THE WALTER H. SHORENSTEIN
ASIA-PACIFIC RESEARCH CENTER

SHORENSTEIN
APARC
STANFORD

ASIA HEALTH POLICY PROGRAM

FREEMAN SPOGLI INSTITUTE
FOR INTERNATIONAL STUDIES

Stanford University
Walter H. Shorenstein Asia-Pacific Research Center
Asia Health Policy Program

Working paper series
on health and demographic change in the Asia-Pacific

Remittances, Informal Loans, and Assets as Risk-Coping Mechanisms: Evidence from Agricultural Households in Rural Philippines

Marjorie C. Pajaron, Asia Health Policy Program, Stanford University

Asia Health Policy Program working paper #32

December , 2012

http://asiahealthpolicy.stanford.edu

For information, contact: Karen N. Eggleston (翁笙和)
Walter H. Shorenstein Asia-Pacific Research Center
Freeman Spogli Institute for International Studies
Stanford University
616 Serra St., Encina Hall E311
Stanford, CA 94305-6055
(650) 723-9072; Fax (650) 723-6530
karene@stanford.edu

STANFORD UNIVERSITY
ENCINA HALL, E301
STANFORD, CA 94305-6055

T 650.725.9741
F 650.723.6530

Remittances, Informal Loans, and Assets as Risk-Coping Mechanisms: Evidence from Agricultural Households in Rural Philippines

Marjorie C. Pajaron
Asia Health Policy Program
Stanford University
pajaron@stanford.edu

Abstract

This paper investigates whether agricultural households in the rural Philippines insure their consumption against income shocks and whether they use migration, 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 little evidence of effective risk-sharing within the networks of family and friends. 2SLS, OLS, and SUR estimates show that only about 16 percent of consumption is insured. While domestic remittances from other families replace about 51 percent of income decline, informal loans decrease by about 34 percent. Additional tests, however, reveal that agricultural households engage in entrepreneurial activity when rainfall increases and children are somehow protected from the adverse effects of rainfall shocks. Hours spent on own family-operated businesses likewise increase.

Keywords: Risk-coping, remittances, informal loans, 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 especially 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 job loss, illness, typhoon, drought, or rainfall variation. It is important to investigate how households cope with such shocks, especially in poor regions of developing countries where there is limited access to formal credit, capital, and insurance markets. Government aid and transfers may also be limited or non-existent.

The main purpose of this paper is to examine how agricultural households in rural areas of the Philippines 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 migration, international remittances, domestic remittances, informal credit, or their assets as *ex post* risk-coping mechanisms.

I choose to examine the Philippines for four 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 seven 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, especially if they depend on rainfall to farm their non-irrigated land. Since rural households have limited access to financial and credit markets, it is apt to examine what mechanisms they use to cope with risks.[1] Part of the reason why rural households, particularly farmers, face credit constraints is that they are required to provide land titles as collateral. Those farmers who do not own the land they farm have a very small chance of accessing loans provided by banks and other financial institutions. Those who are agrarian reform beneficiaries (ARB) face legal restrictions on land transfers; along with the limited use of land as collateral and cooperative membership, they are deemed as risky borrowers.

Second, familial transfers, in the form of international and domestic remittances, play an important role in the economy of the Philippines. The Philippines was ranked fourth in total international remittances received in 2009, after India, China, and Mexico (World Bank, 2012). The inflow 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. International and domestic 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 indicated that, on average, international remittances constituted about 16 percent of the income of agricultural households that received international remittances in 2006, while domestic transfers, on average,

[1] Central Bank of the Philippines (*Bangko Sentral ng Pilipinas*) reports that only about 7 percent of bank loans were granted to the agriculture, fishing, and forestry industry in 2003. In addition, for the same year, only about 10 percent of the total banks in the Philippines were rural banks, which catered to households and businesses in rural areas.

constituted about 50 percent of the income of households that received domestic transfers.

Third, aside from international migration, rural households employ internal migration to diversify risk and to insure and smooth consumption when they face adverse income shocks. Most literature on internal migration in the Philippines use data from the 1980s or 1990s. Quisumbing and McNiven (2005) use 2003-2004 panel data to track internal migration but focus on one rural area in southern Philippines. I implicitly analyze the importance of internal migration for all rural households in the Philippines using the latest national representative survey panel data (2003 and 2006) by investigating how domestic transfers are affected by income shocks and how they are used to smooth consumption. I assume that the domestic transfers from other families are from members who have migrated to urban areas to work. FIES, whose rich panel data started in 2003, is the major source of household income and expenditure data collected from all regions in the Philippines.

Fourth, it would be interesting to analyze if agricultural households can effectively share their risks and which risk-coping strategies help them during bad times. The reason why I focus on agricultural households is that they are the poorest among the poor and marginalized groups in the Philippines. The National Statistical Coordination Board reported that in 2003, farmers and fishermen had the highest incidence of poverty at 43 percent. In addition, FIES data from 2003 indicate that their average household income in a year fell below that needed by a five-member household to stay above the subsistence level.

This paper adds to the literature on consumption insurance and risk-sharing by incorporating migration, international remittances, domestic transfers, informal loans, and assets into this framework. There have been studies on how international remittances serve as insurance, independent 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 the use of international remittances as consumption insurance in the context of other mechanisms: domestic transfers, informal credit, and sales of assets among them. In doing so, this paper determines the relative importance of each risk-coping mechanism and whether they affect or crowd one another out.

To test this empirically, I analyze whether household income affects household consumption. I use the panel data of national representative survey (FIES) from the Philippines for the years 2003 and 2006. I apply first differencing to eliminate fixed effects problems. Since household income is endogenous, which may be due to reverse causation, ordinary least squares (OLS) estimates may result in a biased estimate. Using an instrumental variable for household income may resolve this issue, provided that the instrument used is strong and that it satisfies two conditions: it is exogenous and it is partially correlated to household income. I use rainfall shocks as instruments since agricultural households in the Philippines depend on rainfall significantly, especially those farming non-irrigated land. Rainfall shocks are measured as the difference in rainfall experienced by agricultural households in 2003 and 2006. Using great circle distance (GCD), the closest weather station to the household is determined and the rainfall amount recorded in that weather station is assigned to the household. The instruments, after experimenting with the econometric specification and different measures of rainfall, fall below the conventional weak instrumental variable threshold suggested by Staiger and Stock (1997), and Stock and Yogo (2002). Focusing on the reduced form instead, the OLS estimates indicate that the null hypothesis of full consumption insurance can be rejected, however, partial insurance still exists. I use partial insurance to refer to situations where any form of consumption smoothing exists. The results indicate that rainfall shocks adversely affect income and consumption, which is contrary to the findings of Yang and Choi (2007), who use a Philippine data set from 1996 and 1997. One possible reason for this is that in 1997-1998 the Philippines experienced El Niño such that any rainfall was beneficial not just to farmers but also to entrepreneurs who rely on agricultural products for raw materials, hence the positive impact of rainfall shocks on household income.[2] Another explanation is that in 2006, the Philippines experienced a high volume of rainfall due to record-breaking typhoons that hit the country such that more rainfall caused a decline in the income of agricultural households.

Based on the results of this paper, it can be inferred that OLS estimates, which are consistent with the IV estimates, show that agricultural households insure about 16 percent of their consumption. This result may also mean that 16 percent of consumption is smoothed or that 16 percent of income shocks are insured. Given this finding, I explore five possible risk-coping mechanisms that households employ to smooth their consumption. Domestic transfers are positively affected by rainfall shocks while informal loans are adversely affected; migration, international remittances, and assets are not impacted by rainfall shocks. Domestic transfers replace about 51 percent of income

[2] The El Niño phenomenon is an example of climate variability; it is characterized by a dry season lasting for 12 months or more, and the late start and early termination of the rainy season.

decline; informal loans, about 34 percent. The net change in available resources is about 16 percent of income decline. SUR estimates indicate similar results, which implies that the error terms among the different regressions for risk-coping strategies are uncorrelated.

These results are robust when rural households, regardless of the type of employment of household head, are used. The implication of these results is that families who provide domestic remittances to agricultural households are most likely located in areas unaffected by similar rainfall shocks, hence their ability to provide financial support (Paulson, 2000). Conversely, families who provide informal loans may be experiencing the same shocks and are unable to effectively share risks with other families. The results on informal loans are contrary to the results found by Fafchamps and Lund (2003), who conducted a risk-sharing analysis of villages in the northern Philippines and found that a quasi-credit model of informal risk-sharing fit their data. One possible reason for this difference is the types of shocks that Fafchamps and Lund (2003) used, which are idiosyncratic shocks specific to households, such as unemployment of head or spouse, acute sickness, and funeral. They did not find risk-sharing within the village, but found that networks of family and friends did share risks using a combination of gifts and no-interest loans. In addition, they also found that some shocks are uninsured while some are better insured. Another result of this paper, which is inconsistent with the existing papers on income shocks and international remittances (Clarke and Wallsten, 2003; and Yang and Choi, 2007), is the insignificance of international remittances in insuring household income. This result can be attributed to the fact that in the dataset there are only a few agricultural households that have migrant members abroad (about 13 percent). This is not surprising since sending a migrant abroad requires a large fixed cost, which most agricultural households cannot afford owing to their credit and financial constraints. In addition, there is little variation in the relationship between remittances and rainfall shocks (Figure 1).

I analyze other possible sources of income for agricultural households since a 16-percent replacement rate may be insufficient for them to effectively cope with risks. I find that they also rely on wholesale and retail sales (including sidewalk vending, market vending, and peddling) when they encounter an increase in rainfall shocks. I also examine if their labor supply (hours worked) is affected by shocks and find that agricultural households tend to focus more of their time on own-family operated farm or business without pay to deal with shocks. Finally, I want to know whether children are somehow protected against shocks – their labor supply and schooling are unaffected while their education expenditures actually increase by about 1 percent.

