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Gerald R. Ford School of Public Policy
The University of Michigan
Ann Arbor, Michigan 48109-1220

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Are Remittances Insurance?
Evidence from Rainfall Shocks in the Philippines

Dean Yang

HwaJung Choi

University of Michigan

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Are Remittances Insurance?
Evidence from Rainfall Shocks in the Philippines

Dean Yang*
Gerald R. Ford School of Public Policy
and Department of Economics,
University of Michigan

HwaJung Choi
Department of Economics
University of Michigan

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Abstract

Do remittances sent by overseas migrants serve as insurance for recipient households? This paper examines how remittances sent by overseas migrants respond to income shocks experienced by Philippine households. Because household income and remittances are jointly determined, we exploit rainfall shocks as instrumental variables for income changes. In households with overseas migrants, we find that exogenous changes in income lead to changes in remittances of the opposite sign, consistent with an insurance motivation for remittances. In such households, we cannot reject the null hypothesis of full insurance: on average, essentially *all* of exogenous declines in income are replaced by remittance inflows from overseas. By contrast, changes in household income have no effect on remittance receipts in households without overseas migrants. Remittance receipts may also be partly shared with others: in migrant households, net gifts to other households move in the same direction as remittance receipts in response to income shocks.

Keywords: remittances, migration, insurance, risk, instrumental variables, rainfall, Philippines
JEL codes: D81, F22, F32, O12, O15

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* Corresponding author. Email: deanyang@umich.edu. Address: 440 Lorch Hall, 611 Tappan Street, University of Michigan, Ann Arbor, MI 48109.

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1 Introduction

Several facts motivate this study. First, life in rural areas of developing countries is prone to many kinds of risk, such as illness or mortality of household members, crop or other income loss due to natural disasters (weather, insect infestations, or fire, for example), and civil conflict. Second, international migration and remittance flows are substantial and growing. Between 1965 and 2000, individuals living outside their countries of birth grew from 2.2% to 2.9% of world population, reaching a total of 175 million people in the latter year.[1] The remittances that these migrants send to origin countries are an important but relatively poorly understood type of international financial flow. In 2002, remittance receipts of developing countries amounted to US$79 billion.[2] This figure exceeded total official development aid (US$51 billion), and amounted to roughly four-tenths of foreign direct investment inflows (US$189 billion) received by developing countries in that year.[3] Understanding the functions of remittances for recipient households is necessary for weighing the benefits to origin countries of developed-country policies liberalizing inward migration (as proposed in Rodrik (2002) and Bhagwati (2003), for example).[4]

What connection, if any, is there between the pervasiveness of risk in developing countries and international remittance flows? In particular, do remittances from overseas migrants serve as insurance for relatives back home? We shed light this question by examining how income shocks experienced by households in the Philippines affect their receipt of remittances from overseas. To break the simultaneity between income and remittances, we use rainfall shocks to instrument for changes in household income. In households with members who are overseas migrants, we find that changes in income from domestic sources lead to changes in remittances in the opposite direction of the income change: remittances fall when income rises, and remittances rise when income falls. In such households, we cannot reject the null hypothesis of full insurance: on average, essentially *all* of exogenous declines in income are replaced by remittance inflows from overseas. By contrast, changes in income from domestic sources have no effect on remittance receipts in households without overseas migrants. Remittance receipts may also be partly shared

[1]Estimates of the number of individuals living outside their countries of birth are from United Nations (2002), while data on world population are from U.S. Bureau of the Census (2002).

[2]The remittance figure is the sum of the "workers' remittances", "compensation of employees", and "migrants' transfers" items in the IMF's International Financial Statistics database for all countries not listed as "high income" in the World Bank's country groupings.

[3]Aid and FDI figures are from World Bank (2004). While the figures for official development aid and FDI are likely to be accurate, by most accounts (for example, Ratha (2003)) national statistics on remittance receipts are considerably underreported. So the remittance figure may be taken as a lower bound.

[4]Borjas (1999) argues that the investigation of benefits accruing to migrants' source countries is an important and virtually unexplored area in research on migration.

with others: in migrant households, net gifts to other households move in the same direction as remittance receipts in response to income shocks.

Numerous studies have examined the mechanisms through which households cope with risk in developing countries. Among others, Townsend (1994), Udry (1994), Ligon, Thomas and Worall (2002), and Fafchamps and Lund (2003) have documented risk-pooling arrangements among rural households in developing countries intended to smooth consumption in response to shocks. Households may also autonomously build up savings or other assets in good times and draw down these assets in hard times (Paxson (1992), Rosenzweig and Wolpin (1993), Udry (1995)), increase their labor supply when shocks occur (Kochar (1999)), or take steps (such as crop and plot diversification) to reduce the variation in their incomes (Morduch (1993)).

This paper examines a mechanism for coping with shocks *ex post* on which previous micro-level studies have not focused: remittances from family members overseas. At the international level, it is commonly posited that remittance flows from overseas buffer economic shocks in the migrants' home countries (for example, Ratha 2003), but this claim has been empirically untested with micro-level household data until now.[5] Related research on the role of *internal* (domestic) migration in pooling risk within extended families includes Lucas and Stark (1985), Rosenzweig and Stark (1989), and Paulson (2000).

A key distinguishing facet of this paper is its emphasis on credible identification of the effect of income shocks on international remittances. Existing studies of the impact of household income on remittance receipts use cross-sectional data, and so are subject to potentially severe biases in directions that are not obvious *a priori*. Reverse causation is a major concern: productive investments funded by migrant remittances can raise household income, leading to positive correlations between household income and remittances. Alternately, remittances may reduce households' need to find alternative income sources, leading to a negative relationship between remittances and domestic-source income. Even if reverse causation from remittances to income in migrants' source households was not a problem, it would be difficult to separate the cross-sectional relationship between income and remittances from the influence of unobserved third factors affecting both income and remittances (for example, the entrepreneurial spirit of household members).

Two aspects of the empirical strategy are key in resolving these identification problems. First, we focus on income changes due to shocks—changes in local rainfall—that are credibly exogenous,

[5] On the international macroeconomic level, Yang (2005) documents that international financial flows (including remittances) at the country level respond positively to economic losses due to hurricanes.

so that bias due to reverse causation is not a concern.[6] But the estimated impact of economic shocks in *cross-sectional* data is still likely to be biased, because the *likelihood* of experiencing a shock may be correlated with time-invariant household characteristics (in other words, omitted variables are still a concern). For example, if shocks occur more frequently in poorer areas, and more remittances flow in general to poor areas, estimates of the estimated impact of income on remittances will be biased in a negative direction.

So the second crucial aspect of this paper is its use of panel data, so that estimates of the impact of income shocks can be purged of the influence of unobserved time-invariant household characteristics that are jointly related with remittances and the likelihood of experiencing a shock. Estimation of the impact of shocks focuses on how shocks are related to *changes* in remittances rather than the *level* of remittances.

This paper is organized as follows. Section 2 considers the theoretical role of international remittance flows in sharing risk across family members in different countries. Section 3 describes the data used and provides empirical results. Section 4 provides some concluding comments. Further details on the household datasets are provided in the Data Appendix.

2 Income shocks and remittances in theory

When a household experiences a negative income shock, how should we expect remittance receipts from overseas to change? A basic theoretical result is that if there is a Pareto-efficient allocation of risk across individual entities (in this case, individual household members) in a risk-sharing arrangement, individual consumption should not be affected by idiosyncratic income shocks.

Consider households consisting of two members, indexed by $i \in \{1, 2\}$. Let one household member be located in the origin household in the Philippines, and the other household member be located overseas. Assume that both household members work and are able to send funds back and forth to each other.

Individuals have an uncertain income in each period t, $y^i_{s_t}$, depending on the state of nature $s_t \in S$. Household member i consumes $c^i_{s_t}$, and experiences within-period utility of $U_i\left(c^i_{s_t}\right)$ at time t. Let utility be separable over time, and let instantaneous utility be twice differentiable with $U_i' > 0$ and $U_i'' < 0$. For the allocation of risk across household members to be Pareto-efficient, the

[6] Other research using rainfall shocks as instruments include Paxson (1992), Munshi (2003), and Miguel (2005).

ratio of marginal utilities between members in any state of nature must be equal to a constant:

$$\frac{U_1'\left(c_{s_t}^1\right)}{U_2'\left(c_{s_t}^2\right)} = \frac{\omega_2}{\omega_1}, \text{ for all } s_t, \text{ and } t,$$

where ω_1 and ω_2 are the Pareto weights of members 1 and 2. Household members' marginal utilities are proportional to each other, and so consumption levels between members move in tandem.

Let utility be given by the following constant absolute risk aversion function:

$$U_i\left(c_{s_t}^i\right) = \frac{-e^{-\theta c_{s_t}^i}}{\theta}.$$

Then, following (among others) Mace (1991), Cochrane (1991), Altonji, Hayashi, and Kotlikoff (1992) and Townsend (1994), we can obtain a relationship between individual household member i's consumption and average consumption across the household members $\bar{c}_{s_t}$:

$$c_{s_t}^i = \bar{c}_{s_t} + \frac{\ln \omega_i - \frac{1}{2}\left(\ln \omega_1 + \ln \omega_2\right)}{\theta} \tag{1}$$

Efficient risk-sharing implies that individuals' consumption levels depend here only on mean consumption in the household $\bar{c}_{s_t}$ and an effect determined by the individual's Pareto weight relative to the other's. Because this latter term is constant over time, then *changes* in consumption for each individual will depend only on the change in mean household consumption. Said another way, individuals face only *household-level* risk.

