Moving to Higher Ground: Migration Response to Natural Disasters in the Early Twentieth Century

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Prepared for the American Economics Association Annual Meetings, January 2012

Abstract: Areas differ in their propensity to experience natural disasters. Exposure to disaster risks can be reduced either through migration (i.e., self-protection) or through public infrastructure investment (e.g., building seawalls). Using migration data from the 1920s and 1930s, this paper studies how the population responded to disaster shocks in an era of minimal public investment. We find that, on net, young men move away from areas hit by tornados but are attracted to areas experiencing floods. Early efforts to protect against future flooding, especially during the New Deal era of the late 1930s, may have counteracted an individual migration response.

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Natural disasters cause significant loss of life and property damage in the United States. In 2005, Hurricane Katrina destroyed large sections of New Orleans, resulting in the death of thousands. This salient disaster highlights that millions of people have chosen to locate in geographical areas that are at risk of natural disasters. In fact, the attraction of coastal living has encouraged more and more people to move to areas at risk from hurricanes and flooding (Rappaport and Sachs, 2003). Despite the fact that developed nations suffer less than poor countries from a disaster of a given size, natural disasters are imposing larger economic costs over time (Kahn, 2005; Pielke, Jr., et al., 2008). Many forecasters predict that climate change will only exacerbate these risks.

An individual's exposure to natural disaster risk is a function both of private choices and of governmental decisions over land use zoning and infrastructure investment. Government actions intended to protect the public can reduce the incentive to engage in private self-protection. An intuitive example of such "crowding out," analyzed by Kousky, Luttmer and Zeckhauser (2006), is building new sea walls in New Orleans. More people will stay in or move to a risky area if they believe that sea walls will be built. In this case, government investment can displace self-protection against risk (Peltzman, 1975). Such efforts could be disastrous if the public is overly optimistic about engineers' ability to protect the public.

In this paper, we examine one form of private self-protection, net migration away from disaster-struck areas, during the 1920s and 1930s, a period of high disaster activity taking place before the advent of coordinated federal disaster management. In this era, disaster relief was directed by the American Red Cross (ARC). We use ARC documents to compile all major natural disasters from 1920 to 1940. Floods and tornados are the two most common types of disaster events; our dataset also contains a small number of earthquakes and hurricanes.

Migration activity is measured in two new panel datasets, the first following individuals from 1920 to 1930 and the second tracking location from 1935 to 1940, both using Census sources. We find that, on net, young men move away from areas hit by tornados but are attracted to areas experiencing floods. Early efforts to protect against future flooding, especially during the New Deal era of the late 1930s, may have counteracted an individual migration response.

Migration away from tornado-struck areas in this era before significant government protection is consistent with Hornbeck (forthcoming), which documents out-migration from the Dust Bowl in the mid-1930s. This historical pattern is in sharp contrast with Deryugina (2011), which finds no net population change in counties struck by hurricanes in the 1980s and 1990s. Instead, affected counties receive $356 (2008 dollars) per capita in immediate disaster aid and $670 per capita in additional federal transfers, principally through unemployment insurance and income maintenance programs, over the next ten years. She speculates that these federal transfers may create moral hazard problems, "leading individuals to live in riskier places" (p. 3). The declining private response to natural disasters over the twentieth century provides support for the "crowding out" hypothesis. An unintended consequence of the growth in disaster relief and government investment in protective infrastructure may be to expose more people to risk as they choose not to leave disaster-prone areas or to move to such areas.

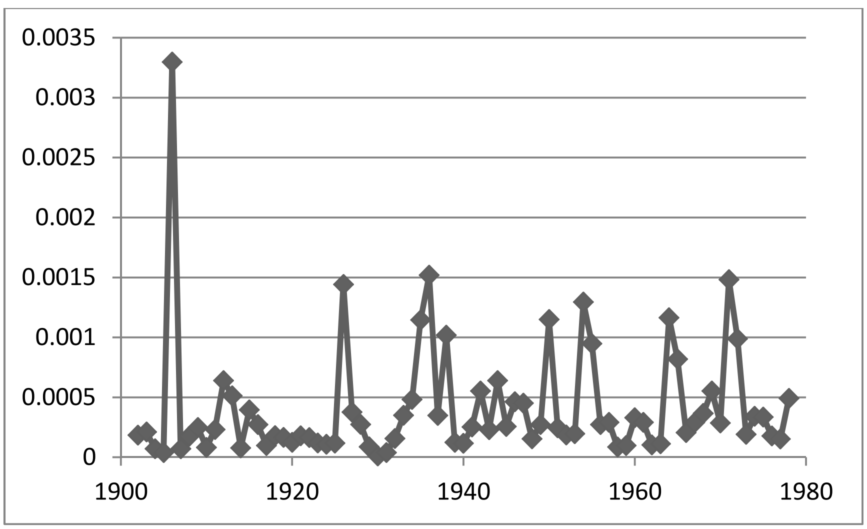
Data on natural disasters and migration activity, 1920-40

