Catastrophe and Climate

Climate-Induced Migration Patterns and Property Insurance

JUNE | 2025

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Executive Summary

The increase in the frequency and severity of natural disasters due to climate change impacts the costs and benefits of living and working in various parts of the United States. As a result, people are likely to migrate from areas that have greater exposure to natural disasters to areas that have less exposure to natural disasters, which could affect property insurance markets in both areas.

This research project examines the net movement of people into and out of the state following the occurrence of a natural disaster in the state. We find that, after controlling for other factors that influence migration rates, major natural disasters in one year are associated with lower net migration into the state in the subsequent year. In other words, the evidence suggests that, on average, more people move out of a state and/or fewer people move into a state following major disasters. Regarding the magnitude of the estimated effect, the occurrence of a major natural disaster in one year is on average associated with a 0.2% decline in a state's net migration rate in the subsequent year.

This project also examines whether the estimated sensitivity of migration rates to natural disasters varies across states based on the state's overall exposure to disasters as measured by the frequency and severity of disasters in the state during the sample period. It was not found that the sensitivity of migration rates to disasters varies across states on these dimensions. It was also not found that the sensitivity of migration rates to disasters during the 2005-2013 time period differs from the 2014-2023 time period.

Case studies were conducted of five major insurer groups operating throughout the U.S. to identify how they are impacted by natural disasters. Specifically, the analysis examines whether state-level annual loss ratios for homeowners of the five insurers are related to the occurrence of a major disaster in the state in the prior year. The analysis finds that state-level loss ratios for homeowners are generally not sensitive to the occurrence of FEMA declared disasters in the prior year. The analysis does find, however, that loss ratios are higher on average in states with more restrictive rate regulation.

The study further investigates the five insurers by examining how their homeowners' loss ratios and premium rates respond to the six largest state-level disasters during the sample period. On average, the analysis finds that these five insurers' state-level homeowners' loss ratios decrease following the largest six disasters during the sample period. Possible explanations include (1) insurers restrict coverage to the properties that are most at risk, and (2) lower than average losses just happened to occur after these six major disasters.

The report ends with a brief discussion of insurance policy changes that could potentially help homeowners' insurance market participants (insurers and property owners) deal with climate change issues. More specifically, the discussion addresses the pros and cons of index and parametric triggers, as well as the implications of having longer-term policy terms.

1. Introduction

Understanding the impact of climate-induced migration on Property and Casualty (P&C) insurers is important for policyholders, regulatory authorities, and insurance company owners and managers. Weather-related hazards, which are made more frequent and severe by climate change, are causing significant disruptions around the world. According to the United Nations High Commissioner for Refugees (UNHCR), an average of 21.5 million people were forcibly displaced each year by sudden onset weather-related hazards between 2008 and 2016. In addition, according to the First Street Foundation, approximately 3.2 million Americans have relocated due to the increasing risk of flooding between 2000 and 2020.

An increase in the frequency and/or severity of natural disasters is likely to increase property owners' awareness of the expected property damages, which would likely increase demand for insurance coverage, all else equal. However, the cost of supplying this coverage is also likely to increase. In addition, more frequent and more severe natural disasters would likely encourage migration out of catastrophe prone areas (Feng, Oppenheimer, and Schlenker, 2012), potentially decreasing the overall market demand for P&C insurance coverage in the affected areas. Even if disaster prone areas do not experience a net decline in population, the composition of the population could change. For example, the migration of wealthy older individuals away from disaster prone areas may coincide with the movement of younger and lower-income individuals into the same regions (Strobl, 2011; Deryugina, 2013), which could influence the demand for insurance coverage.

A number of insurance companies have recently completely withdrawn or reduced their exposure in some catastrophe prone areas due to their inability to profitably provide coverage. For example, Allstate announced in November 2022 that it would 'pause new homeowners, condo, and commercial insurance policies in California to protect current customers.[1] Similarly, in 2022, Bankers Insurance Company, AIG, and Farmers insurance reported their exit from Florida.[2] Thus, the supply of insurance coverage in catastrophe-prone areas is also changing. How these supply-side changes interact with the potential demand-side changes stemming in part from migration is an interesting, but difficult question. To shed some light on the impacts of climate-induced migration on P&C insurance markets, the analysis first examines whether natural disasters are related to migration in and out of states in the U.S. It then investigates whether premium rates and loss ratios of insurers change following natural disasters.

The primary objectives of this project are as follows:

- To identify the most vulnerable regions/states that are disproportionately affected by climate-induced migration.
- To assess the direct and indirect effects of climate-induced migration on the supply and demand for P&C insurance market products.
- To explore the impact of different regulatory environments that could potentially influence the impact of climate-induced migration on insurance market outcomes.
- To propose possible product features for insurers to mitigate the negative impact of climate-induced migration.

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[1] See What homeowners need to know as insurers leave high-risk climate areas (cnbc.com).
[2] See Kousky and Meddors (2024).

In summary, this research seeks to shed light on the impact of climate change on migration patterns and to explore the potential impact of climate-induced migration patterns on property insurance markets.

To achieve the stated objectives, the analysis utilizes U.S. Census Bureau State-to-State Migration Flows data to identify migration patterns in each state.[3] The research also gathers FEMA disaster data at the state level to identify those states that are heavily impacted by climate-related natural disasters. The analysis then estimates the relation between state net annual migration rates and the frequency and severity of recent disasters in the state in an effort to identify the extent to which migration rates are related to recent disasters.[4]

The analysis of the potential impact of disasters on insurance markets focuses on large insurers that conduct business across multiple states. It examines their rate changes and loss ratios following large disasters during the 2009-2023 time period. The insurer product line and rate filing data are sourced from the Standard & Poor's Market Intelligence (S&P MI) dataset.

[3] See State-to-State Migration Flows (census.gov).

[4] See National Risk Index for Natural Hazards | FEMA.gov.

2. Literature Review

There are several relevant literatures related to the impact of climate induced migration on U.S. insurance markets. First, an overview is provided of the factors, other than climate change, which affect migration. This is followed by a discussion of how climate change can influence migration. Much of the literature on migration in general focuses on migration across countries. Since the focus of this research is on the U.S., the discussion is limited to the evidence related to migration within the U.S. Then it moves to insurance markets and a review of the literature on how climate change is influencing insurance markets.

2.1 NON-CLIMATE FACTORS THAT INFLUENCE MIGRATION

A household's decision to migrate to another location can be modeled by comparing the benefits of migrating to the costs of migrating. Potential benefits include better employment opportunities, lower taxes, better government transfer policies, lower crime, better educational systems, being closer to family, and a better climate. Potential costs include the transaction costs associated with moving, including housing costs, transportation costs, job search costs, and the costs of assimilating into a new community (Simpson, 2022).

The household benefits and costs associated with migration are likely to vary by demographic characteristics. For example, on average retirees are likely to place greater weight on being near family and on better climate, and less weight on employment opportunities than young adults. Thus, demographic characteristics could interact with the underlying costs and benefits and yield different outcomes for different demographic groups.

It is also worth noting that business decisions on where to locate can have a large impact on where households decide to live. Business decisions will be influenced by many factors, including tax policies, transportation infrastructure, quality of education institutions, and expected storm damage over time.

2.2 THE IMPACT OF CLIMATE CHANGE ON MIGRATION

Most studies that examine the relation between climate change and migration focus on international migration. These studies usually highlight that climate change could cause terrible living conditions (due to heat, storms, and floods), food and water shortages, and severely limited economic opportunities in some geographical areas. The literature highlights that these effects could cause mass migration to wealthier countries that are not as exposed to climate change. For example, a White House (2021) report focuses on international climate change migration and highlights the humanitarian consequences of displaced individuals and the assistance that governments could provide for the affected individuals.[5] Although the White House (2021) report focuses on international migration caused by climate change, it acknowledges that the impact of climate change on domestic migration is also an issue. Since this study is focused on the U.S., the remainder of this section will focus on migration within the U.S.