How might this within-household (but cross-country) risk-sharing be carried out in practice? It is simplest to imagine that individuals simply send remittances to the other household member when that member experiences a negative shock. Microeconomic studies among households of the insurance role of gifts and remittances include Lucas and Stark (1985), Ravallion and Dearden (1988), Rosenzweig and Stark (1989), Platteau (1991), and Cox, Eser, and Jimenez (1998).

Adapting Fafchamps and Lund (2003), let consumption of individual i in state s_t be the sum of income $y_{s_t}^i$ and net inflows of remittances $r_{s_t}^i$:

$$c_{s_t}^i = y_{s_t}^i + r_{s_t}^i$$

So then we can rewrite equation (1) as:

$$r^i_{s_t} = -y^i_{s_t} + \overline{c}_{s_t} + \frac{\ln \omega_i - \frac{1}{2}(\ln \omega_1 + \ln \omega_2)}{\theta} \tag{2}$$

This equation can be transformed into an empirically testable specification as follows. First, separate income $y^i_{s_t}$ into:

$$y^i_{s_t} = \widetilde{y}^i + z^i_{s_t},$$

where $\widetilde{y}^i$ is the permanent component of income and $z^i_{s_t}$ is the transitory component of income. Only the transitory component depends on the state of the world.

The function of Pareto weights and the permanent income component $\widetilde{y}^i$ can be captured by an individual fixed effect γ_i. The mean household consumption level $\overline{c}_{s_t}$ can be represented by a time effect ϕ_t. Also allow a random component ε_{it}, a mean-zero error term. Then equation (2) becomes:

$$r^i_{s_t} = -z^i_{s_t} + \gamma_i + \phi_t + \varepsilon_{it} \tag{3}$$

The empirical test of this paper will be based on equation (3), where the outcome variable is remittances received from overseas. This paper will focus on a particular type of transitory shock $z^i_{s_t}$, changes in income from domestic (Philippine) sources, using rainfall shocks as instrumental variables.

There are two key questions of interest. First, is the coefficient on remittances with respect to domestic income $z^i_{s_t}$ less than zero? If yes, then this will be evidence that at least some insurance is taking place. Second, can we reject the null of full insurance, i.e., that the coefficient on $z^i_{s_t}$ is equal to negative one?

3 Empirical analysis

In this section, we first describe the data and sample construction, and provide descriptive statistics on the sample households. We then discuss the regression specification and some empirical issues, and present empirical results. Finally, we conduct tests of potential violations of the IV exclusion restriction and of an important omitted variable concern.

3.1 Data and sample construction

The empirical analysis uses data from three linked household surveys conducted by the National Statistics Office of the Philippine government, covering a nationally-representative household sample: the Labor Force Survey (LFS), the Survey on Overseas Filipinos (SOF), the Family Income and Expenditure Survey (FIES), and the Annual Poverty Indicators Survey (APIS).

The LFS is administered quarterly to inhabitants of a rotating panel of dwellings in January, April, July, and October, and the other three surveys are administered with lower frequency as riders to the LFS. Usually, one-fourth of dwellings are rotated out of the sample in each quarter, but the rotation was postponed for five quarters starting in July 1997, so that three-quarters of dwellings included in the July 1997 round were still in the sample in October 1998 (one-fourth of the dwellings had just been rotated out of the sample). The analysis of this paper takes advantage of this fortuitous postponement of the rotation schedule to examine changes in households over the 15-month period from July 1997 to October 1998.

Survey enumerators note whether the household currently living in the dwelling is the same as the household surveyed in the previous round; only dwellings inhabited continuously by the same household from July 1997 to October 1998 are included in the sample for analysis. Because the impact of domestic income shocks on remittance receipts is likely to vary according to whether households had migrant members, we analyze separately households that reported having one or more members overseas in June 1997, and households who did not report having migrant members in that month.

Rainfall data used in constructing instrumental variables for household domestic income were obtained from the Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA). Daily rainfall data are available for 47 weather stations, often as far back as 1951. Rainfall variables are constructed by station separately for the two distinct weather seasons in the Philippines: the dry season from December through May, and the wet season from June through November. Monthly rainfall was calculated by summing daily rainfall totals, with daily missing values replaced by the average among the non-missing daily totals in the given station-month, as long as the station had 20 or more daily rainfall records. When a particular station-month had less than 20 daily rainfall records, monthly rainfall for the station was taken to be the monthly rainfall recorded in the nearest other station with 20 or more daily rainfall records. Seasonal total rainfall for each station in each year is obtained by summing monthly rainfall for the respective months in each wet or dry season (December observations are considered to belong to the subsequent calendar year's dry season).

Rainfall shock variables are then constructed as the deviation of a given season's total rainfall (in thousands of millimeters) from the historical average for that station and season. Historical average rainfall is the average for all available years, up to 1989 (so averages do not include the most recent observations). Households are assigned the rainfall data for the weather station geographically closest to their local area (specifically, the major city or town in their survey domain), using great circle distances calculated using latitude and longitude coordinates. Because some stations are never the closest station to a particular survey domain, the number of stations that end up being represented in the empirical analysis is 38.

See the Data Appendix for other details regarding the contents of the household surveys and the construction of the sample for analysis.

3.2 Characteristics of sample households

Table 1 presents summary statistics for the 27,881 households used in the empirical analysis, separately for migrant and non-migrant households. Migrant households are those with overseas workers in June 1997. The 1,655 migrant households represent 5.9 percent of the sample households.

To provide a sense of the instrumental variables used, the rainfall data are presented in the topmost rows of the table. The rainfall data provided are deviations (in thousands of millimeters) from the historical mean of each station, separately for the dry and wet seasons. The dry season immediately before the first observation for each household ('year 1', where income is from January to June 1997) runs from December 1995 to May 1996, and the wet season for that observation runs from June to November 1996. Correspondingly, the dry season for the second observation for each household ('year 2', where income is from April to September 1998) is December 1996 to May 1997, and the wet season for the second observation runs from June to November 1997.

We describe here the general characteristics of rainfall by season for the migrant households (the mean of the rainfall variables for the non-migrant households are generally quite similar). The dry season in year 1 was on average dryer than normal, with a mean deviation of -0.13 (mean rainfall was 0.13 meters less than the historical average in that season) across households. In year 2, dry season rainfall was wetter than normal, with a mean deviation of 0.28. Therefore, the mean household experienced an increase in dry season rainfall between year 1 and year 2: the mean change in the dry season deviation across households is 0.41.[7] On the other hand, the wet season for year 1 was only wetter than normal, with a mean deviation of 0.22 across households. In year 2 on the other hand, wet season rainfall was only slightly higher than normal on average, with a mean of 0.07. The mean household thus experienced a decline in wet season rainfall between year 1 and year 2 of -0.14. (The changes between years 1 and 2 for the wet and dry seasons will be the instrumental variables for the change in domestic income in the empirical analysis to follow.)[8]

Unsurprisingly, total expenditure and total income in the first period (January-June 1997) is higher in migrant household than non-migrant households. Average total expenditure was 81,538 pesos ($3,136) for migrant households and 50,778 pesos ($1,953) for non-migrant households.[9] Average total income was 94,189 pesos ($3,623) for migrant households and 56,063 pesos ($2,156) for non-migrant households. On average, in migrant households remittances have a mean of 36,122 pesos ($1,389), while for non-migrant households the mean is only 1,889 pesos ($73). Remittances amounted to 39% of total household income for migrant households, but only 2% for non-migrant households. The mean of net gifts (gifts to minus gifts received from other households, which excludes remittances) is -3,456 pesos (-$133) for migrant households and -1,203 pesos (-$46) for non-migrant households (i.e., the mean household was a received more gifts than it gave out).

Average migrant household size is 6.2 members (including overseas members) while non-migrant household size is 5.2 members. 68 percent of migrant households are located in survey-defined urban areas, compared to 58 percent of non-migrant households.[10] Overall, heads in migrant households are more educated than in non-migrant households: around 30% of migrant-household heads have at least a college degree, compared to only 20% for non-migrant household heads. 23 % of migrant household heads worked in agriculture in 1997, compared to 38% of non-migrant household heads. Heads in migrant households are also slightly older than heads of non-migrant households, with mean years of age of 49.9 (compared to 46.7).

[7] Because the mean rainfall measure used to construct the rainfall deviation variable is the same for years 1 and 2, the change between years 1 and 2 is simply the difference in rainfall between the two years.

[8] For a detailed list of all 38 weather stations and the values of all rainfall variables for each station, see Appendix Table 1. The sizes of rainfall deviations in each season and year are depicted graphically in Figures 1 and 2.

[9] Peso figures converted to US dollars at the Jan-Jun 1997 rate of 26 pesos per dollar.

[10] While these may seem to be high urban percentages, the definition of an urban area used by the Philippine National Statistics Office appears to be quite broad, and many areas classified as 'urban' are likely to be quite closely linked to adjacent agricultural areas.

3.3 Identification strategy

Our main interest is to examine whether households use remittances as insurance, by examining overseas remittance responses to exogenous changes in household income from domestic (Philippine) sources. We describe here our identification strategy.