This paper is organized as follows. Section 2 tests whether agricultural households in the Philippines follow the full consumption insurance theory, using two stage least squares (2SLS) and OLS. Section 3 analyzes whether they use familial transfers (international and domestic transfers from migrant members), informal loans, and assets as risk-coping strategies to insure their consumption against income shocks, using OLS. This section also includes the analysis of the impact of rainfall on net available resources for agricultural households by estimating the sum of all risk-mitigating strategies. Section 4 focuses on robustness checks, including using SUR specification and omitting the interaction of time-invariant household characteristics and a time dummy. Section 5 examines the response of different types of households (rural or urban; migrant or non-migrant) to rainfall shocks. Section 6 explores additional questions, including whether entrepreneurial activities, household labor supply, children's labor supply and schooling, education, health, and durable goods expenditures are affected by rainfall shocks. Section 7 concludes.

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 such informal networks (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 of networks of family and friends, and not on the household's own income. This implies that only aggregate risk faced by these networks 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 $i=1,\ldots,N$ be the index of households, each with an uncertain income $y^i_{st}>0$, where $s \in S$ is the state of nature, and $t \in T$ is the index for time. Assume that each household has an instantaneous utility function $U_i(c^i_{st})$ that is separable over time and twice continuously differentiable, where c^i_{st} 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: $U_i(c^i_{st})= -(1/\gamma)\ exp\ (-\gamma\, c^i_{st})$. 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:

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

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^{i}_{st}) into a transitory component of income (y^{iT}_{st}) and permanent component of income (y^{iP}):

$$y^{i}_{st} = y^{iT}_{st} + y^{iP} \tag{2}$$

Along with Pareto weights, the permanent component of income is not dependent on state of nature and can be regarded as a function of 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^{i}_{t}, error term with zero mean, consumption insurance can be empirically tested using the following equation:

$$c^{i}_{st} = d_t + y^{iT}_{st} + \omega^{i} + u^{i}_{t} \tag{3}$$

where transitory income, y^{iT}_{st}, is instrumented using rainfall shocks. There are three possible scenarios. First, if the estimated coefficient of y^{iT}_{st} 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 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 2003, the sampling design of FIES used a new master sample – the 2003 Master Sample for Household Surveys – which was based on the 2000 Census of Population and Housing. This master sample provided a scheme where the same sample households could be used in succeeding survey years. As of this writing, FIES survey data for 2003 and 2006 are the only official data from which a panel data can be constructed and 2009 is yet to be released.

Table 1 depicts the characteristics of the panel data on agricultural households in rural areas. The agricultural households are defined using the 2003 FIES survey data to address possible selection bias and prevent household classification from being endogenous to rainfall if the households were based on 2006 data. There are 721 agricultural households, which constitute about 58 percent of rural households. Of these agricultural households, 611 (85 percent) planted crops as their main source of income and 110 households (15 percent) engaged in other agricultural activities such as farming of animals, animal husbandry, fishing, and logging. Most household heads only completed primary education (about 65 percent) in 2003 and the average household size was five. 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 33 percent between 2003 and 2006, whereas total household expenditures increased by approximately 28 percent. Rainfall variables are discussed in the next section.

2.2.2 Rainfall data

Rainfall data from PAGASA are used as a measure of shocks to the 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 various cities and municipalities. Rainfall shocks are derived by subtracting the annual rainfall (in millimeters) recorded at each of the 45 weather stations in 2003 from the same station's annual rainfall in 2006.

I assign rainfall shocks to households based on their distance from 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. This last condition will be relaxed later and households will not be dropped from the analysis to increase the sample size and to improve the instrumental variable used.

On average, agricultural households experienced more rainfall in 2006 than in 2003, by about 0.12 meters (Table 2). This can be attributed to typhoons that crossed the Philippines in 2006. According to PAGASA (2011), that year's typhoon *Milenyo* is one of five that 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 0.15 meters than the historical mean rainfall from 1974 to 2000, whereas rainfall in 2003 deviated by only about 0.05 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, for which 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 (2011), in 2006 only 46 percent of the total irrigable land in the Philippines was irrigated, which means that agricultural activities on the remaining land depended on rainfall.

Two conditions must be satisfied to make the change in rainfall a strong instrument: it should be partially correlated to household income and uncorrelated to the disturbance term in Equation (3). Otherwise, weak instruments may lead to a substantial bias in the instrumental variable estimators and hypothesis tests that have large size distortions (Stock and Yogo, 2002).

To test the first requirement, change in income is regressed on change in rainfall. The second condition for a strong instrumental variable 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). The preceding section shows whether the instrumental variable I am using is strong.

2.4 Results for full insurance of consumption

2.4.1 Instrumental variable estimation 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 that 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^i), measured in 2003, that did not change much over time, such as marital status and the completed education of household head. Marital status remained the same for approximately 94 percent of the agricultural households in rural 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 province to address serial correlation among error terms of households belonging to the same province. Table 3 shows the results of 2SLS estimation for agricultural households. First stage regression, reported in the first column, indicates that the estimate for rainfall shocks is significantly different from zero. An increase of 500 millimeters of rainfall results in approximately a 6 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 8.4 percentage point decrease in household consumption. This suggests that about 16 percent of household consumption is insured.

However, the results should be interpreted with caution. In the first stage regression, which tests for the relationship between rainfall shocks and household income, the F-statistics can tell us whether the first condition for a strong instrumental variable is satisfied. The F-statistics, which is about 3.7, suggests that the instrumental variable is weak since it is below the weak instrumental variable threshold of 10 (Staiger and Stock, 1997; Stock and Yogo, 2002). This means that rainfall shocks and income are weakly correlated, which may lead to a large asymptotic bias in the instrumental variable estimator even if the second condition is satisfied.

I use several strategies to address the issue of weak instrumental variable. First, I change the assignment of rainfall shocks to households by including households whose distance from the closest weather station exceeds 50 kilometers. This increases the sample size and although this may introduce some noise, there may still be signal that can be derived from here. I then add instrumental variables for rainfall at the next two closest weather stations to improve the F-statistics (Maccini and Yang, 2009). Table 4 shows that the F-statistics for agricultural households actually decreases to about 1.0. All succeeding IV experiments and their corresponding F-statistics are displayed in Table 4.

Second, I experiment with quarterly rainfall variables and seasonal rainfall variables as instrumental variables (Paxson (1992); and Yang and Choi (2007)). This exercise may capture more variation in rainfall and may improve the instrumental variables. The results show that both sets of rainfall shocks are weak instruments for household income, with F-statistics at 1.4 for quarterly rainfall variables and 2.2 for seasonal rainfall.

Third, I add the interaction of rainfall shocks and different categories of other agricultural activities other than planting crops, such as farming of animals, animal husbandry, fishing, and logging as instrumental variables. These other agricultural groups may be differentially affected by rainfall and, therefore, when interacted with rainfall shocks may provide variation in rainfall shocks within a municipality. In addition, the inclusion of these interaction terms may yield a stronger first stage, since rainfall matters more in areas with households more engaged in rain-fed agriculture than in other areas. However, the sample size is small given that only about 15 percent of the agricultural households are engaged in other agricultural activities. These exercises did not yield a stronger first stage, and the F-statistics of 2.6 remains below the conventional cut-off. Even after interacting quarterly and seasonal rainfall variables separately with different types of other agricultural activities, the F-statistics are at about 1.6 and 3.0, respectively.

Fourth, I experiment with the functional form and consider a quadratic relationship between income and rainfall shocks. Change in rainfall and change in rainfall squared are individually significant, however the F-statistics is small, at 4.5.

Fifth, I include typhoon variables as explanatory variables to control for the possibility that it drives the negative effect of rainfall on income and to verify whether it improves the F-statistics. For IV estimation, I measure typhoon as the change in the number of typhoons that hit the area over the past year. The estimated coefficient on rainfall becomes statistically insignificant although it remains negative (Table 6, Column 3), while the F-statistics is at 2.8, which is still below the cut-off. In a later section, I discuss further if typhoon alters the relationship of rainfall and household income.

2.4.2 Reduced form estimation for full insurance of consumption

Given that rainfall shocks prove to be a weak instrument for household income, I focus instead on the reduced form and I use rainfall shocks as an explanatory variable for both household income and consumption. I estimate the following equations using OLS:

$$\Delta y^{i}_{2006} = \xi_1 + \xi_2 \Delta RF^{i}_{2006} + \xi_3 \Delta X^{i}_{2006} + \xi_4\, d_{2006} * V^{i} + \Delta v^{i}_{2006} \tag{5}$$

$$\Delta c^{i}_{2006} = \delta_1 + \delta_2 \Delta RF^{i}_{2006} + \delta_3 \Delta X^{i}_{2006} + \delta_4\, d_{2006} * V^{i} + \Delta u^{i}_{2006} \tag{6}$$

where RF^{i}_{2006} is rainfall shocks, which, along with the rest of the independent variables, are similar to those used to estimate Equation (4) originally.

In Equation (5), a negative and significant estimate of ξ_2 suggests that an increase in rainfall shocks has an adverse effect on household income. In Equation (6), 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_2 are negative, significant, and $\xi_2 > \delta_2$, 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 effects of income shocks.

OLS regression results show that partial consumption insurance exists (Table 5). An increase of 500 millimeters of rainfall results in a 5.8 percentage point decline in household income and a 4.9 percentage point fall in household consumption. These results show that, given a similar increment in rainfall, the decline in household consumption is less than – or about 84 percent of – the decline in income. This suggests that about 16 percent of consumption is insured, which is consistent with the 2SLS results. The high co-movement between income and consumption may be attributed to the damage caused by a typhoon such that there is limited available crops to consume. This may be true if imperfect inter-municipality markets exist; a municipality devastated by a typhoon cannot rely on another locality for provision. In effect, municipalities may not be able to insure each other especially if the typhoon impacts most areas.

