Summer) Crop variation, by village

	Kall_crop mean/sd	Kvillage1 mean/sd	Kvillage3 mean/sd	Kvillage5 mean/sd	Kvillage7 mean/sd	Kvillage8 mean/sd
Sorghum	0.20	0.38	0.02	0.29	0.04	0.01
	0.27	0.29	0.11	0.24	0.15	0.02
Pigeonpea	0.07	0.00	0.36	0.00	0.01	0.01
	0.22	0.02	0.36	0.02	0.06	0.05
OtherPulses	0.05	0.01	0.21	0.00	0.02	0.04
	0.16	0.07	0.29	0.01	0.07	0.12
Castor	0.19	0.48	0.00	0.00	0.26	0.23
	0.28	0.28	0.00	0.00	0.25	0.20
Paddy	0.04	0.08	0.03	0.01	0.09	0.03
	0.12	0.14	0.10	0.04	0.17	0.10
Cotton	0.19	0.00	0.00	0.62	0.00	0.02
	0.32	0.00	0.01	0.27	0.00	0.06
Wheat	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00
Chickpea	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.01	0.00	0.00	0.00
Saffron	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00
Others	0.25	0.05	0.38	0.08	0.58	0.66
	0.33	0.12	0.38	0.16	0.28	0.23
Number Obs	1088	289	269	298	110	122
No HH	169	38	37	35	28	31

Tables show mean and sd, calculated as mean of yearly proportion of household crop cultivation by crop type

Table 4. Rabi (Winter) Crop variation, by village

	Rall_crop mean/sd	Rvillage1 mean/sd	Rvillage3 mean/sd	Rvillage5 mean/sd	Rvillage7 mean/sd	Rvillage8 mean/sd
Sorghum	0.40	0.28	0.86	0.00	0.04	0.00
	0.44	0.38	0.17	0.00	0.17	0.01
Pigeonpea	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00
OtherPulses	0.02	0.10	0.00	0.00	0.00	0.00
	0.14	0.28	0.00	0.00	0.00	0.00
Castor	0.00	0.00	0.00	0.00	0.00	0.03
	0.04	0.00	0.00	0.00	0.03	0.10
Paddy	0.08	0.33	0.00	0.00	0.03	0.01
	0.25	0.40	0.00	0.00	0.17	0.11
Cotton	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00
Wheat	0.25	0.00	0.03	0.57	0.68	0.65
	0.38	0.02	0.07	0.40	0.42	0.31
Chickpea	0.09	0.01	0.06	0.36	0.09	0.04
	0.22	0.09	0.10	0.40	0.25	0.12
Saffron	0.06	0.21	0.01	0.04	0.00	0.00
	0.20	0.35	0.04	0.18	0.00	0.00
Others	0.09	0.07	0.03	0.04	0.16	0.28
	0.20	0.19	0.08	0.10	0.30	0.31
Number Obs	1088	289	269	298	110	122
No HH	169	38	37	35	28	31

Tables show mean and sd, calculated as mean of yearly proportion of household crop cultivation by crop type

Table 5. Soil type, by village

	all_crop mean/sd	village1 mean/sd	village3 mean/sd	village5 mean/sd	village7 mean/sd	village8 mean/sd
Deep black	0.08	0.00	0.26	0.06	0.00	0.00
	0.23	0.00	0.36	0.18	0.01	0.00
Medium black	0.35	0.08	0.38	0.84	0.06	0.01
	0.42	0.18	0.39	0.29	0.19	0.02
Medium to shallow black	0.12	0.11	0.25	0.07	0.00	0.08
	0.24	0.21	0.32	0.20	0.00	0.18
Shallow red	0.20	0.74	0.00	0.03	0.00	0.00
	0.37	0.31	0.00	0.15	0.00	0.00
Gravelly	0.03	0.02	0.09	0.00	0.00	0.00
	0.11	0.08	0.20	0.00	0.00	0.00
Problem soil	0.01	0.05	0.00	0.00	0.00	0.00
	0.10	0.20	0.01	0.00	0.00	0.00
Others	0.10	0.00	0.01	0.00	0.52	0.40
	0.25	0.01	0.07	0.00	0.34	0.32
Sandy	0.10	0.00	0.00	0.00	0.41	0.51
	0.24	0.00	0.00	0.00	0.31	0.31
Number Obs	1088	289	269	298	110	122
No HH	169	38	37	35	28	31

Tables show mean and sd, calculated as mean of yearly proportion of household crop cultivation by crop type

Table 6. First stage regressions: Rainfall on income

	Profit b/se	Livestock b/se	Labor b/se	Trade b/se	Transfers b/se	Non-Tran Y b/se	Remit b/se
R-squared	0.701	0.492	0.122	0.019	0.350	0.606	0.047
N	945	945	945	945	945	945	945
F Stat: Idio	9.527	4.524	1.508	1.069	2.960	6.605	1.179
Prob F	0.000	0.000	0.000	0.253	0.000	0.000	0.051

Idiosyncratic variables are cultivated land by crop interacted with mean monthly rainfall, and soil type interacted with rainfall. F test tests joint significance of sets of rainfall variables. HH fixed effect absorbed.

Table 7. Participaton in Risk Sharing Networks

	Remittances Vill b/se	Caste b/se	Jati b/se
Own Shock	-0.004	-0.004	-0.009**
	(0.004)	(0.003)	(0.003)
Agg Shock	0.015	-0.018**	-0.008*
	(0.025)	(0.006)	(0.003)
Year FE	Yes	Yes	Yes
N	1088	1076	1072
Chi2	0.530	5.973	0.396
p(Chi2)	0.467	0.015	0.529

Dependent variable is remittances. First stage regression is non transfer income as a function of crop/soil weather-specific shocks. Aggregate shock is the group fixed effect. Second stage takes predicted idiosyncratic and aggregate shock. No Remit is a dummy for net remittances current year equal to zero. Chi2 and p(chi2) give the result of the null hypothesis that the effect of the idiosyncratic income shock is the same as the effect of the aggregate shock. Bootstrap standard errors calculated

Table 8. Townsend Risk Sharing Tests: Remittances

	Vill		Caste		Jati	
	b/se	b/se	b/se	b/se	b/se	b/se
Non Tran Income	-0.020*	-0.008	-0.008	-0.004	-0.007	-0.007
	(0.010)	(0.016)	(0.008)	(0.014)	(0.010)	(0.014)
Indiv FE	No	Yes	No	Yes	No	Yes
N	1087	1087	1075	1075	1071	1071

Group heading gives the appropriate year-group FE. Individual fixed effect included in second column of each group. Dependent variable is net remittances, measure of income is real (non-tranfer) income.

Table 9. Townsend Risk Sharing Tests: Consumption

	Vill		Caste		Jati	
	b/se	b/se	b/se	b/se	b/se	b/se
Non Tran Income	0.155***	0.087***	0.155***	0.088***	0.149***	0.081***
	(0.010)	(0.012)	(0.011)	(0.014)	(0.013)	(0.015)
Non Tran Income x No Remit	0.077***	0.070***	0.055*	0.062**	0.070**	0.081***
	(0.020)	(0.018)	(0.022)	(0.019)	(0.023)	(0.020)
Indiv FE	No	Yes	No	Yes	No	Yes
N	1087	1087	1075	1075	1071	1071

Group heading gives the appropriate year-group FE. Individual fixed effect included in second column of each group. Dependent variable is real household consumption, measure of income is real (non-tranfer) income. No Remit is a dummy for net remittances current year equal to zero.