The remittance amount received by each household at time t is determined by household characteristics that are constant over time (such as completed education of household adults), time-variant household characteristics (such as household size), time effects common to all households (such as changes in remittance regulations or the nationwide economic situation), as well as time-varying household income from domestic sources. In addition, there may be time effects that vary systematically according to household characteristics, as when a nationwide economic shock has differential effects on better-educated and less-educated households. For household h at time t, we write the remittance equation as follows:

$$R_{ht} = \alpha + \beta Y_{ht} + \boldsymbol{\theta}'\mathbf{X}_{ht} + \boldsymbol{\delta}'\mathbf{W}_h + \gamma_t + \boldsymbol{\chi}_t'\left(T_t * \mathbf{W}_h\right) + \varepsilon_{ht} \tag{4}$$

R_{ht} is household remittance receipts from overseas, Y_{ht} is household income from domestic sources, $\mathbf{X}_{ht}$ is a vector of time-variant household characteristics, and $\mathbf{W}_h$ is a vector of time-invariant characteristics. γ_t is the time effect for period t, T_t is a dummy for each time period, and the $T_t * \mathbf{W}_h$ term allows the time effect to vary systematically with household time-invariant characteristics. ε_{ht} is a mean-zero error term.

The coefficient of interest is β, the coefficient on domestic income Y_{ht}. If remittances help insure households from losses of domestic income, this coefficient should be negative. Its magnitude represents the replacement rate of domestic income by remittances from overseas (i.e., a coefficient of 0.1 would imply a 10% replacement rate).

Although we have rich information on household characteristics that might be included in the vector $\mathbf{X}_{ht}$, there remain serious problems with obtaining an unbiased estimate of β. First, there is reverse causation: domestic income itself can be a function of remittances, as when remittances help fund household entrepreneurial investments. Another concern is omitted variable bias: unobservable household characteristics (say, the entrepreneurial spirit of household members) are likely to jointly determine domestic income and remittances. Our identification strategy focuses on reducing bias generated from simultaneity and omitted variables.

We have two observations for each household, so we can control for the influence of unobservable household characteristics by taking first differences. Rewriting equation (4) separately for each of the two years (1997 and 1998) obtains:

$$R_{h97} = \alpha + \beta Y_{h97} + \boldsymbol{\theta}'\mathbf{X}_{h97} + \boldsymbol{\delta}'\mathbf{W}_h + \gamma_{97} + \boldsymbol{\chi}'_{97}\left(T_{97} * \mathbf{W}_h\right) + \varepsilon_{h97} \quad (5)$$

$$R_{h98} = \alpha + \beta Y_{h98} + \boldsymbol{\theta}'\mathbf{X}_{h98} + \boldsymbol{\delta}'\mathbf{W}_h + \gamma_{98} + \boldsymbol{\chi}'_{98}\left(T_{98} * \mathbf{W}_h\right) + \varepsilon_{h98} \quad (6)$$

To eliminate the influence of unobservable household time-invariant characteristics $\mathbf{W}_h$, we can take first differences, subtracting equation (5) from equation (6), and rearrange to obtain:

$$\Delta R_{h98} = (\gamma_{98} - \gamma_{97}) + \beta \Delta Y_{h98} + \boldsymbol{\theta}'\Delta\mathbf{X}_{h98} + (\boldsymbol{\chi}_{98} - \boldsymbol{\chi}_{97})'\,\mathbf{W}_h + (\varepsilon_{h98} - \varepsilon_{h97}) \quad (7)$$

It still remains to deal with time-variant heterogeneity $\Delta\mathbf{X}_{h98}$ and with reverse causation. To do so, we instrument for the change in household domestic income ΔY_{h98} with the change in rainfall between 1997 and 1998. The change in rainfall over the study period should be a valid instrument, as it is likely to have an important effect on household income in a country such as the Philippines where most households owe their livelihoods either directly or indirectly to agriculture. In addition, it is also plausible that rainfall affects remittances primarily via the change in household income.[11]

The first stage regression will be:

$$\Delta Y_{h98} = \pi_0 + \pi_1 \Delta RAIN\_DRY_{h98} + \pi_2 \Delta RAIN\_WET_{h98} + \boldsymbol{\mu}'\mathbf{W}_h + \omega_{h98} \quad (8)$$

$\Delta RAIN\_DRY_{h98}$ and $\Delta RAIN\_WET_{h98}$ are the changes in rainfall relevant for the change in income between 1997 and 1998, in the dry and wet seasons, respectively. The inclusion of $\mathbf{W}_h$ in the regression allows for heterogeneity in the time trend from 1997 to 1998 across households depending on time-invariant characteristics. ω_{h98} is a mean-zero error term.

The predicted change in income from equation (8), $\Delta\widehat{Y_{h98}}$, can be substituted for ΔY_{h98} in equation (7), and various terms rewritten to obtain:

$$\Delta R_{h98} = \xi + \beta \Delta\widehat{Y_{h98}} + \boldsymbol{\nu}'\mathbf{W}_h + \eta_{h98} \quad (9)$$

ξ, a constant term, substitutes for the change in year effects, $\boldsymbol{\nu}$ for the change in the vector of

[11] In robustness checks below, we examine and reject the existence of important alternative channels (other than household income) for rainfall's effects on remittances.

coefficients $(\boldsymbol{\chi}_{98} - \boldsymbol{\chi}_{97})$, and the new error term η_{h98} for the remaining terms from equation (7), $\varepsilon_{h98} - \varepsilon_{h97} + \boldsymbol{\theta}'\Delta\mathbf{X}_{h98}$. (Now that the change in household income is instrumented by rainfall, it is plausible to assume that shocks to other household outcomes $\Delta\mathbf{X}_{h98}$ are orthogonal to $\widehat{\Delta Y_{h98}}$ and so can safely be included in the error term.)

Equation (9) will be the estimating equation to be used in the regression analysis. The variables included in the vector of controls $\mathbf{W}_h$ are a set of household characteristics in the first period (Jan-Jun 1997): an indicator for urban location; five indicators for head's highest level of education completed (elementary, some high school, high school, some college, and college or more; less than elementary omitted); six indicators for head's occupation (professional, clerical, service, production, other, not working; agricultural omitted); and log per capita household income.

Serial correlation in the outcome variables is likely to be a problem in this panel dataset, biasing OLS standard error estimates downward (Bertrand, Duflo and Mullainathan (2004)). In particular, the concern is correlation among error terms of households associated with the same weather station, because the rainfall instrumental variables only vary at this level. So standard errors allow for an arbitrary variance-covariance structure within the coverage areas of 38 weather stations (standard errors are clustered by weather station coverage area).

3.4 Regression results

This subsection first describes the impact of rainfall shocks on changes in household domestic income. It then presents the impact of changes in household domestic income (instrumented by rainfall shocks) on changes in household remittance receipts from overseas. In addition, it also looks at the impact of instrumented domestic income on total household expenditures, and gifts given to other households.

3.4.1 Impact of rainfall on domestic income (first stage estimates)

Regression results from the first stage—predicting changes in domestic income using rainfall shocks—are presented separately for migrant and non-migrant households in Table 2. The regressions are as described above in equation (8). The first column presents coefficient estimates for migrant households, while the second row shows results for non-migrant households.

The dependent variable in both regressions is the change in household domestic (Philippine-source) income between the January-June 1997 and April-September 1998 reporting periods, divided by initial (January-June 1997) total household income. (For example, a change amounting to 10% of initial income is expressed as 0.1.[12]) The mean of the dependent variable is 0.10 for migrant households and 0.14 for non-migrant households, indicating that both types of households experienced increases in domestic-source income between the two time periods on average.

The coefficient on the dry season rainfall shock is positive and statistically significant for both migrant and non-migrant households. An increase of 1000 millimeters of rainfall in the preceding dry season leads household domestic income to rise by from 6.1 to 7.6 percentage points (as a fraction of initial total household income) across the two groups of households. The coefficient on the wet season rainfall shock is negative for both migrant and non-migrant households, but in neither case is the coefficient statistically significant. In absolute value, the wet season coefficients are slightly smaller than the dry season coefficients.

The two rainfall shock variables jointly appear to be quite strong as instrumental variables, as evidenced by F-statistics of tests of joint significance. The F-statistic for the test of the joint significance of the rainfall variables in the migrant household regression is 4.68, with a p-value of 0.015. The F-statistic for the test of the joint significance of the rainfall variables in the non-migrant household regression is 3.06, with a p-value of 0.058.

3.4.2 Instrumental variables estimates

The instrumental variables estimates described here have regression equation (9) as the basis.

3.4.2.1 Remittance receipts Table 3 presents OLS and instrumental variables regression results where the outcome variable is the change in household remittance receipts from overseas between the January-June 1997 and April-September 1998 reporting periods, expressed as a share of initial (January-June 1997) household income. On average, both migrant and non-migrant households saw increases in remittances over the time period: the means of the dependent variable for the two subsamples are 0.12 and 0.02, respectively.

OLS and IV estimates are presented for migrant households in the first two columns, and similarly for non-migrant households in the remaining two columns. For migrant households, the OLS estimate of the impact of the change in household domestic income on the change in remittances is negative and statistically significant at the 10% level, but is small in magnitude

[12]Dividing by pre-crisis household income achieves something similar to taking the log of an outcome: normalizing to take account of the fact that households in the sample have a wide range of income levels, and allowing coefficient estimates to be interpreted as fractions of initial household income. I choose to normalize outcome variables in this way (rather than taking the log) because some second-stage outcome variables (in particular, remittances) often take on zero values.

