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Extended Abstract Submission: The Migration-Disaster Nexus in Central America and the Caribbean

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I. INTRODUCTION

Our objective is to develop stylized facts regarding migration as a key form of adaptation to slow and rapid onset disasters in Central America and the Caribbean, a region reported to suffer long-term economic consequences from natural disasters (Hsiang and Jina, 2014). Pioneering studies on environmental migration use samples that are unrepresentative of countries raising external validity concerns (Feng, Krueger, and Oppenheimer, 2010; Dillon, Mueller, and Salau, 2011; Gray and Mueller, 2012; Marchiori, Maystadt, and Schumacher, 2012; Bohra-Mishra, Oppenheimer, and Hsiang, 2014; Mueller, Gray, and Kosec, 2014). A lack of national representation of samples and systematic application in methodologies, migration definitions, and climate variables present a severe knowledge gap: To date, there are few accurate predictions of population movements in response to natural disasters at a regional (yet alone) global scale.

Monitoring internal displacement is crucial from a development standpoint. Diversification out of agriculture can improve welfare (McKenzie, Stillman, and Gibson, 2010; Beegle, Dercon, De Werdt, 2011; Bryan et al., 2014), while come with the additional cost of urbanization (Barrios, Bertinelli, and Strobl, 2006) without growth (Pohelkke, 2015). The isolated case studies in this region found both positive and negative associations between disasters and migration (Halliday, 2006; Feng, Kreuger, and Oppenheimer, 2010). One possible explanation for a lack of consensus is the type of disaster bares varying requirements on the demand for labor during reconstruction. Slow onset events, such as droughts, are rarer and are less likely to require additional labor to repair infrastructure. Another possibility for the disparity in findings is existing wealth and social protection programs cushion vulnerable households from the disaster. To shed light on how the nature of the disaster and development resilience (Barrett and Constatas, 2014) affect adaptation, we compare the internal migration responses to droughts and hurricanes in eight countries with varying wealth and governments in this region.
We link multiple census surveys from the region with natural disaster indicators constructed from georeferenced climate data at the district level to measure the impact of natural disasters on mobility. Drawing on primary longitudinal survey data, the existing literature applies discrete event history models, allowing for the identification of natural disaster impacts by teasing out the influence of pre-disaster individual and household characteristics, as well as regional markets and time trends through the inclusion of spatial and time fixed effects. While census data offers the advantage of increasing national representation over time, it lacks information pertaining to the individual’s health and socioeconomic status prior to the disaster which consequentially affects our ability to adequately measure adaptation responses to disasters. We therefore conduct a natural experimental design which exploits variation in geographic residence at the time of the disaster, the timing of the census, and the age at the time of the disaster to identify the effect of the natural disaster on migration (Akresh et al, 2012; Almond and Mazumder; 2005, Caruso and Miller, 2015; Mancini and Yang; 2009). In particular, we implement a triple difference-in-difference regression, which assumes disasters affect the migration status of an individual in the 15-39 age range significantly more than individuals outside that age range (40-60). The change in the tendency to migrate between younger (15-39) and older (40-60) cohorts over time in districts with low exposure to disasters therefore serves as a control group for what the difference in migration rates between the cohorts would have been in the absence of a natural disaster. Several diagnostic tests are provided to validate the assumptions and the use of the method to identify the effects of specific disasters.

II. DATA

Census Surveys
We use repeated census surveys from the following countries, for the following years: Costa Rica (1984, 2000), Dominican Republic (1981, 2002), El Salvador (1992, 2007), Haiti (1982, 2003), Jamaica (1991, 2001), Mexico (2005, 2010), Nicaragua (1995, 2005), and Panama (2000, 2010). Migration status is defined as whether the person migrated over the last five years prior to the census survey. We further use the age of the person at the time of the survey to define five-year cohorts within the affected (15-39) and unaffected cohort (40-60) groups. Individual and household explanatory variables are created from information on the individual’s gender,
education, homeownership, access to water, electricity, and sanitation in their current residence. Origin district and destination district fixed effects are created from the original and current locations of the individual.

**Historical Climate**

We use the Climate Research Unit’s Time Series (CRUTS) of the University of East Anglia to formulate the 20-year historical average cumulative rainfall and 20-year historical average temperature variables for each district destination. The CRUTS has a resolution of 0.5 by 0.5 degrees, providing monthly rainfall and temperature data over the period of 1901-2014. For each district, we calculate the population-weighted average of the values for the grids within the district boundaries, using the 1995 data provided by CIESIN. We allow historical averages to vary by census year, averaging the data over the twenty years preceding the survey.