Contrary to my findings, Yang and Choi (2007) found a positive effect of rainfall shocks on household income in their 1996-1997 study of households in the Philippines. There are three possible reasons for this inconsistency: first, as mentioned above, in 2006 the Philippines was hit by two super typhoons – one was recorded as the strongest since 1948; the other caused the most damage to properties. The rainfall associated with these typhoons caused harm to crops and other livelihoods of agricultural households. To test this, I add two typhoon variables in both Equations (5) and (6) – one is a change in an indicator variable that measures whether typhoons have occurred in the municipality in the past year, the other measures the change in the number of typhoons that hit the area in the past year. Table 6 shows the coefficient estimates for rainfall shocks when typhoon is measured as a change in an indicator variable (Columns 1 and 2), as a change in the number of typhoons (Columns 3 and 4), and when both typhoon variables are included in the regression (Columns 5 and 6). In all regressions with income as the outcome variable (Columns 1, 3, and 5), income remains adversely affected by rainfall. Furthermore, the results in Columns 1 and 2 are consistent with the results in Table 5 when the reduced form is estimated without typhoons. The rainfall shocks coefficients are negative and statistically significant at 10 percent for both income and consumption regressions. Keeping everything else constant, the results indicate that even after controlling for typhoon, both household income and consumption decrease when rainfall shocks increase.

Since the inverse relationship of rainfall shocks and household income cannot be attributed to typhoon, another explanation for the positive relationship found in the 1996-1997 study is that the Philippines experienced El Niño from 1997 to 1998. Based on a report presented by the Asia Pacific Disaster Management Center, the Philippines experienced a dry spell between June and October 1997 that lingered until mid-September 1998. I can conjecture that during this period any rainfall was good rainfall and beneficial not just to farmers but also to entrepreneurs who relied on agricultural products for raw materials. During the 1997-1998 El Niño, 68 percent of the country was affected by the drought compared to only 28 percent in 1972 and 16 percent in 1982.[3] Six drought events happened during the 1960-1995 period, but the economic impact was not as prominent compared to 1997-1998. For example, the volume and value of rice production increased from 1994 to 2008, with a dip in 1998 as a result of El Niño (Bureau of Agricultural Statistics, 2011).

Third, and related to the second point is that the volume of rainfall experienced by the Philippines in 2006 was much higher relative to that in 1997. The change in rainfall between 2003 and 2006 is 0.12 meters, implying a wetter year in 2006 while the change in rainfall was negative for both dry and wet seasons between 1996 and 1997, suggesting a dryer year in 1997. This supports the explanation above that the positive relationship found between rainfall shocks and income may be attributed to drought in 1997; an increase in rainfall was deemed beneficial for farmers and entrepreneurs relying on agricultural products.

[3] According to PAGASA, there were seven episodes of El Nino since 1968 (1968-1969, 1972-1973, 1976-1977, 1982-1983, 1986-1987, 1990-1995, and 1997-1998).

3. Risk-coping strategies

Given that agricultural households insure their consumption to some degree, I investigate the first 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 2003 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 the 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 and use the national representative survey panel data.

3.1 Theory for risk-coping strategies

Assume that household consumption is financed by own income (y^i_{st}), remittances from a household member living abroad (r^i_{st}), domestic transfers from family members and relatives (t^i_{st}), loans from other families and friends (l^i_{st}), and sale of assets (a^i_{st}):

$$c^{i}_{st} = y^{i}_{st} + r^{i}_{st} + t^{i}_{st} + l^{i}_{st} + a^{i}_{st} \tag{7}$$

Then Equation (1) can be expressed as:

$$r^{i}_{st} + t^{i}_{st} + l^{i}_{st} + a^{i}_{st} = -y^{i}_{st} + \bar{c}_{st} + \frac{1}{\gamma}\left[\ln(\lambda_i) - (1/N)\sum_{j=1}^{N}\ln(\lambda_j)\right] \tag{8}$$

To empirically test Equation (8), household income (y^{i}_{st}) is decomposed into uninsurable permanent income (y^{iP}), which is independent of state of nature, and insurable transitory income (y^{iT}_{st}) 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^{i}_{t}, Equation (8) then translates into:

$$r^{i}_{st} + t^{i}_{st} + l^{i}_{st} + a^{i}_{st} = d_t + y^{iT}_{st} + \omega^i + \varepsilon^{i}_{t} \tag{9}$$

To empirically test Equation (9), I use transitory income shocks, measured as rainfall shocks, to determine whether they affect the outcome variable. If the coefficient estimate is positive 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 950 pesos, while net assets, measured as the sale less purchase of real and financial assets, fell by 336 pesos. Real assets encompass land, real estate, and other personal assets such as jewelry, whereas financial assets constitute profits from the sale of stocks and real assets. Domestic transfers, loans from other families, and net loans all increased. Domestic transfers increased by about 1,270 pesos, while loans from other families rose by approximately 566 pesos. Net loans, defined as loans received from other families less loans given to other families, increased by 938 pesos.

3.3 Reduced form estimation for risk-coping strategies

Given that rainfall shocks are weak instruments for household income, I focus on the reduced form here as well. To determine whether remittances, loans, and assets are used as *ex post* mechanisms to insulate consumption, they are regressed separately on rainfall shocks. 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 the replacement rate or the percentage of a fall in income that is replaced (Yang and Choi, 2007). I estimate the following Equation (10) using OLS :

$$\Delta o^{i}_{2006} = \pi_1 + \pi_2 \, \Delta RF^{i}_{2006} + \pi_3 \Delta X^{i}_{2006} + \pi_4 d_{2006} * V^{i} + \Delta \varepsilon^{i}_{2006} \qquad (10)$$

where Δo^{i}_{2006} is the change in the outcome variable (international remittances, domestic transfers, loans, net loans, and net assets); $\pi_1 = \pi_1 \Delta d_t$ 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, defined in 2003, that did not change over time (household head's marital status and completed education); and interaction of a time dummy and time-invariant household characteristics ($d_{2006} * V^{i}$).

If the 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. The OLS results of testing which risk-mitigating mechanisms households depend on are displayed in Table 7. The standard errors are clustered by province. The estimated coefficient on rainfall shocks is positive and statistically significant at the 5% level for the domestic remittances regression, which suggests that these transfers serve as insurance when rainfall increases. Although this estimate is small in magnitude (0.059), when compared to the rainfall shocks estimate in income regression (-0.116) in Table 5, this can be interpreted as replacing the income decline by roughly 51 percent given an increase of 500 millimeters in rainfall. While the rainfall shocks estimates are statistically insignificant in the international remittances and assets regressions, they are negative and statistically significant in the loans and net loans regressions. There are five possible reasons for this inverse relationship between informal loans and rainfall shocks.

First, 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. To test this, I need another period to see if informal loans from other families increase when they encounter good shocks to their income. This is reserved for further studies since the 2009 results of FIES are unavailable as of this writing.

Second, lenders may be risk averse and relatively less willing to lend during a bad state of nature due to the creditworthiness of the borrowers. To empirically test this, I divide the sample, using 2003 wealth data, into wealthy and unwealthy households, then regress loans and net loans on rainfall shocks. Wealthy households are defined as those whose income are above the average while unwealthy households are those with income below or equal to the mean. If the coefficient estimates on rainfall shocks are negative and significant for unwealthy households but insignificant for wealthy households, then procyclical lending standards may explain why loans and net loans increase during bad state of the nature. Table 8 shows the results of this test for unwealthy and wealthy households separately. While the estimates on rainfall shocks are negative and statistically significant at the 5 percent level for the unwealthy households in loans and net loans regressions (Columns 1 and 2), they are negative and insignificant for wealthy households (Columns 3 and 4). It can be inferred that it is the unwealthy agricultural households who are affected by these lending standards and are unable to borrow money from other families when they encounter rainfall shocks.

Third, borrowers and lenders may be experiencing similar rainfall shocks, particularly if they belong to the same municipality. If so, their incomes most likely have a high covariance, which reduces the effectiveness of local risk-sharing arrangements (Bardhan and Udry, 1999). I cannot explicitly verify this conjecture since the national survey that I use (FIES) does not contain the exact location of families that provide loans. However, I still attempt to test this by introducing interaction terms that could possibly capture some degree of variation in rainfall shocks within the same locality. I interact municipal-wide rainfall shocks and categories of other agricultural activities such as farming of animals, animal husbandry, fishing, and logging. This would verify whether households engaged in different other agricultural activities share risks and insure each other within the same locality and via what mechanisms. Table 9 shows that there is no partial insurance when these interaction terms are included, that is, although rainfall shocks adversely affect household consumption for those who grow crops, they do not impact household income. The same is true for households who engage in other categories of agricultural activities. The results of experimenting with the interaction of quarterly rainfall variables and other agricultural activities suggest that rainfall shocks do not affect income and consumption; the same is true when seasonal rainfall variables are interacted. This exercise shows that there is no evidence of partial consumption insurance and no risk-sharing among different occupational groups.

Fourth and quite a stretch of an explanation is crowding-out effect, that is, domestic remittances crowd-out informal loans. This can be tested empirically by regressing informal loans on domestic remittances. However, the challenge is to find a valid instrument for domestic transfers since it is an endogenous variable. This is reserved for further studies along with testing the *ex-ante* risk-coping mechanism explanation. Fifth, it is possible that agricultural households simply opt not to borrow for fear of defaulting on debt. Out of these five explanations, the one on procyclical lending standards is the only one that has been verified through an empirical test.

3.4 Reduced form estimation for the sum of risk-coping strategies

It can be inferred from the results of tests of full consumption insurance and risk-coping mechanisms above that both household income and consumption of agricultural households are adversely affected by rainfall shocks. However, consumption is partially insured against these shocks by about 16 percent. Based on the tests on risk-coping mechanisms, some degree of consumption smoothing may be attributed to an increase in domestic transfers, which replace about 51 percent of the income decline. However, both loans and net loans are adversely affected by rainfall shocks, and the decrease in informal loans is about 34 percent of decline in income. So, informal loans somehow offset the increase in domestic transfers leading one to conjecture that there is little net change in resource availability. In fact, the net access to resources is about 16 percent after taking into consideration the opposite signs of domestic transfers and loans.

