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**Remittances, informal loans, and assets as risk-coping mechanisms:
Evidence from agricultural households in rural Philippines**

by

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**Remittances, informal loans, and assets as risk-coping mechanisms:
Evidence from agricultural households in rural Philippines**

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Abstract

This paper investigates whether agricultural households in rural Philippines insure their consumption and whether they use remittances, informal loans, or assets as *ex post* risk-coping mechanisms. Since these households have limited access to formal insurance and credit markets, any shocks to their volatile income can have substantial impacts. Using panel data and rainfall shocks as the instrumental variable for income shocks, this paper finds evidence that households depend on their networks of family and friends to partially insure their consumption. 2SLS and OLS estimates show that approximately 27 percent of consumption is insured. International remittances from migrant members replace about 11 percent of income decline while domestic transfers replace about 14 percent. Informal loans, however, decrease as rainfall shocks increase. Borrowers and lenders may be experiencing similar shocks, which would reduce the effectiveness of local risk-sharing arrangements.

Keywords: Risk-coping; Remittance; Informal loan; Consumption insurance; Rainfall shocks; Philippines

JEL classification: O12; Q12; D81; D12; F22; F24

1. Introduction

Households in developing countries often face extreme income variation. This is specifically true for households whose income depends on agriculture and other economic activities susceptible to drastic weather variation. Domestic income shocks may come in the form of loss of job, illness, typhoons, drought, and rainfall variation. It is important to investigate how households cope with these shocks, especially in poor regions of developing countries where there is limited access to formal credit, capital, and insurance markets. Government aid and transfers can also be limited or non-existent.

The main purpose of this paper is to examine how Philippine households in rural areas insure their consumption against transitory income shocks caused by rainfall variation. To achieve this, I first examine whether household consumption is insured against adverse income shocks. Second, if households do insure their consumption, I investigate whether they use remittances, informal credit, or their assets as *ex post* risk-coping mechanisms.

This paper adds to the literature on consumption insurance and risk-sharing by incorporating international remittances, domestic transfers, informal loans, and assets into this framework. There have been studies on how international remittances serve as insurance, independently of other risk-mitigating mechanisms (Lucas and Stark, 1985; Clarke and Wallsten, 2003; Yang and Choi, 2007). To the best of my knowledge, this is the first paper that investigates how international remittances, in relation to domestic transfers, informal credit and sale of assets, may insure household consumption. In doing

so, this paper determines what the relative importance is of each of these risk-coping mechanisms and whether they affect each other or crowd each other out.

I choose to examine the Philippines for two reasons. First, this country is frequented by typhoons and has experienced natural disasters, such as drought and flooding, quite often. According to the Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA), during the 59-year period from 1948 to 2006, an average of 10 typhoons occurred in the Philippine Area of Responsibility annually. There have also been six drought-causing El Niño episodes since 1968. In such an environment, rural households whose primary income depends on agricultural activities face volatility in their income. Since rural households have limited access to financial and credit markets, it is apt to examine what mechanisms they use to cope with risks.

Second, international remittances play an important role in the economy of the Philippines. The Philippines was ranked fourth in total remittances in 2009, after India, Mexico, and Nigeria (International Monetary Fund, 2010). The inflows of remittances to the Philippines in 2009 amounted to approximately 15 billion US dollars, which made these transfers the second largest source of foreign exchange for the Philippines, next to exports of goods and services. Remittances also serve as a major source of income for agricultural households with migrants, affecting their consumption and investment behavior and their entrepreneurial activities. Data from the Family Income and Expenditure Survey (FIES) in the Philippines show that, on average, remittances constitute about 36 percent of the income of remittance-receiving agricultural households in 2006.

2. Full insurance of consumption

Full consumption insurance is possible if households efficiently allocate their risks within their networks of family and friends. There is evidence that Philippine households receive help in response to income shocks mostly from informal networks of family and friends (Fafchamps and Lund, 2003; Yang and Choi, 2007), making this an important kind of risk-sharing to investigate.

A Pareto-efficient allocation of risk exists if household consumption only depends on the average consumption that the networks of family and friends face and not on a household's own income. This implies that only aggregate risk faced by the networks of family and friends affects household consumption. Idiosyncratic income shocks are irrelevant because they are completely insured within the networks. Empirical studies often reject efficient allocation of risk for certain types of shocks and households because of this strong implication (Cochrane, 1991; Mace 1991; Townsend, 1994). Partial Pareto-efficient allocation of risk, however, may exist and households may employ risk-coping mechanisms.

2.1 *Theory for full insurance of consumption*

To test the existence of full consumption insurance among networks of family and friends, let $i=1, \dots, N$ be the index of households, each with an uncertain income $y_{st}^i > 0$, where $s \in \mathcal{S}$ is the state of nature, and $t \in \mathcal{T}$ is the index for time. Assume that each household has an instantaneous utility function $U_i(c_{st}^i)$ that is separable over time and

twice continuously differentiable, where c_{st}^i is the consumption of household i at state of nature s and at time t . To achieve a Pareto-efficient allocation of risk, the weighted sum of the utilities of household i is maximized, given that the weight of household i in the Pareto program is λ_i , where $0 < \lambda_i < 1$, $\sum \lambda_i = 1$. Suppose that each household has a constant absolute risk aversion utility function: $U_i(c_{st}^i) = -(1/\gamma) \exp(-\gamma c_{st}^i)$. Pareto-efficient allocation of risk exists if the ratio of the marginal utilities in any state of nature is equal to a constant; in this case, it is equal to the ratio of Pareto weights (λ_i).

