Migration as coping strategy for natural shock recovery: Evidence from Hurricane Mitch in Nicaragua

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Abstract:

Natural disasters and climate related events are nowadays considered one of the main sources of negative shocks affecting human security in developing countries, especially for agricultural and natural resource-dependent households (UNHCR, 2014). Long-term implications of these shocks may conduct to poverty traps in case of lack of assets to support adaptation and recovery costs, jeopardizing the opportunities for future development (Carter et al., 2007). According to the New Economics of Labour Migration theory, migration constitutes a risk-diversification strategy, grounded on intra-household mutual insurance agreements. Therefore, remittances from migrants may work as insurance in case of natural shocks affecting sending households, reducing income volatility and limiting asset depletion. However, very few contributions have investigated whether migration represents an effective strategy to recover from the detrimental consequences of natural disasters. This study contributes to fill these gaps considering the case of Hurricane Mitch which hit Nicaragua in October 1998. , The paper tests whether the occurrence of the natural disaster boosts international migration, focusing on the interactions between the level of shock exposure and canonical determinants of migration. Moreover, I assesses whether remittance receiving households (RRHs) recover more easily from the damages caused by the Hurricane. The disaster does not act as push factor as a whole. Only individuals belonging to agricultural households experiencing high exposure to rainfalls increase their likelihood to move abroad in the aftermath of the Hurricane. The impact of shock exposure on mobility decisions increases along with household land endowments and for households who cannot rely on alternative guaranteed sources of income. Remittances have a positive impact on long run welfare recovery. Income flows from migrants help households to maintain higher consumption standards. Furthermore, remittances support household assets preservation, especially for agricultural households, reducing the risk of being trapped into poverty.

1. Introduction

A vast literature has examined the implications of risk exposure for households in developing countries (Udry, 1994; De Weerdt and Dercon, 2006). Constraints to the access to credit and insurance markets raise household ex ante exposure to adverse exogenous shocks and affect ex post capability to quickly re-establish previous livelihoods (Fafchamps and Lund, 2003). The long term implications of these shocks may conduct to poverty traps, especially when household asset base is insufficient to support recovery costs (Carter et al., 2007). Moreover, the risk-diversification strategies adopted to cope with unexpected income variability may be costly and not profitable in the long run (Rosenzweig and Wolpin, 1993).

As climatic systems have been changing worldwide, increasing both the frequency and the intensity of extreme meteorological events, natural disasters and climate-related events are nowadays considered one of the main risk factors in developing countries, especially for natural resource dependent households. Therefore, burgeoning interest has been devoted to the analysis of how weather shocks affect human well-being and whether the available strategies to cope with them turn out to be adequate (Field, 2012). The effectiveness of usual risk-management institutions is limited by the fact that weather shocks are spatially covariant. Therefore, the mechanisms that are implemented in case of idiosyncratic risk, they may not be effective when all the households in a geographical area are exposed to the same stress (McKenzie, 2003; Kubik and Maurel, 2016).

The idea of migration as a risk-diversification strategy has been widely analysed by the New Economics of Labour Migration (NELM) literature (Lucas and Stark, 1985; Stark and Bloom, 1985; Katz and Stark, 1986). According to such approach, migration constitutes a household level collective decision driven by mutual insurance purposes. Given that wages and shocks at home and destination are usually not positively correlated, the individual decision to migrate can be the outcome of an informal familiar arrangement, with benefits in terms of risk-diversification and consumption smoothing for all the members (Rapoport and Docquier, 2006; De Weerdt and Hirvonen, 2013).

A large body of literature has tried to determine whether rising exposure to environmental risks influences mobility decisions, assessing whether climate anomalies and natural disasters act as direct push factors or they interact with cultural, social, political or economic determinants in shaping migration patterns (Piguet et al., 2011). Counteractive conclusions on the relationship between climate change and out-migration have been reached according to the characteristics of environmental events (Halliday, 2006), migration episodes (Gray and Bilsborrow, 2013) and individuals observed (Gray and Mueller, 2012), leaving space for further contributions. However, the role played by

remittances in insuring households of origin against exogenous income shocks has been ascertained in diverse contexts (Gubert, 2002; De la Briere et al., 2002; Yang and Choi, 2007). This mechanism seems to operate also in case of natural shock occurrence. Climate-related events have been proved to lead to a substantial increase in remittance flows (Clarke and Wallsten, 2004; Bettin et al., 2016). Anyway, the extent to which these income flows contribute to long term recovery from natural disaster is still an underexplored issue.

This study investigates the role of migration as coping strategy in response to natural shock exposure, examining the case of Hurricane Mitch hitting Nicaragua on October,1998. Firstly, the impact of the sudden-onset climatic shock on subsequent individual mobility decisions is assessed, considering both regional mobility across Central American countries and migration to US and Canada. The interactions between shock exposure and canonical determinants of migration are examined, identifying for which population groups the occurrence of a natural shock impacts on subsequent migration decisions. Secondly, the paper tests whether remittance receiving households (RRHs) recover more easily from the damages caused by the Hurricane. In particular, focusing on a long run perspective, I compare household welfare before and two years and half after the Hurricane. In order to provide some details about how migrant transfers contribute to household recovery, two major dimensions are investigated: growth in per capita consumption between the two survey and wealth scores in 2001. In this way, it is possible to be established if remittances constitute a liquidity source sustaining household consumption and are effective in preserving and restoring household asset endowments.

The findings obtained show that the severity of the shock, measured in terms of aver- age rainfall levels during the Hurricane, does not act as push factor as a whole. Only individuals belonging to agricultural households experiencing high exposure to rainfalls increase their likelihood to move abroad in the aftermath of the Hurricane. As agricultural households are usually the most affected by natural shocks, this suggests that severe unexpected natural disasters provide incentives for migration within the most vulnerable groups. The positive effect of the shock is larger for individuals who do not have relatives employed as wage labourers. This indicates that those households who cannot rely on alternative guaranteed sources of income tend to choose migration as coping strategy. However, the decision to migrate is also linked to household assets. The impact of shock exposure on mobility decisions increases along with household land endowments.

Remittances seem to have a positive impact on long run welfare recovery. Income flows from migrants help households to maintain higher consumption standards. Furthermore, remittances support household assets preservation, reducing the risk of being trapped into poverty. This is valid

especially for agricultural households. In order to deal with selection into migration issues, the estimates are conducted with an instrumental variable (IV) approach. Indeed, RRHs may present specific unobservable characteristics which determines both the decision to send a family member abroad and the capability to recover after a shock. Therefore, historical migration and remittance rates at the department level are used to instrument for household remittance status.

2. Literature review

2.1 Do wealth shocks boost migration?

The role of climate change as push factor for migration varies according to the geo- graphical area, the type of environmental degradation and the characteristics of the migration flows investigated (Piguet and Laczko, 2013; Cattaneo and Peri, 2016; Maurel and Tuccio, 2016; Halliday, 2006). Long-term environmental deterioration turns out to be only partly related to human mobility. Heterogeneous effects of climatic anomalies on migration decisions across gender and ethnic groups have been reported both in Nepal and Ethiopia (Massey et al., 2010; Gray and Mueller, 2012). As migration remains selective with important barriers to participation due to migration costs, adverse climatic conditions further reduce mobility in rural Ecuador because of exacerbated liquidity constraints (Gray and Bilsborrow, 2013). On the contrary, weather anomalies have been found to have an indirect positive impact on internal migration in rural Tanzania conditioned on initial endowments, since only households in the middle of the wealth distribution respond to adverse conditions migrating (Kubik and Maurel, 2016). Evidence of a positive relationship between detrimental climatic conditions and rural-urban migration has been reported also in sub-Saharan Africa (Barrios et al., 2006). Beine and Parsons (2015) use a panel of global bilateral migration flows to show that anomalies in temperature and rainfalls influence international migration indirectly through wage differentials.

As regards short-term environmental shocks, Lewin et al. (2012) find a negative association between rainfall shocks and rural out-migration in Malawi. A reduction in the likelihood of moving out after the occurrence of earthquakes, volcanic eruptions and floods has been reported also in Indonesia (Tse, 2011). On the other hand, the perception of sudden unexpected natural disasters acts as a push factor for human mobility in Vietnam (Koubi et al., 2016). Looking at the inter-cantonal migration gross rates in Costa Rica, Robalino et al. (2015) assess that hydro-meteorological outstanding events affect internal migration patterns, with opposite sign according to the severity of the emergencies. Natural disasters with the most severe consequences in terms of loss of lives, tend to reduce mobility flows.