To formally test whether the net change in resource availability is small or whether it is significant at all I use the change in the sum of four possible risk-coping mechanisms (international remittances, domestic remittances, informal loans, and assets) in proportion to initial household income in 2003 as the dependent variable. Using similar independent variables as in Equation (10), the coefficient on rainfall shocks in Table 10 is statistically insignificant, which points to the conclusion that although there is a change in risk-coping mechanisms used by agricultural households, the net resources available remain relatively unchanged. Given this result, I can infer that since there is little consumption smoothing (16 percent), it may follow that the net change in resources available is insignificant. I complement this result with further tests on the impact of rainfall shocks on entrepreneurial activities, human capital accumulation, household labor supply, and labor supply and schooling of children, which will be discussed in the latter section.

Based on the FIES dataset, the average income (net of international and domestic remittances) of agricultural households in 2003 was about 47,000 pesos a year, which was below the amount needed by a five-member household in the Philippines to stay above the poverty level.[4] It makes sense that agricultural households whose income are vulnerable to weather variation are among the poorest groups in the nation. In fact, in 2003 agricultural households had the highest poverty incidence, at about 43 percent, among financially vulnerable and marginalized groups.[5]

Given the economic situation of farmers in the Philippines and their limited access to credit and financial markets, it is an issue that needs to be addressed if they cannot even effectively share their risks with their network of family and friends. As noted, although they can rely on family members who may have migrated to other areas

---

[4] The National Statistical Coordination Board (NSCB) in the Philippines estimates that Filipino families with five members need to earn a combined monthly income of 5,129 pesos (61,548 pesos a year) to meet their most basic food and non-food needs.

[5] According to the NSCB, among poor and marginalized groups (for example, women, children, youth, senior citizens, urban poor, migrant, and formal sector workers), farmers and fishermen had the highest poverty incidence, at about 42 and 44 percent, respectively.

that are less affected by rainfall shocks and who can send domestic transfers, this is dampened by a corresponding decrease in informal loans, and so the net resources available remain small.

4. Robustness checks

To test the robustness of the OLS results, I consider the possibility that the error terms across the five regressions for the different risk-coping mechanisms are correlated. I estimate Equation (10) using seemingly unrelated regression (SUR). The results are similar with the OLS estimates presented in Table 7. In particular, the estimated coefficients for rainfall shocks are statistically significant for domestic transfers and informal loans regressions. As in OLS, domestic transfers replace about 51 percent of the income decline, whereas informal loans actually decrease when agricultural households experience rainfall shocks. The similarity in results between OLS and SUR may imply that the error terms among the different regressions for international remittances, domestic transfers, informal loans, and assets are actually uncorrelated.

Another test of consistency is omitting the interaction between time-invariant household characteristics (marital status and educational attainment) and the time dummy. In the previous section, these interaction variables are included to control for the differential impacts of aggregate shocks on different demographic groups. The regression specifications are similar to those in Table 7. The results are consistent regardless of whether the interaction variables are omitted (Table 11). Household income and consumption are adversely impacted by rainfall shocks; domestic transfers respond positively to these shocks while informal loans are negatively related to rainfall shocks. One implication of the consistency in the results is that since the null hypothesis of full consumption insurance is rejected and there is small evidence of partial consumption insurance, these groups (educated and less educated, and single and married) do not share risks and do not insure each other when shocks occur.

5 Other types of households

I also use alternative types of households for comparative analysis – rural households, rural non-agricultural households, urban households, agricultural households in urban areas, households with international migrants, and households without international migrations. The results for these regressions are displayed in the Appendix section.

5.1 Rural households

First, I extend my analysis to all rural households (1,236 households), which encompass both agricultural and non-agricultural households. These households, along with the succeeding households analyzed, are defined on the basis of data from 2003. Using the same variables and applying a similar identification strategy as in the analysis of agricultural households, the results from the first row in the Appendix section imply that some degree of consumption insurance exists. The results are consistent with agricultural households: a 500-millimeter increase in rainfall causes a 4.75 percentage point decline in income and a 4 percentage point fall in consumption, which suggests that

16 percent of consumption is insured (Columns 1 and 2). The OLS estimate on rainfall shocks in domestic transfers regression is positive and statistically significant at the 5% level (Column 4). Comparing this estimate (0.033) with the rainfall shocks estimate in income regression (-0.095) in (Column 1), the results suggest that domestic transfers replace about 35 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 and they represent about 30 percent of income decline (Columns 5 and 6). The net change in resource availability is about 5 percent.

5.2 Non-agricultural rural households

I also test the response of non-agricultural households in rural areas. The results, which can be gleaned from the second row in the Appendix section, imply that the income and consumption are unaffected by rainfall shocks. This is to be expected given that the two major sources of income for these households are sales and transportation, which are not directly affected by rainfall.

5.3 Urban households

Urban households are likewise not impacted by rainfall shocks; the estimated coefficients of rainfall shocks are statistically insignificant in the income and consumption regressions. A possible explanation why income of urban households is unresponsive to rainfall shocks is that only about 18 percent of the households are engaged in farming and other agricultural activities; the majority are in sales and other jobs. I also test whether households in urban areas whose primary source of income is agriculture respond to rainfall shocks. The Appendix shows that the rainfall shocks estimate is also insignificant for these households.

5.4 Migrant versus non-migrant households

The finding of this paper that international remittances are unresponsive to rainfall shocks for agricultural households is inconsistent with other studies on insurance and remittances. One explanation for this is that other papers (Yang and Choi, 2007, for example), focused on the entire households in the Philippines as opposed to agricultural households. They separate migrant from non-migrant households to test the sensitivity of international remittances to income shocks (instrumented by rainfall shocks), and determine which type of household has smoother consumption. In their results, migrant households appear to be able to smooth consumption better than non-migrant households although caveat exists since the error terms are too large and the conclusion is deemed to be only suggestive. Another result in their paper suggests that income positively affect remittances for non-migrant households. This may be driven by the positive relationship between income and overseas migration for these households since higher income means that they are able to pay fixed costs associated with international migration assuming that they are facing credit and savings constraints.

I also separate migrant and non-migrant households, which is determined by whether the agricultural household receives remittances from migrant members. I find that while the income and consumption of households with international migrants are unaffected by rainfall shocks, non-migrant households' income and consumption are responsive to rainfall shocks, with the response of consumption being less than that of income (Appendix, fifth and sixth rows). This may imply that non-migrant households are better able to insure their consumption than migrant households. The estimated coefficient for rainfall shocks is insignificant in the domestic transfers regression, but significant and negative in the net loan regression for non-migrant households (Columns 4 and 6). It seems that although there is little consumption smoothing among non-migrant households (about 13 percent), this cannot be attributed to any of the risk-coping mechanisms I am examining.

To put the results into context, I also test how rainfall shocks may affect international migration. I use change in an indicator variable for agricultural households with international migrants between 2003 and 2006. Using specifications similar to Table 7, the results show that rainfall shocks have no effect on international migration (Appendix, Column 8). This might be true since there are only about 17 percent of agricultural households that have migrants in 2003, and about 16 percent in 2006.

In conclusion, international migration does not insure consumption; neither do international remittances. Non-migrant households are no better at smoothing their consumption since only a small percentage of consumption is smoothed and none of the risk-coping mechanism I am analyzing is responsible for this smoothing. In fact, informal loans, as always decreased with rainfall shocks.

To summarize the results for other types of households: first, the results for rural households are consistent with the results for agricultural households. There is evidence of partial insurance in both, there are also more domestic transfers and fewer informal loans when rainfall shocks increase. Second, unlike migrant households, non-migrant households insure their consumption partially, however, they do not rely on any of the risk-mitigating strategies I am examining, in addition, their informal loans actually decrease. Third, as expected, income and consumption in urban households and non-agricultural rural households are unresponsive to rainfall shocks.

6. Additional tests

6.1 Entrepreneurial activities

Based on the results shown above, agricultural households are unable to effectively insure their consumption during bad state of the nature. Aside from the increase in domestic transfers, which is partially offset by the decrease in informal loans, farmers have limited or no access to other mechanisms to smooth (or insure) their consumption.

I want to explore how rainfall shocks affect other outcomes using the panel data. It is possible that agricultural households rely on other sources of income, such as entrepreneurial activities. I use 11 types of entrepreneurial activities, which are listed in Table 12, following how the survey defines them. The majority of agricultural households (69 percent) are engaged in crop farming and gardening activities. I define the outcome variables as: (a) change in entrepreneurial income between 2003 and 2006; (b) change in entrepreneurial income in proportion to household income in 2003; (c) entry into a new entrepreneurial activity, which has a value of one if there is no reported income for this activity in 2003 but has a non-zero value in 2006; (d) exit from entrepreneurial activity, assigned a value of one if the household reports income coming from this activity in 2003, but there is no reported income from a similar activity in 2006; and (e) net entry into an activity, which is the difference between the entry into and exit from this activity.

It can be gleaned from Table 12 (Columns 1 and 3) that entry and net entry into wholesale and retail sales are statistically significant and positively affected by rainfall shocks. The opposite effect is observed for entry into transportation, storage, and communication services and net entry into activities not elsewhere classified; rainfall shocks adversely affect these two outcome variables (Columns 1 and 3).[6] One economic explanation for these results is that during bad state of the nature, farming households find an alternative source of income through peddling. However, transportation and communication services are easily adversely affected by heavy rain, for instance, traveling is limited during typhoon and communication services may be disrupted; the same can be said for activities not elsewhere classified, which include electricity, gas, and water services.

