

# **Do Remittances Act Like Insurance?**

## **Evidence From a Natural Disaster in Jamaica**

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# **Abstract**

Previous research suggests a correlation between income shocks and remittances (money migrants send to households in their home country). Data constraints, however, have prevented this research from dealing with endogeneity issues or estimating the degree to which remittances may insure against shocks. In this paper we construct a household-level panel dataset for Jamaica that includes not only remittance information, but also detailed information about damage incurred due to a major hurricane (Gilbert). The exogenous nature of the shock, the panel data, and the monetary estimates of damage allow us to address these gaps in the literature. We find, even controlling for household fixed effects and potential moral hazard problems by endogenizing hurricane damage, that remittances do act as insurance, but only partially: our parameter estimates suggest that remittances increased by only about 25 cents for every dollar of damage the hurricane inflicted on the household.

## I. INTRODUCTION

Worker remittances—money sent home by family members working abroad—are important sources of foreign exchange and income for developing countries. While total official foreign aid to low- and lower-middle income countries was approximately \$39 billion in 2000, remittances totaled more than \$43 billion.<sup>1</sup> Given the size of these flows, remittances might have a large impact on overall economic development. In particular, to the extent that changes in remittance flows are uncorrelated or negatively correlated with domestic income sources, one important effect of remittances might be to reduce income volatility. Such an effect could be especially important in small, developing economies, which are often considerably more volatile than more developed economies as a result of their heavy reliance on a few commodities or industries and high vulnerability to weather-related shocks.

Whether remittances do, in fact, reduce income volatility depends on how they respond to income shocks. The existing literature suggests that remittances are negatively correlated with changes in other sources of income at the household level, meaning that they might act as a form of insurance. Data constraints, however, force most existing studies to use cross-sectional, rather than panel, household data and regional proxies for shocks rather than data on the actual change in household income due to the shock. They can thus establish general correlations, but can neither rule out reverse causation nor estimate how much remittances change in response to an exogenous shock.

To fill these gaps in the literature, we construct a household panel dataset for Jamaica that includes not only remittance data but also household level information on damage inflicted by a major hurricane (Gilbert). The exogenous nature of the shock, the panel aspect of the data, and household-specific information on the size of the shock allow us to deal with the potential for

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<sup>1</sup> Data from the World Bank's Statistical Information Management & Analysis system. Official foreign aid is defined as "the actual international transfer by the donor of financial resources or of goods or services valued at the cost to the donor, less any repayments of loan principal during the same period. Grants by official agencies of the members of the Development Assistance Committee are included, as are loans with a grant element of at least 25 percent, and technical cooperation and assistance." Worker's remittances are "current transfers by migrants who are employed or intend to remain employed for more than a year in another economy in which they are considered residents." The figure reported is remittance *receipts* only. Net remittances totaled \$36 billion in 2000.

reverse causation and estimate the magnitude of the response. We find that remittances increase when the household is hit by an exogenous shock. However, our estimates suggest that remittances offer only partial insurance, increasing by about 25 cents for every dollar of hurricane damage.

The paper proceeds as follows. First, we summarize the literature on remittances, including possible reasons why emigrants remit and existing studies on factors affecting remittance flows. Next, we discuss the importance of remittances in Jamaica and then describe the dataset we have assembled and its unique advantages over data used in other studies. After this, we explain the empirical methodology and present econometric results. Finally, we conclude with a discussion of those results.

## **II. REMITTANCES AND THE HOUSEHOLD**

Much of the literature on remittances focuses on why migrants remit, suggesting at least four possible reasons. One is self-interest: the migrant hopes to return home someday and wants to retain good relations with his family in order to, for example, insure an inheritance. A second possibility is that remittances are simply a repayment of an intra-family loan that older family members provided to talented younger members to help them migrate (e.g., Poirine, 1997). A third motivation may be intra-family altruism. Funkhauser (1995), for example, develops a model in which migrants maximize functions that include both their own and their family's utility. Finally, remittances might be intended to help families co-insure against shocks in the foreign and domestic economies (e.g., Stark, 1991, Stark and Bloom, 1985). As Lucas and Stark (1985) note, however, the truth is likely to be some combination of all these possibilities.

Indeed, one problem with these motivations as testable hypotheses is that they all may generate very similar behavior. For example, a purely self interested migrant may increase the remittances he sends when his home household suffers a negative income shock if he believes such actions will increase the probability that he will receive an inheritance. Likewise, even if remittances are primarily used to repay intra-family loans, they can serve as insurance if economic shocks are uncorrelated in the sending and receiving countries. Finally, altruistic remitters would certainly increase payments to their home households when the household faces a negative income shock.

While it may not be possible to distinguish between various theories of *why* remitters remit, it is in theory possible to test how remittances respond to household income shocks and, therefore, whether they *act* as insurance. That is, while we may not know whether migrants remit because they are altruistic, selfish, or are following some explicit family arrangement, it should be possible to test whether remittances respond to changes in income. It is perhaps then not surprising that most of the empirical literature has focused on testing relationships between remittances and various household and migrant characteristics, including income. One fairly robust set of results regarding remittances and income is that migrants who earn more tend to send more money home in remittances (e.g., Funkhouser, 1995, or Lianos, 1997 for a review of this literature). Likewise, larger and wealthier households are more likely to send members abroad to work (Funkhouser, 1992).