Data on natural disasters

The 1920s and 1930s witnessed numerous major natural disasters. Deadly tornadoes ravaged Missouri, Illinois and Indiana in 1925, Alabama in 1932, and Mississippi and Georgia in 1936; a 6.4-magnitude earthquake struck in a densely populated area (near Long Beach, CA) in 1933; massive flooding affected the lower Mississippi valley in 1927 and the Ohio-Mississippi river valleys in 1937; and serious hurricanes hit Florida in 1926 and 1928 and New England and New York in 1938.[1]

Figure 1 portrays the combined damage estimates for all major disasters in the United States from 1902 to 1978.[2] Following Pielke, Jr., et al. (2008), we use the GDP deflator to convert damage estimates into constant 2005 dollars. The real series is then "normalized" over time by comparison with real value estimates of national wealth. The year 1906, which witnessed the great San Francisco earthquake, is an obvious outlier. More importantly, three of the 10 years in which natural disasters destroyed more than 0.01 percent of national wealth occurred in one of our study periods (1935-40).

Figure 1: Total Damages from Earthquakes, Tornadoes, Hurricanes, and Floods Normalized by National Wealth, 1902 to 1978



We collect data on disaster activity by county and year from a series of ARC circulars. The ARC received its first congressional charter in 1881, as a voluntary non-profit organization

[1] Among the popular and academic books chronicling these disasters are Barry (1997), Egan (2006), Welky (2011), Burns (2005), and Libecap and Steckel, (2011). In addition, 1930 and 1934-36 witnessed wide spread droughts as documented in Cunfer (2005), Woodruff (1985), and Hornbeck (2011).

[2] For data on floods, see U.S. Weather Bureau (1950), Table F4, pp. 75-76; and Pielke Jr., et. al, (2002); for earthquakes, see Vranes, and Pielke, Jr. (2009); for hurricanes, see Pielke Jr., et. al, (2008); and for tornadoes, see Brooks and Doswell III (2000).

to provide assistance to victims of disasters and wars and to represent the United States at the Geneva Convention. During WWI, the ARC became a mass organization, with over 20 million members and nearly 4,000 local chapters. The premises of its emergency response efforts were that it was crucial to prepare in advance and to accumulate and apply resources and expertise beyond the expected requirements or capacity of any single community. The support was for immediate relief and rehabilitation; funds and supplies were to be gifts and offered neither on credit nor as insurance compensating for realized losses.[3]

As part of its campaign to solicit donations of money and volunteer work during the 1920s and 1930s, the national organization published a series of circulars documenting its disaster relief efforts. The circulars typically sketched the onset of the emergency, its origin and scope, painted a human picture of its victims, and then detailed the agency's response. An especially useful feature of the documents for our purposes is their precise accounting of the geographic area impacted at the county level, the number of victims and extent of property damage, and the amount of relief provided.

The coverage of the circulars correlates well with other authoritative lists of major natural disasters during the interwar period. For example, the ARC circular data set capture every fatal flood event reported in the U.S. Weather Bureau's list of "Losses in Individual Severe Floods in the United States since July 1902," except the Texas floods of 1921; every deadly earthquake appearing on Vranes and Pielke (2009) list of significant earthquakes;[4] all of the major hurricanes – those causing $30 million or more in damage (based on 2005 purchasing

[3] This short history of the American Red Cross is based on Hurd (1959) and American National Red Cross (1955).
[4] The ARC data also correspond well to the fatal earthquakes on the more extensive US Geological Survey list. On the USGS list the only fatal quakes that are missing from the ARC list are Santa Barbara, CA in June 1926 (1 dead), Eureka, CA in June 1932 (1 dead), and Kosmo, UT in May 1934 (2 dead).

power) – along with many of the lesser storms in Piekle, Jr., et al. (2008); and all of the major tornadoes in Brooks and Doswell (2000).[5]

The geographic incidence of disasters is highly uneven. Figure 2 maps the count of natural disasters in the 1930s from our ARC dataset by State Economic Area, a geographic unit made up of counties or collections of counties. We conduct our analysis at the SEA level, which is the finest geographic unit available in the 1940 Integrated Public Use Microdata Series (Ruggles, et al., 2010). 68 percent of SEAs experienced at least one natural disaster in the 1930s. Of these, 9 percent of SEAs suffered from four or more disasters; these high-intensity disaster areas were concentrated in the flood plain of the Mississippi river.