**Hurricanes**

As an illustration of the method, we first estimate the impacts of the largest and most widespread hurricane in the region, Hurricane Mitch (1998). Daily rainfall is extrapolated from NASA’s Tropical Rainfall Measuring Mission (TRMM) which has a resolution of 0.5 by 0.5 degree over the period of 1998 to 2013. Population-weighted cumulative rainfall averages are derived for each district over the period in which Mitch affected the region, October 22, 1998-November 11, 1998. We convert the absolute cumulative rainfall averages in 1998 into the following measures of hurricane exposure using the mean and standard deviations (SDs) of the distribution of rainfall over the Hurricane Mitch dates: greater than 2 SDs below the mean, 1-2 SDs below the mean, 1-2 SDs above the mean, greater than 2 SDs above the mean. Those areas that were exposed to a greater than 1 SD above the mean likely represent regions of high hurricane intensity, while the remaining categories serve as areas that were relatively unaffected.

We then extend the analysis from a specific Hurricane, such as Mitch in 1998, to a continuum of hurricanes. In particular, we identify all category 4 or above hurricanes and their respective dates over the coverage of our census surveys. For those hurricanes that occurred over the last five years prior to each follow-up census survey, we quantify the cumulative rainfall averages over the relevant dates for each identified hurricane. Since a district might have been exposed to more than one category 4 or above hurricane over a five year period, we differentiate
the exposure measure from above by measuring whether the individual had experienced rainfall greater than 2 SDs below the mean for at least 1 hurricane period, 1-2 SDs below the mean for at least 1 hurricane period, 1-2 SDs above the mean for at least 1 hurricane period, greater than 2 SDs above the mean for at least 1 hurricane period.

Droughts

We construct the 12-month Standardized Precipitation and Evaporation Index for each district and for the five years preceding the census surveys (Vicente-Serrano, Beguería, and López-Moreno, 2010) using population-weighted monthly rainfall and temperature data from CRUTS. The mean and standard deviation of the distributions of drought variables for each district are formulated over the period of 1980-2010. We then take the values of the drought indices over the last five years prior to the follow-up census survey in the individual’s district of origin to formulate the following drought intensity variables, whether the person experienced: a greater than 2 SDs below the mean value of the drought index for 1 month, a greater than 2 SDs below the mean value of the drought index for more than 1 month, 1-2 SDs below the mean for 1 month, 1-2 SDs below the mean for more than 1 month, 1-2 SDs above the mean for 1 month, 1-2 SDs above the mean for more than 1 month, greater than 2 SDs above the mean for 1 month, greater than 2 SDs above the mean for more than 1 month. High intensity exposure is likely to occur when the standard deviations are greater than 1 SD below the mean, while the remainder of the drought categories can be considered places that were relatively unaffected by droughts or have low intensity drought exposure.

III. EMPIRICAL STRATEGY

The empirical strategy relies on a comparison of the probability of migrating for similarly aged individuals in districts with high and low disaster exposure over time. The implicit assumption is that differences in migration rates across birth cohorts would be similar across districts with high disaster intensity and low disaster intensity in the absence of the disaster. After verifying the assumption holds, we estimate the following triple difference-in-difference regression to identify the impact of slow and rapid onset events on migration:
\[
\text{Migrate}_{ijkt} = \beta_1 (\text{Disaster Intensity}_k \times \text{Cohort}_c \times \text{After}_i) \\
+ \beta_2 (\text{Disaster Intensity}_k \times \text{Cohort}_c) + \beta_3 (\text{Disaster Intensity}_k \times \text{After}_i) \\
+ \beta_4 (\text{Cohort}_c \times \text{After}_i) + \alpha_j + \rho_k + \delta_c + \gamma c + \theta X_{ijkt} + \mu_{ijkt}
\]

where \(\text{Migrate}_{ijkt}\) is an indicator of migration for individual \(i\) with destination district \(j\), origin district \(k\), belonging to cohort \(c\), and surveyed at time \(t\); \(\text{Disaster Intensity}_k\) is a vector of variables that reflect the intensity of the natural disaster over the period of interest (e.g., 1998 for Hurricane Mitch, last five years prior to the follow-up census surveys for category 4 and above hurricanes and droughts); \(\text{Cohort}_c\) is a vector of 9 5-year dummy variables indicating which cohort the individual was in at the time of the natural disaster, \(\text{After}_i\) takes the value one if the information comes from the more recent census survey; \(X_{ijkt}\) is a vector of individual control variables, \(\mu_{ijkt}\) is a random, idiosyncratic error term. Standard errors will be clustered by origin district and birth year. The parameters of interest are a subset of estimated parameters in vector \(\beta_1\), which measure the effect of high intensity exposure on the probability of migrating among individuals who belonged to the cohorts at risk of moving (15-39) at the time of natural disaster. Standard errors will be clustered by origin district and birth year.

Omitted variables that vary across districts, time, or generations may bias our results. We therefore include \(\alpha_j\) and \(\rho_k\) which represent district fixed effects for the individual’s current \((j)\) and previous \((k)\) residences to control for time invariant unobservables at the district level that may influence the effect of weather shocks on the probability of migrating, such as infrastructure. We further incorporate cohort \(\gamma_c\) and census year \(\delta_c\) fixed effects to account for time- or generational-specific unobserved characteristics that influence migration.
References


