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The Effect of Hydro-Meteorological Emergencies on Internal Migration

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Summary. — We estimate the effect of hydro-meteorological emergencies on internal migration in Costa Rica during 1995–2000. We find that, on average, emergencies significantly increase average migration. However, we also find that emergencies with the most severe consequences, those with loss of lives, decrease migration. The severity of the consequences may explain the differences in the sign of the effect in previous research. We also find that emergencies significantly increase population in metropolitan areas. Less severe emergencies significantly increase migration toward metropolitan areas. More severe emergencies significantly decrease migration toward non-metropolitan areas.

Key words — migration, emergencies, natural disasters, climate, Latin America, Costa Rica

1. INTRODUCTION

An increasing body of evidence suggests that climatic systems are changing around the world (IPCC, 2007, 2012). There are also indications that, along with rising temperatures, the occurrence and intensity of extreme meteorological events may rise (UNDP, 2012). As a consequence, policy makers and researchers have increasingly focused their attention on understanding how weather shocks will affect human wellbeing. Migration is one commonly used variable in economic models that reflect how climate and weather affect quality of life (see, for instance, Piguet and Laczko, 2014; McLeman and Brown, 2011; Cebula and Alexander, 2006; Graves, 1980).

The relationship between extreme climatic events and migration has been studied extensively. Extreme hydro-meteorological events could increase migration flows. A household, for instance, might decide to send away one or more of its members to offset the effect of binding market imperfections and reduce idiosyncratic risks (Massey, 1990; Massey *et al.*, 1993; Stark, 1991; Stark and Bloom, 1985; Waddington and Sabates-Wheeler, 2003). Migration could also serve as an adaptation strategy for entire populations in the face of varying climatic conditions (D'Andrea *et al.*, 2011; Petersen, 1958). However, climatic shocks could also lead to reductions in migration flows (Tse, 2011). This, for instance, might be a consequence of the effects that extreme climatic events have on household wealth, increasing migration barriers.

To contribute to this debate, we analyze the effect of hydro-meteorological emergencies on internal migration in Costa Rica during 1995–2000. We run regressions on inter-cantonal migration gross rates. By focusing on gross rates, we are able to determine whether both sending and receiving flows between canton pairs can be affected by the occurrence of hydro-meteorological emergencies, information that would otherwise be ignored by using net rates. Also, by using rates, we can control for the "gravity effect" that population size has on migration flows both at origin and destination. Namely, we run regressions nationwide, but we also split the sample between those inside and outside the San José Metropolitan Area (also known as the Great Metropolitan Area), where Costa Rica's largest and most urbanized area lies.

We use generalized linear models (GLM), following Papke and Wooldridge (1996) for models where the dependent variable varies from 0 to 1. Our results show that an increase of one hydro-meteorological emergency in the canton of origin increases migration rates, on average, between 0.08 and 0.11 percentage points of the total population of the canton of origin, after controlling for socioeconomic and demographic variables of both origin and destination. These results are always significant and robust to different specifications. We also test ordinary least squares and find that the effects are even higher (0.34 increase in migration rate).

We further break down the data to test whether different types of emergencies affect migration similarly. We split emergencies by type, and analyze the separate effect of floods, landslides, and other events to assess the effect of each component on migration. Our findings suggest that there are differentiated effects by type of event, although the sign of the effect is either positive or insignificant.

We also split emergencies by the consequences they had on populations. We analyze separately the effect of emergencies with loss of lives and other emergencies, which we define as less severe emergencies. We find that less severe emergencies, which were the most numerous, fostered emigration from affected areas. However, we also find that emergencies with loss of lives had a negative impact on migration. The severity of the consequences of the event may explain the different signs found in previous research.

Additionally, we analyze how the effects of hydro-meteorological emergencies might change when we focus on migration

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into the San José Metropolitan Area. We find that, within non-metropolitan areas, hydro-meteorological emergencies increase migration, especially to metropolitan cantons. Within metropolitan areas, these events also increase migration, especially to other metropolitan cantons. We also analyze these effects by severity by making the aforementioned partition of emergencies with loss of lives and less severe emergencies. We find that less severe emergencies significantly increase migration toward the San José Metropolitan Area. However, the most severe emergencies (those causing loss of lives) significantly decrease only migration toward non-metropolitan cantons. This set of results implies that emergencies, even if they do not directly affect urban areas, will significantly and positively affect urban population. This issue is especially important in developing countries, where cities are already facing problems associated with overpopulation, such as congestion and housing deficits (Lora, 2010; UNFPA, 2011).

The remainder of this paper is organized as follows: Section 2 discusses literature on migration and its link to changing climatic conditions. Section 3 describes the model specification and dataset. Section 4 presents results and Section 5 concludes.