6.2 Household labor supply, children's labor supply, and schooling

I also want to know if the total hours worked by all household members change when the household experiences rainfall shocks, as members may be adjusting their working hours in order to cope with risks and smooth their consumption (Halliday,

[6] Wholesale and retail activity encompass market vending, sidewalk vending, and peddling while transportation, storage, and communication include services such as the operation of jeepneys or taxis, storage and warehousing activities, tour and travel agencies, messenger services, and so on. Entrepreneurial activities not elsewhere classified may include electricity, gas and water, financing, insurance, real estate, and business services.

2012). In particular, I want to determine if children need to work, and how their labor supply is affected during bad state of the nature. Do they help their families cope with risks? Is their schooling affected? What about expenditures that are allocated to education and health? I explore all these questions below.

Given the same regression specifications as in Table 7, Table 13 displays the coefficient estimates on rainfall shocks when the outcome variables are change in total hours worked by all members in the household (Column 8) and changes in hours worked in different employment types in the week prior to the survey (Columns 1 to 7).[7] Rainfall shocks estimates are statistically significant and negative for agricultural households with members working for private households, but positive and statistically significant for those working without pay. These results imply that household members work less for private households when rainfall shocks increase and work more without pay on own-family-operated farms or businesses. I can conjecture that during bad state of the nature, family members tend to either work more on their farms to offset the adverse effects of rainfall shocks or they tend to engage in non-farm activities to smooth their consumption. This last explanation may be consistent with the results for entrepreneurial activity seen in Table 12. Given that agricultural households engage more in wholesale and retail entrepreneurial activity (which includes market vending and sidewalk vending) when rainfall shocks increase, it makes sense that household members would devote more hours to own-family-operated businesses to cope with risks and smooth their consumption.

[7] Household members may be working in any of the following seven types of employment, based on a 2003 survey: private household, private establishment, government or government corporation, self-employed, employer, family-owned business (with pay), and family-owned business (without pay).

Table 14 displays the estimated coefficients of rainfall shocks when the outcome variables are change in total hours worked (Column 6) and changes in hours worked in different types of employment (Columns 1 to 5) by all children in the household aged 10 to 17 (in survey year 2003).[8] The estimates are insignificant for all types of employment and for total hours worked, which implies that children's labor supply is unaffected by rainfall shocks.

Table 14 (Column 7) shows the results of regressing children's schooling on rainfall shocks. The outcome variable is measured as the change from 2003 to 2006 in the number of children at school in proportion to the number of children in the household. The estimated coefficient of rainfall shocks is negative but statistically insignificant, suggesting that rainfall shocks have no impact on the schooling of children.

It is good to know that children's labor supply and schooling are unaffected by rainfall shocks, which would imply that children are shielded from the adverse effects of these shocks. Further results below on the impact of similar shocks on education and health may strengthen this inference.

6.3 Human capital accumulation (health and education) and durable goods

It is also interesting to determine what happens to expenditures on health and education when agricultural households experience adverse shocks to their income.

[8] No children worked as employers or in family-owned business with pay, so these categories are omitted from the analysis.

Table 15 displays the results of this exercise if the outcome variable is expenditures on education and health.[9]

The estimated coefficient of rainfall shocks for health expenditures is negative and statistically significant at the 5% level, whereas it is positive and statistically significant at the 1% level for education. The results imply that as rainfall shocks increase by 500 millimeters, expenditures on education increase by almost 1 percentage point while expenditures on health decrease by about 0.5 percentage point. Given that the number of hours worked by children was unresponsive to rainfall shocks, it is possible that they were at school despite the increase in rainfall shocks. However, the increase in education expenditures is somehow offset by the decrease in health expenditures, such that the net impact on human capital accumulation is about 0.5 percentage point given the increase in shocks, which is minimal. This supports the idea that children are somehow protected from the adverse impacts of rainfall shocks. Finally, the estimate for rainfall shocks for durable goods is insignificant.[10] A possible explanation for this is that only 17 percent of agricultural households had expenditures on durable goods in 2003, so there is insufficient variation in the outcome variable.

7. 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

---

[9] Health and education are measured as a change in proportion to the initial household expenditures in 2003.

[10] Durable goods are defined as change in proportion to the initial household expenditures in 2003. Durable goods include audio-visual equipment, kitchen appliances, furniture, and transport equipment.

by rainfall shocks. The second is to examine whether they use migration, 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 migration, 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 offers 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 the rural Philippines cope with extreme income variation, given their limited access to formal credit, capital and insurance markets, and government assistance. A majority of these households depend 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 below the 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.

Although the rainfall shocks turn out to be weak instruments for income shocks I still estimate the model using 2SLS for comparative analysis. I find that the IV estimates are consistent with the OLS estimates when reduced form is used, that is, when both income and consumption are regressed on rainfall shocks. Full consumption insurance is rejected, however, agricultural households do insure their consumption to some degree. Approximately 16 percent of consumption is insured. Family members who migrated to a place where the rainfall shocks covary negatively with those experienced by agricultural households are better able to provide insurance and send remittances to their families experiencing the adverse effects of rainfall (Paulson, 2000). Indeed, domestic remittances increase when rainfall shocks increase, however, informal loans decrease. Domestic remittances replace about 51 percent of the income decline, but this is somehow offset by a decrease in informal loans, which is about 34 percent of the income decline. In effect, the risk-coping mechanism may have changed but the available resources have not, and only about 16 percent of the income decline is replaced. These results are exactly the same when the SUR specification is used, which shows that the error terms among the different regressions for risk-mitigating strategies are uncorrelated and that the OLS estimation method is sufficient.

In addition, the OLS results for agricultural households are consistent among rural households, which indicate a 16 percent consumption insurance, a 35 percent replacement rate for domestic transfers, and a decrease in informal loans that is equal to 30 percent of the income decline. In net, only about 5 percent of the income decline is replaced.

There are five possible reasons why loans from other families are not used to share risks when rainfall increases. First, borrowers and lenders may be experiencing similar shocks. If so, their incomes most likely have a 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 those experienced by agricultural households. The second 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. Third, loans are used instead as an *ex ante* mechanism in insulating consumption. It is possible that farmers borrow more money in good times to invest in technology or innovations (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. Fourth, domestic remittances may be crowding out loans. Remittances are most likely preferable and more convenient than loans because receiving households do not necessarily have to pay back the remitters. The fifth possible reason is that agricultural households opt not to borrow to avoid default risk. Out of these five possible reasons, the one that pertains to the procyclical lending standards is the most plausible and verifiable explanation. The other explanations are reserved for further study due to data limitations.

Agricultural households do not rely on international remittances and sale of financial and real assets. The results on assets can be attributed to how I measure assets, constrained by available 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. With regard to international remittances, only a few agricultural households (about 13 percent) have migrant members abroad who can send remittances owing to the fact that migration entails high fixed costs. Since agricultural households face credit and financial constraints, only a few can afford to send their members abroad. In addition, there is little variation in the relationship between remittances and rainfall shocks. This is supported by the results of directly testing the impact of rainfall shocks on change in the number of migrant members where rainfall shocks estimate is insignificant. Furthermore, when households are split into migrant and non-migrant households, only the second type of household partially insure their consumption.

To put the results in context, although partial insurance exists, only about 16 percent of consumption is insured, which implies that about 84 percent of consumption is not smoothed. In addition while domestic transfers increase, informal loans decrease. To determine whether this risk-coping strategy is effective, I analyze the impact of rainfall shocks on the sum of risk-coping strategies. I find the coefficient insignificant, signaling that the net resources available are not changed. It can be inferred from the results that agricultural households are ineffectively sharing their risks and insuring their consumption.

To complement these results, I investigate whether agricultural households have other forms of risk-coping strategies or sources of income to cope with risks and smooth their consumption. I analyze how entrepreneurial activities could possibly help these households during the bad state of the nature and find that they also engage in wholesale and retail entrepreneurial activity, which includes market vending and peddling. This is supported by another result: when the household labor supply is regressed on rainfall shocks, households tend to work more without pay on own family-operated farms or businesses. I also want to know whether children are affected by rainfall shocks by examining how children's total hours worked, their schooling and expenditures on education change. Neither the children's labor supply nor their schooling are affected by rainfall shocks, and education expenditures increase by about 1 percentage point given a 500-millimeter increase in rainfall. All of these point to the conjecture that children are somehow protected from rainfall shocks. However, expenditures on health decrease by a minimal amount, about 0.5 percentage point, which may mean that there are fewer illnesses and less need to go to the hospital but because of data limitations this cannot be verified.

Agricultural households are perhaps the poorest of the poor among Filipinos. Among the marginalized and poor groups in the Philippines, farmers and fishermen had the highest poverty incidence at about 43 percent. In addition, the 2003 FIES data reveal that the average annual income of agricultural households falls below the amount necessary for a five-member household in the Philippines to meet their most basic and non-food needs for the year. It is easy to understand why these households face such economic difficulties: the results of this paper indicate that their income is vulnerable to weather variations and rainfall shocks and they cannot effectively share their risks with their family and friends, much more with their fellow farmers who are experiencing similar rainfall shocks. They need public transfers and better infrastructure to cope with risks. For example, improving the irrigation system could lessen reliance on rainfall during the 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.

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 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 to find 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.

References

Bardhan, Pranab and Christopher Udry. 1999. *Development Microeconomics*. Oxford: Oxford University Press.

Bureau of Agricultural Statistics. 2011. "Volume of Rice Production." http://countrystat.bas.gov.ph/?cont=10&pageid=1&ma=A10PNVCP.

Clarke, George, and Scott Wallsten. 2003. "Do Remittances Act Like Insurance? Evidence From a Natural Disaster in Jamaica." World Bank Development Research Group, Washington, DC.

Cochrane, John. 1991. "A Simple Test of Consumption Insurance." *Journal of Political Economy* 99 (5): 957-976.

Deaton, Angus. 1992. *Understanding Consumption*. Oxford: Oxford University Press.