Figure 2: Count of Natural Disasters by State Economic Area, 1930-40

Migration data

Our outcome of interest is migration into and out of disaster-struck areas. We measure migration activity using two panel datasets that follow one set of individuals from 1920 to 1930

[5] Brooks and Doswell (2000) define "a major tornado" as one that "either killed at least 20 people or had an inflation-adjusted damage total of at least $50 million in 1997 dollars, or both." ($50 million in 1997 translates to about $61 million in 2005 dollars.)

and another from 1935 to 1940. Our sample focuses on prime-age men between the ages of 30 and 40 in the end of the migration period, a group that typically has high mobility rates. One important advantage of our panel data is that we are able to observe in-migration to an area alongside out-migration of existing residents, rather than simply measuring net changes in population. With this data, we are able to test whether an asymmetry exists in the response to natural disasters between incumbents, who have established social networks and may have developed skills for coping with local shocks, and outsiders who are considering moving to an area but have limited information or knowledge about coping strategies.

For the 1935 to 1940 period, our measure of migration relies on a question in 1940 Census that asks respondents where they lived five years before. We partition the country into 467 SEAs. The implied decadal migration rate between SEAs is 26 percent. We build a comparable dataset for the 1920s by matching young men by first and last name, age and place of birth (state or country) between the 1920 IPUMS sample and the 1930 Census manuscripts.[6] Because most false matches will be erroneously coded as migrants, we follow a conservative matching procedure, requiring all successful matches to be unique by name and place of birth within a five-year age band (+12/-12 years around the 1920 age in 1930). We are able to match 24 percent of men who are unique by name, age and place of birth in 1920, which is comparable with the existing literature (Ferrie, 1996). We know county of residence in 1920 and 1930 for all successful matches; for consistency across time periods, we aggregate counties to the SEA level. 48 percent of our sample migrated across SEAs in the 1920s. By this measure, the migration rate is almost twice as high in the 1920s than in the 1930s, a pattern due both to higher mobility in the prosperous 1920s and likely to some misclassification of migrants due to our matching procedure.

[6] Names are standardized for orthographic differences using the NYSIIS algorithm.

Estimation strategy and results

Conditional logit models of migration

Alongside productivity and local amenities, susceptibility to natural disasters is one feature of an area that individuals take into account when making location choices. Imagine a simple model of location choice in an open system of cities with no migration costs. If everyone has identical preferences defined over location-specific attributes such as unemployment risk and real earnings (net of housing prices), basic hedonic compensating differentials theory predicts that wages and rents will adjust across geographical areas to sketch out the representative agent's indifference curve (Rosen, 2002). If an area faces higher natural disaster risk, and this is common knowledge, then real wages will be higher and rents will be lower to compensate individuals for locating in such a risky area.

In reality, the assumptions in the simple model sketched above are unlikely to hold. Migration costs rise with age. People are not fully informed about the natural disaster risk facing different regions of the country, particularly in the 1920s and 1930s, when national information was less readily available.[7] In this sense, recent natural disasters were likely to be "new news" in this period. Rational expectations studies of local labor markets, such as Topel (1986), highlight that migrants respond to shocks that are unexpected and are more likely to move if they believe that the shock is permanent.

A disaster event bundles together new information about local risks, damage to short run quality of life and perhaps a positive shock to labor demand due to rebuilding and new construction. To study how recent disasters affect migration patterns, we estimate an augmented version of a standard migration model that embodies gravity effects (that is, distance from one's origin location to every possible SEA destination) and other SEA attributes

[7] For example, only 37 percent of American households had a radio in 1930.

such as climate and local labor market opportunities. Our innovation is to introduce measures of recent disaster shocks as additional place based attribute.

In particular, we estimate a series of conditional logits for the 1920s and 1930s, the outcome of which is an indicator variable that equals one if the individual chooses to live in SEA *j*. For illustration, equation 1 presents our estimating equation for the 1935 to 1940 time period for a man who lived in SEA *l* in 1935. In this equation, *Z* is a vector of SEA level attributes, *Dist* is the mileage distance between SEA *l* and SEA *j* and *Disasters* is a vector of disaster counts for SEA *j* in the previous decade.

$$prob(choose\ j\ in\ 1940\ |\ in\ l\ in\ 1935) = \frac{\exp(B_1 Z_j + B_2 Dist_{jl} + B_3 Disasters_j)}{\sum_{m=1}^{467} \exp(B_1 Z_m + B_2 Dist_{ml} + B_3 Disasters_m)}$$

The main explanatory variable of interest is a count of disaster events by type in the SEA over the previous decade. Disaster types include earthquakes, hurricanes, floods and tornados. In some specifications, we also include disaster counts in the previous (or subsequent) decade as a measure of baseline risk against which recent disasters may reflect "new news."[8]

Other SEA-level controls, included in the *Z* vector, include the logarithm of total population and of land area; the black population share; a quadratic in latitude and in longitude, which captures variation in temperature and other climatic conditions; a dummy variable equal to one for SEAs with some coastal exposure; and a proxy for employment growth in the area. Control variables are measured in the base year. Following Bartik (1991), our proxy for employment growth uses base-year industrial composition of employment in the SEA to weight

[8] In on-going work, we estimate hedonic wage and housing price regression models using the 1940 IPUMS sample. We find that each natural disaster event reduces housing prices by a statistically-significant 4 percent.

national trends in employment growth by industry. We also include a quartic in distance between SEA *j* and all other possible SEA locations *l*.