Focusing on international migration, Reuveny and Moore (2009) suggest that the shock intensity is positively related to international out- migration.

Moreover, it is far from being clear how and to what extent environmental changes interact with other migration drivers. As regards rural households, climatic change seems to influence migration decisions through its indirect effect on agricultural productivity and rural livelihoods. Damaging crops and livestock assets, environmental degradation reduces household income, especially in case of lack of alternative working opportunities or adaptation strategies (Black et al., 2011). Nevertheless, although an unexpected reduction in the reliability of income may constitute an incentive for migration, it drastically diminishes available resources to cover migration costs (Lilleør and Van den Broeck, 2011; Halliday, 2006).

However, how this translates into individual migration decisions it is still uncertain. The ways in which the degree of exposure interacts with ex ante characteristics determining the coping strategies to undertake are still unexplored (Carvajal and Medalho Pereira, 2009). Although household asset base before the shock has been recognised being determinant in orienting mobility decisions, to the best of my knowledge no contribution has assessed whether income composition plays a role. In line with the theoretical frame- work of the NELM, I assume that migration decisions respond to intra-household mutual insurance requirements. Therefore, I test whether household income composition deter- mines the circumstances under which moving abroad turns out to be a preferred response to natural disaster exposure.

2.2 Migration as an intra-household insurance strategy

Several empirical analyses confirm that monetary transfers from both internal and international migrants compensate for income shortfalls experienced by sending families. De la Briere et al. (2002) observe that the amount of money sent home by Domini- can female migrants in US increases in response to unanticipated family income shocks. Crop income drops experienced by those who stay behind are shown to significantly raise remittances to Western Mali (Gubert, 2002). Fluctuations in income are negatively related to changes in remittance flows from overseas to the Philippines (Yang and Choi, 2007). Molina Millan (2014) provides further evidence about the co-insurance mechanisms driving remittance behaviour, assessing that not only internal and regional migrants provide insurance to their households of origin in rural Nicaragua, but also the other way round. Migration is a valid strategy to mitigate exposure to price volatility too. De Brauw (2011) explores the implications of the 2008 worldwide food price crisis on anthropometric statistics among young children in El Salvador,

showing that children in households with access to international migration were not affected as negatively as those in households without such access.

The contribution of migration in mitigating natural shock consequences has been mainly investigated observing remit behaviour response to natural disasters experienced by sending families. Households with internal migrants settled before the Typhoon Ketsana in Vietnam started to receive more remittances than ahead of the shock. Moreover, around 17% of non-migrant households sent members away immediately after the disaster, who began to remit similar amounts of money (Groger and Zylberberg, 2016). Clarke and Wallsten (2004) claim that remittances did act as household level insurance in the context of Hurricane Gilbert in Jamaica, but they only partially covered the reported damages. At macro level, Bettin et al. (2016) observe that remittances increase in the aftermath of a disaster contributing to the reconstruction process. They also find that remittances act as ex ante risk preparedness for those countries that experienced more disruptive events in the past.

All these studies focus on verifying whether an intra-household insurance mechanism activates in case of shock occurrence. However, the contribution of these money transfers in driving household ex post recovery has been only rarely considered. To the best of my knowledge Mohapatra et al. (2012) show that RRHs perform better in terms of per capita consumption immediately after a flood in Bangladesh. Anyway, no details are provided about the efficacy of remittances in driving long run recovery patterns.

2.3 Recovering from natural disaster exposure

Environmental shocks, similarly to other economic shocks may have a dramatic impact on household welfare, with both short and long term implications for family livelihoods (Skoufias, 2003). Instantaneous increases in poverty and deprivation due to a drop in consumption levels are frequently reported in correspondence to shock exposure (IADB,2000). Natural disasters generate also large losses in terms of physical assets, damaging the productive capital of firms and self-employed workers. The occurrence of a natural shock may force physical capital liquidation to fund reconstruction and rebuild or reacquire household non-productive assets such as houses. Moreover, climate-related events can also negatively affect public productive infrastructures and disrupt marketing chains, with major consequences also on people not directly hit by the shock (Gignoux and Menendez, 2016).

Exposure to a temporary income shock may push households below the poverty line. However, the long term implications of such episodes depend on how much this event damages household asset base. In case natural disaster degrades asset endowments supporting livelihoods, this may lead households to fall into long term poverty traps (Carter and Barrett, 2006). Carter et al. (2007) follow the evolution of rural Honduran household assets from before Hurricane Mitch occurrence, in order to shed light on factors influencing resilience to shocks. A critical asset threshold, below which families are unable to successfully recover is identified. Medium term effects of the shock vary according to initial household wealth, with wealthier households able to partially rebuild their lost assets throughout the three years after the disaster.

The capability to preserve asset endowments depends on both the level of shock exposure and strategies households can adopt in response to the shock. The efficacy of usual risk-management institutions, i.e. risk sharing networks, informal credit, is limited by the fact that weather shocks are spatially covariant (De Weerdt and Dercon, 2006; Fafchamps and Lund, 2003). Natural disasters affecting whole regions may spoil the capacity of local group-based institutions that in normal circumstances may be quite effective in providing some insurance. More broadly, as this kind of aggregate shocks hit wide geographical areas, they may also upset market-based coping mechanisms such as borrowing from formal financial institutions (Carter et al., 2007). In these circumstances migration, through the intra-household insurance mechanism provided by remittances, may constitute an adequate spatial income diversification strategy.

On the other side, several claims have been done regarding the creative destruction component of natural disasters (Hallegatte and Dumas, 2009). Damages provoked by natural shocks force a renewal of productive assets and stimulate the adoption of more up-to-date production technologies. Moreover, the mobilization of external aid and the involvement of international organizations in recovery interventions incentive local institutions to invest in infrastructure improvement. Gignoux and Menendez (2016) analyse the long term effects of a series of earthquakes in Indonesia on individual economic outcomes, showing that affected individuals, despite suffering short term economic losses, display welfare gains in the long run. The mechanisms driving such positive transformations can be activated also by the mobilization of savings and other household resources, among them migrant remittances.

3. Hurricane Mitch and migration trends in Nicaragua

Hurricane Mitch hit Central American countries on October 1998. Although Nicaragua is vulnerable to tropical storms, the destruction intensity of Hurricane Mitch was totally unpredictable[1]. Approximately 45,000 households were directly affected by Mitch. En- tire areas of the country were cut off for several months because of floods and highway and bridges collapse. The region mostly touched by the storms was the Pacific, in particular the departments of Leon and Chinandega which hold more than 83% of all deaths (INEC, 2000). The total damages at country level have been estimated at $ 1 billion to $ 1.3 billion (around 50% of the country GDP in 1998), with 20% of the population left without habitable dwellings, 1500 miles of roads destroyed, and one-third of agricultural crops severely damaged (CEPAL, 1999). Hundreds of schools, health clinics, civic buildings and public markets were wrecked. As the agro-exporter sector is particularly relevant for the country, the whole economy suffered enormously the impact of Mitch. Production losses caused both short and long term unemployment, with consequences on poverty especially in rural areas (Carter et al., 2007).

As regards the historical evolution of migration flows out of Nicaragua we observe that until the beginning of 1970s, international migration was a limited phenomena, involving less than 2% of the population. A first flow of emigrants left Nicaragua shortly after the December, 1972 earthquake epicentred in Managua (IOM, 2001). Out-migration leakages started to growth with the escalation of the civil war against the Somoza regime in 1979. They intensified during the 1980s because of the outbreak of the armed conflict between the Sandinista Government and the counter-revolutionary forces (known as *Contras*). After 1990, some of the war refugees returned in Nicaragua. Anyway, emigration flows have continued to rise during the 1990s driven by economic reasons.