Following Cochrane (1991), Mace (1991), and Townsend (1994), a relationship between individual household i 's consumption and average consumption across households can be expressed as:

$$c_{st}^i = \bar{c}_{st} + \frac{1}{\gamma} \left[\ln(\lambda_i) - (1/N) \sum_{j=1}^N \ln(\lambda_j) \right] \quad (1)$$

Equation (1) shows that household i 's consumption depends only on the networks' average consumption \bar{c}_{st} and Pareto weights. Household income does not affect household consumption when households efficiently pool risks. Therefore, if consumption is regressed on income, the estimated coefficient of income should be insignificant if full consumption insurance holds. To empirically verify this, I follow Fafchamps and Lund (2003) and decompose household income (y_{st}^i) into a transitory component of income (y_{st}^{iT}) and permanent component of income (y_{st}^{iP}):

$$y_{st}^i = y_{st}^{iT} + y_{st}^{iP} \quad (2)$$

Along with Pareto weights, the permanent component of income is not dependent on state of nature and can be regarded as a function of a vector of household fixed effect (ω^i). Since average level of consumption in the networks does not vary across households, a dummy variable for time (d_t) is used as a proxy (Ravallion and Chaudhuri, 1997; Fafchamps and Lund, 2003; Yang and Choi, 2007). Given these assumptions and allowing for a random component, u_t^i , error term with zero mean, consumption insurance can be empirically tested using the following equation:

$$c_{st}^i = d_t + y_{st}^{iT} + \omega^i + u_t^i \quad (3)$$

where transitory income, y_{st}^{iT} , is instrumented using rainfall shocks. There are three possible scenarios. First, if the estimated coefficient of y_{st}^{iT} is equal to one, then the null hypothesis of full consumption insurance can be rejected. Second, if this estimate is between zero and one, then there exists some degree of consumption insurance. Third, if the estimate is zero then full consumption insurance cannot be rejected.

2.2 Description of data for full insurance of consumption

2.2.1 Household survey data

I use household data for 2003 and 2006 from Family Income and Expenditure Survey (FIES) to construct a panel data. FIES survey data for 2003 and 2006 are the only official data from which a panel data can be constructed. FIES is a nationwide survey

conducted every three years by the National Statistics Office (NSO) as a rider to the Labor Force Survey (LFS). FIES is the main source of data on Philippine household income and expenditure levels.

In Table 1, the first column depicts the characteristics of the panel data of agricultural households in rural areas. There are 691 agricultural households, which constitutes about 59 percent of rural households. Of these agricultural households, 558 (81 percent) planted crops as their main source of income and 133 households (19 percent) engaged in other agricultural activities such as farming of animals, fishing, hunting, forestry, and logging. The average household size in the agricultural rural areas was about five members for both survey years. Most household heads only completed primary education (63 percent).

Table 2 depicts the definition, mean, and standard deviation of the rainfall and outcome variables. On average, the annual total household income of agricultural households increased by about 34 percent in 2006, whereas total household expenditures increased by approximately 27 percent.

2.2.2 Rainfall data

Rainfall data from PAGASA are used as a measure of shocks to transitory income of Philippine households. Several authors, such as Paxson (1992), Paulson (2000), and Yang and Choi (2007), have used rainfall shocks as shocks to income. Monthly and annual rainfall data come from the 45 weather stations of PAGASA, which are located in different cities and municipalities. Rainfall shocks are derived by subtracting the annual

rainfall (in millimeters) recorded at each of the 45 weather stations in 2003 and 2006 from the same station's average annual rainfall over a period of 27 years (1974 to 2000).

I assign rainfall shocks to the households based on their distance to the nearest weather station using great circle distance. Great circle distance between two points, in mathematics, is the shortest distance over the surface of a sphere. In addition, the climate type of the household's city or municipality is matched with the climate type of the nearest weather station's city or municipality. According to PAGASA, if the municipality (or city) of the household and the municipality (or city) of the nearest weather station have a similar climate type and the distance between them is less than about 50 kilometers, then the rainfall shocks from the weather station can be assigned to the household. If there are two or more weather stations that meet the criteria, I average rainfall shocks and assign the average to the household. If there are no weather stations close to the household (within the 50-kilometer range), then this household is deleted from the analysis.

On average, agricultural households experienced more rainfall in 2006 than in 2003, by about 0.14 meters (Table 2, first column). This can be attributed to typhoons that crossed the Philippines in 2006. According to PAGASA (2011), that year's typhoon *Milenyo* was one of the five typhoons that have caused the most damage to properties in the Philippines since 1948. One of the five strongest typhoons in the same period, typhoon *Reming*, hit the Philippines in 2006 as well. Consequently, the average rainfall in 2006 deviated more from the historical mean than the average rainfall in 2003. The 2006 rainfall was greater by 0.17 meters than the historical mean rainfall from 1974 to 2000, whereas rainfall in 2003 deviated only by about 0.03 meters.

2.3 *Estimation strategy for full insurance of consumption*

Estimating Equation (3) to test full consumption insurance using OLS may result in a biased estimate for the transitory component of income, which can be attributed to reverse causation and fixed effects. Reverse causation implies that household income may be a function of household consumption itself. For example, higher food consumption may translate into more nourished household members, more productive work, and higher income. A study of farm households in the Philippines shows that food consumption serves as a nutritional investment that affects marginal productivity of members (Dubois and Ligon, 2005). Fixed effects mean that there exist unobserved variables, such as preferences to work or not to work, that may influence both household income and consumption.