Understanding whether remittances act as insurance, however, requires knowing how they respond to income shocks, not simply whether they are correlated with income. Under substantial data constraints, existing studies have used three general approaches to investigate this question. One approach—and perhaps a good test of whether households intend to use migration to a form of insurance—is to investigate whether migrants tend to move to regions whose economies are less likely to covary with the economy of their home region. The empirical (within-country) evidence suggests that families may behave this way. While not explicitly about remittances, Rosenzweig and Stark (1989), for example, find that Indian households that face greater risk are more likely to have daughters marry further away from home (i.e., as a form of geographical risk dispersion). Similarly, Paulson (2000) uses historical rainfall and GDP data across provinces in Thailand as a proxy for economic variation, and finds that remitters are less likely to move to Bangkok the more its economy covaries with the economy of their home province. In other words, her results suggest that remitters are more likely to move to a province when its economy moves counter-cyclically (or at least, not cyclically) with the migrant's home province.

Finding that migrants move to places where the economy does not covary with the economy of their home region is consistent with an insurance hypothesis, but is also consistent with other hypotheses. Migrants might move to different economies for insurance reasons or, for example, because there is no point in moving to an economy in which they are likely to do the

same work they did at home. Moreover, even if migrants move for insurance reasons, such tests cannot determine whether and how much remittances change in response to discrete shocks.

To more explicitly address the question of response to shocks, some researchers adopt a second approach that exploits geographic variation more directly. Essentially, this approach tests whether shocks in the home household *region* are correlated with remittances. Lucas and Stark (1985), in a study of intra-country migration in Botswana, find that migrants to urban areas send more money home as remittances when there is a drought in their home region and their families own drought-sensitive assets (measured in cows and crop acres). Likewise, Miller and Paulson (1999) find that households in Thailand are more likely to receive money and remitters more likely to send money if the home province is experiencing a negative rainfall shock (relative to a ten-year average).

Looking for correlations between regional weather or GDP shocks and remittances has the benefit of using an arguably exogenous proxy for changes in income. However, this approach still suffers from the problem that the data on the shock is only *regional*, meaning that it does not measure whether and how much any given household suffers due to the shock. Some studies have therefore adopted a third approach to better target household variation. These studies typically test for correlations between remittances and some measure of household welfare—typically whether the household head has work. Funkhauser (1995), finds, for example that remittances to households in Nicaragua and El Salvador tend to be lower when the household head is working. For Caribbean households, Itzigsohn (1995) also finds a negative correlation between remittance receipt and employment status of the household head.

A problem with this approach, however, is that such tests have little to say on the direction of causality. Reverse causation is a serious concern when analyzing the effects of income changes and employment on remittances. While a negative correlation between changes in remittances and changes in income from other sources is consistent with the hypothesis that remittances increase in response to reductions in other sources of income, it is also consistent with the alternate hypothesis that household members change their behavior when they receive remittances. That is, exogenous changes in remittances might affect the behavior of family members in the home country in ways that affect income from other sources. For example, if

leisure is a normal good at the household level, a sudden exogenous increase in remittances might encourage some family members in the home country to reduce the hours that they work or even to pull out of the labor force entirely. Indeed, there is evidence that such behavior occurs. Massey *et al.* (1994), for example, find that households tend to farm less intensively as household members migrate.

In addition to problems particular to each approach, the existing studies share certain deficiencies resulting from common data constraints. First, the data they use are typically cross-sections rather than panels. Cross sectional data makes certain analyses and controls impossible, as Lucas and Stark (1985) lament when discussing their own paper. For example, cross sectional analyses cannot look at changes in remittances or income by household. In addition, while these studies often control for household characteristics, it is not possible to control for household fixed effects in cross sectional analysis. Second, to our knowledge, none of the existing studies has specific data on actual household-level shocks, making it impossible to assess the degree of insurance remittances might provide. Finally, these studies do not explicitly deal with the problem of endogeneity, which we discuss in greater detail below.

We build on the existing literature to address these remaining questions. We construct a panel dataset of households in Jamaica that includes not only remittance data, but also specific household-level amounts of hurricane damage. While a hurricane is clearly exogenous, we endogenize hurricane *damage* to control for a possible moral hazard problem if households receiving remittances are less likely to take other steps to protect their property against potential damage.

In the next section we discuss the role of remittances in Jamaica and why Jamaica is a useful country to study in this context. We then discuss the dataset, our empirical approach, and the econometric results.

### **III. REMITTANCES, INSURANCE, AND NATURAL DISASTERS IN JAMAICA**

Remittances are an important component of the Jamaican economy. Remittance receipts were equivalent to 10.2 percent of GDP, 23.8 percent of exports of goods and services, 59.2 percent of gross receipts from tourism or 173.1 percent of foreign direct investment in the year

2000 (World Bank, 2002). Moreover, the flow of remittances has grown markedly from \$94 million in 1980 to \$159 million in 1990 to \$809 million in 2001 (in 1995 US\$).<sup>2</sup> Although data from national accounts might overstate the growth of remittances over the past decade if there has been a shift from informal to formal transfer mechanisms, for example due to either the increased ease of electronic transfers or the liberalization of foreign currency markets in the early-mid 1990s, other data also supports the view that remittances have become more important in recent years.<sup>3</sup> For example, data from the Jamaica Survey of Living Conditions (JSLC) shows that whereas only about 24 percent of Jamaican households received remittances in 1990, about 33 percent of households did in 1999. Payments have also increased in both dollar terms and relative to other income sources over this period. The median payment for households receiving remittances increased from US\$162 to US\$380 over this period, from 6 percent to 11 percent of household expenditures.<sup>4</sup>

Jamaica, like many of the islands in the Caribbean, is highly vulnerable to natural disasters. Between 1980 and 2002, Jamaica was hit by 4 hurricanes, several tropical storms and several additional natural disasters (primarily floods). In total, three events (two hurricanes and one flood) resulted in damage of more than 2 percent of GDP. Of these major events, Hurricane Gilbert, which struck in September of 1988, was by far the most destructive. It resulted in over US\$1 billion in damage (about 28 percent of GDP) and 45 deaths.<sup>5</sup> Nearly three-quarters of Jamaican households reported some damage due to Hurricane Gilbert and 21 percent reported serious damage to their house.<sup>6</sup> The average amount of damage reported by households was about J\$3,072 (about 21 percent of average household income).