Overall, distinct profiles for individuals moving abroad can be defined. Some differences emerge also within the migrant group according to destination. Migration to the United States requires higher travel and indirect costs due to cultural and linguistic barriers. On the contrary, migration to Costa Rica is less expensive and the temporary and circular nature of migration flows shrinks the difficulties related to the integration process. Consequently, the probability of having a member living abroad and receiving remittances are driven by household socio-economic backgrounds determining heterogeneous opportunities to access to education, social networks, and infrastructure. Wealthier and more educated families are more likely to have a migrant abroad. The proportion of households having a relative in US is higher within the richest quartile of the income distribution (Murrugarra and Herrera, 2011). As regards geographical distribution, more than 90 per cent of migrants to US comes

[1] This tropical storm has been classified as an event of category 5 - highest level - on the Saffir Simpson Scale which is a 1-5 rating based on the hurricane's present intensity. Mitch provoked about 11,000 total deaths in the region (including 3,800 in Nicaragua), vastly more than those caused by other storms.

from urban areas, while almost the 40 per cent of those going to Costa Rica comes from rural areas. Anyway, the propensity to send a member abroad is lower among agricultural households.

The Hurricane had some implication also on migration flows. Both USA and Costa Rica, the two main destinations of migration out of Nicaragua, launched a series of im- migration policies during the months following October 1998 directed to foreign citizens coming from Central American countries hit by the disaster. These elements seem to suggest that the migration flows towards the canonical destinations experienced a boost in the aftermath of the shock (IOM, 2001 and 2012). Carvajal and Medalho Pereira (2009) show that the exposure to the Hurricane affects subsequent migration decisions differently according to wealth quartile and area of residence. In the previous chapter, I showed that shock exposure does not act as a direct push factor as a whole. Only individuals belonging to agricultural households experiencing the highest exposure to rainfalls increase their likelihood to move abroad during the two years and half period after the Hurricane.

4. Data

4.1 Data sources

The analysis are based on data from the 1998 and 2001 Nicaraguan Living Standard Measurement Studies (NLSMS), carried out by the National Institute of Statistics and Census of Nicaragua, with the support of the World Bank. The surveys are representative of the population at the national, urban and rural, and department levels. Conducted using a multi-stage stratified sampling technique, they collect information on household demographics, consumption, assets, migration and economic activities. The panel sub- sample includes around 17,000 individuals from 3500 households and it covers all 15 departments and the two autonomous regions of the country. The field work for the 1998 wave was carried between 15th April and 31st August 1998, a few months before the Hurricane occurs. The second wave was conducted between April and August 2001.

The 1998 wave is exploited as baseline to collect ex ante household information, including demographic and socio-economic characteristics, geographical location and welfare indicators, i.e. assets endowment, consumption level, and income composition. Information on access to credit and savings are also provided. Migration history information collected in the second wave allows to identify individuals migrated abroad during the time in between[2] and households who receive

[2] As the paper focuses on economically-driven migration rather than displacement, I consider only mobility episodes which occurred at least two months after the shock (from January 1999), in order to avoid including temporary

international remittances. In addition, the 2001 wave provides information on access to aid and public transfers between the shock and the survey, and measurements of welfare indicators two years and half after the Hurricane.

The level of shock exposure is measured considering the intensity of rainfalls during the days of the Hurricane. As household GPS coordinates are not provided, rainfall data have been elaborated by QGIS interpolation procedures and aggregated at the lowest level of geographical identification reported by the survey, i.e. municipalities[3] . Rainfall data are retrieved from the Precipitation L3 1 day 0.25 degree x 0.25 degree version 7 database of the Tropical Rainfall Measuring Mission (TRMM) [4]. The data are available for a grid of 0.25 degrees, corresponding to about 25 km. Average daily rainfalls range between 34 mm/day in the municipality of Nueva Guinea in the Atlantico Sur to 255 mm/day in some areas of Chinandenga and Leon. I use both a continuous measure of rainfall levels and a dummy for severe exposure to the shock, i.e. average daily rainfalls higher than 250 mm/day[5].

4.2 Descriptives

Some important differences in baseline individual characteristics can be observed ac- cording to migration status after the Hurricane. (Table 1). In line with the migration patterns depicted above, the percentage of males and individuals having some education is higher among migrants. Migrants are two times more likely of being 15-29 and more than one fourth of them has already a relative abroad. As regards income composition, the percentage of households having at least a member working as wage labourer is higher among migrants, while self-employed and informal labourer member are more frequent among non-migrants. Migrant households depend more on non-labour income and less on agricultural activities. They are slightly more likely to be in the highest consumption quartile. On average, they report a larger asset endowments, less children and more elderly members. As expected,

displacement cases. The study focuses on international migration as precise details are available about migration episodes abroad occurring throughout the whole period between the two surveys. Moreover, migration towards other Central American countries is not so different from internal movements in terms of costs. Thus, regional migration may be considered as an attracting strategy alternative to internal migration, as long as the whole Nicaraguan economy had been negatively affecting by the Hurricane.

[3] According to the 1995 Census Population used as reference basis for the 1998 NLSMS, a total of 14 *municipios* are reported in Nicaragua.

[4] Goddard Earth Sciences Data and Information Services Center (2016), TRMM (TMPA) Precipitation L3 1 day 0.25 degree x 0.25 degree V7, version 7, , Goddard Earth Sciences Data and Information Services Center (GES DISC), Accessed [04 April 2016] http://disc.gsfc.nasa.gov/datacollection/ TRMM_3B42_Daily_7.html.

[5] This threshold corresponds to the highest quartile of the rainfall distribution. Referring to the map in Figure 1 the areas considered as seriously damaged are those corresponding to dark blue and blue areas.

around two thirds of them come from urban and less remote areas. Individuals migrated in this time interval are 290, corresponding to 3% of the sample.

Analogously, divergences in baseline household characteristics according to remittance status in the follow-up survey emerge (Table 2). Education level of the household head and welfare indicators are on average higher among RRHs. Data on income composition, geographical location and household composition confirm the elements highlighted above. Regarding the access to aid and reconstruction programmes between the two time periods, RRHs are slightly more likely to be an aid programme beneficiary. RRHs are about 600, corresponding to 20% of the household sample.

To estimate the long term effects of the Hurricane on household welfare and compare the outcomes of the recovery process across the two groups, two dimension are considered. Firstly, variation in consumption per capita is analysed. The consumption measure adopted is adjusted for the number of members in the household and for the geographical differences in prices. Moreover, to better quantify the variation in real consumption along the time interval, consumption levels reported in 2001 are deflated to baseline values. The impact of the disaster on physical assets is measured considering variation in a wealth score index. The index is constructed following the Demographic Health Survey guidelines (Shea and Johnson, 2004). The indicator variables included summarise information on assets and utility services owned, house and land tenure. In order to be able to compare rural agricultural households with urban counterparts, agricultural productive assets are also included. Following Filmer and Pritchett (2001), Principal Component Analysis (PCA) is applied to aggregate indicator variable information in a single index.

Comparing reported per capita consumption levels in the two waves, we see that on aver- age consumption increases along time for both household groups. This provide evidence in support of the idea of the creative destruction component of natural disasters. Consequently, to identify whether RRHs performed better in terms of consumption expansion, gaining relatively more from the recovery process, consumption growth between the two time periods is considered. As it is shown in the lower part of Table 1, RRHs report on average an almost double growth rate with respect to their counterparts. Furthermore, the average wealth score in 2001 is positive for RRHs and slightly negative for the others.

5. Empirical framework

5.1 Impact of the Hurricane on migration outflows

Probit regression models are estimated in order to assess whether exposure to the shock has a significant effect on the decision to migrate abroad. Thus, the dependent variable is a dummy taking value 1 if the individual moved abroad between January 1999 and April 2001. The sample includes also children aged 6 or more at the time of the Hurricane. Indeed, according to the *Encuesta Nacional de Trabajo Infantil y adolescente* conducted in 2000, on average 14 per cent of children aged 5–17 were working and another 20 per cent were employed in domestic activities. The rates are even higher in rural areas. A range of individual and household characteristics are included in the regression models as controls. Age, gender and education level of the respondents at the baseline period are considered. Household income composition is depicted through dummy variables reporting whether families get income from wage, self-employed, entrepreneurial or informal labour. In addition, agricultural households and families depending on other sources of income (retirements, rents, profits, insurances, etc..) are identified. Household size and composition, total consumption per capita [6] and asset endowments are also embodied as migration determinants. Finally, distance from the main road is taken as a proxy of remoteness and direct migration costs. Following the social network theory of migration, I include a dummy variable capturing whether another family member has migrated before.