Since there are two observations for each household, the first difference, where 2003 data are subtracted from 2006 data, can be derived to eliminate time-invariant household fixed effects. Reverse causation is addressed using change in rainfall shocks as the instrumental variable for change in income. Rainfall shocks are a good measure of income shocks since agricultural households rely heavily on rainfall, particularly households that farm non-irrigated land. According to the National Irrigation Administration, in 2006 only 46 percent of the total irrigable land in the Philippines was irrigated, which means that agricultural activities on the remaining land depend on rainfall.

Two conditions must be satisfied to make the change in rainfall a valid instrument: it should be partially correlated to household income and uncorrelated to the

disturbance term in Equation (3). To test the first requirement, change in income is regressed on change in rainfall.¹ Table 3 (first column) shows that the estimate for rainfall shocks is significantly different from zero, which meets the first requirement. The second condition is satisfied because the rainfall shocks variable is exogenous to the causal system that constitutes how household income affects household consumption. This means that the factors that affect rainfall variation are determined outside of Equation (3).

2.4 Results for full insurance of consumption

I measure household income (net of remittances) as a change from 2003 to 2006 divided by initial household income in 2003. Similarly, household expenditure is measured as change divided by initial household expenditure in 2003. I choose to express consumption and income this way, instead of taking the logs, to be consistent with how I measure risk-coping mechanisms, which have zero values. In addition, I can interpret estimated coefficients as a percentage of the initial household income.

I use a time dummy (d_t , which is equal to one if $t = 2006$, zero otherwise) in my regression analysis to account for time effects that affect all households, such as price inflation. I also include time-variant household characteristics (X_t^i), such as household size and age of the household head, and household characteristics (V^j) that did not change over time like marital status and completed education of household heads. Marital status remained the same for approximately 94 percent of the agricultural households in rural

¹ A quadratic relationship between income and rainfall was considered and tested. Change in rainfall and change in rainfall squared are jointly significant but change in rainfall squared is insignificant.

areas, so I consider it a time-invariant household characteristic. I interact time-invariant household characteristics with a dummy variable for time ($d_t * V^i$) to allow time effects to vary according to household characteristics, such as nationwide economic shocks that may have different effects on educated and less-educated households (Yang and Choi, 2007). I initially estimate the following Equation (4), which is derived from Equation (3), by 2SLS to investigate if household income, instrumented by rainfall shocks, affects household expenditures.

$$\Delta c^i_{2006} = \delta_0 + \beta_1 \Delta y^{iT}_{2006} + \beta_2 \Delta X^i_{2006} + \beta_3 d_{2006} * V^i + \Delta u^i_{2006} \quad (4)$$

where $\delta_0 = \delta_0 \Delta d_{2006}$ given that d_t is equal to one if $t = 2006$ and zero otherwise.

I cluster standard errors by weather station to address serial correlation among error terms of households belonging to the same weather station. Table 3 shows the results of 2SLS estimation for agricultural households. A decrease of 500 millimeters of rainfall results in approximately an 8 percentage point fall in household income (first column). The second column shows the results of second stage regression where the estimated coefficient of income is positive and less than one, and statistically significant at the 1% level. This means that some degree of consumption insurance exists. The decrease in household consumption is not as much as the decrease in household income: a 10 percentage point decline in household income leads to approximately a 7.3 percentage point decrease in household consumption. This suggests that about 27 percent of household consumption is insured.

3. Risk-coping strategies

Given that agricultural households insure their consumption to some degree, I investigate three *ex post* mechanisms that they may use to insulate consumption against shocks to income: transfers from family and friends, informal loans from other families, and profits from selling their own assets. Data from FIES show that 77 percent of the agricultural households in the Philippines use one or a combination of these risk-coping strategies, which several different empirical studies also find to be in use. Some authors investigate risk-sharing among villagers through credit (Platteau and Abraham, 1987; Udry, 1990). Others examine how self-insurance through saving, along with purchase and sale of assets, helps smooth consumption (Deaton, 1992; Rosenzweig and Wolpin, 1993). The risk-coping mechanisms that I examine are closest to those used by Fafchamps and Lund (2003). However, I distinguish domestic from international transfers to account for the role of international migrants in insuring origin households.

3.1 Theory for risk-coping strategies

Assume that household consumption is financed by own income (y_{st}^i), remittances from a household member living abroad (r_{st}^i), domestic transfers from family members and relatives (t_{st}^i), loans from other families and friends (l_{st}^i), and sale of assets (a_{st}^i):

$$c_{st}^i = y_{st}^i + r_{st}^i + t_{st}^i + l_{st}^i + a_{st}^i \quad (5)$$

Then Equation (1) can be expressed as:

$$r_{st}^i + t_{st}^i + l_{st}^i + a_{st}^i = -y_{st}^i + \bar{c}_{st} + \frac{1}{\gamma} \left[\ln(\lambda_t) - (1/N) \sum_{j=1}^N \ln(\lambda_j) \right] \quad (6)$$

To empirically test Equation (6), household income (y_{st}^i) is decomposed into uninsurable permanent income (y^{iP}), which is independent of state of nature, and insurable transitory income (y_{st}^{iT}) given a state of nature s at time t . Year dummy (d_t) serves as a proxy for average consumption while household fixed effect (ω^i) is used as a proxy for permanent income and welfare weights. With these in mind and allowing for zero-mean error term, ε_t^i , Equation (6) then translates into:

$$r_{st}^i + t_{st}^i + l_{st}^i + a_{st}^i = d_t + y_{st}^{iT} + \omega^i + \varepsilon_t^i \quad (7)$$

I test whether the coefficient of transitory component of income (y_{st}^{iT}), which is instrumented using rainfall shocks, is significantly different from zero. If it is negative and significant, then households use the dependent variable as a tool to insure consumption against income shocks.