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<sup>2</sup> Data for 1980 and 1990 are from World Bank (2002). Data for 2001 are from Bank of Jamaica (2001)

<sup>3</sup> Handa and King (forthcoming) describe the process of foreign exchange liberalization in Jamaica over this period.

<sup>4</sup> Authors' calculations using data from the JSLC and exchange rates and CPIs from World Bank (2002)

<sup>5</sup> Data is from EM-DAT: The OFDA/CRED International Disaster Database (<http://www.cred.be/emdat>), Université Catholique de Louvain, Brussels, Belgium.

<sup>6</sup> Serious damage implies either that the house was destroyed, that the roof and structure were seriously damaged or that the roof was destroyed. Data is from the 1989 Jamaica Survey of Living Conditions (JSLC), which is described in section IV.



Despite the number of natural disasters and the potential for property damage, housing insurance is uncommon in most low and middle-income countries in the Caribbean region (World Bank, 2002). In 1999, only about 10 percent of Jamaican households reported having any insurance. Although property insurance up to the value of the mortgage is generally required for houses with mortgages, relatively few households reported having mortgages – only about 8 percent of households that owned their own houses reported making mortgage payments.<sup>7</sup>

One way that households on small islands might self-insure against economic shocks is to diversify sources of labor income through international migration. For the same reasons that growth tends to be volatile in small economies – openness, heavy reliance on a narrow range of products, and the prevalence of natural disasters – it might be difficult for households within small economies to diversify income and assets domestically. Some observers suggest that these conditions make it important for small open economies to be open to international capital markets, since this will make it easier for households to diversify capital income.<sup>8</sup> Capital income, however, is not the most important source of income for most households in developing countries, making it unlikely that capital market liberalization will allow people to diversify adequately. For this reason, labor income diversification is also likely to be important. Because labor diversification *within* small countries heavily dependent on a few industries (like tourism) may not be possible, families may encourage some members to migrate so that they can remit part of their earnings to their family in their home country.

#### IV. DATA

The data we use in this paper comes from the Jamaica Survey of Living Conditions (JSLC). The JSLC is a cross-sectional Living Standards Measurement Study (LSMS) survey that has been conducted annually since 1988.<sup>9</sup> In most years, the JSLC covers about 0.5 percent

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<sup>7</sup> Data presented in this paragraph are from the 1999 Jamaica Survey of Living Conditions (JSLC).

<sup>8</sup> See, for example, Easterly and Kraay (2000)

<sup>9</sup> The JSLC is described in detail in World Bank (2002). Individual surveys are also described in annual reports by the Statistical Institute of Jamaica (STATIN) and the Planning Institute of Jamaica (PIOJ). For example, STATIN/PIOJ (2000) for the 1999 report. These reports are available on the LSMS website at the World Bank (<http://www.worldbank.org/lms/>).

of households in Jamaica. The JSLC contains various modules, including modules on household members, unearned income, consumption, and housing characteristics. The module on unearned income includes a question about cash and in-kind remittances received from friends and relatives from abroad. In addition, the 1989 survey contained several questions relating to Hurricane Gilbert, including estimated damage to housing and other property.

Although the JSLC does not contain any information on labor force participation or earned income, the quarterly Labor Force Survey (LFS), which was conducted a few months before the JSLC, does contain this information. Unique identifiers make it possible to match dwellings, although not individuals or households, between the LFS and JSLC. By comparing the age and sex of individuals in each dwelling, it is possible to tentatively match households and individuals between the two surveys.<sup>10</sup> In practice, since the surveys were taken several months apart and non-response patterns were different, labor force data is missing for many of the households in the JSLC. To compute household income in the 1989 survey, earnings had to be available for all adults in the household.

The JSLC was not designed to provide panel data. However, it is possible to combine data from some of the surveys to produce small panels following households for two or three years. We would ideally like to have remittance data from a year before the hurricane and a year after the hurricane. Unfortunately, the master sample was revised between 1988 and 1989, making it impossible to link households across that time period, while the 1990 and 1991 samples were constructed in such a way that they cannot be linked with the 1989 sample.<sup>11</sup> Thus, while the JSLC is conducted annually, it is possible to link the 1989 survey only to the 1992 survey. In other words, we have to use data from the year following the hurricane (1989) and a year several years after the hurricane (1992). To the extent that the hurricane had a long-term impact on remittances (i.e., if remittances increased for several years before returning to their previous level), we might underestimate the impact of the hurricane on remittances.

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<sup>10</sup> In the 1989 survey, codes were provided in the data set to match individuals. This was not true for most other years (see World Bank (2002, pp. 41-42)). It is important to note that this matching is not perfect. For example, if the original household moves out of the dwelling, while a household with individuals of similar sex and age moves in, a false match would be possible.