(-0.067). By contrast, the corresponding IV estimate is negative, large in magnitude (-1.067), and statistically significant at the 5% level.

The OLS and IV estimates of the impact of changes in household domestic income on changes in remittances are dramatically different, highlighting the importance of the IV approach to this question. A number of factors are likely to help explain this difference. First of all, classical measurement error in domestic household income will lead the OLS coefficient to be attenuated (particularly as this is a regression in first-differences). Second, reverse causation may be at work. For example, increases in remittances may reflect increased investment in household entrepreneurial enterprises, leading to increased domestic income. This would lead the OLS coefficient to be biased in a positive direction. Finally, there may be omitted variables positively correlated with both the change in remittances and the change in income. For example, a need to accumulate resources for a large household purchase (such as a vehicle) or some other lump-sum payment (like tuition, or medical expenses) might lead to both increased remittances, increased domestic labor supply, and increased domestic income. Omitted variable stories such as these would also cause positive bias in the OLS coefficient compared to the IV.

For migrant households, the IV estimate of the impact of changes in household domestic income on changes in remittances indicates that essentially all of household income declines are replaced by remittance receipts from overseas. We cannot reject the null hypothesis of full insurance (that the coefficient is equal to negative one).

The contrast to the results for the non-migrant households (the latter two columns of Table 3) is striking. In both the OLS and IV regressions, the coefficient on the change in domestic income is quite small in magnitude and not statistically significantly different from zero. These results are sensible, as they indicate that remittances do not appear to serve as insurance in households that do not have a member working overseas.

3.4.2.2 Household expenditures If remittances serve as insurance for migrant households, changes in household expenditures should be relatively *unresponsive* to changes in household domestic income, because remittances respond so strongly (and in the opposite direction) to changes in household domestic income. It is also of interest to explore whether expenditures in migrant households are smoother than in non-migrant households in the face of domestic income shocks.

So Table 4 presents results from OLS and instrumental variables regressions where the outcome variable is the change in household expenditures between the January-June 1997 and April-

September 1998 reporting periods, expressed as a share of initial (January-June 1997) household expenditures. The mean of the dependent variable is 0.18 for migrant households and 0.09 for non-migrant households (on average, expenditures increase between the two time periods).

The regression specifications and the overall format of the table are otherwise the same as in Table 3. The OLS results indicate that household domestic income is highly positively related with total expenditures for both migrant and non-migrant households. For example, for migrant households a 10 percentage point increase in domestic household income is associated with 5.8 percentage point increase in total expenditure; the magnitude of the OLS coefficient is similar for non-migrant households.

In the IV specification, however, the magnitude of income coefficient for migrant households declines dramatically (from 0.584 to -0.077) and also declines somewhat for non-migrant households (from 0.647 to 0.358). Neither of the IV coefficients on the change in domestic income in the migrant and non-migrant household samples are statistically significantly different from zero. The fact that the coefficient on the change in domestic income in the migrant regression is so close to zero (and that it is not statistically significant) is consistent with remittances playing an important role in helping these households maintain their expenditure levels when they experience income shocks. That said, standard errors in the IV regressions are quite large (the equality of the OLS and IV coefficients cannot be rejected), so these results should only be taken as suggestive.

The relative decline in the coefficient on the change in domestic income is larger for migrant households than for non-migrant households, although again standard errors are too large to allow strong conclusions. This is most appropriately taken as merely suggestive evidence that migrant households are better able to smooth expenditures in the face of exogenous income shocks.

3.4.2.3 Net gifts to other households The theoretical model of section 2 assumes that risk-sharing takes place between overseas migrants and their family members in the origin country. But it could also be the case that overseas migrants enter into risk-sharing arrangements with others who are not part of the origin household, such as more distant family members or friends. If this is the case, it is reasonable to imagine that remittances from the overseas migrants to the non-household members would be sent first to the origin household members before being passed on to others outside the household.

We explore this possibility by asking whether net gifts from migrant households to other households rise when negative income shocks occur. The outcome variable will be the change in net gifts (gifts to other households minus gifts received from other households, in cash and in-kind) between the January-June 1997 and April-September 1998 reporting periods, expressed as a share of initial (January-June 1997) household expenditures.[13] On average, both types of households increased their net giving over the time period: the means of the dependent variable for migrant and non-migrant households are 0.03 and 0.02, respectively.

To start with, it is important to recall that the rainfall shocks used as instruments are common to all households in a local area, so that the exogenous variation in income identified is also common to all households in the same area. In other words, migrant households predicted to be suffering from negative income shocks are in areas where other households also experienced such shocks. If remittances were partly shared with other households, then we should see net gifts to other households move in the same direction as remittances in response to changes in household domestic income: declines in (instrumented) domestic income should lead to increases in remittance receipts, alongside increases in net gifts to other households. So when the change in net gifts is the dependent variable, the coefficient on the change in domestic household income should be negative.

Table 5 presents results from OLS and instrumental variables regressions. Again, specifications and the table format are the same as in Tables 3 and 4. For migrant households, the OLS coefficient on the change in domestic income is negative and statistically significant at the 10% level, but it is quite small in magnitude (-0.012). By contrast, the corresponding IV coefficient is substantially larger in magnitude (-0.179), negative, and statistically significant at the 10% level. The IV result suggests that a 10 percent point decrease in domestic income is associated with 1.8 percentage point increase in net gifts (as share of initial total expenditures). This result is consistent with remittance receipts of migrant households being shared with other households, and may be explained by migrants being in risk-sharing arrangements with people in the origin country beyond just their immediate household members.[14]

By contrast, there is no evidence of changes in net gifts among non-migrant households when domestic income fluctuates. The coefficient on the change in domestic income is close to zero and not statistically significant in both the OLS and IV specifications.

[13] As defined, gifts exclude remittances sent or received.

[14] It is also possible that migrants' origin-country household members themselves independently enter into risk-sharing arrangements with non-household members.

3.5 Robustness checks

We discuss here evidence against alternative channels (other than income) of rainfall's effects, and against an important potential confounding factor (exchange rate changes in migrants' overseas locations).

3.5.1 Potential violations of exclusion restriction

An important concern when instrumenting for changes in household income using rainfall variation is that rainfall shocks affect all households in a local area. Because of this, at least part of the effects found may be due to changes in locality-level economic conditions (such as wage rates), rather than merely due to changes in household income.[15] This would be a violation of the IV exclusion restriction, the assumption that the rainfall instruments only affect household remittances via their effect on household income.

In this subsection we test for potential violations of the exclusion restriction. One way in which rainfall might affect remittances is via changes in the relative returns to various types of work, which could lead households to change their labor supply. This could be problematic if changes in household labor supply lead to changes in remittances independent of their effects on household income. For example, if adults in the household spend more time working, households may hire maids or nannies to provide child care, and remittances may rise to help pay for such help. Or, households may invite older relatives to live with them and look after children, and remittances may rise to help support the larger number of household members. If such responses are empirically important, the IV regression estimates of the impact of the change in domestic income on the change in remittances will be biased, in directions that cannot be predicted in advance.

To test whether such concerns have any basis, it is useful to test the stability of the IV regression coefficients in the previous tables to the inclusion of control variables for the change in various alternative channels. In particular, we include control variables for the change in total household hours worked, and for the change in household size.[16] Any substantial change in the IV estimates when including these control variables would cast doubt on the assumption that the effects of rainfall are working primarily via changes in domestic income.

[15] Rosenzweig and Wolpin (2000) raise concerns from using weather events as instrumental variables.

[16] Hours worked in the past week are reported for all household members above the age of 10. The change is from July 1997 to October 1998. The change in household size is over the same time period, and includes overseas members.

Table 6 presents the results of this exercise. Each cell of the table is the coefficient (standard error) on the change in household domestic income, in either an OLS or IV regression, for migrant and non-migrant households separately.

The first row of the table presents coefficient estimates in regressions where the outcome variable is the change in remittances, as in Table 3. As it turns out, the coefficient estimates are very similar to those in Table 3. For example, the coefficient in the IV specification for migrant households in Table 6 is -0.953 (and is statistically significant at the 5% level), compared with -1.067 in Table 3. There appears to be little reason to be concerned that rainfall affects remittances via changes in household labor supply or changes in household size, independently of rainfall's effects on income.

The second and third rows of the table are similar to the first row, except that the outcome variables are different. The second row presents results for the change in household expenditure (compare these to Table 4), and the third row for the change in net gifts (corresponding to Table 5). In neither of these cases are the coefficient estimates substantially different from previous tables. In the migrant-household IV regressions, the coefficient for household expenditure remains close to zero and is still not statistically significantly from zero, while the coefficient for net gifts is very similar in magnitude and significance level to the corresponding coefficient in Table 5. For these outcomes as well, there appears to be little cause for concern that the IV exclusion restriction is violated.[17]

3.5.2 An omitted variable concern: changes in exchange rates

Another general identification concern arises because 1997-1998 was a time of substantial economic fluctuation in the Philippines (and in other Asian countries) due to the Asian financial crisis. The Philippine economy experienced a decline in economic growth after the onset of the crisis in mid-1997. Annual real GDP contracted by 0.8% in 1998, as compared to growth of 5.2% in 1997 and 5.8% in 1996 (World Bank 2004). The urban unemployment rate (unemployed as a share of total labor force) rose from 9.5% to 10.8% between 1997 and 1998, while the rural unemployment rate went from 5.2% to 6.9% over the same period (Philippine Yearbook (2001), Table 15.1).