3.2 Description of data for risk-coping strategies

To test which risk-coping mechanisms households depend on, I examine the same panel data (for 2003 and 2006) I used in full consumption insurance analysis. Likewise, the same rainfall data are assigned to households.

Table 2 displays the mean, standard deviation, and definition of the outcome variables. On average, international remittances and net assets decreased in 2006. International remittances declined by approximately 1,400 pesos while net assets, measured as sale less purchase of real and financial assets, fell by 481 pesos. Real assets encompass land, real estate, and other personal assets such as jewelry, whereas financial assets constitute profits from sale of stocks. Domestic transfers, loans from other families, and net loans all increased. Domestic transfers increased by about 500 pesos, while loans from other families rose by approximately 540 pesos. Net loans, defined as loans received from other families less loans given to other families, increased by 912 pesos.

3.3 Estimation strategy for risk-coping strategies

To estimate Equation (7), I follow the identification strategy used in estimating household consumption. Fixed effects, which may cause a biased estimate for household income, exist if there is an unobservable omitted variable that jointly affects household income and international remittances, such as entrepreneurial spirit (Yang and Choi, 2007). Such unobserved variable can also affect loans, domestic transfers, and assets. To

eliminate time-invariant fixed effects, observations in 2003 are subtracted from those in 2006

Another source of a biased estimate for household income is reverse causation between risk-coping mechanisms and household income. For example, remittances may be used to fund entrepreneurial activities, which will then have an impact on household income (Yang and Choi, 2007). Domestic transfers, informal loans, and sale of assets can also finance entrepreneurial endeavors of household members. Change in rainfall shocks is used as the instrumental variable for change in household income to account for reverse causation.

3.4 *Results for risk-coping strategies*

The risk-coping tools are measured as a change from 2003 to 2006 divided by income in 2003 so that they can be interpreted as replacement rate or percentage of fall in income that is replaced (Yang and Choi, 2007). I perform multivariate regression analysis (2SLS) separately for international remittances, domestic transfers, loans, net loans, and net assets to test Equation (8) below and determine which of them insulate consumption of households:

$$\Delta r^i_{2006} + \Delta t^i_{2006} + \Delta l^i_{2006} + \Delta a^i_{2006} = \phi_0 + \gamma_1 \Delta y^{iT}_{2006} + \gamma_2 \Delta X^i_{2006} + \gamma_3 d_{2006} * V^i + \Delta \varepsilon^i_{2006} \quad (8)$$

where $\phi_0 = \phi_0 \Delta d_t$ given that d_t is equal to one if $t = 2006$ and zero otherwise; X^i_{2006} is time-variant household characteristics (age of household head and household size); V^i is a

vector of household characteristics that do not change over time (marital status and household heads' completed education); and interaction of a time dummy and household characteristics that are fixed over time ($d_{2006} * V^i$).

The 2SLS results of instrumenting for household income and testing which risk-mitigating mechanisms households depend on are displayed in Tables 3 and 4. The standard errors are clustered by weather station. The estimated coefficient of household income (instrumented by rainfall shocks) is -0.11 and statistically significant at the 10% level for the international remittances regression (Table 4, first column). This suggests that about 11 percent of income fall is replaced by remittances received by the households. The estimated coefficient of income for loans and net loans regressions, on the other hand, are positive and statistically significant at the 5% level (Table 4, fourth and fifth columns). Assets do not appear to respond to income shocks. Remittances seem to crowd out informal loans: as loans from other families fall, remittances rise to reduce the effect of income decline on household consumption. It is possible that lenders and borrowers might be experiencing similar rainfall shocks. Therefore, they are unable to share risks because their incomes have high covariance. I cannot verify this last conjecture since the national survey that I use (FIES) does not contain the location of families that provide loans. It is also possible that lenders are risk-averse and they perceive that during a bad state, borrowers would have a hard time repaying.

4. Reduced-form estimation for full consumption insurance and risk-coping strategies

For sensitivity analysis, I use another specification to analyze consumption insurance and risk-coping strategies of agricultural households. Instead of using rainfall shocks as an instrument for household income, I use them as an explanatory variable for consumption and risk-coping equations. I estimate the following equations in reduced-form using OLS:

$$\Delta y^i_{2006} = \xi_1 + \xi_2 \Delta RF^i_{2006} + \xi_3 \Delta X^i_{2006} + \xi_4 d_{2006} * V^i + \Delta v^i_{2006} \quad (9)$$

$$\Delta c^i_{2006} = \delta_1 + \delta_2 \Delta RF^i_{2006} + \delta_3 \Delta X^i_{2006} + \delta_4 d_{2006} * V^i + \Delta u^i_{2006} \quad (10)$$

where RF^i_{2006} is rainfall shocks, while the other variables are the same as those used in testing consumption insurance and risk-coping strategies.