As with the LFS and JSLC data sets, households are matched by matching dwellings and then comparing individuals living in those dwellings to assess whether the family remained the same. We considered households to be matched only when all adult members of the household could be matched by age and sex across the two years. As a result, the analysis excludes households in which a member was present in 1989 but migrated before the 1992 survey and began sending remittances and households where a member returned after the 1989 survey and thus ceased sending remittances. This approach reduces concerns that the hurricane might affect migration decisions (e.g., if household members decided to migrate after their assets were destroyed by the hurricane).

Only 583 dwellings between the 1989 and 1992 surveys match (World Bank, 2002). However, we drop a substantial number of these dwellings because we were unable to match all adults in the household. In addition, as discussed in detail below, our analysis dictates that households can be included in the sample only if they received remittances in at least one of the two years. Because only about 36 percent and 23 percent of households received remittances in 1989 and 1992 respectively, this results in a large reduction in sample size. Due to the extremely small number of households that remain (about 100), we are not able to include any data from the LFS in the panel regressions since this would result in a further loss of observations.

One drawback of the JSLC data is that it does not include any information on the remitters, only on the household receiving remittances. Consequently, we are unable to look at questions such as how remittances respond to shocks in the foreign economy where the remitters work. Although this is potentially a concern, the inclusion of fixed household effects in panel analysis should potentially reduce problems related to the lack of data on the remitters. That is, since we exclude households where household members could not be matched in the two years, the household fixed effects should help us control for characteristics of the remitters in addition to unobserved characteristics of the home household.

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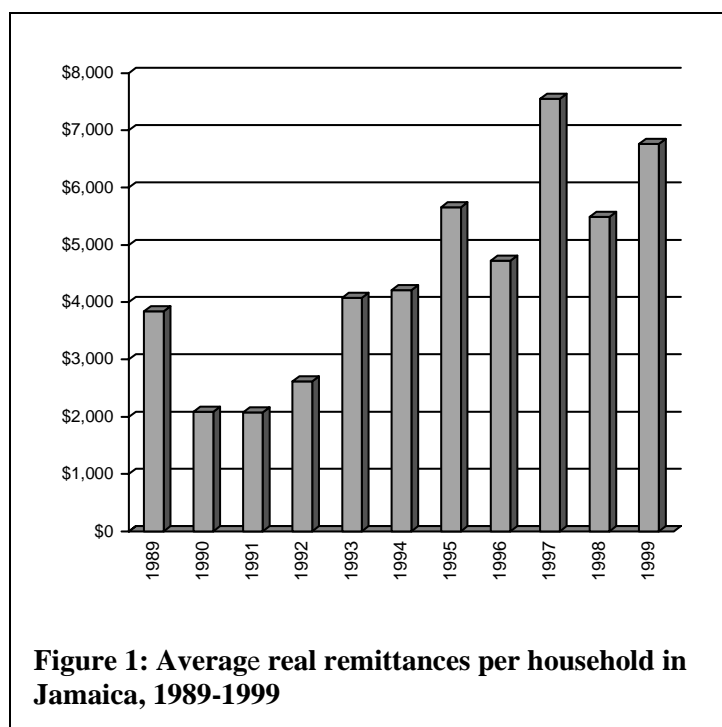
<sup>11</sup> Fewer than five dwellings can be matched between the 1989 survey and the 1990 and 1991 surveys.

## V. EMPIRICAL METHODS AND RESULTS

Our strategy for analyzing the data is to start at the most general level and build to more rigorous tests. Thus, we first look at some very aggregate trends that can be derived from a decade of JSLC surveys. We then turn to econometric analyses, first using the 1989 cross section and then the panel in which we also endogenize hurricane damage.

### *Aggregate Trends*

Aggregate remittance data over time from the JSLC suggest that remittances might be a form of insurance. Even taking the upward trend into account, remittances appeared to surge in response to two negative macroeconomic shocks (Figure 1). The first peak is in 1989—just following Hurricane Gilbert. Although comparable data was not available before 1989,



*Source:* Authors' calculations based upon data from the JSLC. All figures are in 1995 Jamaica dollars, converted using consumer price indices from World Bank (2002)

remittances appear to be significantly higher in 1989 than in the next several years. The 1989 JSLC survey was the first conducted after Hurricane Gilbert devastated the island, and because it covers the twelve months prior to the survey date it should include remittances received following the hurricane. The second peak appears to be in 1997, the worst year of a recession, when the economy contracted by two percent. These two pieces of data suggest that aggregate remittances increase in response to aggregate shocks, consistent with them being a form of self-insurance.

Self-reported answers to questions in the 1999 JSLC about how households respond to financial difficulties also support the hypothesis that remittances increase when families face

negative shocks. Rather than passively receiving remittances, households that receive remittances appear to play an active role in initiating transfers (i.e., remittances are not only sent at the initiative of the remitter). In Jamaica, nearly 20 percent of households facing financial difficulties reported that they asked relatives abroad for help. Consistent with this, Connell and Conway (2000) note “the evidence suggests that most remitters respond to rather than initiate [remittances]” The combination of relatives sending money when asked and households responding to crises by asking relatives abroad for help suggests that remittances could act as self-insurance.

### *Basic Econometric Strategy*

Aggregate trends are suggestive, but are not rigorous tests. They do not control for other factors that can affect remittances, and do nothing to address endogeneity issues. To more rigorously explore the relation between remittances and income shocks we econometrically test whether remittances increased in response to Hurricane Gilbert. The cross-sectional and panel analyses each estimate versions of equation (1) below.