Climate risk can have two opposing effects on migration: on the one hand, deteriorating economic conditions and safety concerns may motivate migration (Kleemans, 2015; Cattaneo and Peri, 2016). For example, Feng, Oppenheimer, and Schlenker (2012) find a statistically significant relationship between changes in net outmigration and climate-driven changes in crop yields in the rural counties of the Corn Belt. On the other hand, negative income/wealth shocks caused by climate risk may prevent households from

[5] See Yayboke, Nzuki, and Ballard, 2021 for a summary of the report.

migrating due to a lack of funds (liquidity) to pay the migration costs (Kleemans, 2015; Cattaneo and Peri, 2016). Consistent with migration costs being important, Kleemans (2015) and Cattaneo and Peri (2016) find that higher temperatures in middle-income areas increased migration rates to urban areas. In contrast, in poor areas, higher temperatures reduced the probability of migration to urban areas and to other countries, consistent with the presence of severe liquidity constraints in poor areas. In the United States, evidence indicates that there is simultaneously inflows and outflows of migrants following climatological natural disasters (Strobl, 2011; Deryugina, 2013).

Interestingly, the intuitive predictions regarding the impact of future climate change on migration patterns in the U.S. are opposite of some of the migration patterns that prevailed in the U.S. during the latter part of the 1900s, and which continue to some extent today. Specifically, during this period, there was migration to coastal areas and areas with warmer climates (e.g., Florida and Arizona).[6] Many of these locations will likely experience greater frequency of storms, flooding, and extremely high temperatures, which are predicted to cause migration out of these areas in the future (Partridge, Feng, and Rembert, 2017).

Hauer (2017) estimates the impact of sea level rise (SLR) in the U.S. during this century on migration patterns out of coastal areas and into other areas using Core Based Statistical Areas as the unit of analysis.[7] To incorporate the potential impact of adaption measures (e.g, sea walls, home elevation, etc.), he assumes adaption is positively related to income level in each area. When his results are aggregated to the state level, he estimates that 1.8 meters of SLR over the century could cause Florida to lose more than 2.5 million residents. The states with the next highest estimated population losses are Louisiana, New Jersey, and Virginia, with forecasted population losses in these states being less than 0.5 million. Texas is forecasted to gain the most residents (1.5 million). The states with the next largest increases in forecasted population, again all less than 0.5 million, are Georgia, North Carolina, and Pennsylvania.

Robinson, Dilkina, and Moreno-Cruz (2020) also examine the effects of sea level rise on migration in the U.S. They highlight several conceptual issues associated with empirical studies of climate-induced migration. First, climate induced migration may not follow historical patterns; therefore, using only historical data to develop forecasting models may be problematic. Second, most climate-induced migration is likely to be over short distances. Thus, in order to capture such migration, the geographical unit of analysis may need to be relatively small. Third, there are likely to be feedback loops in the sense that current migration due to climate change may be influenced by prior climate-induced migration.

Robinson, Dilkina, and Moreno-Cruz (2020) use artificial neural network models to estimate the probability of migration from one county to another county based on the population in the two counties and the distance between the counties. They estimate two models: one for migration due to climate events and one for normal, non-climate related reasons. They train the climate related migration model using IRS migration data from seven counties that were affected by Katrina and Rita as origin counties and 3,099 counties across the U.S. as destination counties. They train the non-climate migration model using the IRS migration data from 2004-2011 for all the remaining county-to-county pairs.[8]

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[6] For an early study, see Graves (1976), who shows that people relocated to cities in coastal areas and the sunbelt over the 1960-1968 time period. The variables that are significantly related to migration are per capital income growth, average annual rate of unemployment, number of physicians per 100,000, proportion of population that was nonwhite, and number of heating degree days. Also, see Rappaport (2007) and Partridge et al. (2008).

[7] A Core Based Statistical Area (CBSA) is defined by the Office of Management and Budget and can be a metropolitan area or a micropolitan area. Hauer's study used 915 CBSAs.

[8] They exclude the change from 2010-2011 due to an IRS reporting change for these years.

To estimate the effect of sea level rise on migration, Robinson, Dilkina, and Moreno-Cruz (2020) couple their migration models with forecasts of sea level rise along the coastlines of the U.S. They assume that people migrate if their property becomes flooded due to sea level rise. Their methodology allows them to estimate the direct effects of sea level rise as well as potential indirect effects. As an example of indirect effects, an increase in population in county X caused by a recent catastrophe in a nearby county could cause other people in county X to leave because of the increased population density. Similar to Hauer (2017), they predict that areas adjacent to the coasts and urban areas in the southeast will experience the most out migration from sea level rise.[9]

Sheldon and Zhan (2022) examine the impact of natural disasters on migration at the Designated Market Area (DMA) level.[10] They find that following the declared disasters by FEMA, households increase their propensity to move both within their DMA and out of their DMA. This propensity to move is lower for low-income households.

Sheldon and Zhan (2023) use a difference-in-difference approach by matching counties that were hit by disasters in a given year to counties that were not hit but had similar natural disaster exposure and similar demographics. They find that FEMA declared disasters increase the number of households that out-migrate, and that out-migration is positively associated with per capita assistance from FEMA's Individual and Household Program (IHP). Regarding the destinations of households that out-migrated from areas with declared disasters, they find that households are less likely to move to areas with a larger number of past disasters or lower elevations. However, they find "no evidence that treated households move away from the coast."

Shu et al. (2023) examines the impact of flood exposure on population movements in the U.S. They examine census blocks across the U.S. to estimate the impact of various aspects of flood risk exposure, including the depth of flooding and the likelihood of flooding. They control for amenities (e.g., proximity to water) and a variety of social and economic characteristics (e.g., incomes, home values, and employment rates). Their results indicate that population growth is negatively related to flood exposure at the census block level, but not when the data are aggregated at the state or county level.

First Street (2024) extends Shu et al. (2023) by analyzing not only flood risk, but also the impacts of other hazards on migration patterns at the census block level in the U.S. Their model uses historical relationships between climate hazards and population changes over the 2000 to 2020 period to estimate future population changes due to each of the following hazards: floods, wildfire smoke, wildfires, drought, extreme heat, and tropical cyclone winds under various assumptions about how the climate will change through 2055. Using the historical data, they find that exposure to flood and wildfire smoke hazards are negatively associated with population changes, but that wildfires, drought, extreme heat, and tropical cyclone winds are not associated with population changes. However, they find a negative relation does exist between population changes and the latter hazards if the analysis is restricted to census blocks that lost population during the time period from 2000-2020. They conclude that climate hazards act as an additional "push" factor in areas that are already experiencing population loss.

[9] However, relative to Hauer (2017), who finds that Texas's population increases as a result of sea level rise (see above), the results in Robinson, Dilkina, and Moreno-Cruz (2020) indicate that the migration patterns vary within Texas, as Houston and Dallas have greater out-migration and Austin has less out migration.
[10] The U.S. is divided into 210 media or television markets. These markets are referred to as Designated Market Areas or DMAs.

First Street (2024) then projects future population growth taking into account climate change through 2055, under different climate scenarios.[11] The results indicate that flood risk has the highest impact on future population changes. To examine the geographic differences in the impact of climate change on population, they aggregate the data to the county level and present the results using a map of the U.S. The map clearly indicates that coastal areas are expected to experience the greatest population changes due to climate change.

The migration of people due to climate change can be influenced by public policy programs that reduce the cost associated with migrating out of areas subject to climate change risk. “Managed Retreat” programs are an example of one type of program. Managed retreat programs attempt to move people and property out of areas that are exposed to high flooding losses and/or storm damage losses. Most of these programs are voluntary and involve purchases by government agencies of properties that are exposed to climate related property damage. Since the sellers of the property are required to move, managed retreat programs can induce migration out of high climate risk areas.

As an example, local governments in South Carolina can purchase properties using funds from a HUD Community Development Block Grant. The program is voluntary on the part of the homeowners and is managed by the State’s Office of Resiliency. The maximum purchase price is $250,000 (SCOR, 2023). After the property is purchased, the house is removed, and the land becomes a park or open space.

FEMA also manages a federally funded program to reduce the losses to the National Flood Insurance Program from properties that have had repeated flood losses. Since 1989, FEMA has acquired over 40,000 properties. Generally, FEMA will pay 75% of the value of the home with the other 25% coming from the property owner or some other aid program (Mukherji et al., 2024).