The estimation are replicated using different proxies of disaster exposure, and separated estimations are conducted for individuals migrated in the 12 months after the Hurricane. Furthermore, a multinomial logit model is estimated distinguishing between two destinations: regional migration within Central American countries and international migration towards US and Canada. These analyses aim to verify whether the impact of the climate disaster varies according to the characteristics of the migratory phenomenon and along with time elapsed from shock occurrence. Moreover, the study tests whether the effect is different for agricultural households, which are widely recognised as the more exposed to climatic disasters. Separated regressions are run for individuals coming from agriculture-dependent households. In all the regression models, standard errors are clustered by departments to control for the fact that individuals from the same area might how similar response

[6] The variable included is already divided by the number of household members and adjusted for differences in prices between different areas of the country.

patterns[7] This may be related to previous local migration dynamics and level of public efforts put in disaster recovery, which varies with the quality of local institutions.

5.2 Impact of remittance on household recovery

In order to identify the causal effect of receiving remittances on household long-term recovery performances, multivariate models are estimated assuming consumption or asset outcomes as dependent variables and controlling for household ex ante characteristics, degree of shock exposure and access to other coping strategy. The regression specification is the following:

$$Y_{i,t+1} = \alpha_0 + \alpha_1 R_{i,t+1} + \alpha_2 P_i + \alpha_3 Z_{i,t+1} + \alpha_4 X_{i,t} + u_i, \quad (1)$$

where $Y_{i,t+1}$ correspond to the outcome considered and $R_{i,t+1}$ is the remittance status, a dummy being 1 if the household receives remittances from abroad during the 12 months before the second wave. P_i is the average daily rainfall level experienced during the Hurricane, $Z_{i,t+1}$ is a dummy equal to 1 if the household get access to public aid or international cooperation programmes between the disaster and the 2001 wave, $X_{i,t}$ is a vector of household baseline characteristics and ui is the zero-mean error term. The vector of controls entails socio-demographic characteristics (education level of the household head, household size and composition), wealth proxies (wealth score index, per capita consumption level) and income composition dummies before the shock occurs. In addition, dummies for savings availability and the presence of constraints to the access to credit are included, in order to control for the presence of consumption smoothing strategies mitigating the damages.

Referring to Carter et al. (2007), consumption growth equations include the initial consumption level, to get the idea that there is a long run consumption equilibrium level towards which households converge. In case the baseline consumption coefficient turned out to be less than zero, it would indicate a convergent accumulation process, with low consumption households growing more rapidly than wealthier families. The rate of growth of the latter would slow down and approach zero as the equilibrium level is reached. Baseline wealth levels are included in the consumption growth equation, in order to control for asset endowments before the disaster. Indeed, as selling assets may represent a strategy to smooth consumption after a negative unexpected shock, initial asset base is determinant in predicting how households perform in terms of long run consumption. Analogously, baseline wealth score is included as a control in the regressions estimating wealth scores in 2001. In this case

[7] All models have been run clustering standard error also by households. Results confirm all the findings obtain by the shown models.

a negative coefficient would indicate that lower wealth households perform relatively better in terms of assets accumulation. Therefore we could expect they were more likely to recoup ex ante standards.

5.3 Identification

As already mentioned above, selection into migration and consequently into remittances is an important concern, since households having migrants abroad may presents different characteristics with respect to no remittance households. Although we control for an array of observable household demographic and socio-economic factors, there are potentially unobservable characteristics that might affect both the migration decision and the outcome observed. For example, more enterprising and less risk-adverse households may be more likely to invest in international migration of a family member. At the same time, they could show more spirit of initiative in recovering from a shock and under- taking challenging but more profitable recovery strategies. Another endogeneity issue regards the fact that households more exposed to this type of climate-related events may be more likely to adopt migration as an ex ante household level insurance strat- egy against natural disaster occurrence. However, the unforeseeable magnitude of this exogenous shock is exploited to deal with this concern.

To overcome this selectivity issue, an IV approach is implemented. Geographical variation in historical migration rates is exploited as an exogenous source of variation in the probability of getting transfers from migrant abroad. The choice of instruments is driven by the idea that migration networks influence the probability to migrate and remit, but not household capability to recover after a shock, neither the degree of expo- sure to the shock. The argument sustaining this criterion is that intense past migration flows from the home region facilitates more recent migration. A larger network of migrants provides contacts, information and logistic support for new migrants. Moreover, international migration is more likely to be undertaken when people get in touch with successful experiences reported by neighbours or acquaintances (Adams and Cuecuecha, 2010; Calero et al., 2009).

In order to identify suitable instruments, I refer to the historical evolution of migration flows out of Nicaragua (see section 3). Therefore, two variables have been selected to instrument household remittance status. Firstly, the rate of residents abroad at the department level is retrieved from the 1971 National Census of Dwellings and exploited to proxy geographical origin of migrants at the dawn of the international migration phenomena. Secondly, the department rate of RRHs has been computed using data from the *Encuesta Nacional de Hogares sobre Medicion de Niveles de Vida* 1993. This second instrument catches the variation in geographical location of households still having

a member abroad after the end of the Contra war contributing to household budgeting. Figure 2 and Figure 3 show the correlation of the two instruments with the remittance rates at department level reported by the survey. As expected, first stage regressions reported in Table 7 confirm that historical migration and remittance rates are powerful predictors of current remittance status. The F statistics reported rule out the concern for weak instruments.

6. Results

6.1 Migration flows

The results of the probit model estimations reported in Table 3 summarize the determinants of migration decisions in the aftermath of the Hurricane. As expected by the migration profiles depicted previously, men and people aged 15 - 30 are more likely to leave the country. Education has a positive effect on the probability to migrate: individuals with primary education are more likely to move to Costa Rica and nearby countries, while secondary education is a determinant of migration to North America. Household assets positively affect the probability to move abroad, especially towards US and Canada. Not surprisingly, distance from the main road limits mobility, as the direct costs to afford migration are higher. On the other hand, having a relative already resident in the destination countries reduces the indirect costs, boosting migration decisions. As regards household income composition, it influences migration decisions especially immediately after the disaster (Column 3). Having at least one member working as wage labourer or relying on other sources of income rather than labour augments the probability to migrate. Therefore, it appears that immediately after the shock having a guaranteed source of income helps to cover migration costs fostering mobility. How- ever, such mechanism tends to run out over time. Depending on agricultural activities reduce mobility during the 12 months after the shock. However, I will discuss in the next paragraphs, this effect is not homogeneous at all levels of shock exposure.

Indeed, focusing on the main variable of interest, it is confirmed across specifications (Columns 1-4, 6 7) that rainfall levels do not have a significant impact on the probability to migrate. This has been confirmed considering both continuous and discrete measures of shock exposure, distinguishing among destinations and for time elapsed from the shock. Such results indicate that in general the natural disaster does not act as push factor for mobility. However, as it is shown in Column 5, this is not confirmed for agricultural households. Indeed, estimating the regression model including only households reporting agricultural activities, it turns out that severe rainfalls significantly increase the

likelihood to migrate. Exposure to high damages, other things being equal, increases the probability to move from 1.07% to 2.75%. Such evidence is coherent with the idea that, as individuals coming from natural resource dependent households are the most affected by climatic events, they are more likely to choose migration as intra-household spatial risk-coping strategy.

However, results in Table 4 provide further evidence on the circumstances encouraging the choice of migration as coping strategy for agricultural households. Testing whether the impact of shock exposure changes according to income composition (Model 1), it turns out that having a household member working as wage labourer nullifies the positive effect of the shock on the probability to migrate. In particular, being exposed to severe damages increases the likelihood to migrate by 3 percentage points when households do not have wage labourers, while the effect is negative and not significant in case of positive wage labour income. A similar trend is observed also for the no labour income dummy, although the coefficient is not significant. These elements demonstrate that in case of a severe shock, only households not accessing alternative guaranteed sources of income, as formal sector contracts ensure, choose migration as coping strategy. However, as Model 2 shows, also baseline assets influence the effect of the Hurricane on migration decisions. The interaction term between size of land owned and shock exposure is positive and significant. Thus, the effect of severe rainfalls on the probability to move out is positive and significant for individuals coming from households owning 50 *manzanas* [8] or more and it increases along with land size. Thus, migration constitutes an affordable coping strategy only for wealthier households. This is further confirmed by the specification in Column 3, where the double interaction between land dimension and the dummy for wage labour income confirms that shock exposure is a significant push factor only for individuals belonging to households who do not have wage workers. However, the magnitude of this effect varies from 3 percentage points for households owning no land to 15 percentage points for those owning 500 *manzanas*.