Of course, any effects of the domestic economic downturn common to all households are not an issue, as the regressions of this paper use first-differenced variables, so that common economic shocks are captured in the constant term. In addition, the control variables for households' 1997

[17] Results in Table 6 for non-migrant households are also similar to corresponding estimates in Tables 3, 4, and 5.

characteristics included in all regressions (education, occupation, income, and urban indicator) will help account for any differential effects of the 1997-1998 crisis that differ across households by socio-economic status.

However, there is another important dimension of heterogeneity that is particularly relevant for migrant households: fluctuations in the exchange rates faced by migrant members. The devaluation of the Thai baht in June 1997 set off a wave of speculative attacks on national currencies, primarily (but not exclusively) in East and Southeast Asia. Overseas Filipinos work in dozens of foreign countries, including many of those most affected by exchange rate shocks due to the 1997 Asian financial crisis such as Korea and Malaysia (and, to a lesser extent, Taiwan, Singapore, and Japan).[18]

An omitted variable concern arises if the 1997-1998 exchange rate shocks experienced by households in particular areas happen to be correlated with the rainfall shocks in the same areas over the same time period. If, for example, areas that had bigger declines in dry season rainfall (and thus greater declines in income) also had exchange rate shocks that allowed migrants to send more remittances, then the negative relationship between income and remittances would be overstated.

To test whether such concerns are empirically important, we repeat the main regressions of the paper for migrant households while including as a control variable the change in the exchange rate (Philippine pesos per unit of foreign currency) experienced by the household's migrants. The change in the exchange rate is the average of the 12 months leading to Oct 1998 minus the average of the 12 months leading to Jun 1997, divided by the latter (e.g., a 10% increase is 0.1).[19]

Table 7 presents coefficient estimates on the change in household domestic income from OLS and IV regressions when including this exchange rate shock control variable. The outcome variables are the change in remittances (first row), the change in household expenditure (second row), and the change in net gifts (third row). None of the coefficients turn out to be substantially different from the corresponding coefficients in Tables 3 to 5 (when this control is not included). The exchange rate shocks experienced by household migrants appear to be orthogonal to the rainfall shocks experienced by their origin households back home. There is no evidence that omitted variables bias due to correlation between exchange rate and rainfall shocks is a cause for concern.

[18] Yang (2004a) examines the impact of these heterogeneous exchange rate shocks on human capital investment and entrepreneurship in migrants' origin households.

[19] For further discussion of the exchange rate shock measure, see Yang (2004a).

4 Conclusion

It is widely claimed that international remittances serve as insurance for family members in migrants' origin countries in the face of economic shocks. However, until now there has been no evidence using microdata on households in developing countries that remittances in fact respond in this manner to changes in household income. This paper fills this gap, using panel household survey data from the Philippines that includes data on remittance receipts from overseas and on household income.

Household income and remittances are jointly determined, making an instrumental variables approach necessary. In particular, we exploit rainfall shocks as instrumental variables for changes in household income. In households with overseas migrants, we find that exogenous changes in income lead to changes in remittances of the opposite sign, consistent with an insurance motivation for remittances. In such households, we cannot reject the null hypothesis of full insurance, as we estimate a replacement rate of household domestic income by remittances very close to 100%. By contrast, changes in household income have no effect on remittance receipts in households without overseas migrants. Remittance receipts may also be partly shared with others outside the household: in migrant households, net gifts to other households move in the same direction as remittance receipts in response to income shocks. The magnitude of the change in net gifts is roughly one-sixth the size of the change in remittances.

A key question that arises is whether remittance responses to income shocks depend on the performance or availability of alternative methods of coping with risk, such as credit markets, reciprocal transfer networks, and asset sales. In particular, the availability of other risk-coping mechanisms may depend on whether shocks are *aggregate* (shared by other households) or *idiosyncratic* (on average uncorrelated with other households).

By focusing on income shocks driven by local weather changes, this paper assesses the role of remittances as insurance in the face of *aggregate* shocks to local areas. One reason why we find such large responses of remittances to rainfall-driven income shocks could be that such shared shocks make it more difficult to access credit or interhousehold assistance networks that normally help households cope with risk. For example, when a large fraction of households in a local area experience a negative shock, the demand for credit may rise, leading to increases in local interest rates. Some substantial fraction of households needing loans may thus be priced out of the credit market. In addition, there may be difficulties in smoothing consumption via asset sales when shocks are aggregate, because other households simultaneously seek to sell their assets, driving down asset prices.[20] If aggregate shocks lead local-level risk-coping mechanisms to break down, remittance inflows from migrant household members may be used more heavily as a smoothing device.

An important avenue for future research may therefore be to examine whether remittances exhibit such large responses to income shocks when the shocks are *idiosyncratic*, or specific to given households. An idiosyncratic shock experienced by a given household, if truly uncorrelated on average with shocks experienced by other households, should have negligible effects on the quality of local-level risk-coping mechanisms, and so households should be better able to use such mechanisms than if the shock was aggregate. One might hypothesize that remittances might not respond nearly as much to idiosyncratic shocks, precisely because households should still have access to alternative local-level risk-pooling arrangements.

5 Data appendix

Four linked household surveys were provided by the National Statistics Office of the Philippine government: the Labor Force Survey (LFS), the Survey on Overseas Filipinos (SOF), the Family Income and Expenditure Survey (FIES), and the Annual Poverty Indicators Survey (APIS).[21]

The Labor Force Survey (LFS) collects data on primary activity, hours worked in the past week, and demographic characteristics of household members aged 10 or above. These data refer to the household members' activities in the week prior to the survey. The survey defines a household as a group of people who live under the same roof and share common food. The definition also includes people currently overseas if they lived with the household before departure. As collected in the LFS, hours worked refers only to work for pay or profit, whether outside or within the household, or work without pay on a family farm or enterprise; it excludes housekeeping and repair work in one's own home.

The Survey on Overseas Filipinos (SOF) is administered in October of each year to households reporting in the LFS that any members left for overseas within the last five years. The SOF collects information on characteristics of the household's overseas members, their overseas locations and lengths of stay overseas, and the value of remittances received by the household from overseas in the last six months (April to September).

In the analysis, we use the July 1997 and October 1998 rounds of the LFS and the October 1997 and October 1998 rounds of the SOF. We obtain household income and expenditures from the FIES for Jan-Jun 1997 and from the APIS for Apr-Sep 1998 (because no FIES was conducted in 1998). Total income includes remittance receipts, but we instrument for the change in domestic household income (which excludes remittances). Total expenditures include current consumption as well as purchases of real property, home repairs, installment payments, and loan repayments.

The sample used in the empirical analysis consists of all households meeting the following criteria: (1) *The household's dwelling was also included in the October 1998 LFS/SOF.* As men-

[20] This point has been made by Rosenzweig and Wolpin (1993), Fafchamps, Udry, and Czukas (1998), and Lim and Townsend (1998).

[21] Use of the data requires a user fee, and the datasets remain the property of the Philippine government.

tioned above, one-quarter of households in the sample in July 1997 had just been rotated out of the sample in October 1998. (2) *The same household has occupied the dwelling between July 1997 and October 1998.* This criterion is necessary because the Labor Force Survey does not attempt to interview households that have changed dwellings. Usefully, the LFS dataset contains a field noting whether the household currently living in the dwelling is the same as the household surveyed in the previous round. (3) *The household has complete data on pre-crisis control and outcome variables (recorded July 1997).* (4) *The household has complete data on post-crisis outcome variables (recorded October 1998).*

Of 30,744 dwellings that the National Statistics Office did not rotate out of the sample between July 1997 and October 1998 (criterion 1), 28,152 (91.6%) contained the same household continuously over that period (criterion 2). Of these households, 27,781 had complete data for all variables used in the empirical analysis (criteria 3 and 4).

To divide the sample into migrant and non-migrant households, we needed to determine if a particular individual in the October 1997 Survey on Overseas Filipinos was overseas in June 1997. Among other questions, the SOF asks when a family member *last* left for overseas, and when a family member returned home from his/her *last* departure (if at all). These questions unambiguously identify individuals as being away in June 1997 if they left for overseas in or before that month, and returned afterwards (or have not yet returned). Unfortunately, the survey does not collect information on stays overseas *prior* to the most recent one. So there are individuals who most recently left for overseas between June 1997 and the survey date in October 1997, but who were likely to have been overseas before then as well. Fortunately, there is an additional question in the SOF that is of use, asking how many months the family member has worked/been working abroad during the last five years. Assuming all stays overseas are continuous (except for vacations home in the midst of a stay overseas), the questions asked on the SOF are then sufficient to identify whether a household had a member overseas in June 1997.