Siders (2019) highlights that, although managed retreat programs can be an effective adaption policy, to date it has been done on a relatively small scale and that achieving greater scale is important. She then discusses the barriers that prevent greater use of managed retreat programs. For some people, the benefits of living in an area with nice views, proximity to abundant water resources, and warm weather outweigh the disaster risk costs associated with their property. Provided these people understand and bear the full costs associated with the disaster risk associated with their property, they are not imposing costs on society and so one can argue that they should not be forced to participate in managed retreat programs. On the other hand, if most of the costs of disaster risk are covered by the Federal government (taxpayers) through disaster aid programs, then an argument can be made that property owners should be forced or encouraged to participate in managed retreat programs.

Other property owners may not participate in managed retreat programs because of decision making biases, such as underestimating the damage risk or overestimating the effectiveness of protective measures. Many people are also subject to status quo bias (Samuelson and Zeckhauser, 1988)—a preference for maintaining their current situation and resisting actions that may alter the current state of affairs. Siders (2019) also highlights institutional factors that can reduce the use of managed retreat programs. Specifically, many of the jurisdictions that determine land use regulations and utilize manage retreat programs benefit from additional property taxes when at-risk areas are developed and therefore want to encourage development in high-risk areas, not discourage it.

[11] They use the five Shared Socioeconomic Pathways (SSPs) used by the Intergovernmental Panel on Climate Change (IPCC).

In summary, multiple research studies have found historical evidence indicating that migration increases as the exposure to flood risk increases. The geographical unit of analysis in most of these studies is at the county level or smaller. Also, there is some evidence that migration at the state level is related to that state's recent exposure to natural catastrophes.

2.3 HOW CLIMATE CHANGE AFFECTS INSURANCE MARKETS

2.3.1 CLIMATE CHANGE IMPACT ON INSURANCE PREMIUMS

In a competitive property insurance market without regulatory or market imperfections,[12] climate change would influence the cost of supplying insurance in two ways. First, premiums would reflect the expected claim costs associated with insuring property, which implies that premiums would increase as a result of an increase in expected climate induced damages. For example, if the likelihood or severity of wildfires were to increase due to climate change, then insurers would need to increase premiums to cover the additional expected claim costs. Second, to the extent that climate change increases uncertainty about claim costs, insurers would need to hold more capital or purchase more reinsurance to maintain the same level of insolvency risk. For example, if an increase in the likelihood or severity of wildfires also caused property damage to be more highly correlated across properties in a given region and thereby increased the likelihood that an insurer in that region would experience very high claim costs, then the insurer would need to hold more capital and/or purchase more reinsurance to maintain its insolvency risk. The costs of raising and holding the additional capital and the additional reinsurance costs would be passed on to the property insurance customers in a competitive market without imperfections.

In response to higher expected losses and higher variability/correlation in losses due to climate change, insurers would likely try to increase insurance rates. On the other hand, state insurance regulators could experience greater pressure from consumer groups to keep insurance affordable and therefore regulators could suppress or compress insurance rates. "Suppression" refers to preventing prices from rising to a level that reflects the cost of providing the insurance. "Compression" refers to reducing the differences in prices charged to consumers with different expected claim costs, which essentially yields cross-subsidization across consumer groups (e.g., those in different geographical areas).

When the approved insurance rates are below what insurers deem to be actuarially needed, insurers may increase premiums elsewhere and/or reduce their supply of insurance in high-risk areas. In the extreme, the reduction in supply can mean withdrawal from the market. The following paragraphs discuss the evidence related to supply responses of insurers to increased climate risk and to regulatory constraints on insurer pricing.

There have been a number of studies that examine whether insurers reduce supply in response to higher perceived risks, which is usually proxied by a recent catastrophe (Choi and Weiss, 2005; Grace and Klein, 2006, 2007; Froot and O'Connell, 2008; Ragin and Halek, 2016). Some studies find that insurers restrict coverage availability and adjust policy terms following such events (Grace and Klein, 2006, 2007, 2009; Chen, Doerpinghaus, Lin, and Yu, 2008). In some cases, they may even exit the market altogether (Born and

[12] "Imperfections" refers to market conditions that could inhibit prices of products and services from reflecting the expected costs, which includes a "fair" return to capital providers. For example, a lack of competition in a market could cause prices to be set above expected costs. Conversely, regulatory restrictions on prices could cause prices to be set below expected costs for some consumers.

Klimaszewski-Blettner, 2013). Aseervatham, Born, Lohmaier, and Richter (2017) also highlight the variability of exit decisions based on specific hazards.

Relatively new research by Oh, Sen, and Tenekedjieva (2024) provides interesting evidence on cross subsidization of climate risk costs across states based on the restrictiveness of price regulation at the state level. They construct a measure of state regulatory restrictiveness based on the difference between the actuarially based rate changes requested by an insurer and the actual rate changes that were approved. Based on the constructed metric, states are classified in one of three groups, Low-Restriction, Medium-Restriction, or High-Restriction. They compare the pricing and performance of insurers in Low-Restriction states to those in High-Restriction states. They find that underwriting profitability (measured using the combined ratio) is greater in Low-Restriction states.

Oh, Sen, and Tenekedjjeva (2024) also compare how rate change requests respond to past losses in Low- versus High-Restriction states. They classify past losses as “same-state losses” if the losses occur in the state in which they are filing a rate change and “out-of-state losses” if the losses occur in another state. They find that insurers with same-state losses are less likely to file a rate change request in High-Restriction states and that they receive a lower rate change approval for same-state losses in High-Restriction states. In addition, they find that rates respond to out-of-state losses in Low-Restriction states, but not in High-Restriction states. These results are consistent with cross-subsidization of losses from High-Restriction states to Low-Restriction states.

Research by Keys and Mulder (2024) examines over 47 million observations of property insurance premiums from 2014-2023. The data, which is obtained from mortgage escrow accounts, indicates that property insurance premiums increased in nominal terms by 33% and in real terms by 13% from 2020 to 2023. Their objective is to explain the variation in zip code level homeowners’ premiums by disentangling the effects of disaster risk, home prices, demographics, time, and other zip code characteristics.

Unlike many other studies, Keys and Mulder (2024) differentiate “disaster risk” from “climate risk.” The former is defined as the expected annual losses per dollar of building value from disasters across hazards that are normally covered by homeowners’ insurance. To make these calculations, they combine data from the National Risk Index and the First Street Foundation. Climate risk is the expected change in disaster risk from 2023 (as described above) to the forecasted disaster risk in 2053, which is calculated using models from First Street Foundation.

They find that most of the within-state variation in premiums is explained by home prices and disaster risk. They also find that the increase in premiums observed recently coincides with property catastrophe reinsurance prices doubling from 2018 to 2023. In addition, they find that the increase in premiums during this time period was greater, holding other factors constant, in states in which insurers were more exposed to the reinsurance market, where reinsurance exposure is measured by the extent to which the insurers in the state purchase reinsurance.

2.3.2 IMPACT OF INSURANCE PREMIUMS ON REAL ESTATE PRICES

In a well-functioning market, an increase in insurance premiums caused by either an increase in expected losses or an increase in the variability of losses due to climate change provides a signal that the cost of living in a certain location has increased. In response, property owners may attempt to relocate to another area (migrate). However, to the extent that property prices properly capitalize the higher future insurance costs, the selling price of the property will be lower by an amount approximately equal to the present value of the higher expected future insurance costs plus the expected future uninsured property damage.[13] In other words, the existing property owners would likely bear the higher expected costs associated with an increase in climate change risk regardless of whether they continue to own the property or not.

On the other hand, if property values do not fully reflect the expected future insurance costs plus the expected uninsured property damage, then a current property owner could sell the property and avoid some of the future expected costs due to climate change. In essence, the current owner would be sharing the future expected costs with a new owner. Thus, an important issue is to what extent do property prices reflect expected increases in climate change damages? As discussed below in Box 1, the evidence indicates that real estate prices do, at least to some extent, reflect climate change risk, and that the extent to which real estate prices reflect climate change risk depends on whether the marginal investor is a believer in climate change and is considered to be a more informed/sophisticated owner, where the latter trait is proxied by the property owner not occupying the property, i.e., is renting the property to another party.[14]

Another possibility is that property owners facing higher insurance costs due to climate change could forego insurance. However, most mortgages would prevent them from doing so. Property owners without mortgages could choose not to insure the property and hope that they do not experience damage or hope that government disaster aid programs would implicitly provide insurance at no cost.