Results

Table 1 reports the odds ratios of living in or moving to a disaster area over the 1920s or 1935-40 period derived from our conditional logit estimation. Tornados and floods are the two most common types of natural disasters. We find that the population is up to 10 percent less likely to locate in SEAs that experienced a recent tornado, while residents are up to 15 percent *more* likely to be found in a flooded SEA. These patterns are driven by a combination of out-migration of existing residents and in-migration of new arrivals. In columns 3 and 5, we re-estimate the conditional logit for samples of men who moved between SEAs, allowing us to focus on factors that affect the decision to migrate into an SEA. We continue to find that in-migrants are attracted to flooded areas and shy away from areas recently hit by a tornado. In-migrants appear to be more responsive to tornado activity than are existing residents.

The migration response to floods and tornados is notably similar across the two time periods, despite differences in data construction. We hesitate to interpret the observed response to hurricanes and earthquakes given the rarity of these events. For example, the hurricane activity in the 1920s is based on two events in south Florida. The large odds ratio is likely picking up the rapid in-migration to Florida in this era. We also find that, as today, migrants in the 1920s and 1930s were attracted to larger cities and cities experiencing greater local labor demand. Migrants also sought out warmer winter and cooler summer geographic areas.

The disparity in the migration response to floods and tornados is consistent with nascent public efforts at flood control during the period, especially during the Roosevelt Administration's New Deal. For example, in response to the 1937 flood of the Ohio-Mississippi

**Table 1: Effect of Natural Disasters on Location Choice,
Odds Ratios from Conditional Logit Models, 1920-40**

	Num. SEAs, 1920-30	1920-30 Full sample	1920-30 Movers only	1935-40 Full sample	1935-40 Movers only
Flood count	95	1.120	0.992	1.028	1.048
		(5.69)	(-0.25)	(0.86)	(3.57)
Tornado count	48	1.003	0.971	0.902	0.831
		(0.11)	(-0.64)	(-3.28)	(-11.09)
Hurricane count	4	1.931	2.243	0.918	1.089
		(3.89)	(4.96)	(-1.58)	(3.04)
Earthquake count	5	0.982	0.967	0.945	0.959
		(-0.17)	(-0.22)	(-1.36)	(-2.15)
Controls		Y	Y	Y	Y

Column 1 reports the number of SEAs (out of 467) affected by each disaster type in the 1920s. For columns 2-5, cells report odds ratios from conditional logit models with z-statistics in parenthesis. Other controls (not reported) include the logarithm of total population and of land area; the black population share; a quadratic in latitude and in longitude; a dummy variable equal to one for SEAs with some coastal exposure; a proxy for employment growth in the SEA; total disaster count in the previous or subsequent decade; and a quartic in distance between the SEA of origin and the current SEA. Columns 2 and 5 restrict the sample to men who moved away from their origin SEA.

river valleys, the federal government dispatched thousands of Works Progress Administration workers and millions of dollars for relief efforts and commissioned the Army Corps of Engineers and the Tennessee Valley Authority to construct storage reservoirs to prevent future flooding. In contrast, we know of few defensive investments that government can make to mitigate tornado risk.

Conclusion

This paper has investigated the role of natural disaster shocks in determining gross migration flows, controlling for other place-based features. Using two micro data sets, we documented that population was repelled from tornado prone areas, with a larger effect on potential in-migrants than on existing residents, while flood events were associated with net in-migration in the 1920s and 1930s.

The differential migration responses by disaster type raises the question of whether public efforts at disaster mitigation influence – and perhaps counteract – individual migration decisions. The nascent investment in rebuilding and protecting flood-prone areas may provide an example of public investment crowding out private self-protection (i.e migration).

In future work, we plan to explore the role of New Deal disaster management more directly by exploiting variation across SEAs in federal expenditures and representation on key congressional committees. We predict that residents of areas that received federal largesse after a disaster in the 1930s will be less likely to move out and that new arrivals may be more likely to move in, while residents of areas that benefited less from New Deal spending will continue to use migration as a means of self-protection, as in the 1920s.

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