[8] 1 *manzana* corresponds to around 0.7 hectares.

6.2 Remittances and consumption growth patterns

Table 5 presents the estimations of Equation (1) for the regressions having as dependent variable per capita consumption growth between the two surveys. OLS results (Model 1 and 3) show that RRHs report significantly higher growth rates than their counterparts. This applies both to the full sample and the subsample of agricultural households. The effect becomes larger when instrumental variable estimations are conducted (see Model 2 and 4). These elements are in line with the interpretation of migration as intra-household insurance contract, with remittances providing an external source of liquidity helping families to regain and maintain higher living standards in the long term.

As expected, the degree of shock exposure has a slight negative and significant effect on consumption growth, confirming that being exposed to a severe natural disaster affects subsequent long term welfare trends. Household baseline socio-economic background plays a role in driving ex post recovery: both household head's education level and household wealth positively affect ensuing consumption growth. Human and physical capital endowments at the baseline sustain households in dealing with shock drawbacks, through asset selling or adoption of more effective income diversification strategies, including household member migration. Family income composition affects consumption patterns: having a household member working as wage labourer or being entrepreneur rises reported growth rates. This can be due to the fact that relying on a guaranteed source of income allows to cope with liquidity shortages in the short run preventing from being stuck at low consumption levels. Analogously, productive assets owned by entrepreneur members and revenues of business activities ensure better performances in terms of consumption expansion. On the contrary, neither access to credit nor own savings at the time of the shock impacts on welfare performances.

In line with the fact that natural resource dependent households are usually the most deeply hit by climate events, agricultural households report significantly smaller consumption growth rates. The losses in terms of productive assets for crop and livestock activities caused by the Hurricane jeopardize subsequent welfare performances. Coefficients of logarithm of consumption level at the baseline are negative in all the estimations, suggesting a convergent accumulation process going on. As regards household composition, the number of dependent children is negatively associated to consumption growth, indicating that a higher dependency ratio limits household welfare expansion. Finally, having benefited from aid has a slight negative impact on consumption growth patterns. This unexpected effect may be due to the fact that households receiving aid may be more vulnerable and consequently more likely to get trapped at low consumption levels in the medium and long run.

6.3 Remittances and wealth score index

As findings reported in Table 6 suggest, household remittance status significantly deter- mines asset accumulation patterns after the shock. The OLS outcomes (Model 5 and 7) show that wealth indexes for RRHs are significantly higher than for their counterparts. The magnitude of the effect rises if we consider only agricultural households. The instrumental variable estimations (Model 6 and 8) confirm the significance of the remittance terms only within the subsample of agricultural households. The coefficient estimated with IV is larger than OLS.

Average daily rainfall levels have a positive impact on wealth score indexes in 2001, providing evidence in support of the hypothesis of a creative destruction component of natural disasters. Coherently with what found by Gignoux and Menendez (2016), dam- ages provoked by natural shocks appear to foster asset accumulation, probably forcing a renewal of both productive and non-productive assets. Two dummy variables identifying if households have benefited from aid programmes specifically directed to home and infrastructure reconstruction and amelioration are included in this specification. In this way, it is possible to assess if the mobilization of external aid contributes to asset preservation. The positive coefficients obtained in Model 5-8 seem to confirm this idea.

Household head education and consumption levels at the baseline period have a positive effect on ensuing wealth scores. However, asset base levels before the shock, measured by wealth score index in 1998, report negative coefficients across all the models. Low wealth households appear to have gained more in terms of asset value with respect to wealthier households. As expected, agricultural households are more deeply damaged by the Hurricane even in terms of assets, reporting significantly smaller wealth scores in 2001. The positive effect of relying on wage income on household welfare performances after the shock is confirmed also in this case. Demographic characteristics also play a role, with household size and number of dependent members being respectively positively and negatively associated with wealth score indexes.

7. Conclusions

This paper explores the role played by international migration as coping strategy against natural shock exposure, analysing the case of Nicaraguan households long term rebound from Hurricane Mitch. To have a broader picture of the way migration may impact on household welfare performances in the aftermath of a sudden-onset climatic shock, two hypothesis have been questioned. Firstly, the nexus between natural disaster and international migration flows is examined, testing whether the level of shock exposure is a significant determinant of ensuing individual mobility decisions. The findings

demonstrate that rainfall levels during the Hurricane do not act as a migration push factor as a whole. Only members of agricultural households increased their probability to move abroad with the exposure to high rainfall shocks. Coherently with the interpretation of migration as a household level risk diversification strategy, heterogeneity in the effect of the natural disaster on individual migration decisions is observed according to house- hold income. Among individuals belonging to agricultural households and experiencing a severe shock, only those coming from households not accessing alternative guaranteed sources of income, as formal sector wages, see their probability to migrate increasing. Moreover, the size of this pushing effect rises along with household land endowments. Therefore, international migration turns out to be a preferred strategy to deal with natural shock exposure in case of lack of other regular sources of liquidity, but when household asset endowments allow to cover migration costs.

Secondly, the contribution of remittances in driving recovery process is investigated, comparing consumption and asset performances before and two years and half after the Hurricane. Using historical migration and remittance rates to instrument for current remittance status, I find that receiving migrant transfers increase the consumption growth rate by around 83 and 89 percentage points respectively in the full sample and in the agriculture subsample. Similarly, households getting migrant transfers report higher wealth score indexes in 2001. In this case, IV estimations confirm the significance of the remittance status coefficient only for families relying on agricultural activities, with RRHs reporting higher household wealth indexes by 1.7 points.

The findings obtained indicate that remittance flows from international migrants constitute an effective strategy to sustain long term rebound from natural disaster damages. Particularly relevant is the positive impact of receiving remittances on agricultural household asset base. This proves that migrant transfers contribute to re-establish ex ante livelihoods and assets, reducing the risk of being pushed into poverty traps, from which recovery would be extremely hard. The fact that the protective effect of remittances is significant and larger for those households more vulnerable to climate-related shocks confirms the key role they play as insurance tool.

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Table 1: Descriptive statistics - Migrant characteristics

	Migrants after Mitch	No migrants
Average daily rainfalls (mm/day)	206.98	202.64
High exposure (%)	35.45	31.05
Individual characteristics		
Female (%)	0.46	0.51
Education Level (%)		
No education	5.05	21.33
Primary	49.83	50.39
Secondary	39.73	21.64
Full Secondary or more	5.39	6.63
Age (%)		
6-14	22.74	31.81
15-29	60.54	31.33
30-49	14.05	22.97
50+	2.68	13.89
Household characteristics		
Employee or worker income (%)	65.55	50.94
Self-employed income (%)	46.13	52.48
Entrepreneur income (%)	7.69	7.60
Informal labour income (%)	28.76	39.58
No labour income (%)	48.49	30.41
Agricultural activities (%)	24.57	39.39
Consumption per capita (%)		
1st quartile	21.89	29.88
2nd quartile	25.25	25.82
3rd quartile	25.25	23.91
4th quartile	27.61	20.39
Household size (#)	7.00	7.00
# of children	2.74	2.96
# of elderly	0.29	0.26
Land size (manzanas)	13.69	8.58
# rooms per capita	0.47	0.41
Urban (%)	64.88	53.13
Distance from road (km)	27.65	11.16
Migrant relative (%)	26.42	2.00
N	299	13461