Box 1 – Do Real Estate Prices Reflect Climate Change Risk?

Baldauf, Garlappi, and Yannelis (2020) examine whether predicted sea level rise affects housing prices by analyzing over 10 million housing price transactions. They develop a model that incorporates homeowners' beliefs about climate change. The key assumption in their model is that people like to live near other people who think like them. This yields the prediction that housing prices will reflect the effects of climate change more so in areas in which people are "believers" in climate change. Their evidence is consistent with this prediction—after controlling for other factors that have been shown to affect housing prices, the price of homes that are projected to be underwater due to sea level rise are lower in areas with a higher percentage of believers. Specifically, they estimate that prices decrease by about 7% for each standard deviation increase relative to the national mean in the percentage of households who are believers. They cannot unravel whether this effect is due to believers underpricing or non-believers overpricing or some combination of the two.

Bernstein, Gustofson, and Lewis (2018) find a 7% discount on coastal real estate projected to be subject to sea level rise relative to otherwise similar properties not subject to sea level rise. The discount is larger in markets with a higher percentage of non-owner occupied properties, which is consistent with a greater discount when the owners are more sophisticated. The discount also has increased over time, consistent with greater awareness of potential sea level rise.

[13] This analysis assumes that all market participants place the same value on all the characteristics of the property including the expected damages from climate change.
[14] See Clayton et al. (2021) for a more extensive review of the literature on whether real estate prices reflect climate change risk.

3. Empirical Analysis

3.1 DATA DESCRIPTION

3.1.1 MIGRATION DATA

This analysis uses U.S. Census Bureau State-to-State Migration Flows data (source: State-to-State Migration Flows). These annual data start in 2005 and go through 2023; however, there are no data for 2020. The Net_Migration_Rate is calculated as the number of people moving into a state minus the number of people moving out of the state each year divided by the population in the prior year.[15]

Table 1 provides summary statistics for the states with the five highest and five lowest average migration rates over the 2005-2023 time period. The average annual Net_Migration_Rate across all states and years is 0.03%, but there is substantial variation across states in their average net migration rates. For example, Arizona has an average annual net migration rate of 1.04%, while Alaska has an average equal to -4.22%. Table A1 in the Appendix provides the average migration rate of each state over the sample period, as well as the minimum and maximum migration rate for each state during the sample period. Table A1 illustrates that four states (Arizona, North Carolina, South Carolina, and Texas) have a positive net migration rate in each year and that four states (California, Illinois, New Jersey, and New York) have a negative net migration rate in each year from 2005 to 2023.

Table 1

SUMMARY STATISTICS FOR STATE ANNUAL NET MIGRATION RATES FROM 2005-2023

	Mean	Stdev	Min	Max
States with Lowest Annual Mean Net Migration Rates				
AK	-4.22%	3.12%	-9.30%	0.50%
DC	-1.18%	0.98%	-2.50%	1.00%
NY	-0.94%	0.28%	-1.40%	-0.50%
NJ	-0.79%	0.21%	-1.00%	-0.20%
IL	-0.75%	0.26%	-1.20%	-0.40%
States with Highest Annual Mean Net Migration Rates				
DE	0.80%	0.50%	0.00%	1.50%
NV	0.81%	0.57%	-0.30%	1.70%
ID	0.82%	0.62%	-0.10%	2.10%
SC	0.94%	0.31%	0.60%	1.70%
AZ	1.04%	0.49%	0.20%	2.30%
All States in the U.S.	**0.03%**	**0.98%**	**-9.30%**	**2.30%**

Net migration rates are calculated as the number of people moving into a state minus the number of people moving out of a state in a given year divided by the population in the prior year. Data are from U.S. Census Bureau State-to-State Migration Flows.

[15] The data only include people who moved into the U.S., but do not include people who moved out of the U.S. To be consistent, the analysis only considers state-to-state migration.

3.1.2 FEMA DISASTER DECLARATIONS AND AID

To assess the extent to which states are subject to climate related disasters, the analysis uses the Federal Emergency Management Agency (FEMA) data on Disaster Declarations during the years 2001-2023 (source: Disaster Declarations Summaries - v2 | FEMA.gov). The Stafford Act of 1988 outlines the process by which a state governor requests federal emergency aid. That aid becomes available if the U.S. president declares that the event was a disaster needing federal assistance. The analysis uses the number of disaster declarations for each state as one measure of the state's exposure to climate related disasters.

The analysis also uses the amount of disaster aid approved by FEMA under its Individual and Households Program to measure a state's exposure to climate related disasters (source: FEMA Web Disaster Summaries - v1 | FEMA.gov). The Individual and Household Program (IHP) provides monetary assistance and direct services to individuals and households for expenses incurred as a result of a disaster which are not insured or are underinsured. These expenses could include temporary housing costs or rebuilding costs.[16]

Table 2 below provides summary statistics for the FEMA data. There were 1,078 FEMA Disaster Declarations during the 2005-2023 period. The amount of approved funds across all states from IHP averaged $1.476 billion per year. The maximum funds approved in a given year to an individual state was $5.77 billion to Louisiana in 2005. The states of Louisiana, Texas, Florida, New York, and Mississippi received the highest total amounts approved for IHP. These five states account for 68% of the total approved amounts for the entire program over this time period.[17] Descriptive statistics for these states are provided in Table 2 below.

Table 2

FEMA DISASTER DECLARATIONS AND FEMA APPROVED FUNDS UNDER THE INDIVIDUAL AND HOUSEHOLD PROGRAM (IHP)

State	# of Declarations	Annual Mean	Max	Total
MS	31	0.081	1.29	1.46
NY	30	0.095	1.01	1.71
FL	25	0.169	1.16	3.04
TX	27	0.206	1.66	3.70
LA	27	0.483	5.77	8.69
All States in the U.S.	**1,078**	**$1.476**	**$5.77**	**26.57**

Table includes the five states with the highest total amounts of IHP approved funds from 2005-2023. Annual mean is the total IHP approved funds over the sample period divided by 18, the number of years in sample.

One objective of the study is to investigate the relation between climate change risk exposure and migration. As a first pass at the relationship, Figures 1A-1G in the Appendix present the net migration rate (the red line) along with the total IHP approved amounts over the sample period (the blue bars) for the six states in the case study sample (to be described below), plus Florida. Visually, one can see that Louisiana (1A), Florida (1B), Mississippi (1C), New York (1E), and California (1G) have lower migrations rates following

[16] The analysis also considers the insured loss to identify disaster events. Insured losses are not found to be significantly associated with net migration rates.

[17] The FEMA data for all individual states is presented in Table A2 in the Appendix. That table reveals that Oklahoma had the most declared disasters with 47 and that the states with the fewest declared disasters were Wyoming and Nevada, with seven declared disasters.

years with high IHP approved amounts (i.e., large disasters). The graphs suggest that natural disasters are associated with lower migration rates. This issue is now examined using regression analysis.

3.2 REGRESSION ANALYSIS OF NET MIGRATION RATES

To investigate the relation between migration and climate related natural disasters, the analysis estimates regression models in which the dependent variable is the net migration rate for state s in year t. A state's exposure to climate related natural disasters in a given year is measured in two ways. One way is by constructing variables to indicate whether the state experienced large disasters in a given year, where large is defined by the FEMA's approved payments from its Individual and Households Program (IHP) in the year relative to other years in the state. These indicator variables, FEMA_p25 (FEMA_p50, FEMA_p75), equal one if approved payments to the state in the given year exceed the 25th (50th, 75th) percentile value of the annual payments to the state over the period from 2005-2022.[18]

To provide more clarity about the construction of the FEMA_pXX variables, first consider FEMA_p25. The 25th percentile IHP approved payment in each state is zero. Therefore, FEMA_p25 indicates whether there was a positive IHP approved payment for a given year. Now consider FEMA_p50. The median IHP approved payment is positive for only three states (Mississippi, Florida, and Texas). Therefore, FEMA_p50 indicates whether the state had a positive IHP approved payment in all but these three states. For these three states (Mississippi, Florida, and Texas), FEMA_p50 takes a value of one if the IHP approved payment for the year exceeds \$0.005, \$0.015, and \$0.035 billion for the year, respectively. There are seven states that a have a value of FEMA_p50 equal to one more than seven times during the sample period. They are Texas (9), Florida (9), Mississippi (9), California (8), Kentucky (8), Missouri (8), and Oklahoma (8).