In Equation (9), a negative and significant estimate of ξ_3 suggests that an increase in rainfall shocks has an adverse effect on household income. In Equation (10), if δ_2 is equal to zero then the null hypothesis of full consumption insurance cannot be rejected. If instead, δ_2 is negative and significant, then full consumption insurance is rejected. However, some degree of insurance may exist if both δ_2 and ξ_3 are negative, significant, and $\xi_3 > \delta_2$, in absolute terms. This suggests that household consumption does not fall as much as income does when rainfall shocks increase because households may be using risk-coping strategies to mitigate the adverse effect of income shocks.

OLS regression results show that partial consumption insurance exists (Table 5). An increase of 500 millimeters of rainfall results in a 7.8 percentage point decline in household income and a 5.7 percentage point fall in household consumption. These results show that, given a similar increment in rainfall, the decline in household consumption is less than—about 73 percent of—the decline in income. This suggests that about 27 percent of consumption is insured, which is consistent with the 2SLS results.

To determine whether remittances, loans, and assets are used as *ex post* mechanisms to insulate consumption, they are regressed separately on rainfall shocks. I estimate the following Equation (11) using OLS and applying the same independent variables used in Equations (9) and (10):

$$\Delta r^i_{2006} + \Delta l^i_{2006} + \Delta a^i_{2006} + \Delta \alpha^i_{2006} = \pi_1 + \pi_2 \Delta RF^i_{2006} + \pi_3 \Delta X^i_{2006} + \pi_4 d_{2006} * V^i + \Delta \varepsilon^i_{2006} \quad (11)$$

If estimated coefficients of rainfall shocks are significantly different from zero and positive ($\pi_2 > 0$) then households use the dependent variable as a risk-coping mechanism. An OLS estimate on rainfall shocks is positive and statistically significant at the 10% level for the international remittances regression, which suggests that remittances serve as insurance when rainfall increases (Table 6, first column). Although this estimate is small in magnitude (0.018), when compared to the rainfall shocks estimate in income regression (-0.156) in Table 5 (first column), this can be interpreted as replacing income decline by roughly 11 percent given an increase of 500 millimeters in rainfall. The rainfall estimates are significant in the loans and net loans regressions.

However, the signs of the estimated coefficients are negative. These findings are consistent with the results using 2SLS. It is possible that loans are instead used as an *ex ante* mechanism to insulate consumption. During a good state of nature, households may borrow more money to invest in technologies and crops that are not susceptible to weather variation. This is to ensure a steady stream of income even during a bad state of nature.

I extend my analysis to all rural households (1,169 households), which encompass both agricultural and non-agricultural households. Using the same variables and applying a similar identification strategy as in the analysis of agricultural households, the results imply that some degree of consumption insurance exists. A 500-millimeter increase in rainfall causes a 6 percentage point decline in income and a 4 percentage point fall in consumption (Table 7). The OLS estimate on rainfall shocks in domestic transfers regression is positive and statistically significant at the 10% level (Table 8, second column). Comparing this estimate (0.017) with the rainfall shocks estimate in income regression (-0.124) in Table 7 (first column), the results suggest that domestic transfers replace about 14 percent of income decline given a similar increment in rainfall. Again, the coefficients of rainfall in loans and net loans regressions are significant but negative.

5. Conclusion

The goals of this paper are twofold: the first is to investigate whether agricultural households in rural Philippines insure their consumption against income shocks measured

by rainfall shocks. The second is to examine whether they use international remittances, domestic transfers, informal loans, or assets as *ex post* risk-coping mechanisms.

This paper contributes to the existing literature on risk-sharing by incorporating international remittances, domestic transfers, informal loans, and assets into this framework. Although there have been studies on how remittances serve as insurance, investigating how households use them relative to other risk-coping strategies can give new insights into the nature and efficacy of their role. Consequently, the insurance role of other risk-coping strategies relative to remittances is also explored.

It is imperative to examine how households in rural Philippines cope with extreme income variation given that they have limited access to formal credit, capital and insurance markets, and government assistance. A majority of these households depends on agriculture, and their income is sensitive to weather changes. Not only is the income of agricultural households dependent on weather variation, their income is minimal, oftentimes only enough to live at subsistence level. In addition, the Philippines has had its share of natural disasters (drought in 1997–1998, frequent typhoons, and earthquakes), which make farming households more vulnerable.

Using rainfall shocks as the instrumental variable for income shocks and based on the 2SLS results, this paper rejects full consumption insurance. Agricultural households, however, do insure their consumption to some degree: approximately 27 percent of consumption is insured. This result is consistent when reduced-form is estimated and household consumption is regressed on rainfall shocks. Agricultural households rely on their migrant family members for international transfers to cope with risks. 2SLS and OLS results show that international remittances replace roughly 11 percent of income

decline. Rural households (which include both agricultural and non-agricultural households), on the other hand, depend on domestic transfers when they encounter shocks to their income. About 14 percent of income decline is replaced by domestic remittances.

Agricultural households (and all rural households) do not depend on informal loans to share risks. Loans from other families decrease when rainfall increases. There are four possible reasons for this: first is that remittances crowd out loans. Remittances are most likely preferable and more convenient than loans because receiving households do not necessarily have to pay back the remitters. Second, borrowers and lenders may be experiencing similar shocks. If so, their incomes most likely have high covariance, which reduces the effectiveness of local risk-sharing arrangements (Bardhan and Udry, 1999). Domestic migrants, on the other hand, most likely migrated to urban areas or places where rainfall shocks covary little or inversely with the ones experienced by agricultural households. This also explains how international migrants are able to insure their families, because their incomes are not directly affected by rainfall shocks in the Philippines. The third possible explanation is related to the creditworthiness of the borrowers. Lenders may be risk-averse and relatively less willing to lend during a bad state of nature. Fourth, loans are used instead as an *ex ante* mechanism in insulating consumption. It is possible that farmers borrow more money during a good state to use technologies (such as drought-resistant crops) or to diversify their activities (that is, to include non-farm activities) to guarantee a relatively more stable stream of income.