Dubois, Pierre, and Ethan Ligon. 2005. "Incentives and Nutrition for Rotten Kids: Intrahousehold Food Allocation in the Philippines." Working Paper, Department of Agricultural and Resource Economics, University of California at Berkeley.

Fafchamps, Marcel, and Susan Lund. 2003. Risk-Sharing Networks in Rural Philippines. *Journal of Development Economics* 71: 261-287.

Halliday, Timothy. 2012. "Intra-Household Labor Supply, Migration, and Subsistence Constraints in a Risky Environment: Evidence from Rural El Salvador." *European Economic Review* 56: 1001-1019.

Lucas, Robert, and Oded Stark. 1985. "Motivations to Remit: Evidence from Botswana." *Journal of Political Economy* 93 (5): 901-918.

Maccini, Sharon, and Dean Yang. 2009. "Under the Weather: Health, Schooling, and Economic Consequences of Early-Life Rainfall." *American Economic Review* 99 (3): 1006-1026.

Mace, Barbara. 1991. "Full Insurance in the Presence of Aggregate Uncertainty." *Journal of Political Economy* 99 (5): 928-956.

National Irrigation Administration. 2011. "Irrigated Area by Year and Item." http://countrystat.bas.gov.ph/selection.asp.

Paulson, Anna. 2000. "Insurance Motives for Migration: Evidence from Thailand." Northwestern University, Kellogg Graduate School of Management.

Paxson, Christina. 1992. "Using Weather Variability to Estimate the Response of Savings to Transitory Income in Thailand." *American Economic Review* 82 (1): 15–33.

Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA). 2011. "Climatology and Agrometeorology." http://kidlat.pagasa.dost.gov.ph/cab/cab.htm.

Platteau, Jean-Philippe, and Anita Abraham. 1987. "An Inquiry into Quasi-Credit Contracts: The Role of Reciprocal Credit and Interlinked Deals in Small-Scale Fishing Communities." *Journal of Development Studies* 23 (4): 461-490.

Quisumbing, Agnes, and Scott McNiven. 2005. "Migration and the Rural-Urban Continuum: Evidence from the Rural Philippines." Food Consumption and Nutrition Division Discussion Paper 197.

Ravallion, Martin, and Shubham Chaudhuri. 1997. "Risk and Insurance in Village India: Comment." *Econometrica* 65 (1): 171-184.

Rosenzweig, Mark, and Kenneth Wolpin. 1993. "Credit Market Constraints, Consumption Smoothing and the Accumulation of Durable Production Assets in Low-Income Countries: Investments in Bullocks in India." *Journal of Political Economy* 101 (2): 223-244.

Staiger, Douglas, and James Stock. 1997. "Instrumental Variables Regression with Weak Instruments." *Econometrica* 65 (3): 557-586.

Stock, James, and Motohiro Yogo. 2002. "Testing for Weak Instruments in Linear IV Regression." NBER Technical Working Paper 284, National Bureau of Economic Research.

Townsend, Robert. 1994. "Risk and Insurance in Village India." *Econometrica* 62 (3): 539-591.

Udry, Christopher. 1990. "Credit Markets in Northern Nigeria: Credit as Insurance in a Rural Economy." *World Bank Economic Review* 4 (3): 251-269.

World Bank. 2012. "Workers' Remittances and Compensation of Employees, Received (Current US$)." http://data.worldbank.org/indicator/BX.TRF.PWKR.CD.DT.

Yang, Dean, and HwaJung Choi. 2007. "Are Remittances Insurance? Evidence from Rainfall Shocks in the Philippines." *World Bank Economic Review* 21 (2): 219-248.

Figure 1 Relationship between international remittances and rainfall shocks

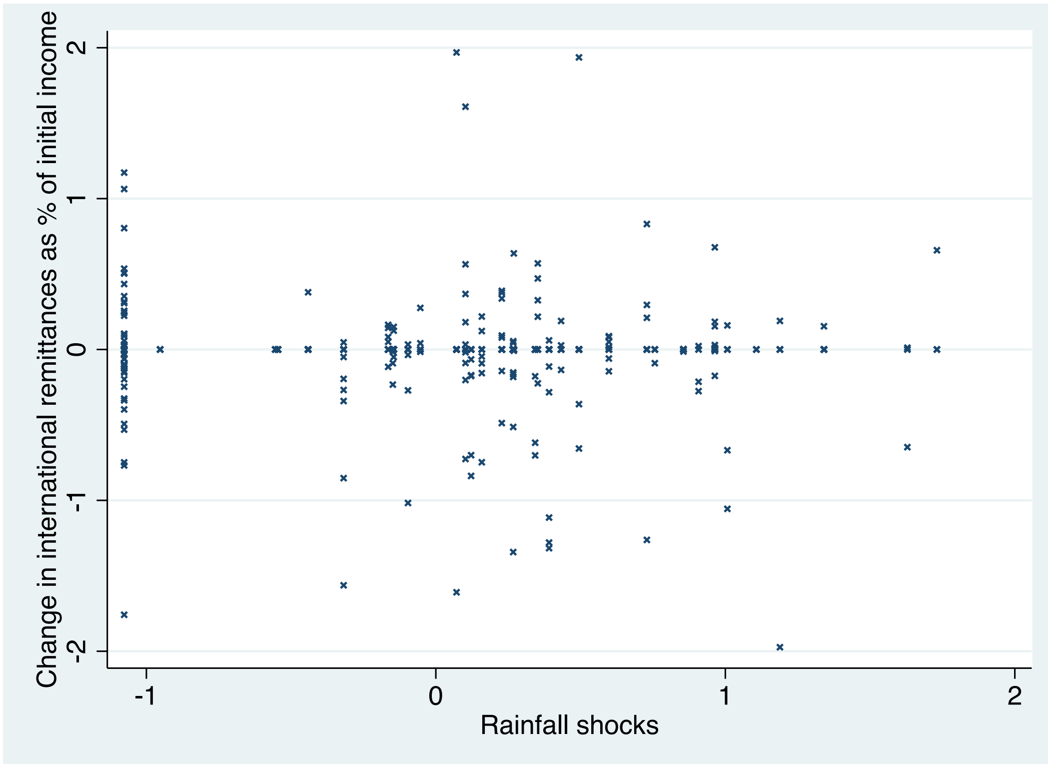

Table 1 Household Head Characteristics in 2003 for Agricultural Households (Mean)

	Agricultural Households
Survey year 2003	
Education	
Elementary	0.65
High School	0.26
College	0.06
No Grade Completed	0.04
Marital Status	
Single	0.13
Married	0.87
Widowed	0.09
Divorced/Separated	0.02
Type of Job	
Agriculture	0.85
Other Agriculture	0.15
Age	48
Household size	5
Survey year 2006	
Age	51
Household size	5
Number of Households	721

[a/] Other Agriculture refers to agricultural activities other than planting crops, such as farming of animals, animal husbandry, fishing, and logging.

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

Outcome Variable	Description	Mean (Std. Dev.)
Total Income	Change in household income (from 2003 to 2006) as share of income in 2003	0.33 (0.89)
	Change in household income	10,676 (64,261)
Total Expenditure	Change in expenditures of households (from 2003 to 2006) as share of expenditures in 2003	0.28 (0.59)
	Change in household expenditures	12,721 (46,001)
International Remittance	Change in international remittances (from 2003 to 2006) received as share of income in 2003	-0.01 (0.36)
	Change in international remittances	-949 (27,130)
Domestic Remittance	Change in domestic remittances (from 2003 to 2006) as share of income in 2003	0.01 (0.29)
	Change in domestic remittances	1,269 (12,489)
Net Asset	Change in net assets as share of initial annual 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 (0.39)
	Change in net assets	-336 (18,449)
Loans	Change in loans (from 2003 to 2006) from other families as share of income in 2003	0.002 (0.11)
	Change in loans from other families	566 (9,562)
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.	0.002 (0.13)
	Change in net loans	938 (11,071)
Rainfall Variables		
RF 2006 - RF 2003 (1000 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 (GCD)	0.12 (0.60)
RF 2006 - RF mean (1000 mm.)	2006 annual rainfall less mean annual rainfall (1974-2000)	0.15 (0.34)
RF 2003 - RF mean (1000 mm.)	2003 annual rainfall less mean annual rainfall (1974-2000)	0.05 (0.52)
Number of Households		721

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

Variables	First Stage *(Income)*	Second Stage *(Consumption)*
RF 2006 - RF 2003	-0.116*	
(1000 mm.)	(0.061)	
Income		0.845***
		(0.280)
Household Size	0.147***	-0.010
	(0.024)	(0.041)
Age	-0.006	0.004
	(0.005)	(0.005)
Marital Status *(Married omitted)*		
Single [b/]	-0.046	-0.074
	(0.076)	(0.063)
Education *(Elementary omitted)* [a/]		
High School	-0.044	0.014
	(0.087)	(0.065)
College	0.118	-0.159
	(0.155)	(0.101)
Type of Job *(Agriculture omitted)*		
Other Agriculture [c/]	-0.069	-0.069
	(0.105)	(0.075)
Constant	0.408***	0.010
	(0.070)	(0.126)
Number of households	721	721
R-squared	0.079	0.152
F-statistics		3.671

Notes: * significant at 10%, ** at 5%, and *** at 1%. Parentheses indicate standard errors clustered by province. 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, animal husbandry, fishing, and logging.