The other way that a state's exposure to natural disasters is measured is by using the number of declared disasters in a year, which are called FEMA_number. The states with the greatest number of declared disasters over the sample period are Oklahoma (47), California (36), South Dakota (35), Iowa (33), Kansas (33), Missouri (33), Mississippi (31), Alabama (30), Alaska (30), and New York (30).

According to Sasser (2010); Boustan, Kahn, Rhode, and Yanguas (2020); and Hageman, Robb, and Schwebke (2021), migration is influenced by economic conditions, housing affordability, and state-specific amenities. Thus, the analysis controls for these factors by including the state's prior year unemployment rate, GDP growth rate, and average house value in the regression equations. These three variables are sourced from Bureau of Labor Statistics, U.S. Bureau of Economic Analysis, and Zillow Home Value Index, respectively.[19]

In addition, the analysis includes measures of the extent to which a state is urbanized and a measure of a state's tax burden due to state and local taxes. LessUrban is a dichotomous variable equal to one if the state's urban population rank is below the median of all states. The urbanization data are sourced from the U.S. Census Bureau and based on the 2010 census. Following Hageman, Robb, and Schwebke (2021), the study defines the variable TaxBurden as revenue from state and local taxes divided by personal income in the state, which is obtained from the Tax Policy Center.

[18] The results are the same if FEMA payments per capita are used.

[19] Housing Data - Zillow Research.

The correlations among these independent variables are shown in Table 3. The high correlations among the FEMA variables indicate that they are capturing similar effects. Since this study uses only one of the FEMA variables in a given regression model, the high correlations are not a concern.

Table 3
CORRELATION COEFFICIENTS FOR THE VARIABLES USED IN THE REGRESSION ANALYSIS

	FEMA **_p25**	FEMA **_p50**	FEMA **_p75**	FEMA **_Number**	GDP **Growth**	**Unemployment**	House **Value**	Less **Urban**
FEMA_p25	1.00							
FEMA_p50	0.95	1.00						
FEMA_p75	0.72	0.76	1.00					
FEMA_Number	0.47	0.46	0.36	1.00				
GDP Growth	-0.10	-0.12	-0.13	-0.07	1.00			
Unemployment	0.12	0.11	0.11	0.04	-0.43	1.00		
House Value	-0.06	-0.04	0.04	-0.09	0.17	-0.16	1.00	
LessUrban	0.06	0.05	0.02	0.14	0.01	-0.16	-0.33	1.00
TaxBurden	-0.07	-0.05	-0.01	-0.04	-0.02	0.04	0.29	0.00

In addition to these control variables, the analysis includes year fixed effects (Υ_t) in the following regression model, which is estimated using the whole sample of states and years:

$$\text{Net Migration Rate}_{is} = \Upsilon_t + \beta1^*(\text{Climate Risk Measure}_{s,t-1}) + \beta2^*\text{Controls}_{s,t-1} + e_{st}\ .$$

The regression model uses explanatory variables that are lagged one year relative to the migration rate. This is a reasonable assumption given household migration actions are not likely to respond to contemporaneous information and all of the variables are measured at an annual frequency.

Table 4 contains estimated coefficients on the climate related disaster variables. The complete results, which include the coefficient estimates on the control variables, are presented in Table A3 in the Appendix. Column (1) shows results based on the 25% IHP threshold. The coefficient on FEMA_p25$_{t-1}$ is negative and statistically significant at the 5% level, which indicates that on average states that have natural disasters in the prior year that yield IHP approved funds above the 25th percentile have lower net migration. The coefficient estimate indicates that the migration rate decreases on average by 0.2%. In column (2), the variable of interest is FEMA_p50$_{t-1}$; its estimated coefficient is also -0.2% and is statistically significant at the 5% level. Column (3) shows results based on the 75% IHP threshold. The coefficient on FEMA_p75$_{t-1}$ is also negative and statistically significant at the 5% level. The magnitude of the effect is similar to that of FEMA_p50$_{t-1}$. In column (4) the analysis measures a state's exposure to climate related disasters using the number of previous catastrophic events in the previous year. The coefficient is - 0.001% and statistically significant, indicating that one additional FEMA declaration in the prior year is associated with a decrease in the net migration rate by 0.1%. These results suggest that both the frequency and severity of climate related disasters are associated with migration decisions.

Table 4

REGRESSION RESULTS FOR NET MIGRATION RATE

Dependent Variable	Net Migration Rate	Net Migration Rate	Net Migration Rate	Net Migration Rate
FEMA_P25$_{t-1}$	-0.002**			
	(-2.43)			
FEMA_p50$_{t-1}$		-0.002**		
		(-2.41)		
FEMA_p75$_{t-1}$			-0.002**	
			(-2.12)	
FEMA_number$_{t-1}$				-0.001***
				(-3.08)

FEMA_pXX$_{t-1}$ is a dichotomous variable equal to one if the state experienced FEMA approved payments in year t-1 under its Individual and Households Program (IHP) above the XX percentile value of the payments over the period from 2001 to 2023, and zero otherwise. FEMA_number$_{t-1}$ equals the number of FEMA declared disasters in the prior year. Coefficient estimates of the control variables are not reported here; see Table A3 in the Appendix.

As reported in Table A3 in the Appendix, the coefficients on the state's GDP growth rate, unemployment rate, average house value, degree of urbanization, and tax burden are all statistically significant and the signs are consistent with expectations. A higher state GDP growth rate attracts more people to move in, while higher unemployment rates, higher house values, less urbanization, and higher taxes are associated with less migration.

To explore further the relation between state migration and prior year climate related disasters, the analysis considers the possibility that the sensitivity of migration rates to disasters in the past year depends on the overall likelihood of disasters in the state. One could argue that a prior year disaster would cause people to be more likely to move out of the state if the state has an overall low likelihood of declared disasters, because people are not as prepared for disasters, they are unaccustomed to living with disasters, or the occurrence in the prior year significantly changed their expectations of future disaster. On the other hand, one could argue the opposite (migration out is less likely following a disaster in the prior year if the state had an overall low likelihood of disasters), reasoning that the prior year disaster was an anomaly and not likely to happen in the future.

To investigate these issues, the analysis divides states into quartiles based on the number of FEMA declared disasters during the entire sample period (see Table A2 in the Appendix for the number of declared disasters in each state). The analysis defines the dichotomous variable Quartile1 (Quartile4) if the state is in quartile one (four), and zero otherwise. Quartile1 (4) is the group of states with the least (most) declared disasters during the sample period. The following regression equation is estimated:

$$\text{Net Migration Rate}_{it} = \Upsilon_t + \beta1{*}\text{Quartile1}_i + \beta2{*}\text{Quartile4}_i +$$

$$B3{*}(\text{FEMA\_Disaster}_{i,t-1}) + \beta4{*}\text{Quartile1}_i{*}(\text{FEMA\_Disaster}_{,t-1})$$

$$+ \beta5{*}\text{Quartile4}_i{*}(\text{FEMA\_Disaster}_{i,t-1}) + \beta6{*}\text{Controls}_{t-1} + e_{it}$$

The focus is on the interaction term of the quartile dichotomous variables with the FEMA_Disaster variable. The coefficient on the Quartile1 (Quartile4) interaction variable indicates whether the migration rate in states that are least (most) likely to have disasters respond more or less to disasters in the prior year than the states in general. Table 5 presents the coefficient estimates β1, β2, β3, β4, β5. The complete results are presented in Table A4 in the Appendix.