Agricultural households do not rely on sale of financial and real assets. This result can be attributed to how I measure assets, which is due to data limitation. One way

to extend this study in the future would be to use assets that are more useful and relevant to agricultural households, such as machinery or livestock.

Even though international remittances serve as a risk-coping tool, it is important to put this in context. Only about 16 percent of agricultural households received remittances in 2003 (about 15 percent in 2006). Therefore, it is possible that the rest of the agricultural households were incapable of insuring their consumption. Such households still need public transfers and better infrastructure to cope with risks. For example, improving the irrigation system could lessen the reliance on rainfall during planting season and might allow farmers to plant crops even during the dry season. This could distribute the inflows of income and help farmers have a more consistent source of income.

Rural households, on the other hand, rely more on domestic transfers: about 51 percent of them depended on domestic transfers in 2003 (50 percent in 2006). Given that the regression analysis shows that these familial transfers are significant in insuring rural households, it would be helpful to improve on the banking system and informal channels to facilitate a less costly flow of domestic transfers.

One limitation of this paper is that the shocks that I am using are actually aggregate shocks that the entire municipality or city experiences. Because of this, it is possible that the sale of assets and credit are not as effective in coping with income risks, especially if the networks of family and friends belong to the same municipality or city and are thus experiencing the same negative income shock. A future examination of household-specific shocks would shed more light on the risk-coping behavior of rural households. The challenge, however, is finding an exogenous measure of these

idiosyncratic shocks. Another possible future line of research is one that addresses *ex ante* risk-coping mechanisms such as using new farming technologies, planting rapidly maturing crops, or diversifying activities, all of which may limit the impact of rainfall variation. Investigating these strategies would help to put the *ex post* mechanisms employed by farming households into perspective.

Table 1 Household Head Characteristics (Mean)

	Agricultural Households	Rural Households
Education		
Elementary	0.63	0.52
High School	0.27	0.31
College	0.06	0.14
No Grade Completed	0.04	0.03
Marital Status		
Single	0.02	0.03
Married	0.86	0.85
Widowed	0.10	0.11
Divorced/Separated	0.01	0.01
Type of Job		
Agriculture	0.81	0.48
Other Agriculture ^{a/}	0.19	0.11
Manufacturing		0.05
Sales		0.09
Transportation and Communication		0.08
Construction		0.07
Others		0.11
2006		
Age	50.14	48.23
Household size	5.03	5.08
2003		
Age	47.28	45.71
Household size	5.20	5.16
Number of Households	691	1169

^{a/} Other Agriculture refers to agricultural activities other than planting crops, such as farming of animals, fishing, hunting, forestry, and logging.

Table 2 Definition, Mean (Standard Deviation) of Outcome and Rainfall Variables

Outcome Variable	Description	Agricultural Households	Rural Households
Total Income	Change in household income (from 2003 to 2006) as share of income in 2003	0.34 (0.96)	0.37 (0.94)
	Change in household income	11,847 (82,020)	16,985 (86,098)
Total Expenditure	Change in expenditures of households (from 2003 to 2006) as share of expenditures in 2003	0.27 (0.57)	0.31 (0.58)
	Change in household expenditures	12,554 (48,657)	17,976 (60,370)
International Remittance	Change in international remittances (from 2003 to 2006) received as share of income in 2003	-0.01 (0.35)	0.02 (0.75)
	Change in international remittances	-1,413 (27,022)	200 (36,954)
Domestic Remittance	Change in domestic remittances (from 2003 to 2006) as share of income in 2003	0.01 (0.16)	0.01 (0.15)
	Change in domestic remittances	502 (10,138)	514 (9,824)
Net Asset	Change in net assets as share of income in 2003. Net Assets defined as sale less purchase of assets. Assets are either: (a) real assets, which encompass land, real estate, and other personal assets such as jewelry; or (b) financial assets, which include profits from sale of stocks and real assets.	0.01 (0.29)	-0.01 (0.27)
	Change in net assets	-481 (20,698)	370 (25,583)
Loans	Change in loans (from 2003 to 2006) from other families as share of income in 2003	0.01 (0.10)	0.003 (0.09)
	Change in loans from other families	543 (9,407)	327 (9,116)
Net loans	Change in net loans (defined as loans received from other families less loans given to other families) from 2003 to 2006 as share of income in 2003	0.01 (0.11)	0.0002 (0.11)
	Change in net loans	912 (11,007)	35.18 (16,225)
<i>Rainfall Variables</i>			
RF 2006 - RF 2003 (1,000 mm.)	Change in annual rainfall from 2003 to 2006 (in 1,000 mm.) assigned to households based on their municipalities' climate type and their distance from the nearest weather station, computed using great circle distance	0.14 (0.63)	0.11 (0.64)
RF 2006 - RF mean (1,000 mm.)	2006 annual rainfall less mean annual rainfall (1974- 2000)	0.17 (0.37)	0.15 (0.35)
RF 2003 - RF mean (1,000 mm.)	2003 annual rainfall less mean annual rainfall (1974- 2000)	0.03 (0.54)	0.04 (0.56)
Number of Households		691	1,169