The dependent variable – remittances received from friends and relatives abroad – is a limited dependent variable bounded below by zero (i.e., many households do not receive any remittances). We assume that remittances can be explained as a function of the amount of hurricane damage faced by the households and other household characteristics:

$$(1) \text{Remittances}_{it} = \begin{cases} \alpha + \beta_1 \text{Damage}_{it} + \gamma H_{it} + \lambda_t + \mu_i + u_{it} & \text{if } \alpha + \beta_1 \text{Damage}_{it} + \gamma H_{it} + \lambda_t + \mu_i > u_{it} \\ 0 & \text{otherwise} \end{cases}$$

$\text{Remittances}_{it}$  are remittances received by household  $i$  in year  $t$ ,  $\text{Damage}_{it}$  is the damage caused by Hurricane Gilbert for household  $i$  in year  $t$ ,  $H_{it}$  are other household characteristics,  $\lambda_t$  is a year dummy,  $\mu_i$  is a household level fixed effect, and  $u_{it}$  is a disturbance term. As noted previously, the JSLC does not include any information on the migrants themselves—although the inclusion of household fixed effects in the panel analysis might help control for this. The disturbance term,  $u_{it}$ , is assumed to have a normal distribution and the model is estimated using maximum likelihood techniques.

As discussed below, the model is estimated cross-sectionally using data for all households for which data are available in 1989 and as a panel regression using a subset of the 1989 sample for which data are also available in 1992.

#### *Cross Section Based on the 1989 JSLC*

The cross sectional analysis is based on the 1989 data, which we could match with the LFS to include detailed household characteristics. The estimated equation is described above in equation (1), although the time dummy is absorbed into the constant  $\alpha$  and the individual fixed effects,  $\mu_j$ , are omitted. However, we are able to include a series of regional dummies.<sup>12</sup> These dummies are based upon the 217 sampling regions in the 1989 JSLC. Each individual sampling region is wholly contained within one of Jamaica's 14 parishes, has approximately the same number of dwellings as the other regions, and is composed of relatively homogenous housing units.

As a first exercise, we present results from a simple Tobit regression of remittances from friends and relatives abroad on the amount of hurricane damage that the household faced and other variables to control for household characteristics (see Table 1). In columns (2) and (3), we add measures of unearned income and proxies for earned income into the base regression.

The coefficient on the variable representing the amount of hurricane damage faced by the household is positive and statistically significant at a 10 percent level or higher in all three regressions. The coefficient from this estimation suggests that remittances only increase modestly in response to hurricane damage – a \$1 increase in damage results in only about 4.5 cents in remittances.

The other controls indicate that households with female heads receive about J\$815 more in remittances than male-headed households. Female-headed households might receive higher remittances than other households either because female heads are more likely to have spouses or

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<sup>12</sup> These are omitted from the panel analysis, since they are collinear with the household dummies. Because households are matched based upon dwelling, households that move regions are necessarily excluded from the analysis.

partners located abroad than other households or because other relatives are more likely to remit to female-headed households. Although there was not enough information in the 1989 JSLC to identify whether heads of female-headed household had absent spouses, evidence from other years suggests that female-headed households might receive higher remittances for both reasons. In 1999, 41 percent of female-headed households with married heads with absent spouses (including common law spouse) received remittances, while only 37 percent of other female-headed households received remittances (World Bank, 2002, Table 3.14). Although this suggests that the higher remittances received by female-headed households might partially be due to absent spouses, only 31 percent of male-headed households received remittances suggesting that the difference is not simply due to absent spouses.<sup>13</sup>

The negative coefficient on age and the positive coefficient on age squared indicate a u-shaped relationship between age of the head and the amount of remittances that the household receives. The minimum occurs at about age 33, with older and younger heads receiving higher remittances than middle-aged heads. Based upon the parameter estimates in column (1), households with heads aged 25 and 75 received about J\$70 and J\$2150 more than a household with a head aged 33. Urban households also received about J\$931 more in remittances than rural households.

In column (2), we add a measure of other unearned income to the regression. The coefficient on unearned income is positive but statistically insignificant at conventional significance levels. The point estimate of the coefficient suggests that a \$1 increase in other unearned income increases remittances by about 10 cents.

In column (3), we add a series of variables to proxy for earned income – dummies indicating the sector of the economy where the household head works, dummies indicating type of job held by household head (e.g., managerial, professional, skilled, unskilled or clerical), a dummy indicating whether the head was employed and a dummy indicating the amount of agricultural land owned by the household. When these variables are included, sample size is

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<sup>13</sup> It is also important to note that females also migrate from Jamaica leaving other family members behind. In recent years, private companies from Britain have recruited nurses and teachers from Jamaica – professions typically

reduced and the coefficients on most of the other controls become statistically insignificant. However, the coefficient on hurricane damage remains statistically significant and similar in size to previous results. In addition, the coefficients on age and age squared remain jointly significant at a 1 percent level.