Table 5

REGRESSION RESULTS OF NET MIGRATION RATE AND THE NUMBER OF DECLARED DISASTERS

FEMA_Disaster Variable =	FEMA_p25	FEMA_p50	FEMA_p75	FEMA_Number
Quartile1	0.003***	0.003***	0.003***	0.002**
	(3.43)	(3.49)	(3.65)	(2.27)
Quartile4	-0.000	-0.000	0.000	-0.001
	(-0.10)	(-0.04)	(0.25)	(-0.45)
$FEMA\_Disaster_{t-1}$	-0.002*	-0.002*	-0.002*	-0.001***
	(-1.81)	(-1.82)	(-1.81)	(-2.71)
$FEMA\_Disaster_{t-1}$*Quartile1	-0.000	-0.000	0.001	0.001
	(-0.00)	(-0.05)	(0.28)	(0.84)
$FEMA\_Disaster_{t-1}$*Quartile4	0.001	0.001	0.001	0.001
	(0.99)	(0.91)	(0.49)	(1.43)

$FEMA\_pXX_{t-1}$ is a dichotomous variable equal to one if the state experienced FEMA approved payments under its Individual and Households Program (IHP) above the XX percentile value of the payments over the period from 2001 to 2023, and zero otherwise. FEMA_Number is the number of declared disasters in the prior year. Quartile1 (Quartile4) equals 1 if the state is in the 1st (4th) quartile with respect to the number of FEMA declared disasters from 2001 to 2023.

The analysis finds that states least likely to have declared disasters (states in Quartile1) have, on average, a higher overall net migration rate into their state than other states. Consistent with the previously reported results, disasters in the prior year reduce migration rates into a state on average. However, there is no evidence that the impact of disasters in the prior year on migration is significantly influenced by the overall likelihood of disasters in the state (i.e., whether the state is in Quartile1 or Quartile4). In other words, the finding that prior year disasters reduce migration rates on average, all else being equal, remains valid even after controlling for the frequency of disasters at the state level.

The results in Table 5 indicate that the impact of disasters in the prior year on migration rates does not depend on the overall likelihood that a state is to have declared disasters. The analysis now examines whether the impact of disasters in the prior year on migration rates is influenced by the overall severity of disasters in the state. Specifically, the analysis examines whether the effect of prior year disasters on migration rates is different in states that experienced the highest natural disaster losses between 2005 and 2023. Recall from Table 2 that the five states with the highest total approved amounts of aid from the Individual and Households Program (IHP) are Louisiana, Florida, Texas, New York, and Mississippi. Together, the cumulative amounts for these five states account for about 68% of the total IHP amount nationwide. Therefore a dummy variable is created, High_Loss_State, which equals 1 if the state is one of these five states, and 0 otherwise. The High_Loss _State variable also interacts with the prior year disaster measures. Table 6 presents the results.

The coefficients on the prior year disaster variables are negative and statistically significant, as they were in the prior tables. However, the coefficients on the High_Loss_State variables are not statistically significant and the coefficients on the interaction variables of High_Loss_State with prior year disaster variables are not statistically significant.[20] Thus, it does not appear that the severity of losses influences the relation between migration rates and prior year disasters.

Table 6

REGRESSION RESULTS OF NET MIGRATION RATE IN HIGH LOSS STATES

FEMA_Disaster Variable =	FEMA_p25	FEMA_p50	FEMA_p75	FEMA_Number
High_Loss_State	-0.001	-0.001	-0.001	-0.002
	(-1.17)	(-1.15)	(-1.08)	(-1.59)
FEMA_Disaster$_{t-1}$	-0.002**	-0.002**	-0.002**	-0.001***
	(-2.36)	(-2.33)	(-1.97)	(-3.21)
FEMA_Disaster$_{t-1}$ *High_Loss_State	-0.000	-0.000	-0.000	0.001
	(-0.03)	(-0.02)	(-0.07)	(0.98)

FEMA_pXX is a dichotomous variable equal to one if the state experienced FEMA approved payments under its Individual and Households Program (IHP) in year t-1 above the XX percentile value of the payments over the period from 2001 to 2023, and zero otherwise. FEMA_number$_{t-1}$ equals the number of FEMA declared disasters in the prior year. High_Loss_State equals one if the state is one of the five states (Louisiana, Florida, Texas, New York, and Mississippi), and 0 otherwise.

3.3 OTHER ROBUSTNESS CHECKS

We now describe some robustness checks for the results presented above. A potential control variable not included in the regression models presented above that could potentially influence migration is a qualitative measure of the benefits of living in a particular location. To investigate this issue, the Gallup Well-Being Index is used. This annual survey conducted by Gallup-Sharecare evaluates various aspects of well-being, including purpose, social relationships, financial security, community connections, and health. It ranks states on a scale from one to 50, with one representing the state with the highest well-being and 50 representing the state with the lowest. A better ranking in the index indicates that the state provides higher-quality public services (Hageman, Robb, and Schwebke, 2021). However, the index data is available only from 2008 to 2022, which reduces the number of observations in the sample. When the well-being index is included as a control variable in the regression models for net migration rates, the coefficient on the well-being index is not statistically significant (not reported in a table). More importantly, the coefficients on the prior year disaster variables are negative and statistically significant in three of the four specifications, consistent with the results reported above.

The analysis also examines whether the effects of natural disasters differ during the latter part of the sample period, reasoning that awareness of climate change risk has increased over time as temperatures have increased and climate related disasters have become more frequent. More specifically, the analysis estimates the regression models in Table 3 letting the coefficients on the natural disaster variables differ during the 2005-2013 period from the coefficients during the 2014-2023 period. It is found that net migration rates are on average greater in the post-2013 period. In addition, some evidence is found that the negative impact of prior year disasters on migration is greater during the post-2013 period. More specifically, when prior year disasters are measured using FEMA_p75 or FEMA_number, the impact of

[20] The analysis also examined the results if the High_Loss_State variables are replaced with a dichotomous variable that equals one if the state is California or one of the southern states (Alabama, , Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, or Virginia), and zero otherwise. This results in similar results to those in Table 6.

disasters on migration out of a state is concentrated in the post-2013 period. These results are reported in Table A6 in the Appendix.

The analysis reported above relates migration rates to declared disasters in the prior year. To examine whether declared disasters have a longer term relationship with migration rates, the analysis estimates the regression model with an additional explanatory variable indicating whether a natural disaster occurred two years prior. The coefficients of the additional lagged variables are not statistically significant.

3.4 CASE STUDIES OF FIVE INSURANCE GROUPS

The analysis now examines whether natural disasters are associated with insurance market outcomes (premium rate changes and loss ratios). At the outset, it is important to highlight that, even if an association between natural disasters and insurance market outcomes is found, evidence on the channels that cause the association are not being provided. Indeed, as discussed earlier, there are multiple ways that disasters could affect the demand and supply of insurance coverage. Moreover, as documented in the previous section, disasters are associated with migration rates, which could also affect insurance market demand and supply, and therefore affect rate changes and loss ratios.[21]

Homeowners' insurance premium rate changes and loss ratios were obtained from insurance company filings with state regulators. These data are compiled by SNL Financial. [22] The analysis is limited to five large insurance groups that write homeowners' insurance in most states in the U.S. Together, these five groups have a substantial market share of the U.S. homeowners' insurance market premium. Florida is excluded from this analysis because SNL Financial does not report approved rates for Florida.

3.4.1 MEASURING REGULATORY ENVIRONMENTS

To control for variation across states in regulatory environments, the analysis follows Oh, Sen, and Tenekedjeva (2024) and measures the extent to which regulators have approved historical rate change filings for each insurer in each state for each year. The variable $RegRestr_{fist}$ for filing f by insurer i in state s in year t is defined as follows:

$$\text{RegRestr}_{fist} = 1 - \frac{Approved\ Rate\ Change_{fist}}{Indicated\ Rate\ Change_{fist}}.$$

The Indicated Rate Change in the denominator of the formula represents the rate deemed appropriate by the insurers' actuaries, based on factors such as historical data, projected losses, expenses, and profitability needs. The Approved Rate Change in the numerator refers to the actual adjustment implemented in the rates charged to policyholders. A larger gap between the Approved Rate Change and the Indicated Rate Change suggests greater regulatory restrictions, i.e., the insurer is restricted by regulation from setting rates that reflect its view of the appropriate rate.

The average value of the regulatory restriction variable for all filings of the five insurers across all states and years is 0.37, implying that these insurers, on average, can implement 63% of their target rate change. Of

[21] Ideally, a model would be available to describe how state level homeowners' insurance market outcomes (e.g., loss ratios) respond to the occurrence of disasters and to net migration rates, while also incorporating the interaction between disasters and net migration rates. This study pursued this path, but did not develop a model with much confidence. Therefore, results are reported using reduced form models in this section, i.e., the analysis examines how insurance market outcomes are related to disaster events and do not try to disentangle the separate effects of migration and disaster events.