2. BACKGROUND

(a) *Weather events and emergencies*

Central America is particularly prone to experiencing major weather events (see for instance Magrin *et al.*, 2014; Palmieri *et al.*, 2006; Pielke *et al.*, 2003; Tucker *et al.*, 2010). Moreover, tropical cyclones forming in the Atlantic, which are the most recurrent type of major weather event to hit the region, have been increasing steadily since 1970 (NOAA, 2012). The number of major hurricanes has also been growing, at even faster rates, accounting for nearly 14% of all cyclones in the 2000–09 decade, in contrast to the 10% they represented during 1970–79 (NOAA, 2012). Current forecasts by the IPCC predict an increase of 10% in the number of major meteorological events faced by the region in the next three decades (ECLAC *et al.*, 2011).

In Costa Rica, 40 out of the 44 national emergencies to which the Costa Rican National Emergencies Commission responded during 1993–2009 were related to extreme weather episodes, striking rural areas the most. Most important, a large number of smaller weather-related occurrences repeatedly hit the country. Costa Rican authorities report that they responded to 23 national weather-related emergencies during 2000–09, but nearly 5000 minor events during the same period.

Some climate change scenarios have suggested that by 2040 the country may have an intensification of seasons on the Pacific shore and in the Central Region (where 60% of the population live). The Atlantic and North regions, which are already subject to intense rainfall seasons, may also experience a sharp increase in rainfall levels in the wet season. Additionally, the country may face more droughts, water scarcity, and floods as a result of climate change (UNDP, 2012).

(b) *Climate, climate change, and migration*

Climate changes have greatly contributed to shaping today's population distribution across the globe (Meze-Hausken, 2000). Higher temperatures, sea-level rise, and changes in precipitation levels, variability, and intensity may lead to climate-related migration (Foresight, 2011). Migration can be fostered by negative agricultural productivity shocks and labor demand decline, which are very likely to be affected by climate phenomena; also, climate shocks may lead to loss and damage of infrastructure, resulting in net wealth loses (Marchiori *et al.*, 2011). These two channels suggest the rural poor will be affected the most (Piguet *et al.*, 2011).

Analysis of the current contribution of climate to migration poses challenges. First, existing studies are unevenly distributed and mostly focused on certain regions (Piguet and Kaenzig, 2014). Secondly, studies that have analyzed the relationship between migration and climate change have not been properly validated and estimates are often full of best guesses (McLeman, 2011; Oliver-Smith, 2008). For instance, existing estimates of migrants after Ethiopia's drought during the 1980s range from 116,000 to 1.32 million (Meze-Hausken, 2000). Third, the environment may play only a contextual role in the decision of when and whether to migrate rather than being a direct cause of migration flows between regions, so that identifying causation may be elusive (IOM, 2009; OCHA-IDMC, 2009).

In recent years, an increasing body of evidence has analyzed climate change effects on migration decisions at the community level. For example, evidence from Greenland in the past 4500 years shows that abrupt temperature changes in the course of a few decades coincided in timing with settlement and abandonment by local cultures (D'Andrea *et al.*, 2011). Additionally, it has been documented that high climate variability was associated with the migration period between 250 and 550 C.E. in Europe (Büntgen *et al.*, 2011). Increases in the frequency and intensity of hydro-climatic hazards is projected in Europe, with important implications for patterns of migration (Mulligan *et al.*, 2014). The natural catastrophes associated with the presence of climate variability and extreme events will also play an important part affecting migration patterns in Latin America (Kaenzig and Piguet, 2014).

(c) *Weather variability and migration*

When facing climate shock risks and events, one alternative response or adaptation is migrating out of the affected area. Out-migration as a response to extreme hydro-meteorological events can be rationalized in two different ways. One is a household decision where one individual is sent off. Another is a group movement, where entire households and even communities migrate.

Neoclassic migration theory has stressed the importance of distance costs and economic expectations as the core factors driving migration decisions (Sjaastad, 1962; Todaro, 1970; Todaro and Harris, 1970). However, the new economics of labor migration models emphasizes the role of migration as a risk reduction strategy, where households decide to send away one or more of their members to offset the effect of binding market imperfections and reduce idiosyncratic risks (Massey, 1990; Massey *et al.*, 1993; Stark, 1991; Stark and Bloom, 1985; Waddington and Sabates-Wheeler, 2003). For example, the lack of an insurance market instrument to offset the potential effects of extreme weather events increases the risks associated with rain-fed agriculture (Clarke and Grenham, 2011). If one or more household members migrate, households may then offset the idiosyncratic risks associated with extreme weather events and other location-specific characteristics, thereby reducing overall risk.

Empirically, estimations of weather-induced migration have looked for a methodological solution to overcome the challenges of estimating causal effects [1] in the migration literature (Munshi (2003) for Mexico; Chen (2009) for China; Pugatch and Yang (2010) for Mexico). These papers used rainfall