As discussed previously, information on earned income is both poor quality and is available only for some of the households in the main sample. Column (4) presents results with a more complete measure of income that includes both earned and unearned income. This reduces the sample size by over 500 households, nearly one-third of the total sample. The coefficient on this variable is very close to zero and is statistically insignificant at conventional significance levels. The point estimate of the parameter suggests that a \$1 increase in income decreases remittances by less than one-tenth of a cent. Once this variable is included, all other parameters become statistically insignificant at 5 and 10 percent significance levels. However, this appears to primarily be the result of reduced sample size rather than the impact of including this variable in the analysis. When the regression is repeated on the smaller sample omitting the income variable, the coefficients on the other variables are very close to the coefficients from the regression with household income included.<sup>14</sup>

#### *Panel Analysis and Endogeneity*

The cross-sectional analysis provides good evidence that remittances are higher when the household incurs a negative income shock. Estimating the effects of damage from a natural disaster on remittances substantially reduces concerns about remittances directly affecting contemporaneous household behavior. It seems highly unlikely that households who receive an exogenous increase in remittances will respond by destroying their property during a natural disaster. However, looking at the effect of losses due to a natural disaster does not reduce two other endogeneity concerns.

First, households with particularly unstable earnings or risky assets might be more likely to encourage family members to migrate to diversify risk. For example, households whose

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dominated by women in Jamaica.



income and assets are most vulnerable to hurricane damage (e.g., families involved in industries such as banana production) will benefit more from income diversification due to migration than other households. Consequently, they might be more likely to have family members living abroad who can send remittances in the event of a hurricane. Second, moral hazard is also a concern. If remittances increase when income from other sources falls, households with members living abroad might behave differently from households without this safety net. That is, since self-insurance (e.g., diversifying household income through migration) acts as a substitute for self-protection, households that anticipate receiving remittances in the event of a shock might be less likely to invest in self-protection (Ehrlich and Becker, 1972). For example, households might be less likely to take costly actions such as installing hurricane shutters or strengthening roofs if they know that their relatives abroad will help them pay for any repairs after a hurricane has occurred.

The panel regressions help reduce the potential for reverse causation due to the possibility that families with vulnerable assets might be the most likely to encourage migration. While a positive cross-sectional correlation between hurricane damage and remittances might be due to households facing exceptionally high risk encouraging members to migrate, in the panel regressions the household fixed effects control for idiosyncratic unobserved household risk that might affect the household's propensity to have members migrate. If households that face the greatest risk are most likely to have members migrate, we would expect the coefficient estimate to be smaller in the panel regressions than it is in cross-sectional estimation. However, it is also possible that the coefficient might be larger in the panel regressions than it is in the cross-sectional regressions. This would be the case if risk-averse households are more likely to have members migrate in order to diversify income sources and are also more likely to invest in self-protection mechanisms that reduce the likelihood of hurricane damage.

An additional advantage of using panel data rather than cross-sectional data is that the panel results will not be driven by short-term migration. As noted previously, households are only matched when household members are present in both 1989 and 1992. This means that

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<sup>14</sup> Results available from the authors upon request.

results will not be driven by short-term migration of household members that might have occurred in response to the hurricane; households with members that temporarily migrated in response to the hurricane would be dropped from the sample if the member returned by 1992. Similarly it will also drop households where members temporarily returned from abroad due to the hurricane (e.g., to help with reconstruction).

Neither the use of panel data nor the focus on natural disasters eliminates the second remaining endogeneity concern—possible reverse causation due to moral hazard. To address this concern, we also endogenize hurricane damage by using the average damage faced by other households in the same sampling region in that year as an instrument for the household’s own damage. Remittances received by a household should not affect the decisions of other nearby households (i.e., household  $i$ ’s decisions regarding construction will not be affected by the fact that household  $j$  might receive remittances to help household  $j$  rebuild following the hurricane). However, given the localized nature of hurricane damage, it is likely that the amount of damage will be highly correlated for households in the same region of the country. To calculate this variable, we drop all households in the panel sample from the main sample and then take the average damage for the remaining (non-panel) households in each sampling region. Consequently, damage faced by households in the panel data sample is not included in the average. The instrument is highly correlated with the variable of interest and, therefore, appears to be an appropriate instrument.<sup>15</sup>

One issue, unrelated to concerns about reverse causation, is that including fixed effects in models with censored dependent variables results in some computational problems. If the household did not receive remittances in either 1989 or 1992, the coefficient on the household dummy for that household will become infinitely negatively large when the model is estimated. As a result, households that have never received remittances have to be discarded (Maddala, 1983, p. 325). When the model is estimated after these observations are dropped, the estimator is called an “unconditional estimator”. Since many households did not receive remittances in either year, many end up being discarded. Heckman and Macurdy (1980) propose (in a slightly

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<sup>15</sup> The simple correlation is 0.58 and is significant at higher than a 1% level.

different Tobit-type model) an estimator that explicitly takes into account the conditioning that arises from discarding these observations (the conditional estimator).<sup>16</sup> They note that since the two estimators require the same asymptotic assumptions for consistency, there is no theoretical reason to prefer the conditional estimator to the unconditional estimator (p. 59).<sup>17</sup> Therefore, we present results from the unconditional model since it is significantly easier to estimate.

Table 2 presents results from the panel estimation, which includes observations of remittances in 1989 and 1992 for a sub-sample of the households in the 1989 JSLC. As noted above, the inclusion of fixed effects in these regressions results in excluding from the sample households that never received remittances. Since these regressions include household level fixed effects and year dummies, most of the household level controls (e.g., characteristics of the household head and regional dummies) have to be omitted since they are collinear with the fixed household and year effects. Column (1) presents results with hurricane damage treated as exogenous (i.e., ignoring the possibility that households might invest less in hurricane protection if they believe that they will receive higher remittances to help them to finance any repairs due to hurricane damage).