Table 4 F-statistics for Different Instrumental Variables Used for Agricultural Households

Instruments	**F-statistics**
3 IV for 3 closest weather stations	1.0
Quarterly Rainfall	1.4
Seasonal Rainfall	2.2
Interaction of Rainfall and Other Agriculture	2.6
Interaction of Quarterly Rainfall and Other Agriculture	1.6
Interaction of Seasonal Rainfall and Other Agriculture	3.0
Quadratic Form	4.5
Inclusion of Typhoon	2.8

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

Variables	**Income**	**Consumption**
RF 2006 - RF 2003	-0.116*	-0.098**
(1000 mm.)	(0.061)	(0.046)
Household Size	0.147***	0.115***
	(0.024)	(0.011)
Age	-0.006	-0.001
	(0.005)	(0.007)
Education *(Elementary omitted)* [a/]		
High School	-0.044	-0.024
	(0.087)	(0.066)
College	0.118	-0.059
	(0.155)	(0.071)
Marital Status *(Married omitted)*		
Single [b/]	-0.046	-0.113***
	(0.076)	(0.036)
Type of Job *(Agriculture omitted)*		
Other Agriculture [c/]	-0.069	-0.127**
	(0.105)	(0.056)
Constant	0.408***	0.355***
	(0.070)	(0.053)
Number of households	721	721
R-squared	0.079	0.113

Notes: * significant at 10%, ** at 5%, and *** at 1%. Parentheses indicate standard errors clustered by province. 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, animal husbandry, fishing, and logging.

Table 6 Effects of Rainfall on Household Income and Consumption in Agricultural Households (With Typhoon) (OLS)

VARIABLES	Income (1)	Consumption (2)	Income (3)	Consumption (4)	Income (5)	Consumption (6)
RF 2006 - RF 2003	-0.111*	-0.090*	-0.129	-0.062	-0.132*	-0.067
(1000 mm.)	(0.060)	(0.045)	(0.077)	(0.061)	(0.075)	(0.060)
Typhoon 1	-0.140**	-0.202***			-0.156**	-0.185***
	(0.066)	(0.045)			(0.061)	(0.045)
Typhoon 2			0.003	-0.010	0.006	-0.007
			(0.011)	(0.010)	(0.011)	(0.011)
Number of households	721	721	721	721	721	721
R-squared	0.080	0.118	0.079	0.115	0.081	0.119

Notes: * significant at 10%, ** at 5%, and *** at 1%. Parentheses indicate standard errors clustered by province. Typhoon 1 is defined as the change in an indicator variable for whether typhoons have occurred in the municipality in the past year and Typhoon 2 is measured as the change in the number of typhoons that hit the area in the past year.

Table 7 Effects of Rainfall on Remittances, Loans, and Net Assets in Agricultural Households (OLS)

	International Transfers	Domestic Transfers	Loans	Net Loans	Net Assets
Variables					
RF 2006 - RF 2003	-0.027	0.059**	-0.018**	-0.022***	-0.025
(1,000 mm.)	(0.018)	(0.024)	(0.007)	(0.007)	(0.032)
Household Size	0.020	-0.012**	0.001	-0.001	0.010
	(0.012)	(0.006)	(0.002)	(0.002)	(0.009)
Age	-0.000	0.001	0.001	0.001	-0.002
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
Education *(Elementary omitted)* [a/]					
High School	-0.016	-0.012	0.006	0.012	-0.030
	(0.034)	(0.014)	(0.009)	(0.010)	(0.022)
College	0.015	-0.088**	0.005	0.018	-0.213
	(0.059)	(0.037)	(0.019)	(0.021)	(0.144)
Marital Status *(Married omitted)*					
Single [b/]	0.036	-0.023	0.003	0.012	-0.158*
	(0.064)	(0.036)	(0.017)	(0.018)	(0.091)
Type of Job *(Agriculture omitted)*					
Other Agriculture [c/]	0.002	-0.054**	0.027*	0.030*	-0.061
	(0.038)	(0.026)	(0.016)	(0.017)	(0.073)
Constant	-0.007	0.023	-0.005	-0.008	0.050
	(0.023)	(0.016)	(0.011)	(0.011)	(0.031)
Number of households	721	721	721	721	721
R-squared	0.011	0.030	0.019	0.023	0.037

Notes: * significant at 10%, ** at 5%, and *** at 1%. Parentheses indicate standard errors clustered by province. 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, animal husbandry, fishing, and logging.

Table 8 Effects of Rainfall on Loans (Wealthy versus Unwealthy) in Agricultural Households (OLS)

	Unwealthy		Wealthy	
	Loans	Net Loans	Loans	Net Loans
Variables	(1)	(2)	(3)	(4)
RF 2006 - RF 2003	-0.017**	-0.020**	-0.001	-0.019
(1,000 mm.)	(0.007)	(0.008)	(0.020)	(0.021)
Household Size	0.002	0.001	-0.005	-0.012
	(0.002)	(0.002)	(0.008)	(0.009)
Age	-0.001	-0.001	0.021**	0.020**
	(0.001)	(0.001)	(0.008)	(0.009)
Education				
Elementary [a/]			-0.018	-0.020
			(0.017)	(0.022)
High School	0.000	0.010		
	(0.009)	(0.011)		
College	-0.018	-0.013	0.009	0.041
	(0.023)	(0.020)	(0.026)	(0.038)
Marital Status *(Married omitted)*				
Single [b/]	-0.013	-0.006	0.049**	0.069***
	(0.011)	(0.012)	(0.022)	(0.023)
Type of Job *(Agriculture omitted)*				
Other Agriculture [c/]	0.016	0.017	0.031	0.042
	(0.011)	(0.012)	(0.040)	(0.041)
Constant	0.003	0.002	-0.052	-0.066*
	(0.007)	(0.007)	(0.031)	(0.032)
Number of households	616	616	105	105
R-squared	0.013	0.015	0.275	0.237

Notes: * significant at 10%, ** at 5%, and *** at 1%. Parentheses indicate standard errors clustered by province. 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, animal husbandry, fishing, and logging.

Table 9 Effects of Rainfall on Household Income and Consumption with Interaction of Rainfall and Other Agricultural Activities in Agricultural Households (OLS)

Variables	Income	Consumption
RF 2006 - RF 2003	-0.113	-0.100**
(1,000 mm.)	(0.070)	(0.046)
RF* Farm Animals	-0.190	0.083
	(0.376)	(0.150)
RF* Animal Husbandry	0.166	0.337
	(0.309)	(0.362)
RF* Forestry	-0.471***	-0.470***
	(0.092)	(0.089)
RF * Fishing	0.209**	0.110
	(0.095)	(0.078)
Other Agriculture		
Farm Animals	0.544	0.017
	(0.380)	(0.100)
Animal Husbandry	-0.504***	-0.291***
	(0.108)	(0.099)
Forestry	0.160	0.121
	(0.099)	(0.104)
Fishing	-0.177	-0.124*
	(0.110)	(0.070)
Household Size	0.146***	0.118***
	(0.024)	(0.010)
Age	-0.006	-0.000
	(0.005)	(0.007)
Education *(Elementary omitted)* [a/]		
High School	-0.062	-0.021
	(0.089)	(0.067)
College	0.064	-0.061
	(0.138)	(0.072)
Marital Status *(Married omitted)*		
Single [b/]	-0.056	-0.108***
	(0.079)	(0.038)
Constant	0.414***	0.350***
	(0.069)	(0.055)
Number of households	714	714
R-squared	0.100	0.126

Notes: * significant at 10%, ** at 5%, and *** at 1%. Parentheses indicate standard errors clustered by province. a/ Elementary includes No Grade Completed. b/ Single includes Widowed, Divorced, and Separated.

Table 10 Effects of Rainfall Shocks on Sum of Risk-coping Strategies in Agricultural Households (OLS)

Variables	**Sum of risk-coping strategies**
RF 2006 - RF 2003	-0.033
(1,000 mm.)	(0.052)
Household Size	0.010
	(0.009)
Age	-0.002
	(0.002)
Education *(Elementary omitted)* [a/]	
High School	-0.158*
	(0.091)
College	
	-0.030
Marital Status *(Married omitted)*	(0.022)
Single [b/]	-0.213
	(0.144)
Type of Job *(Agriculture omitted)*	
Other Agriculture [c/]	-0.061
	(0.073)
Constant	0.050
	(0.031)
Number of households	721
R-squared	0.037

Notes: * significant at 10%, ** at 5%, and *** at 1%. Parentheses indicate standard errors clustered by province. 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, animal husbandry, fishing, and logging.

Table 11 Effects of Rainfall on Income, Consumption, and Risk-coping Strategies without Interaction between Time-invariant Characteristics and Time Dummy in Agricultural Households (OLS)

Variables	Income	Consumption	International Remittances	Domestic Transfers	Loan	Net Loan	Net Assets
RF 2006 - RF 2003	-0.115*	-0.098**	-0.026	0.059**	-0.017**	-0.023***	-0.018
(1,000 mm.)	(0.062)	(0.044)	(0.018)	(0.024)	(0.007)	(0.007)	(0.032)
Household Size	0.147***	0.112***	0.019	-0.014**	0.002	-0.000	0.007
	(0.025)	(0.011)	(0.013)	(0.006)	(0.002)	(0.002)	(0.007)
Age	-0.006	-0.000	-0.000	0.001	0.001	0.001	-0.001
	(0.005)	(0.007)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)
Constant	0.386***	0.309***	-0.004	0.003	0.001	0.002	-0.004
	(0.046)	(0.038)	(0.013)	(0.010)	(0.006)	(0.006)	(0.011)
Number of households	721	721	721	721	721	721	721
R-squared	0.077	0.103	0.010	0.020	0.011	0.013	0.002

Notes: * significant at 10%, ** at 5%, and *** at 1%. Parentheses indicate standard errors clustered by province.