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Table 1: Characteristics of sample households, 1997

	Migrant households					Non-migrant households				
	Mean	Std. Dev.	10th pctile.	Median	90th pctile.	Mean	Std. Dev.	10th pctile.	Median	90th pctile.
Rainfall deviation, (000 mm.)										
Dry season year 1	-0.13	0.13	-0.25	-0.14	-0.03	-0.15	0.15	-0.32	-0.14	-0.03
Dry season year 2	0.28	0.40	-0.04	0.10	0.55	0.38	0.50	-0.03	0.20	0.90
Change between dry season year 1 and 2	0.41	0.49	-0.03	0.22	0.71	0.54	0.62	-0.01	0.38	1.21
Wet season year 1	0.22	0.55	-0.46	0.40	0.74	0.23	0.48	-0.44	0.27	0.74
Wet season year 2	0.07	0.47	-0.35	-0.03	1.16	0.01	0.40	-0.35	-0.03	0.54
Change between wet season year 1 and 2	-0.14	0.69	-0.90	-0.29	0.79	-0.21	0.61	-0.90	-0.29	0.43
Outcome variables (changes between Jan-Jun 1997 and Apr-Sep 1998)										
Change in household domestic income (as share of initial household income)	0.10	0.70	-0.46	0.00	0.69	0.14	1.60	-0.55	-0.04	0.85
Change in household remittance receipts (as share of initial household income)	0.12	0.73	-0.49	0.00	0.82	0.02	0.24	0.00	0.00	0.00
Change in household expenditure (as share of initial household expenditures)	0.18	0.91	-0.52	-0.04	1.04	0.09	1.27	-0.52	-0.06	0.76
Change in net gifts (as share of initial household expenditures)	0.03	0.11	-0.03	0.01	0.12	0.02	0.11	-0.03	0.00	0.09
Household financial statistics (Jan-Jun 1997)										
Total expenditure	81,538	87,109	25,189	61,002	150,369	50,778	64,103	13,771	33,424	100,958
Total income	94,189	92,636	28,093	71,012	175,000	56,063	77,685	13,513	35,908	113,465
Domestic income	20,204	21,356	5,510	15,206	39,166	11,858	15,117	2,863	7,624	24,100
Total Income per capita in household	58,067	80,815	7,971	38,310	120,317	54,174	75,920	13,076	34,800	109,780
Remittance receipts	36,122	46,752	0	26,000	87,000	1,889	13,184	0	0	0
Remittance receipts (as share of total income)	0.39	0.31	0.00	0.37	0.85	0.02	0.10	0.00	0.00	0.00
Net gifts	-3,456	25,880	-9,034	-335	480	-1,203	7,793	-3,366	-150	290
HH size (including overseas members, Jul 1997)	6.2	2.4	3.0	6.0	9.0	5.2	2.3	3.0	5.0	8.0
Located in urban area (indicator)	0.68					0.58				
Household head characteristics (Jul 1997)										
Age	49.9	13.9	32.0	50.0	68.0	46.7	14.1	30.0	45.0	67.0
Highest education level (indicators)										
Less than elementary	0.17					0.28				
Elementary	0.20					0.22				
Some high school	0.10					0.11				
High school	0.22					0.18				
Some college	0.16					0.11				
College or more	0.14					0.09				
Occupation (indicators)										
Agriculture	0.23					0.38				
Professional job	0.08					0.06				
Clerical job	0.13					0.11				
Service job	0.05					0.07				
Production job	0.14					0.26				
Other	0.38					0.12				
Does net work	0.00					0.00				
Marital status is single (indicator)	0.03					0.03				
Number of households	1,665					26,126				

NOTES -- Data source: National Statistics Office, the Philippines. Surveys used: Labor Force Survey (Jul 1997 and Oct 1998), Survey on Overseas Filipinos (Oct 1997 and Oct 1998), 1997 Family Income and Expenditures Survey (for Jan-Jun 1997 income and expenditures), and 1998 Annual Poverty Indicators Survey (for Apr-Sep 1998 income and expenditures). Rainfall variables are deviations (in 000 mm) from historical average of each station in corresponding season. Dry season for year 1 is Dec 1995 - May 1996, and wet season for year 1 is Jun 1996 - Nov 1996. Dry season for year 2 is Dec 1996 - May 1997, and wet season for year 2 is Jun 1997 - Nov 1997. Rainfall data are collected from 38 stations. Total expenditures include current consumption as well as purchases of real property, home repairs, installment payments, and loan repayments. Total income includes both domestic-source income and remittances from overseas. Remittance receipts are only from overseas.

Table 2: Impact of rainfall shock on domestic income, 1997-1998
(OLS estimates, first stage of IV regression)

Dependent variable: Change in household domestic income (as share of initial household income)

	Migrant households	Non-migrant households
Dry season rainfall shock (000 mm.)	0.061	0.076
	(0.022)***	(0.031)**
Wet season rainfall shock (000 mm.)	-0.022	-0.042
	(0.015)	(0.036)
Household head characteristics		
Highest education level (indicators)		
Elementary	-0.047	0.035
	(0.036)	(0.031)
Some high school	0.034	0.075
	(0.054)	(0.039)*
High school	0.045	0.111
	(0.065)	(0.028)***
Some college	0.077	0.213
	(0.061)	(0.042)***
College or more	0.126	0.445
	(0.055)**	(0.056)***
Occupation (indicators)		
Professional job	0.097	0.226
	(0.077)	(0.044)***
Clerical job	0.065	0.171
	(0.049)	(0.037)***
Service job	0.076	0.134
	(0.079)	(0.030)***
Production job	-0.025	0.051
	(0.069)	(0.029)*
Other job	0.153	0.272
	(0.039)***	(0.037)***
Does not work	-0.130	0.262
	(0.061)**	(0.093)***
Log income per capita in household	-0.196	-0.412
	(0.022)***	(0.036)***
Located in urban area (indicator)	0.094	0.143
	(0.038)**	(0.022)***
F-statistic: joint significance of rainfall shock variables	4.680	3.060
P-value	0.015	0.058
Num. of obs.	1,655	26,126
R-squared	0.04	0.03

* significant at 10%; ** significant at 5%; *** significant at 1%

NOTE -- Each column of table is separate first differenced regression. Standard errors in parentheses, clustered by weather station. Migrant HHs are those with overseas worker in Jun 1997. The change in domestic income (Jan-Jun 1997 to Apr-Sep 1998) is HH total income excluding remittances from overseas, expressed as fraction of initial household income (Jan-Jun 1997). Rainfall shocks are changes in rainfall variables between first and second period. Omitted occupation indicator is "Agricultural job". Omitted education indicator is "Less than elementary". See Table 1 for other variable definitions.

Table 3: Impact of domestic income shock on remittances, 1997-1998
(OLS / IV estimates)

Dependent variable: Change in household remittance receipts (as share of initial household income)

	Migrant households		Non-migrant households	
	OLS	IV	OLS	IV
Change in household domestic income	-0.067	-1.067	-0.002	0.041
(as share of initial household income)	(0.039)*	(0.440)**	(0.001)	(0.045)
Household head characteristics				
Highest education level (indicators)				
Elementary	0.043	-0.005	0.008	0.006
	(0.053)	(0.077)	(0.003)**	(0.003)*
Some high school	0.053	0.079	0.004	0.000
	(0.070)	(0.085)	(0.003)	(0.004)
High school	0.124	0.173	0.015	0.010
	(0.053)**	(0.094)*	(0.004)***	(0.006)*
Some college	0.185	0.262	0.022	0.013
	(0.050)***	(0.106)**	(0.007)***	(0.011)
College or more	0.324	0.445	0.027	0.009
	(0.095)***	(0.121)***	(0.008)***	(0.021)
Occupation (indicators)				
Professional job	-0.006	0.080	0.005	-0.004
	(0.083)	(0.089)	(0.010)	(0.016)
Clerical job	-0.074	-0.016	0.008	0.000
	(0.069)	(0.098)	(0.005)	(0.009)
Service job	-0.010	0.059	-0.002	-0.007
	(0.058)	(0.109)	(0.005)	(0.008)
Production job	-0.039	-0.067	0.006	0.004
	(0.066)	(0.091)	(0.004)	(0.005)
Other job	0.034	0.179	0.016	0.004
	(0.053)	(0.092)*	(0.008)*	(0.015)
Does not work	0.626	0.488	-0.165	-0.175
	(0.721)	(0.691)	(0.108)	(0.110)
Log income per capita in household	-0.303	-0.494	-0.014	0.003
	(0.030)***	(0.091)***	(0.003)***	(0.018)
Located in urban area (indicator)	0.072	0.174	0.007	0.001
	(0.050)	(0.064)**	(0.003)**	(0.008)
Num. of obs.	1,655	1,655	26,126	26,126

* significant at 10%; ** significant at 5%; *** significant at 1%

NOTES -- Each column of table is separate first differenced regression (OLS/IV). Instrumental variables for change in domestic household income are rainfall shocks in dry and wet seasons (see Table 2 for first stage regression). Standard errors in parentheses, clustered by weather station. See Table 2 for other notes, and Table 1 for variable definitions.