[22] SNL Financial was acquired by S&P Global Marketplace in 2015. The firm changed its name from S&L Securities to SNL Financial in 1987.

course there is variation in *RegRestr* across states. For the five insurers in the sample, North Carolina, Massachusetts, and New Jersey have the highest average regulatory restriction measures (average for the five insurers is about 0.75), while Alaska, Idaho, and Oklahoma have the lowest measures (the average is about 0.13).[23]

3.4.2 REGRESSION ANALYSIS OF RATE CHANGES AND LOSS RATIOS

Similar to the earlier analysis of the relationship between net migration rates and declared disasters, the examination begins by analyzing how loss ratios of the five insurers vary with the occurrence of declared disasters in the prior year. Specifically, the analysis estimates regression models where the dependent variable is the loss ratio for insurer I's homeowners' policies in state s and year t. The main explanatory variable is one of the FEMA disaster variables used in the earlier migration part of the study (FEMA_p25, FEMA_p50, or FEMA_p75).

Also included is the median value of RegRestr variable defined above for each insurer in each state and year. The median RegRestr variable interacts with the FEMA variables. In addition, the analysis controls for insurer size using the natural logarithm of assets. Finally, the analysis includes year fixed effects and firm fixed effects. The results are reported in Table 7.

[23] Insurers do not always report indicated rates when filing product rate changes. In the sample, there are 19,299 rate change filings, but only 6,553 include indicated rates. In addition, many filings show a 0% overall price change but include adjustments to rates, discounts, or deductibles for different customers within their customer pool. Insurers may also raise a specific policyholder's premium at renewal due to changes in the policyholder's risk profile (e.g., more claims or moving to a higher-risk area).

Table 7

LOSS RATIO REGRESSION RESULTS FOR FIVE LARGEST HOMEOWNERS' INSURERS

	(1)	(2)	(3)
$RegRestr_{iist-1}$	0.002***	0.002***	0.002***
	(7.15)	(5.36)	(6.81)
$RegRestr_{ist-1}$ * $FEMA\_25_{st-1}$	0.021		
	(0.38)		
$RegRestr_{ist-1}$ * $FEMA\_50_{st-1}$		0.053	
		(0.93)	
$RegRestr_{ist-1}$ * $FEMA\_75_{st-1}$			-0.008
			(-0.12)
$FEMA\_25_{st-1}$	0.048		
	(1.95)		
$FEMA\_50_{st-1}$		0.033	
		(1.47)	
$FEMA\_75_{st-1}$			0.024
			(0.66)
ln_asset_{it-1}	-0.090	-0.092	-0.094
	(-1.43)	(-1.48)	(-1.47)
Constant	2.172**	2.216**	2.256**
	(1.93)	(1.99)	(1.97)
Observations	1,744	1,744	1,744
R-squared	0.130	0.130	0.123
Group Fixed Effects	YES	YES	YES
Year Fixed Effects	YES	YES	YES

$RegRestr_{ist-1}$ equals insurer i's median regulatory restriction for its homeowners rate filings proposed in state s during the previous year. $FEMA\_pXX_{st-1}$ is a dichotomous variable equal to one if the state experienced FEMA approved payments in the prior year under its Individual and Households Program (IHP) above the XX percentile value of the payments over the period from 2001 to 2023, and zero otherwise.

The results indicate that loss ratios for these five insurers are on average positively associated with regulatory restrictions on rate setting. There is some evidence that loss ratios increase in years followed by declared disasters as the coefficient on FEMA_p25 is positive and marginally statistically significant. The coefficients on FEMA_50 and FEMA_75 are also positive, but not statistically significant.

3.4.3 FOCUS ON MAJOR DISASTERS

The previous results do not provide strong evidence that declared disasters are related to insurer underwriting profitability. One explanation is that many of the disasters included in the previous analysis are not of sufficient magnitude to impact insurer operations. To further investigate the effect of disasters on insurer loss ratios and premium rates, the analysis focuses on the largest six state level disasters during the 2007-2023 period as measured by a state's FEMA IHP approved amounts in a year. These six state-year events are listed in Table 8. [24]

[24] In this section an event study is conducted of insurer homeowners' premium rates and loss ratios to six major disaster events in different states. Section 3.2examined, in Table 6, whether migration rates responded differently across the entire sample period in so-called High_Loss_States (the five states with the most approved IHP funds). Not surprisingly, the High_Loss_States overlap with the sample used in this section. In particular, LA, TX, NY, and MS are in both samples. Florida is a High_Loss_State but is not in the sample used here because the insurance data needed for the event study are not available for Florida. The two states in the sample used in this section that are not classified as High_Loss_States are CA and NJ.

Table 8 also reports the type of regulation (prior approval or file and use) in each of the six states and the median value of *RegRestr* for the five insurers in those six states. Note that each of the six states has a median value for the *RegRestr* that is larger than the average value of all states, reported above (0.37), suggesting that each of the six states with large disaster losses also have greater than average rate setting restrictions.

Table 8
STATE – YEAR COMBINATIONS WITH THE HIGHEST IHP APPROVED AMOUNTS FROM 2007 TO 2023

State	Event Year	Names of Events	Rate Regulation	Median Restr
California	2020	Wildfires	Prior Approval	0.73
Louisiana	2021	Hurricane Ida	Prior Approval	0.52
Mississippi	2020	Hurricanes Laura, Sally, Zeta	Prior Approval	0.50
New Jersey	2012	Hurricane Sandy	Prior Approval	0.61
New York	2012	Hurricane Sandy	Prior Approval	0.54
Texas	2017	Hurricane Harvey	File-and-Use	0.51

The analysis examines whether the five large insurers increase their rates for homeowners' insurance in the two years following the event year. The analysis therefore calculates the average annual percentage rate change for each insurer in the two years before the event year and in the two years after the event year. The analysis then takes the difference (the post event year value minus pre-event year value) for each insurer in each state. Due to missing data, this provides 27 state-insurer observations (as opposed to 30). The mean difference is 1.7, implying that the average percentage rate change is 1.7% greater after the event than prior to the event. However, this difference is not statistically significant at the 10% level using a two-tailed test. In other words, the evidence that insurers raise their rates following these major events is weak.

The analysis now examines whether the underwriting profitability of the five large insurers changes after the major disaster events. Similar to the previous analysis, each insurer's average loss ratio is calculated for the two years after the major disaster event in each state minus the average loss ratio for the two years before the major event in each state. In this case, data are available for each state and insurer and so the number of observations is 30 (six states x five insurers). The average loss ratio is 0.32 lower after the major events than prior to the major events and this is significantly different from zero at 0.01 level. The lower loss ratio implies higher underwriting profitability after the major events, all else equal.

Also analyzes are the rate changes and loss ratio changes for the five insurers in the six states over the five-year period using regression analysis, where the analysis controls for insurer fixed effects. The number of observations is 150 (5 x 6 x 5). We define the variable Post as equal to one if the year is the event year or the two years after the event year and equal to zero if the year is prior to the event year.[25] Similar results are found if the Post variable is defined as equal to one if the year is after the event year, and zero otherwise. The following regression models are estimated, where δ_i is a vector of insurer fixed effects:

$$\text{Rate Change}_{ist} = \alpha + \beta \, \text{Post}_t + \delta_i + e_{ist}$$

[25] Regulatory restrictions are not controlled for because all the states have relatively high regulatory restriction scores compared to the overall mean value (0.37). See Table 7.

$$\text{Loss\_Ratio}_{ist} = \alpha + \beta \text{ Post}_t + \delta_i + e_{ist}$$

The estimated β coefficients are reported in Table 9. Consistent with the mean changes reported above, column (1) indicates that rates are not statistically significantly higher in the post period; whereas, loss ratios are significantly lower in the post period, i.e., underwriting profitability is on average higher. The coefficient estimate on the post variable in the loss ratio equation indicates that on average, the insurer's loss ratio improves by 0.14.

Table 9

REGRESSION RESULTS FOR HOMEOWNERS RATE CHANGES AND LOSS RATIOS AROUND LARGE DISASTERS

	Rate_Change	Loss_ratio
Post	0.33	-0.14**
	(0.59)	(-2.91)

Data are for five large insurers in six states that experienced large disasters as measured by approved IHP payments. The year of the disaster is the event year. The sample includes the five years surrounding the event year (two years before and two years after). Group fixed effects are included in both regression models.