Table 12 Effects of Rainfall on Entrepreneurial Activities in Agricultural Households (OLS)

Entrepreneurial Activities	Entry	Exit	Net Entry	Change in Entrep. Income	Change in Entrep. Income as a Share of Initial Household Income
	(1)	(2)	(3)	(4)	(5)
Crop farming and gardening	-0.015	0.022	-0.036	-1,736.067	-0.018
	(0.017)	(0.024)	(0.033)	(1,702.471)	(0.121)
Livestock and poultry raising	0.005	-0.019	0.024	-1,487.332	-0.037
	(0.027)	(0.027)	(0.046)	(1,455.422)	(0.033)
Fishing	0.007	0.027	-0.021	157.356	-0.018
	(0.012)	(0.018)	(0.021)	(433.268)	(0.061)
Forestry and hunting	0.031	0.010	0.021	492.477	0.018
	(0.036)	(0.008)	(0.035)	(509.531)	(0.020)
Wholesale and retail	0.033*	-0.014	0.047**	-904.761	-0.019
	(0.019)	(0.013)	(0.021)	(835.377)	(0.042)
Manufacturing	0.011	0.017	-0.006	154.514	0.016
	(0.011)	(0.013)	(0.014)	(218.907)	(0.012)
Community, social, recreational, and personal services	0.003	-0.006	0.009	-82.269	-0.008
	(0.013)	(0.008)	(0.009)	(102.629)	(0.006)
Transportation, storage, and communication services	-0.021**	-0.016	-0.005	122.284	-0.006
	(0.009)	(0.011)	(0.009)	(300.553)	(0.007)
Mining and quarrying	0.002	0.007	-0.005	-72.627	-0.001
	(0.004)	(0.005)	(0.004)	(58.333)	(0.001)
Construction	0.001	0.002	-0.001	33.387	0.001
	(0.002)	(0.003)	(0.004)	(33.143)	(0.002)
Activities not elsewhere classified	-0.009	0.004	-0.013*	-78.998	-0.012
	(0.008)	(0.006)	(0.007)	(98.929)	(0.010)
Number of households in all regressions in column	721	721	721	721	721

Note: * significant at 10%, ** at 5%, and *** at 1%. Parentheses indicate standard errors clustered by province.

Table 13 Effects of Rainfall on Household Labor Supply in Agricultural Households (OLS)

Variables	Private Household	Private Establishment	Self Employed	No Pay	Government	Employer	With Pay	Total Hours
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RF 2006 - RF 2003	-1.338**	-2.560	0.014	3.122**	0.051	1.051	0.031	1.506
(1,000 mm.)	(0.587)	(3.629)	(3.810)	(1.307)	(0.481)	(1.027)	(0.132)	(3.137)
Household size	0.670	3.284***	0.044	0.012	0.656***	0.970*	0.017	7.297***
	(0.487)	(0.788)	(0.820)	(0.579)	(0.235)	(0.532)	(0.044)	(1.486)
Age	-0.046	0.196	0.158	0.204	-0.072	0.057	0.012	0.507
	(0.059)	(0.206)	(0.329)	(0.129)	(0.060)	(0.066)	(0.009)	(0.432)
Education *(Elementary omitted)* [a/]								
High School	-0.875	4.460	1.990	-0.720	1.019*	-1.291	-0.261	3.790
	(1.192)	(3.483)	(3.429)	(1.939)	(0.590)	(1.684)	(0.245)	(4.247)
College	-1.288*	2.971	1.628	2.060	0.895	-1.026	-0.207	4.696
	(0.658)	(5.714)	(5.867)	(2.223)	(2.043)	(3.229)	(0.221)	(8.961)
Marital Status *(Married omitted)*								
Single [b/]	-1.700	-3.504	0.527	-0.674	1.051*	-1.499	-0.162	-6.569
	(1.632)	(4.325)	(2.519)	(2.515)	(0.533)	(2.062)	(0.171)	(4.729)
Type of Job *(Agriculture omitted)*								
Other Agriculture [c/]	0.369	-9.636	-0.041	2.280	0.483	-0.129	0.811	-4.698
	(1.179)	(5.896)	(3.756)	(2.639)	(0.860)	(3.633)	(0.682)	(7.564)
Constant	1.487**	0.396	0.718	-1.317	-0.293	-2.539	0.082	-4.214
	(0.665)	(2.622)	(2.955)	(1.455)	(0.487)	(1.683)	(0.176)	(4.206)
Number of households	721	721	721	721	721	721	721	721
R-squared	0.008	0.032	0.001	0.009	0.025	0.010	0.008	0.055

Notes: * significant at 10%, ** at 5%, and *** at 1%. Parentheses indicate standard errors clustered by province. 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, animal husbandry, fishing, and logging. d/ Columns 1 to 7 are measured as change in hours worked in different employment types in the week prior to the survey and Column 8 is measured as change in total hours worked by all members (regardless of employment type).

Table 14 Effects of Rainfall on Children's Labor Supply and Schooling in Agricultural Households (OLS)

Variables	**Private Household**	**Private Establishment**	**Self Employed**	**No Pay**	**Government**	**Total Hours**	**Schooling**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
RF 2006 - RF 2003	-0.989	-0.027	0.735	1.308	-0.126	0.775	-0.001
(1,000 mm.)	(0.927)	(1.233)	(0.436)	(1.357)	(0.139)	(1.666)	(0.073)
Household size	0.339	1.456	-0.008	0.150	0.025	1.986*	-0.001
	(0.399)	(0.979)	(0.117)	(0.515)	(0.024)	(1.162)	(0.017)
Age	0.066	-0.315	0.004	-0.085	-0.009	-0.349	-0.004
	(0.054)	(0.289)	(0.035)	(0.107)	(0.010)	(0.287)	(0.006)
Education *(Elementary omitted)* [a/]							
High School	-2.311	2.713	1.604*	0.502	-0.215	2.078	0.068
	(1.778)	(2.168)	(0.824)	(1.668)	(0.210)	(3.898)	(0.077)
College	-0.829	0.826	0.605	0.436	-0.181	0.675	0.052
	(0.615)	(1.408)	(0.505)	(1.213)	(0.196)	(2.145)	(0.063)
Marital Status *(Married omitted)*							
Single [b/]	-3.666	-5.180	-1.122	0.299	-0.154	-9.977	0.027
	(3.222)	(6.004)	(1.255)	(1.047)	(0.161)	(6.857)	(0.170)
Type of Job *(Agriculture omitted)*							
Other Agriculture [c/]	0.162	-7.468**	-0.485	1.259	-0.119	-6.770*	-0.048
	(0.623)	(3.338)	(0.439)	(1.685)	(0.118)	(3.406)	(0.049)
Constant	1.014**	1.586	-0.668	-1.704*	0.275	0.777	0.040
	(0.469)	(2.098)	(0.583)	(0.878)	(0.271)	(2.238)	(0.049)
Number of households	319	319	319	319	319	319	319
R-squared	0.017	0.042	0.029	0.005	0.004	0.033	0.006

Notes: * significant at 10%, ** at 5%, and *** at 1%. Parentheses indicate standard errors clustered by province. 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, animal husbandry, fishing, and logging. d/ Columns 1 to 5 are measured as change in hours worked in different employment types in the week prior to the survey and Column 6 is measured as change in total hours worked by all children (regardless of employment type).

Table 15 Effects of Rainfall on Education, Health, and Durable Goods in Agricultural Households (OLS)

Variables	**Education**	**Health**	**Durable Goods**
RF 2006 - RF 2003	0.017***	-0.010**	-0.015
(1,000 mm.)	(0.005)	(0.004)	(0.011)
Household size	0.006	0.002	0.008
	(0.004)	(0.002)	(0.005)
Age	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.001)
Education *(Elementary omitted)* [a/]			
High School	0.006	0.008	-0.030*
	(0.007)	(0.006)	(0.018)
College	0.022	-0.009	-0.046*
	(0.034)	(0.011)	(0.025)
Marital Status *(Married omitted)*			
Single [b/]	0.005	-0.007	-0.014
	(0.009)	(0.006)	(0.010)
Type of Job *(Agriculture omitted)*			
Other Agriculture [c/]	0.007	-0.007	0.009
	(0.013)	(0.008)	(0.012)
Constant	0.004	0.016***	0.021
	(0.006)	(0.003)	(0.015)
Number of households	721	721	721
R-squared	0.022	0.012	0.014

Notes: * significant at 10%, ** at 5%, and *** at 1%. Parentheses indicate standard errors clustered by province. 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, animal husbandry, fishing, and logging.

Appendix

Effects of Rainfall on Income, Consumption, and Risk-coping Strategies in Rural, Rural Non-Agricultural, Urban, Urban Agricultural, Migrant, and Non-Migrant Households (OLS)

Type of Household	Number of Households	Income (1)	Consumption (2)	International Remittances (3)	Domestic Transfers (4)	Loans (5)	Net Loans (6)	Net Assets (7)	Change in Migration (8)
Rural Households	1,236	-0.095*	-0.080**	0.019	0.033**	-0.013**	-0.015**	-0.004	
		(0.053)	(0.036)	(0.035)	(0.014)	(0.005)	(0.006)	(0.016)	
Rural Non-Agriculture	515	-0.074	-0.065	0.077	0.003	-0.007	-0.005	0.013	
		(0.054)	(0.044)	(0.077)	(0.011)	(0.007)	(0.008)	(0.010)	
Urban Households	1,170	0.064	0.004	0.017	-0.009	-0.000	-0.004	0.005	
		(0.085)	(0.053)	(0.016)	(0.009)	(0.003)	(0.004)	(0.011)	
Urban Agricultural	204	0.096	-0.001	0.012	-0.041	-0.006	-0.007	0.016	
		(0.088)	(0.058)	(0.062)	(0.026)	(0.024)	(0.026)	(0.020)	
Migrant	124	0.074	0.011	-0.112	0.175	-0.009	-0.017	-0.018	-0.054
		(0.103)	(0.047)	(0.081)	(0.108)	(0.018)	(0.019)	(0.036)	(0.074)
Non-Migrant	597	-0.169**	-0.147***	-0.028	0.029	-0.015	-0.019*	-0.037	
		(0.067)	(0.053)	(0.026)	(0.024)	(0.010)	(0.011)	(0.038)	

Note: Similar regression specification as in agricultural households. * significant at 10%, ** at 5%, and *** at 1%. Parentheses indicate standard errors clustered by province.