Table 4: **Impact of domestic income shock on total expenditure, 1997-1998 (OLS / IV estimates)**

Dependent variable: Change in household expenditure (as share of initial household expenditures)

	Migrant households		Non-migrant households	
	OLS	IV	OLS	IV
Change in household domestic income (as share of initial household income)	0.584 (0.059)***	-0.077 (0.494)	0.647 (0.075)***	0.358 (0.252)
Household head characteristics				
Highest education level (indicators)				
Elementary	-0.083 (0.073)	-0.114 (0.080)	-0.001 (0.013)	0.008 (0.019)
Some high school	-0.066 (0.095)	-0.049 (0.093)	-0.000 (0.015)	0.020 (0.031)
High school	-0.042 (0.064)	-0.009 (0.082)	-0.021 (0.016)	0.012 (0.034)
Some college	0.041 (0.067)	0.092 (0.087)	-0.022 (0.024)	0.039 (0.059)
College or more	0.157 (0.084)*	0.236 (0.096)**	-0.141 (0.056)**	-0.015 (0.120)
Occupation (indicators)				
Professional job	-0.092 (0.064)	-0.036 (0.080)	-0.063 (0.031)**	0.001 (0.065)
Clerical job	-0.027 (0.082)	0.011 (0.109)	-0.024 (0.036)	0.026 (0.051)
Service job	0.067 (0.087)	0.113 (0.104)	-0.043 (0.022)*	-0.003 (0.041)
Production job	0.012 (0.082)	-0.006 (0.099)	-0.031 (0.016)*	-0.014 (0.022)
Other job	-0.020 (0.062)	0.076 (0.105)	-0.011 (0.028)	0.069 (0.082)
Does not work	0.160 (0.353)	0.069 (0.340)	-0.153 (0.119)	-0.081 (0.128)
Log income per capita in household	-0.147 (0.037)***	-0.273 (0.100)***	0.085 (0.033)**	-0.031 (0.102)
Located in urban area (indicator)	0.039 (0.063)	0.107 (0.085)	-0.019 (0.016)	0.023 (0.040)
Num. of obs.	1,655	1,655	26,126	26,126

* significant at 10%; ** significant at 5%; *** significant at 1%

NOTES -- Each column of table is separate first differenced regression (OLS/IV). Instrumental variables for change in domestic household income are rainfall shocks in dry and wet seasons (see Table 2 for first stage regression). Standard errors in parentheses, clustered by weather station. See Table 2 for other notes, and Table 1 for variable definitions.

<u>Table 5:</u> Impact of domestic income shock on net gifts, 1997-1998
(OLS / IV estimates)

<u>Dependent variable</u>: Change in net gifts (as share of initial household expenditures)

	Migrant households		Non-migrant households	
	OLS	IV	OLS	IV
Change in household domestic income (as share of initial household income)	-0.012 (0.006)*	-0.179 (0.088)*	0.003 (0.003)	-0.033 (0.024)
Household head characteristics				
Highest education level (indicators)				
Elementary	-0.007 (0.010)	-0.015 (0.011)	0.001 (0.002)	0.002 (0.003)
Some high school	-0.002 (0.015)	0.002 (0.019)	0.003 (0.003)	0.006 (0.004)
High school	-0.003 (0.007)	0.005 (0.013)	-0.000 (0.002)	0.004 (0.004)
Some college	0.002 (0.010)	0.015 (0.014)	0.000 (0.002)	0.008 (0.006)
College or more	-0.026 (0.010)**	-0.006 (0.015)	-0.004 (0.003)	0.011 (0.011)
Occupation (indicators)				
Professional job	0.009 (0.016)	0.024 (0.020)	0.004 (0.004)	0.012 (0.007)*
Clerical job	-0.010 (0.010)	-0.000 (0.014)	0.000 (0.002)	0.006 (0.005)
Service job	-0.012 (0.015)	-0.000 (0.015)	0.004 (0.003)	0.009 (0.005)*
Production job	-0.014 (0.010)	-0.019 (0.013)	0.004 (0.002)*	0.006 (0.003)**
Other job	-0.011 (0.009)	0.013 (0.017)	0.018 (0.004)***	0.028 (0.008)***
Does not work	-0.058 (0.065)	-0.081 (0.061)	0.004 (0.015)	0.013 (0.015)
Log income per capita in household	0.014 (0.005)***	-0.018 (0.018)	0.007 (0.001)***	-0.008 (0.009)
Located in urban area (indicator)	0.012 (0.009)	0.028 (0.011)**	-0.005 (0.002)**	0.000 (0.004)
Num. of obs.	1,655	1,655	26,126	26,126

* significant at 10%; ** significant at 5%; *** significant at 1%
NOTES -- Each column of table is separate first differenced regression (OLS/IV). Net gifts are gifts to other households minus gifts received from other households (includes both cash and in-kind transfers, but not remittances). Instrumental variables for change in domestic household income are rainfall shocks in dry and wet seasons (see Table 2 for first stage regression). Standard errors in parentheses, clustered by weather station. See Table 2 for other notes, and Table 1 for variable definitions.

Table 6: Impact of domestic income shock on all outcomes, 1997-1998
(Controlling for change in household size and labor supply)
(OLS / IV estimates)

	Migrant households		Non-migrant households	
Outcomes: Changes in …	OLS	IV	OLS	IV
Remittance receipts	-0.071 (0.039)*	-0.953 (0.415)**	-0.002 (0.002)	0.055 (0.046)
Expenditure	0.566 (0.067)***	-0.007 (0.434)	0.644 (0.078)***	0.396 (0.251)
Net gifts	-0.014 (0.007)**	-0.155 (0.071)**	0.003 (0.003)	-0.033 (0.024)
Num. of obs.	1,655	1,655	26,126	26,126

* significant at 10%; ** significant at 5%; *** significant at 1%
NOTES -- Each cell of table presents coefficient estimate on change in household domestic income in a separate regression. Instrumental variables for change in domestic household income are rainfall shocks in dry and wet seasons (see Table 2 for first stage regression). Each regression includes control variables for the change in number of household members and the change in hours worked by household members between 1997 and 1998. Dependent variables are as in Tables 3, 4, and 5. Standard errors in parentheses, clustered by weather station. See Table 2 for other notes, and Table 1 for variable definitions.

Table 7: Impact of domestic income shock on all outcomes, 1997-1998
(Controlling for household exchange rate shock; migrant households only)
(OLS / IV estimates)

Outcomes: Changes in …	OLS	IV
Remittance receipts	-0.067 (0.039)*	-1.073 (0.446)**
Expenditure	0.585 (0.059)***	-0.073 (0.496)
Net gifts	-0.013 (0.006)*	-0.182 (0.091)*
Num. of obs.	1,655	1,655

* significant at 10%; ** significant at 5%; *** significant at 1%
NOTES -- Each cell of table presents coefficient estimate on change in household domestic income in a separate regression. Instrumental variables for change in domestic household income are rainfall shocks in dry and wet seasons (see Table 2 for first stage regression). Each regression includes control variables for the exchange rate shock faced by migrant members between 1997 and 1998. Dependent variables are as in Tables 3, 4, and 5. Standard errors in parentheses, clustered by weather station. See Table 2 for other notes, and Table 1 for variable definitions.

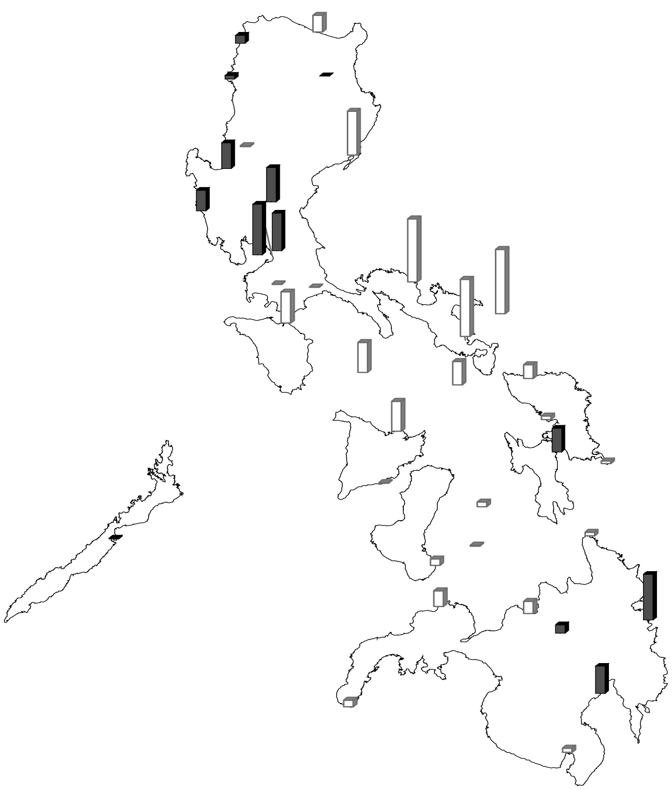
Appendix Table 1: Rainfall shocks recorded by Philippine weather stations
(ordered from north to south)