Table 3 Effect of Household Income on Household Consumption in Agricultural Households (2SLS)

	First Stage (Income)	Second Stage (Consumption)
Income		0.734 (0.182)***
RF 2006 - RF 2003 (1000 mm.)	-0.156 (0.053)***	
Household Size	0.155 (0.029)***	-0.005 (0.028)
Age	-0.011 (0.005)**	0.003 (0.003)
Education (Elementary omitted) ^{a/}		
High School	0.004 (0.067)	-0.041 (0.028)
College	0.381 -0.244	-0.244 (0.144)*
Marital Status (Married omitted)		
Single ^{b/}	0.035 (0.107)	-0.053 (0.049)
Type of Job (Agriculture omitted)		
Other Agriculture ^{c/}	0.045 (0.108)	-0.094 (0.062)
Constant	0.381 (0.059)***	0.059 (0.075)
No. of obs.	691	691

Notes: * significant at 10%, ** at 5%, and *** at 1%. Parentheses indicate standard errors clustered by weather station. a/ Elementary includes No Grade Completed. b/ Single includes Widowed, Divorced, and Separated. c/ Other Agriculture refers to agricultural activities other than planting crops, such as farming of animals, fishing, hunting, forestry, and logging.

Table 4 Effect of Household Income on Remittances, Assets, and Loans in Agricultural Households (2SLS: Second Stage)

	International Transfers	Domestic Transfers	Net Assets	Loans	Net Loans
Income	-0.114 (0.070)*	-0.098 (0.107)	0.040 (0.179)	0.101 (0.051)**	0.116 (0.050)**
Household Size	0.029 (0.016)*	0.007 (0.016)	-0.001 (0.031)	-0.015 (0.008)*	-0.019 (0.008)**
Age	-0.002 (0.001)	0.001 (0.001)	-0.002 (0.001)	0.002 (0.002)	0.002 (0.002)
Education (Elementary omitted)^{a/}					
High School	-0.035 (0.022)	-0.004 (0.015)	-0.012 (0.021)	-0.010 (0.010)	-0.006 (0.013)
College	0.016 (0.049)	0.022 (0.059)	-0.084 (0.076)	-0.030 (0.039)	-0.026 (0.043)
Marital Status (Married omitted)					
Single ^{b/}	0.012 (0.026)	-0.013 (0.018)	-0.075 (0.073)	-0.010 (0.012)	-0.009 (0.015)
Type of Job (Agriculture omitted)					
Other Agriculture ^{c/}	-0.002 (0.035)	0.012 (0.020)	-0.014 (0.024)	0.004 (0.011)	0.004 (0.014)
Constant	0.040 (0.029)	0.044 (0.036)	0.007 (0.066)	-0.033 (0.023)	-0.041 (0.023)*
No. of obs.	691	691	691	691	691

Notes: * significant at 10%, ** at 5%, and *** at 1%. Parentheses indicate standard errors clustered by weather station. a/ Elementary includes No Grade Completed. b/ Single includes Widowed, Divorced, and Separated. c/ Other Agriculture refers to agricultural activities other than planting crops, such as farming of animals, fishing, hunting, forestry, and logging.

Table 5 Effect of Rainfall on Household Income Consumption in Agricultural Households (OLS)

	Income	Consumption
RF 2006 - RF 2003 (1000 mm.)	-0.156 (0.053)***	-0.114 (0.039)***
Household Size	0.155 (0.029)***	0.109 (0.014)***
Age	-0.011 (0.005)**	-0.005 (0.005)
Education (Elementary omitted) ^{a/}		
High School	0.004 (0.067)	-0.038 (0.043)
College	0.381 (0.299)	0.036 (0.110)
Marital Status (Married omitted)		
Single ^{b/}	0.035 (0.107)	-0.028 (0.069)
Type of Job (Agriculture omitted)		
Other Agriculture ^{c/}	0.045 (0.108)	-0.061 (0.041)
Constant	0.381 (0.059)***	0.339 (0.043)***
R-squared	0.086	0.109
No. of obs.	691	691

Notes: * significant at 10%, ** at 5%, and *** at 1%. Parentheses indicate standard errors clustered by weather station. a/ Elementary includes No Grade Completed. b/ Single includes Widowed, Divorced, and Separated. c/ Other Agriculture refers to agricultural activities other than planting crops, such as farming of animals, fishing, hunting, forestry, and logging.

Table 6 Effect of Rainfall on Remittances, Loans, and Net Assets in Agricultural Households (OLS)