Table 2: Descriptive statistics by remittance households

	Remittance Households	No Remittance Households
Average daily rainfalls (mm/day)	211.70	201.64
Baseline characteristics		
Education Level household head (%)		
No education	23.11	36.00
Primary	41.64	45.38
Secondary	23.93	14.06
Full Secondary or more	11.31	4.56
Female household head (%)	37.12	25.56
Employee or worker income (%)	56.89	47.33
Self-employed income (%)	42.63	51.41
Entrepreneur income (%)	8.27	7.26
Informal labour income (%)	22.85	36.65
No labour income (%)	51.22	26.82
Agricultural activities (%)	19.87	41.10
Consumption per capita (cordobas)	9138	5990
Household size (#)	5.56	5.79
# of children	2.14	2.55
# of elderly	0.32	0.23
Credit constrained (%)	47.18	58.71
Savings (%)	11.33	5.82
Wealth score (%)		
1st quartile	8.83	29.16
2nd quartile	16.81	27.35
3rd quartile	26.32	24.76
4th quartile	48.05	18.73
Urban (%)	74.23	49.45
Access to aid between the Hurricane and 2001		
Aid (%)	74.88	70.44
Aid for house (%)	13.78	18.59
Aid for infrastructure	56.56	47.49
Outcomes		
Consumption per capita 2001 (cordobas)	12331	7510
Consumption growth (1998 - 2001)	0.25	0.13
Poverty (1998)	0.26	0.48
Poverty (2001)	0.18	0.46
Wealth score (1998)	1.81	-0.49
Wealth score (2001)	1.99	-0.50
Difference Wealth scores (1998 - 2001)	0.18	0.01

Table 3: Determinants of migration after Hurricane Mitch

	-1	-2	-3	-4	-5	-6	-7	
	Probit	Probit	Probit	Probit	Probit	Probit	Mlogit	
	All	All	1999	2000/1	No agricultural	Agricultural	Regional	International
Rainfalls (daily)	-0.00038							
	(0.00065)							
Severe damage		0.00418	0.04419	-0.01633	0.44098**	-0.11100	-0.26171	0.38115
		(0.10524)	(0.12563)	(0.10071)	(0.16425)	(0.08406)	(0.35883)	(0.28141)
Female	-0.10414***	-0.10465***	-0.02081	-0.14301**	-0.06133	-0.11254*	-0.26761**	-0.19744
	(0.03037)	(0.03052)	(0.04453)	(0.04750)	(0.06916)	(0.05646)	(0.08901)	(0.21249)
Education: no education								
Primary	0.37462**	0.37281**	0.49286**	0.26133	0.37047+	0.35969+	0.93764*	1.38910
	(0.14430)	(0.14440)	(0.16817)	(0.19244)	(0.22374)	(0.18664)	(0.42910)	(0.84611)
Secondary	0.35418*	0.35013*	0.43328*	0.27337	0.46863*	0.30491+	0.65207	2.02158*
	(0.14543)	(0.14439)	(0.17319)	(0.16999)	(0.22551)	(0.16941)	(0.43012)	(0.96100)
Higher	-0.12876	-0.13361	0.17980	-0.31601	0.30489	-0.24665	-0.90782	1.14200
	(0.23131)	(0.23225)	(0.26558)	(0.23982)	(0.28106)	(0.28906)	(0.83621)	(0.95745)
Age: 6 - 14								
15 - 29	0.48782***	0.48945***	0.33726**	0.52159***	0.58886***	0.47486***	1.46245***	0.16997
	(0.09008)	(0.09069)	(0.11062)	(0.09305)	(0.14836)	(0.10894)	(0.23052)	(0.24822)
30 - 49	0.00433	0.00409	0.11085	-0.09533	-0.26524	0.06515	0.01593	-0.21697
	(0.06205)	(0.06216)	(0.08815)	(0.07345)	(0.24925)	(0.09676)	(0.13249)	(0.32770)
50+	-0.48749***	-0.48777***	-0.18566+	-0.70863*	-0.20171	-0.62487***	-1.21649**	-1.83154**
	(0.13298)	(0.13410)	(0.10898)	(0.28026)	(0.22806)	(0.15142)	(0.40712)	(0.70621)
Employee or worker	0.13222	0.13133	0.24878**	0.04457	-0.15092	0.23962***	0.47594*	0.07638

	(0.08436)	(0.08310)	(0.08387)	(0.11849)	(0.26538)	(0.05308)	(0.24208)	(0.30286)
Self-employed	0.06708	0.06790	0.18100*	-0.00604	0.17302	0.07916	0.06850	0.51671
	(0.05743)	(0.05754)	(0.07511)	(0.06946)	(0.11041)	(0.06306)	(0.18639)	(0.34830)
Entrepreneur	0.09260	0.09813	0.19561	0.02589	0.09055	0.03170	0.44365	-0.50465
	(0.17024)	(0.16374)	(0.22374)	(0.20203)	(0.23639)	(0.21640)	(0.42310)	(0.68024)
Informal work	-0.10998	-0.10736	-0.17219	-0.03213	0.15739	-0.21122+	0.05074	-1.60505*
	(0.10588)	(0.10300)	(0.16381)	(0.08549)	(0.14112)	(0.11424)	(0.15169)	(0.69243)
Agricultural household	-0.13552	-0.13244	-0.37221***	0.04884			0.38831+	0.95091*
	(0.10164)	(0.10304)	(0.09253)	(0.13874)			(0.21247)	(0.40452)
No labour income	0.23456*	0.23599**	0.21744*	0.23788*	0.21671	0.27449**	-0.09155	-1.35025*
	(0.09381)	(0.08815)	(0.10120)	(0.09471)	(0.15283)	(0.09627)	(0.33659)	(0.53378)
Consumption: 1st quartile								
2nd quartile	-0.10589	-0.10452	-0.32586*	0.06657	-0.01313	-0.20339	-0.22475	-0.34007
	(0.06886)	(0.06827)	(0.13302)	(0.08698)	(0.18081)	(0.13835)	(0.16473)	(0.79859)
3rd quartile	-0.03454	-0.03476	-0.29577*	0.14263	0.18201	-0.19499	-0.04072	-0.22700
	(0.09389)	(0.09105)	(0.14338)	(0.10509)	(0.17097)	(0.11919)	(0.25812)	(0.79859)
4th quartile	-0.03431	-0.03647	-0.36381+	0.17503	-0.16378	-0.08395	-0.36135	0.30918
	(0.15114)	(0.14808)	(0.18689)	(0.16597)	(0.23711)	(0.18086)	(0.42268)	(0.87290)
Household size	0.02770	0.02696	0.02455	0.02169	-0.03307	0.04001	-0.02084	0.24123**
	(0.02474)	(0.02478)	(0.03282)	(0.02584)	(0.03396)	(0.02707)	(0.05817)	(0.09231)
Number of children	-0.01928	-0.01748	-0.06772+	0.01082	0.05228	-0.03732	0.01806	-0.20112
	(0.02416)	(0.02525)	(0.03660)	(0.03716)	(0.05164)	(0.03476)	(0.06346)	(0.15731)
Number of elderly	0.03467	0.03704	-0.21030*	0.14395+	-0.02521	0.04681	-0.02166	0.13584
	(0.07037)	(0.07003)	(0.08326)	(0.08362)	(0.11505)	(0.10611)	(0.21041)	(0.24497)
Land size (manzanas)	0.00101*	0.00101*	0.00153***	0.00064	0.00082*		-0.00234	0.00529***
	(0.00048)	(0.00046)	(0.00039)	(0.00056)	(0.00040)		(0.00213)	(0.00111)
Room per capita	0.17923*	0.18148*	0.12830	0.18950*	0.41860**	0.14416+	0.25158	0.78116*
	(0.07612)	(0.07423)	(0.14666)	(0.07996)	(0.13858)	(0.07851)	(0.27556)	(0.33510)
Urban	-0.03442	-0.02990	-0.16871	0.09245	0.26923	-0.10818	0.00195	-0.26257

	(0.10644)	(0.11291)	(0.20319)	(0.11232)	(0.17624)	(0.09949)	(0.34643)	(0.69260)
Distance from the main road	-0.00000***	-0.00000***	-0.00000*	-0.00000**	-0.00000	-0.00000**	-0.00000*	-0.00001*
	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)
Migrant relative	1.37260***	1.37555***	1.20637***	1.27796***	1.23285***	1.37794***	2.88045***	2.56373***
	(0.05940)	(0.06061)	(0.12719)	(0.09716)	(0.21078)	(0.08977)	(0.14340)	(0.28622)
Constant	-2.70366***	-2.79132***	-2.87081***	-3.14300***	-3.28680***	-2.66483***	-5.69502***	-8.26270***
	(0.19541)	(0.17476)	(0.23309)	(0.24571)	(0.26655)	(0.20686)	(0.51104)	-113.605
N	13167	13167	13167	13055	5193	7948	13167	
Pseudo R2	0.17436	0.17414	0.16334	0.17350	0.18421	0.18458	0.19693	

Note: Standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.5, + p<0.1.