Station name	Rainfall deviation (000 mm.)					
	Dry season			Wet season		
	year 1	year 2	year 2-year 1	year 1	year 2	year 2-year 1
Basco Batanes	-0.06	0.41	0.47	-0.14	-0.77	-0.63
Aparri Cagayan	0.09	-0.18	-0.28	0.26	-0.90	-1.16
Laoag City Ilocos Norte	-0.05	0.05	0.10	0.62	-0.72	-1.33
Tuguegarao Cagayan	0.27	0.00	-0.27	0.60	-0.05	-0.66
Vigan Ilocos Sur	-0.09	0.02	0.11	0.54	-0.98	-1.52
Baguio City Benguet	-0.03	-0.01	0.02	0.23	-1.10	-1.33
Casiguran Quezon	0.82	-0.48	-1.30	0.49	-0.75	-1.24
Dagupan City Pangasinan	-0.10	0.16	0.26	-0.01	-0.18	-0.17
Cabanatuan Nueva Ecija	0.17	0.22	0.05	-0.38	-0.85	-0.46
Iba Zambales	0.04	0.13	0.08	-0.96	-0.72	0.24
Science Garden Quezon City	0.08	0.24	0.16	-0.35	-0.49	-0.14
Port Area (Mco) Manila	0.09	0.32	0.23	-0.30	-0.12	0.18
Daet Camarines Norte	1.24	-0.69	-1.93	-0.47	-0.84	-0.38
Ambulong Batangas	-0.04	-0.01	0.03	-0.09	-0.57	-0.48
Tayabas Quezon	0.47	0.00	-0.47	1.16	-0.84	-2.00
Virac Synop Catanduanes	2.26	-0.70	-2.96	-0.05	-0.50	-0.45
Calapan Oriental Mindoro	0.20	-0.34	-0.54	0.35	-0.62	-0.98
Legaspi City Albay	2.06	-0.63	-2.68	-0.20	-0.43	-0.23
Romblon Romblon	0.20	-0.33	-0.53	-0.30	-0.70	-0.40
Catarman Northern Samar	1.92	-0.15	-2.07	-0.41	-0.63	-0.22
Masbate Masbate	1.05	-0.26	-1.30	-0.25	-0.19	0.06
Catbalogan Western Samar	0.71	-0.04	-0.75	-0.42	-0.26	0.16
Roxas City Aklan	0.47	-0.33	-0.80	-0.25	-1.01	-0.77
Tacloban City Leyte	0.90	0.15	-0.75	0.10	0.05	-0.06
Guiuan Eastern Samar	1.74	-0.03	-1.77	0.13	-0.48	-0.62
Iloilo City Iloilo	0.55	-0.01	-0.55	-0.03	-0.42	-0.39
Mactan International Airport Cebu	0.17	-0.05	-0.22	0.06	-0.02	-0.08
Surigao Surigao De Norte	0.89	-0.04	-0.93	0.10	-0.12	-0.22
Puerto Princesa Palawan	0.22	0.00	-0.22	-0.20	-0.38	-0.18
Tagbilaran City Bohol	0.55	-0.01	-0.56	0.19	0.03	-0.16
Dumaguete City Negros Oriental	0.36	-0.07	-0.43	-0.08	-0.16	-0.08
Dipolog Zamboanga Del Norte	0.17	-0.17	-0.35	0.00	-0.50	-0.50
Cagayan De Oro Misamis Oriental	0.37	-0.13	-0.50	-0.26	-0.19	0.07
Hinatuan Surigao Del Sur	1.08	0.29	-0.79	-0.21	-0.22	-0.01
Malaybalay Bukidnon	0.03	0.05	0.02	-0.26	0.09	0.35
Davao City Davao Del Sur	-0.01	0.18	0.19	-0.11	-0.17	-0.06
Zamboanga City Zamboanga Del Sur	0.24	-0.07	-0.31	0.11	-0.48	-0.58
General Santos South Cotabato	0.10	-0.05	-0.14	0.08	-0.30	-0.38

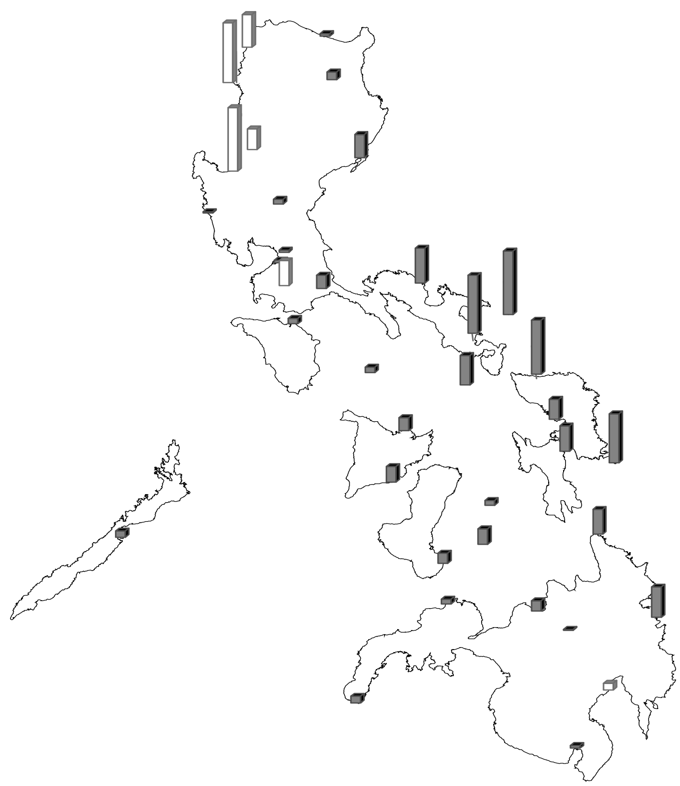
NOTES - Stations ordered from north to south. Rainfall deviation is deviation (in 000 mm) from historical rainfall average in each station. Dry season for year 1 is Dec 1995 - May 1996, and wet season for year 1 is Jun 1996 - Nov 1996. Dry season for year 2 is Dec 1996 - May 1997, and wet season for year 2 is Jun 1997 - Nov 1997.

Figure 1: Dry season rainfall deviations, Philippines

A. Dec 1995 – May 1996

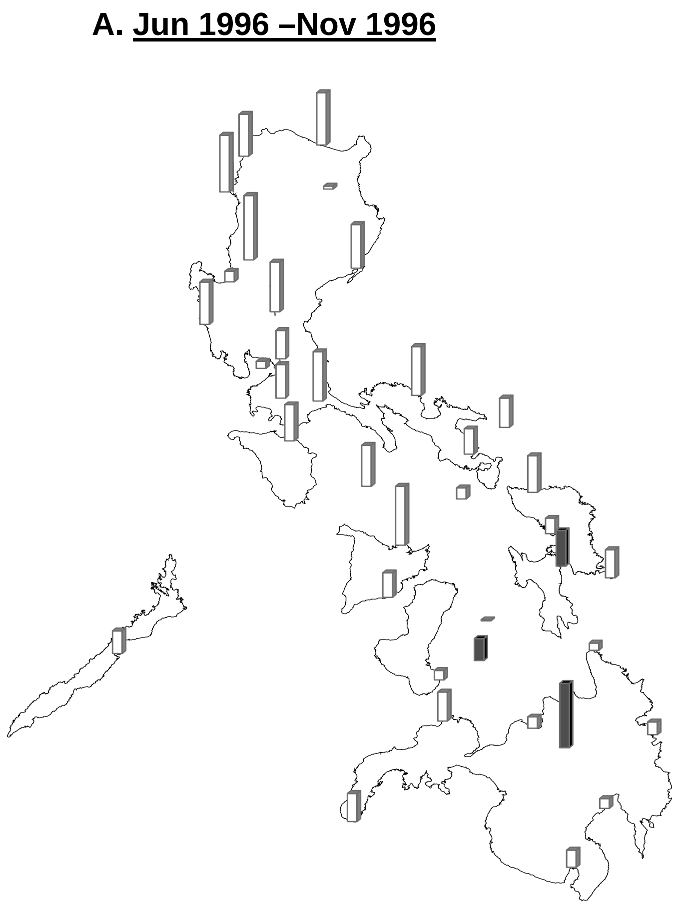


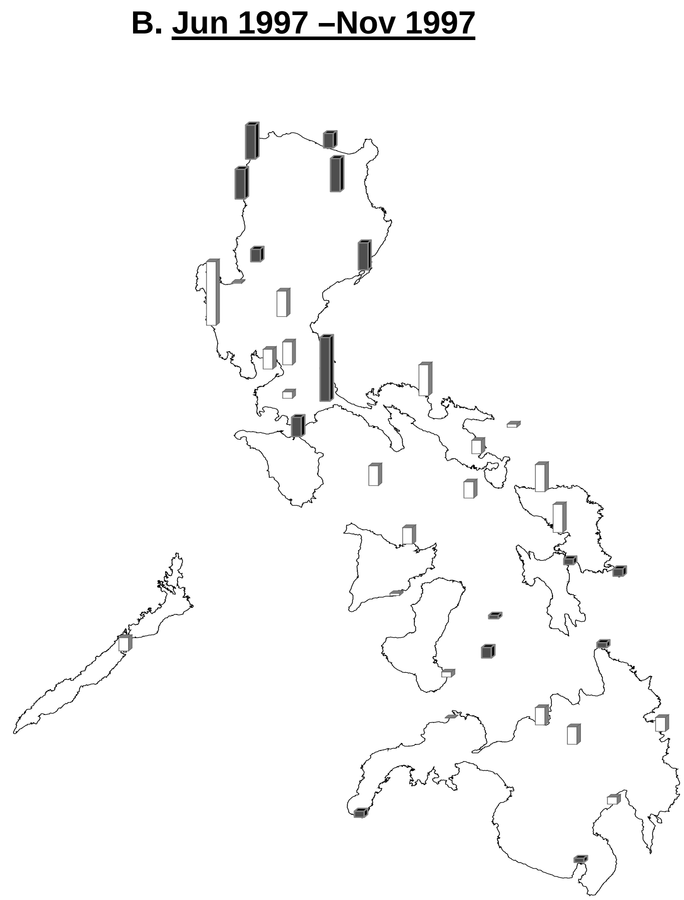
B. Dec 1996 – May 1997



Legend: Dark bar: *positive* deviation from historical mean, 000mm. Light bar: *negative* deviation from historical mean, 000mm. Base of each bar indicates location of weather station.

<u>Figure 2</u>: Wet season rainfall deviations, Philippines





Legend: Dark bar: *positive* deviation from historical mean, 000mm. Light bar: *negative* deviation from historical mean, 000mm. Base of each bar indicates location of weather station.