	International Transfers	Domestic Transfers	Net Assets	Loans	Net Loans
Variables					
RF 2006 - RF 2003 (1,000 mm.)	0.018 (0.011)*	0.015 (0.014)	-0.006 (0.03)	-0.016 (0.007)**	-0.018 (0.007)*
Household Size	0.011 (0.011)	-0.008 (0.004)*	0.006 (0.006)	0.000 (0.002)	-0.001 (0.002)
Age	0.000 (0.001)	0.002 (0.002)	-0.002 (0.002)	0.001 (0.002)	0.001 (0.002)
Education (<i>Elementary omitted</i>) ^{a/}					
High School	-0.035 (0.022)	-0.004 (0.012)	-0.011 (0.022)	-0.009 (0.01)	-0.005 (0.01)
College	-0.028 (0.033)	-0.016 (0.022)	-0.069 (0.062)	0.008 (0.013)	0.018 (0.016)
Marital Status (<i>Married omitted</i>)					
Single ^{b/}	0.008 (0.030)	-0.016 (0.020)	-0.074 (0.068)	-0.006 (0.007)	-0.005 (0.010)
Type of Job (<i>Agriculture omitted</i>)					
Other Agriculture ^{c/}	-0.007 (0.038)	0.008 (0.021)	-0.012 (0.028)	0.009 (0.008)	0.004 (0.01)
Constant	-0.003 (0.012)	0.006 (0.012)	0.022 (0.017)	0.005 (0.007)	0.007 (0.008)
R-squared	0.006	0.012	0.013	0.016	0.015
No. of obs.	691	691	691	691	691

Notes: * significant at 10%, ** at 5%, and *** at 1%. Parentheses indicate standard errors clustered by weather station. a/ Elementary includes No Grade Completed. b/ Single includes Widowed, Divorced, and Separated. c/ Other Agriculture refers to agricultural activities other than planting crops, such as farming of animals, fishing, hunting, forestry, and logging.

Table 7 Effect of Rainfall on Household Income and Consumption in Rural Households (OLS)

	Income	Consumption
RF 2006 - RF 2003 (1,000 millimeters)	-0.124 (0.049)**	-0.084 (0.033)**
Household Size	0.135 (0.024)***	0.105 (0.012)***
Age	0.000 (0.003)	-0.005 (0.003)
Education (Elementary omitted) ^{a/}		
High School	-0.013 (0.063)	-0.023 (0.046)
College	0.149 (0.149)	0.002 (0.068)
Marital Status (Married omitted)		
Single ^{b/}	0.071 (0.066)	-0.055 (0.052)
Type of Job (Agriculture omitted)		
Other Agriculture ^{c/}	0.050 (0.111)	-0.066 (0.042)
Sales	0.123 (0.106)	0.169 (0.069)**
Manufacturing	-0.201 (0.105)*	-0.081 (0.072)
Transportation and Communication	-0.105 (0.067)	0.011 (0.050)
Construction	0.121 (0.070)*	0.064 (0.056)
Others	0.041 (0.097)	0.052 (0.051)
Constant	0.355 (0.055)***	0.336 (0.042)***
R-squared	0.069	0.106
No. of obs.	1169	1169

Notes: * significant at 10%, ** at 5%, and *** at 1%. Parentheses indicate standard errors clustered by weather station. a/ Elementary includes No Grade Completed. b/ Single includes Widowed, Divorced, and Separated. c/ Other Agriculture refers to agricultural activities other than planting crops, such as farming of animals, fishing, hunting, forestry, and logging.

Table 8 Effect of Rainfall on Remittances, Assets, and Loans in Rural Households (OLS)

	International Transfers	Domestic Transfers	Net Assets	Loans	Net loans
RF 2006 - RF 2003 (1,000 mm.)	-0.052 (0.41)	0.017 (0.008)*	0.001 (0.017)	-0.012 (0.005)**	-0.015 (0.005)**
Household Size	0.019 (0.011)*	-0.007 (0.003)**	0.002 (0.005)	0.000 (0.001)	-0.001 (0.001)
Age	-0.003 (0.002)	0.000 (0.001)	-0.001 (0.001)	0.000 (0.000)	0.000 (0.001)
Education (Elementary omitted) ^{a/}					
High School	-0.062 (0.033)*	-0.003 (0.01)	0.000 (0.018)	-0.009 (0.007)	-0.007 (0.007)
College	0.045 (0.090)	0.000 (0.013)	-0.022 (0.035)	0.000 (0.008)	0.003 (0.01)
Marital Status (Married omitted)					
Single ^{b/}	-0.089 (0.055)	-0.008 (0.014)	-0.076 (0.041)*	-0.011 (0.007)	-0.013 (0.007)
Type of Job (Agriculture omitted)					
Other Agriculture ^{c/}	0.005 (0.04)	0.006 (0.021)	-0.012 (0.027)	0.008 (0.008)	0.008 (0.01)
Sales	0.062 (0.039)	0.003 (0.017)	0.047 (0.030)	-0.009 (0.01)	-0.017 (0.012)
Manufacturing	0.034 (0.03)	0.011 (0.018)	0.020 (0.020)	0.006 (0.01)	0.004 (0.011)
Transportation and Communication	0.019 (0.027)	0.004 (0.010)	0.032 (0.041)	0.001 (0.009)	-0.018 (0.016)
Construction	-0.002 (0.052)	-0.008 (0.015)	-0.006 (0.018)	-0.008 (0.008)	-0.011 (0.009)
Others	0.154 (0.138)	0.001 (0.01)	0.042 (0.029)	-0.003 (0.008)	-0.003 (0.009)
Constant	0.030 (0.017)*	0.009 (0.009)	0.010 (0.015)	0.006 (0.005)	0.006 (0.006)
R-squared	0.011	0.012	0.013	0.014	0.016
No. of obs.	1,169	1,169	1,169	1,169	1,169

Notes: * significant at 10%, ** at 5%, and *** at 1%. Parentheses indicate standard errors clustered by weather station. a/ Elementary includes No Grade Completed. b/ Single includes Widowed, Divorced, and Separated. c/ Other Agriculture refers to agricultural activities other than planting crops, such as farming of animals, fishing, hunting, forestry, and logging.

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