Table 4: Determinants of migration (agriculture) - Interaction models

	(1) Probit Income	(2) Probit Assets	(3) Probit Income*Assets
Severe damages	0.97203*	0.30614+	0.67298***
	(0.41021)	(0.17425)	(0.15138)
Employee or worker	0.23716	-0.12049	0.20903
	(0.18078)	(0.26470)	(0.20656)
Severe damages * Employee or worker	-1.12763***		-1.02133**
	(0.32538)		(0.34261)
Severe damages * Employee or worker *Land			-0.00683*
			(0.00290)
No labour income	0.29073+	0.19107	0.26000+
	(0.17284)	(0.15670)	(0.13663)
Severe damages * No labour income	-0.22913		
	(0.29059)		
Self-employed	0.23218	0.15707	0.18659+
	(0.14748)	(0.10968)	(0.09703)
Severe damages * Self-employed	-0.18127		
	(0.22061)		
Entrepreneur	-0.08286	0.11529	0.10627
	(0.25574)	(0.22777)	(0.22127)
Severe damages * Entrepreneur	0.50446		
	(0.30725)		
Informal work	0.23339+	0.11471	0.13735
	(0.14019)	(0.14652)	(0.15719)
Severe damages * Informal work	-0.21771		
	(0.30297)		
Land size	0.00091**	-0.00112	-0.00134
	(0.00034)	(0.00105)	(0.00157)
Severe damages * Land size		0.00235*	0.00308+
		(0.00101)	(0.00158)
Rooms per capita	0.43973***	0.44621*	0.51273***
	(0.11269)	(0.20178)	(0.13434)
Severe damages * Rooms per capita		0.10508	0.00058
		(0.34000)	(0.00134)
Migrant relative	1.24316***	1.23816***	1.25384***
	(0.20179)	(0.19340)	(0.18354)
Demographics	Yes	Yes	Yes
N	5193	5193	5193
Pseudo R2	0.21059	0.18399	0.21376

Note: Standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.5, + p<0.1.

Table 5: Consumption growth equations

	Full sample		Agricultural sample	
	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)
Remittance household	0.1678***	0.4685	0.2012**	0.7841
	(0.0349)	(0.2603)	(0.0706)	(0.4188)
Rainfalls (daily)	-0.0001	-0.0001	-0.0002	-0.0001
	(0.0002)	(0.0002)	(0.0003)	(0.0003)
Access to aid	-0.0210	-0.0356	-0.1150*	-0.1632**
	(0.0293)	(0.0321)	(0.0484)	(0.0601)
Baseline characteristics				
Education - reference category: no education				
Primary	0.0107	0.0112	0.0394	0.0553
	(0.0317)	(0.0320)	(0.0455)	(0.0479)
Secondary	0.0188	0.0034	0.1043	0.1319
	(0.0467)	(0.0490)	(0.1025)	(0.1067)
Higher	-0.0481	-0.0715	0.0214	0.0699
	(0.0671)	(0.0707)	(0.2327)	(0.2406)
Female household head	0.0509	0.0355	0.1557*	0.1310
	(0.0309)	(0.0339)	(0.0644)	(0.0682)
Employee or worker	0.0662*	0.0786*	0.1436*	0.1622**
	(0.0330)	(0.0350)	(0.0579)	(0.0607)
Self-employed	-0.0161	-0.0108	0.0058	0.0148
	(0.0304)	(0.0310)	(0.0538)	(0.0554)
Entrepreneur	0.0280	0.0274	0.0382	0.0246
	(0.0533)	(0.0538)	(0.0719)	(0.0742)
Informal work	-0.0101	-0.0013	-0.0381	-0.0217
	(0.0325)	(0.0336)	(0.0493)	(0.0518)
Agricultural household	-0.0846*	-0.0780*		
	(0.0380)	(0.0388)		
No labour income	-0.0036	-0.0423	0.0569	-0.0054
	(0.0305)	(0.0453)	(0.0527)	(0.0696)
Household size	0.0467***	0.0432***	0.0387**	0.0342*
	(0.0091)	(0.0097)	(0.0146)	(0.0153)
Number of children	-0.0245	-0.0207	-0.0141	-0.0086
	(0.0125)	(0.0131)	(0.0193)	(0.0201)
Number of elderly	0.0227	0.0133	-0.0241	-0.0349
	(0.0263)	(0.0278)	(0.0392)	(0.0409)
Savings available	0.0834**	0.0867**	0.1112*	0.1137*
	(0.0276)	(0.0280)	(0.0453)	(0.0464)
Credit constrained	0.1167*	0.1147*	0.0890	0.0700
	(0.0558)	(0.0564)	(0.1577)	(0.1619)
Wealth score - reference category 1st quartile				
2nd quartile	-0.0492	-0.0603	-0.0533	-0.0667

	(0.0400)	(0.0415)	(0.0520)	(0.0540)
3rd quartile	-0.0860	-0.1120*	-0.1639*	-0.1791*
	(0.0492)	(0.0545)	(0.0809)	(0.0835)
4th quartile	-0.1788**	-0.2463**	-0.3395**	-0.4680**
	(0.0585)	(0.0827)	(0.1309)	(0.1620)
Urban	-0.0063	-0.0079	0.1137	0.0854
	(0.0375)	(0.0379)	(0.0658)	(0.0702)
Constant	-0.2991*	-0.2945*	-0.4066	-0.3704
	(0.1401)	(0.1415)	(0.3391)	(0.3480)
N	2651	2651	971	971

Note: Standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.5, + p<0.1.

Table 6: Difference in wealth score index

	Full sample		Agricultural sample	
	OLS	IV	OLS	IV
	(5)	(6)	(7)	(8)
Remittance household	0.3486***	1.2768**	0.4002***	1.8794**
	(0.0577)	(0.4661)	(0.0923)	(0.6102)
Rainfalls (daily)	0.0009**	0.0011**	0.0005	0.0008
	(0.0003)	(0.0004)	(0.0004)	(0.0005)
Access to aid (home)	0.2124***	0.2212***	0.2621***	0.2481***
	(0.0580)	(0.0607)	(0.0657)	(0.0735)
Access to aid (infrastructure)	0.0945*	0.0372	0.1147*	0.0022
	(0.0435)	(0.0536)	(0.0570)	(0.0783)
Baseline characteristics				
Education - reference category: no education				
Primary	0.0751	0.0794	0.1184*	0.1606*
	(0.0520)	(0.0544)	(0.0594)	(0.0685)
Secondary	0.3024***	0.2635**	0.3485**	0.4172**
	(0.0772)	(0.0829)	(0.1340)	(0.1522)
Higher	0.5126***	0.4741***	1.1566***	1.2592***
	(0.1122)	(0.1187)	(0.2995)	(0.3369)
Female household head	0.0061	-0.0425	0.1388	0.0872
	(0.0506)	(0.0581)	(0.0836)	(0.0956)
Employee or worker	0.2339***	0.2778***	0.2111**	0.2646**
	(0.0538)	(0.0602)	(0.0756)	(0.0871)
Self-employed	0.1232*	0.1410**	0.0609	0.0739
	(0.0498)	(0.0527)	(0.0697)	(0.0779)
Entrepreneur	0.1329	0.1462	-0.0099	-0.0400
	(0.0889)	(0.0931)	(0.0943)	(0.1059)

Informal work	-0.0287	-0.0067	0.0021	0.0456
	(0.0534)	(0.0568)	(0.0643)	(0.0739)
	-	-		
Agricultural household	0.3661***	0.3544***		
	(0.0621)	(0.0651)		
No labour income	0.0896	-0.0222	0.1154	-0.0317
	(0.0502)	(0.0765)	(0.0691)	(0.0976)
Household size	0.0344*	0.0251	-0.0044	-0.0145
	(0.0151)	(0.0164)	(0.0190)	(0.0216)
	-			
Number of children	0.0693***	-0.0615**	-0.0026	0.0078
	(0.0208)	(0.0221)	(0.0253)	(0.0285)
Number of elderly	-0.0847	-0.1152*	-0.0456	-0.0799
	(0.0432)	(0.0476)	(0.0513)	(0.0589)
Credit constrained	-0.0620	-0.0590	-0.0571	-0.0557
	(0.0457)	(0.0477)	(0.0590)	(0.0659)
Savings available	0.1076	0.0937	-0.2813	-0.2828
	(0.0928)	(0.0971)	(0.2144)	(0.2393)
	-	-	-	-
Wealth score 1998	0.2120***	0.2451***	0.1816***	0.2145***
	(0.0125)	(0.0210)	(0.0208)	(0.0268)
Urban	0.4279***	0.4396***	0.4916***	0.4319***
	(0.0613)	(0.0643)	(0.0873)	(0.1004)
	-	-		
Constant	0.9167***	0.9917***	-0.5047	-0.6448
	(0.2284)	(0.2414)	(0.4529)	(0.5088)
N	2635	2635	958	958

Note: Standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.5, + p<0.1.