The coefficient on the variable representing hurricane damage is positive and statistically significant at a 1 percent level. The coefficient indicates that households receive about 23 cents in remittances for every dollar of hurricane damage – higher than the estimates from the cross-sectional regressions (only about 4 cents for every dollar of damage). One plausible explanation for the difference is that there are omitted household characteristics in the cross-sectional regressions that are negatively correlated with hurricane damage but positively correlated with remittance receipt. For example, households with low lifetime income might be more likely to live in areas and houses that are vulnerable to hurricane damage and less likely to receive

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<sup>16</sup> Essentially this means adding  $\sum \text{Log}_e (P_i)$  to the log-likelihood, where  $P_i$  is the probability that the benefit level for state  $i$  is greater than zero for at least one period in the sample (see Maddala, 1983, p. 326).

<sup>17</sup> In particular, both models require the number of time periods and the number of cross-sectional units to become large (i.e.,  $I \rightarrow \infty$  and  $T \rightarrow \infty$ ) for consistency. Heckman and Macurdy did not perform a Monte Carlo study to test whether one estimator has better small sample properties than the other. However, based upon other sample selection models, they suggest that the conditional estimator might perform better than the unconditional estimator.

remittances than other households.<sup>18</sup> Alternatively, risk-averse households might be more likely to receive remittances (due to attempts to diversify income) but also more likely to invest in self-protection (e.g., moving to safer areas or investing in stronger housing).

This result is robust to treating hurricane damage as endogenous, using average damage faced by households in the same constituency as an instrument. When remittances are treated as endogenous, the model is estimated using a generalized least-squares procedure for censored regressions with endogenous variables proposed by Amemiya (1979). As discussed previously, since the self-protection decisions of other nearby households are unlikely to be affected by the possibility of remittance receipt by the household in the sample, this seems to be an appropriate instrument. In practice, the results are similar whether hurricane damage is treated as endogenous or exogenous – the coefficient remains similar in size and remains statistically significant at a 10 percent level or higher. Since the results are similar in the two cases, this suggests that moral hazard is not a major problem in this sample. If households allowed the fact that they will receive increased remittances in the event of a hurricane to affect their decisions regarding self-protection (i.e., decisions regarding construction), we would expect the coefficient to become smaller after controlling for endogeneity.

Unearned income varies between years in the sample for individual households and, therefore, is not collinear with the household dummies. Including this variable does not appear to have a large effect on the coefficient on damage due to Hurricane Gilbert. The coefficient increases slightly to about 25 cents per dollar of damage when treated exogenously and nearly 27 cents when treated endogenously, and is statistically significant at a five percent level or higher whether hurricane damage is treated as exogenous or endogenous. The coefficient on unearned income is statistically significant and negative, suggesting that an increase in unearned income results in a decrease in remittances from abroad. This result is interesting because the coefficient on unearned income was positive, although statistically insignificant, in the cross-sectional

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<sup>18</sup> World Bank (2002) notes that limited resources and land ownership and tenure patterns often induce poorer households in the Caribbean region to settle on lands such as unstable slopes, riverbanks and low-lying coastal areas that are especially prone to natural disasters and might be more likely to live in poorly constructed shelters. On the other hand, low-income households will generally have fewer physical assets than richer households.

regressions. As noted previously, earned income is available for too few households to include this variable in the regression.

The difference between the cross-sectional and panel results could reflect the differential effects of long-term income and short-term income shocks on remittances. The positive correlation between income and remittances in the cross-sectional regressions might be due to a positive correlation between long-term income and remittances. Since migrating is relatively costly, individuals from households with a low lifetime income might be less likely to migrate and, therefore, less likely to remit than individuals from households with a high lifetime income.<sup>19</sup> In the cross-sectional regressions, the income measure might therefore primarily reflect lifetime income (i.e., income differences between households). In contrast, the income measure might primarily reflect income shocks in the panel regressions (i.e., income differences between 1989 and 1992 for individual households since the household dummy will remove the influence of long-term income). That is, the negative coefficient in the panel regressions might reflect that remittances temporarily increase in years when households face temporary income shocks. This would be consistent with the previous result that households facing temporary shocks due to the hurricane also receive higher income. The coefficient on unearned income suggests that a dollar decrease in other income results in about a 22-cent increase in remittances – an amount similar in magnitude to the effect of hurricane damage on remittances.

## **VI. CONCLUSIONS**

The evidence from Jamaica following Hurricane Gilbert strongly suggests that remittances protect households against exogenous shocks. Evidence from cross-sectional regressions indicates that households that faced the greatest damage during Hurricane Gilbert received higher remittances following the hurricane than households that faced less damage.

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<sup>19</sup> Consistent with this, highly educated individuals from Jamaica are more likely to migrate than less educated individuals. World Bank (2002) reports that individuals with a University education were more than four times as likely to report that they planned to migrate due to financial difficulties than individuals with only a primary education. In fact, according to calculations by the Pew Hispanic Center based upon US census data, there were almost three times as many university-educated individuals born in Jamaica living in the United States as there were in Jamaica.

However, these regressions suggest that the effect is small. For every dollar of additional damage, remittances appear to increase by only a few cents.

Qualitatively, the results from the panel estimation are similar to those from the cross-section: households that faced the greatest damage received higher remittances relative to the amounts they received in a non-hurricane year. However, the coefficient estimates suggest a much greater effect in the panel analysis than they did in the cross-sectional analysis; remittances increased by about 25 cents for every dollar of hurricane damage in the panel estimation. One possible explanation for the larger coefficients in the panel analysis is that risk-averse households might be more likely both to encourage income diversification through migration of household members and to invest in self-protection mechanisms that reduce hurricane damage.