Table 7: NLSMS - First stage equations

	Consumption growth		Wealth score differences	
	Full sample	Agricultural sample	Full sample	Agricultural sample
Rainfalls (daily)	-0.0004***	-0.0004**	-0.0005***	-0.0004**
	(0.0001)	(0.0002)	(0.0001)	(0.0002)
Access to aid	0.0421**	0.0734***		
	(0.0163)	(0.0219)		
Access to aid (home)			-0.0153	0.0085
			(0.0195)	(0.0229)
Access to aid (infrastructure)			0.0530***	0.0616**
			(0.0146)	(0.0199)
Baseline characteristics				

Education - reference category: no education				
Primary	-0.0031	-0.0250	-0.0058	-0.0269
	(0.0176)	(0.0206)	(0.0175)	(0.0207)
Secondary	0.0525*	-0.0375	0.0433	-0.0351
	(0.0258)	(0.0465)	(0.0260)	(0.0468)
Higher	0.0841*	-0.0854	0.0500	-0.0717
	(0.0372)	(0.1054)	(0.0378)	(0.1045)
Female household head	0.0562**	0.0518	0.0570***	0.0459
	(0.0171)	(0.0292)	(0.0170)	(0.0292)
Employee or worker	-0.0417*	-0.0397	-0.0465*	-0.0410
	(0.0182)	(0.0263)	(0.0181)	(0.0264)
Self-employed	-0.0093	-0.0073	-0.0117	-0.0018
	(0.0169)	(0.0244)	(0.0168)	(0.0244)
Entrepreneur	0.0164	0.0299	0.0004	0.0271
	(0.0296)	(0.0326)	(0.0300)	(0.0329)
Informal work	-0.0264	-0.0292	-0.0217	-0.0308
	(0.0180)	(0.0223)	(0.0180)	(0.0224)
Agricultural household	-0.0131		-0.0047	
	(0.0211)		(0.0209)	
No labour income	0.1205***	0.0985***	0.1139***	0.0938***
	(0.0169)	(0.0241)	(0.0169)	(0.0244)
Household size	0.0118*	0.0081	0.0098	0.0070
	(0.0050)	(0.0066)	(0.0051)	(0.0067)
Number of children	-0.0134	-0.0096	-0.0091	-0.0071
	(0.0069)	(0.0087)	(0.0070)	(0.0088)
Number of elderly	0.0284	0.0128	0.0302*	0.0178
	(0.0146)	(0.0178)	(0.0145)	(0.0179)
Credit constrained	-0.0021	0.0025	0.0044	0.0050
	(0.0154)	(0.0206)	(0.0154)	(0.0206)
Savings available	0.0119	0.0365	0.0198	0.0106
	(0.0309)	(0.0714)	(0.0312)	(0.0748)
Wealth score - reference category 1st quartile				
2nd quartile	0.0396	0.0291		
	(0.0222)	(0.0237)		
3rd quartile	0.0802**	0.0245		
	(0.0275)	(0.0373)		
4th quartile	0.2093***	0.2063***		
	(0.0326)	(0.0593)		
Urban	0.0008	0.0488	-0.0167	0.0425
	(0.0208)	(0.0298)	(0.0207)	(0.0305)
Remittance rate 1993 (department)	0.9681***	0.9650***	0.9061***	0.8993***
	(0.1456)	(0.2180)	(0.1460)	(0.2203)

Rate of residents abroad (departmnet)	9.0852***	10.8412***	9.2566***	11.5097***
	-21.699	-31.427	-21.629	-31.334
Wealth score 1998			0.0333***	0.0207**
			(0.0042)	(0.0073)
Constant	-0.0826	-0.1404	0.0114	0.0005
	(0.0782)	(0.1543)	(0.0776)	(0.1591)
N	2651	971	2635	958
r2	0.1419	0.1101	0.1485	0.1085
F-stat	245.198	248.714	221.539	223.178
	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Note: Standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.5, + p<0.1.

Figure 1: Average daily rainfalls during Hurricane Mitch

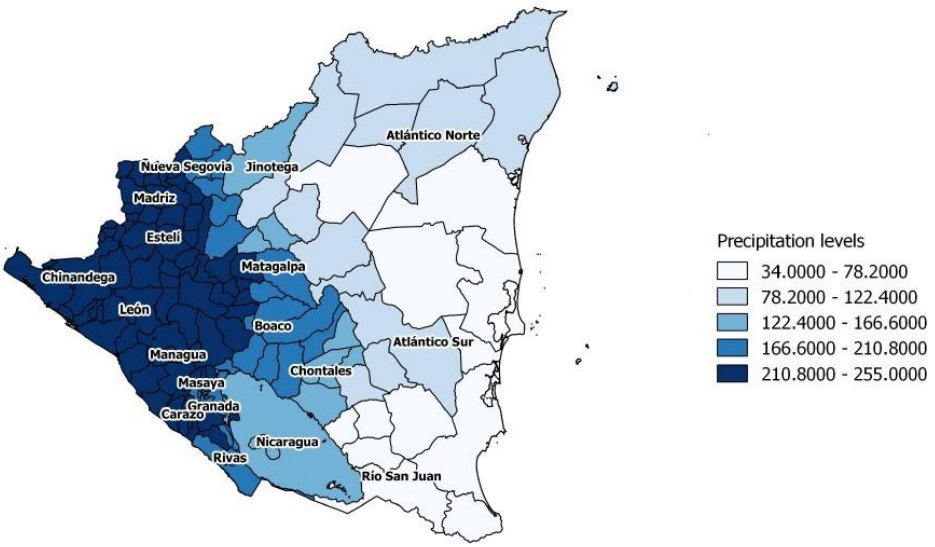

Figure 2: Remittance rates at the department level 1993 and 2001

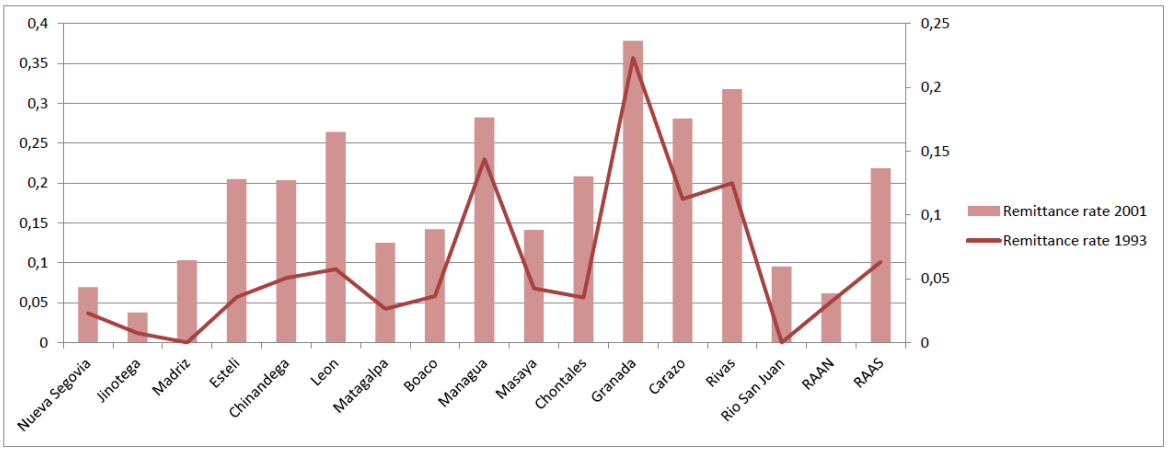

Figure 3: Migration rates (1971) and remittance rates (2001) at the department level