The results are robust to allowing hurricane damage to be endogenous due to the possibility of moral hazard. Further, the point estimates of the parameters are similar in the two models, suggesting that moral hazard is not a major problem in this case. If moral hazard were a significant problem, we would expect the coefficient to be considerably smaller after allowing hurricane damage to be determined endogenously.

Although remittances seem to act as insurance against losses due to natural disasters, it is important to note that the insurance they provide is incomplete. The largest coefficient estimates suggest that remittances increase by only about 25 cents for every dollar of hurricane damage. This could suggest that moral hazard remains a concern, resulting in migrants being unwilling to provide complete insurance. However, given the results that suggest no evidence of reverse causation, it might also suggest that losses due to hurricanes are simply too large for migrants to fully bear, resulting in only partial insurance.

Even if remittances act as a form of insurance in the event of a natural disaster, this does not mean that they will increase when other types of shocks occur. Damage due to hurricanes and other natural disasters is relatively easy to observe and is mostly exogenous. In contrast, it might be more difficult for a migrant in a distant country to assess the extent to which the family in the home country is responsible for other forms of income loss (i.e., moral hazard might be a greater concern in these other cases). For example, it might be difficult to know whether unemployed family members are unemployed due to bad luck or due to them not wanting to find

new employment. These problems might be reduced when remittances are provided to family members – it is probably easier for a family member to assess the extent of moral hazard than it would be for an outsider – but they are probably not completely eliminated. Understanding the extent to which remittances successfully operate as insurance under these circumstances would be a useful goal for future research.

## VII. TABLES

**Table 1: Effect of Hurricane Damage on Remittances (Cross-Sectional Tobit Estimation)**

	(1)	(2)	(3)	(4)
<i>Estimation Method</i>	Tobit	Tobit	Tobit	Tobit
<b>Dependent Variable</b>	Remittances from Friends and Relatives Abroad (000s of 1995 J\$)			
<b>Number of Observations</b>	1884	1856	1633	1362
<b>Region Dummies</b>	Yes	Yes	Yes	Yes
<b>Occupational Dummies for Household Head</b>	No	No	Yes	No
<b>Occupational Sector Dummies for Household Head</b>	No	No	Yes	No
<b>Hurricane Damage</b>				
Hurricane Damage (000s of J\$)	0.0456** (2.13)	0.0421* (1.95)	0.0446* (1.82)	0.0368 (1.27)
<b>Income</b>				
Other Unearned Income (000s of J\$)		0.1051 (1.62)	0.0936 (1.38)	
Earned and Unearned Income (000s of J\$)				-0.0008 (-0.12)
<b>Household Characteristics</b>				
Rural Location (Dummy)	-0.8765* (-1.83)	-0.9044* (-1.88)	-0.7138 (-1.42)	-0.7269 (-1.24)
Household Head is Male (Dummy)	-0.8050** (-2.53)	-0.7831** (-2.45)	-0.4178 (-1.07)	-0.6137 (-1.53)
Age (Years)	-0.0794 (-1.49)	-0.0747 (-1.39)	0.0010 (0.02)	-0.0540 (-0.81)
Age Squared (Years)	0.0012** (2.30)	0.0011** (2.23)	0.0004 (0.67)	0.0009 (1.36)
<b>Earned Income</b>				
Agricultural Land (Acres)			-0.0229 (-0.95)	
Household Head is Employed (Dummy)			-0.3156 (-0.68)	
Household Head Has Secondary Education (Dummy)			0.3343 (0.67)	
Household Head Has University Education (Dummy)			-0.4749 (-0.29)	
<b>Log-Likelihood</b>	-2732.3	-2699.8	-2382.2	-2006.8

The sector dummies are dummies for agriculture; manufacturing, mining and construction; electricity, gas and water; trade; transportation; financial services; and other services. The occupational dummies are professional; managerial; clerical; service employee; skilled worker; and unskilled worker.

\* Significant at 10% level      \*\* Significant at 5% level      \*\*\* Significant at 1% level

Source: Data is from the Jamaica Survey of Living Conditions (JSLC) for 1989.



**Table 2: Effect of Hurricane Damage on Remittances (Fixed Effects Tobit Estimation)**

	(1)	(2)	(3)	(4)
<i>Estimation Method</i>	<i>Tobit</i>	<i>IV Tobit</i>	<i>Tobit</i>	<i>IV Tobit</i>
<b>Dependent Variables</b>	Remittances from Friends and Relatives Abroad (000s of 1995 J\$)			
<b>Household Dummies</b>	Included	Included	Included	Included
<b>Number of Observations</b>	210	210	209	209
Damage due to Hurricane Gilbert (000s of 1995 J\$)	0.2338*** (2.74)	0.2410* (1.83)	0.2463*** (2.83)	0.2668** (2.00)
Year – 1992 (Dummy Variable)	-1.7713 (-0.73)	-1.6505 (-0.56)	-1.4824 (-0.60)	-1.1338 (-0.38)
Other (Non-Remittance) Unearned Income (000s of 1995 J\$)			-0.2261* (-1.78)	-0.2247* (-1.78)

All regressions include a series of dummies for individual households. In the IV Tobit regressions the instrument is the average damage faced by households not included in the sample due to missing data for 1989 in the same constituency as the household in the sample.

\* Significant at 10% level      \*\* Significant at 5% level      \*\*\* Significant at 1% level

Source: Data is from the Jamaica Survey of Living Conditions (JSLC) for 1989 and 1992

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