The results regarding the differences in rate changes and loss ratios suggest that insurers do not substantially file rate changes following these disasters; nevertheless, insurers' underwriting profitability increases following these disasters. One potential explanation is that insurers reduce their exposure to disasters after experiencing a major disaster event.

An empirical investigation of the extent to which insurers withdrew coverage following the disaster events is difficult because insurers do not report coverage. Premium revenue, which is the price per unit multiplied by the number of units sold, is perhaps the best proxy for coverage. Therefore, the analysis investigates whether the five insurers reduced premium revenue for homeowners' insurance in the states impacted by the six disaster events. In general, consistent evidence is not found of lower homeowners' premium revenue subsequent to disaster events in the six states included in this event study.[26]

It is important to highlight that the sample of states in the event study does not include Florida due to the lack of rate data. However, it is found that four of the five insurers in the event study sample reduced premium revenue in Florida in recent years. Moreover, evidence provided by Kousky and Meddors (2024) show that national insurers have reduced coverage in Florida, and some have left the state in recent years.

[26] Even though Florida is not one of the states in the case analysis, the investigation of Florida's premium revenue for the five insurers in the sample revealed that four of the five insurers reduced their premium revenue in Florida in recent years.

4. Potential Insurance Contract Changes to Deal with Climate Change Risk

This section briefly discusses some potential insurance contract policy changes that might help insurers deal with climate change.

4.1 PARAMETRIC OR INDEX TRIGGERS

Instead of using indemnity triggers (claim payment is based on the policyholder's loss), insurers have been experimenting with parametric and index triggers. Parametric insurance pays out a predetermined amount when a specific event or condition occurs, based on a measurable trigger such as wind speed, earthquake magnitude, rainfall amount, or temperature. If the parameter reaches or exceeds this value, a fixed payout is automatically made to the insured, regardless of the actual loss.

An index trigger bases the claim payment not on the policyholder's loss, but instead, on an index of losses, where the index could be the state's losses. The potential benefits of these products are lower claim processing costs , quicker claim payments, and reduced moral hazard problems (Niehaus and Mann, 1992). The main disadvantage is the basis risk associated with policyholders not being reimbursed based on their actual losses (Harrington and Niehaus, 1999). The benefits of these policy triggers are more likely to exceed the costs when the triggers are applied to reinsurance, as opposed to primary insurance, because the basis risk would be lower for an insurer with a portfolio of policies than with an individual policyholder who is not diversified.

4.2 LONG-TERM PROPERTY INSURANCE

Insurers and property owners whose property is subject to high climate change risk could potentially benefit from longer term insurance contracts, as opposed to the annual contracts that currently dominate the market (see Jaffee, Kunreuther, and Michel-Kerjan, 2010). Longer-term contracts with either fixed prices or prices that grow at a rate that is not affected by the evolution of climate change risk, would shift climate change risk from property owners to insurers. Jaffee et al. (2010) argue that, in addition to lowering risk for property owners, longer-term policies would provide more incentive for property owners to invest in mitigation. The greater risk placed on insurers could increase capital and reinsurance costs, but longer-term contracts would also reduce marketing and administrative costs for insurers.[27]

[27] The capital and reinsurance costs could potentially be reduced through the use of catastrophe bonds.

5. Summary and Conclusions

Previous studies suggest that natural disasters can drive migration by worsening economic conditions and compromising safety (Kleemans, 2015; Cattaneo and Peri, 2016). However, the income and wealth losses associated with climate risks may also hinder migration, as affected households may lack the financial resources needed to cover relocation costs (Kleemans, 2015; Cattaneo and Peri, 2016). This study investigates whether state-to-state migration in the U.S. is associated with natural disasters. While disasters likely increase the perceived benefits of migrating out of a state, disasters also destroy wealth for residents in the affected area, making migration more difficult for these residents.

The analysis of net migration rates (flow of people in versus out) of states indicates that following years in which states experience major disasters, the net migration rate declines relative to normal years, i.e., migration out of the state increases. This finding holds when controlling for a state's GDP, unemployment rate, average house value, degree of urbanization, and tax burden. See Table 4.

The existing literature on migration within the U.S. generally uses smaller geographical areas (e.g., counties) compared to the analysis in this report of state level migration. When the results of prior research are aggregated to the state level, there are mixed results. The forecasts in Hauer (2017) related to sea level rise indicate that there will likely be substantial migration out of Florida and migration into Texas. On the other hand, Shu et al.'s (2023) evidence indicates that there is local migration related to flooding, but not substantial migration across states. The results of this report indicate that net migration at the state level is related to the occurrence of natural disasters in the prior year. Regarding the magnitude of the effect, it is found that, on average, the occurrence of a large disaster in the prior year (damages above the median for the state) is associated with about a 0.2% decrease in the population due to more people moving out versus moving into the state.

This analysis also examines whether the sensitivity of net migration to prior year disasters is affected by several factors. It is found that, on average, states with the lowest or highest likelihood of declared disasters do not differ from other states in their migration sensitivity to prior year disasters. Similarly, states with higher magnitude of historical disaster losses do not differ in their sensitivity to prior year disasters. See Table 6. In addition, it is found that migration rates are, on average, higher in the post-2012 period and some evidence that the negative relation between prior-year disasters and migration is greater during the post-2012 period.

To examine potential impacts of migration on state insurance markets, the analysis focuses on five large national insurers with a substantial share of the homeowners' insurance market. When using the data from all the states that have the required data, it is found that underwriting profitability (the loss ratio) of the five insurers is not strongly related to the occurrence of natural disasters. However, loss ratios are related to rate setting regulatory restrictions.

The analysis then focuses the analysis on the six state-years with the largest disasters as measured by FEMA IHP assistance. The state-years are California - 2020, Louisiana - 2021, Mississippi - 2020, New Jersey - 2012, New York - 2012, and Texas - 2017. For these six state-year combinations, the analysis examines the rate changes and loss ratios of the five national homeowners' insurer groups in the two years before and two years after the event year. The five major insurer groups do not significantly increase rates after the disaster event year. This could be due to these states having relatively high regulatory restrictions, which prevent insurers from adjusting rates upward. Another possibility is that the disaster events do not change the insurers' assessment of expected future losses and therefore the insurers do not seek large rate adjustments.

Despite not increasing rates, these insurers' loss ratios decrease significantly in the post event two years. One possible explanation is that they reduced their loss exposure by not renewing policies. Another explanation is that these states experienced lower than expected losses in the post-event period. Yet, another possibility is that insurers adjusted their policy terms, such as increasing deductibles following disaster events (see e.g., Grace and Klein, 2006, 2007, 2009; Chen, Doerpinghaus, Lin, and Yu, 2008).

As originally proposed, there were four primary objectives. This analysis achieved some of the objectives but fell short on others. Below, is the original objective and then the assessment.

1. Identify states that are disproportionately affected by climate-induced migration.

   Consistent with the objective, the regression analysis of net migration rates indicates that states that experience climate related disasters can expect, on average, to lose population due to people moving out of the state. Moreover, it is found that the sensitivity of migration to climate related disasters does not vary across states based on a state's average frequency or severity of disasters. In other words, the evidence does not indicate that climate-induced migration is disproportionate in states that have an overall higher or lower likelihood or severity of disasters.

2. Assess the effects of climate-induced migration on the market for property insurance markets.

   The literature review discusses the potential impacts of climate change and of migration on the demand and supply of property insurance. However, this report has not empirically disentangled the effects of climate change, normal migration patterns, and of climate-induced migration on property insurance markets. Frankly, the authors of this report are not optimistic that the separate effects of climate, normal migration, climate-induced migration can be identified empirically.

3. Explore the impact of different regulatory environments that could influence the insurance market outcomes.

   The empirical analysis of homeowners' loss ratios of five major insurer groups over time and across states indicates that loss ratios are positively associated with regulatory restrictions on rate setting, indicating lower underwriting profitability on average in states with greater regulatory restrictions.

4. Propose product features for insurers to mitigate the negative impacts of climate-induced migration.

   The advantages and disadvantages of using index and parametric triggers in settling property insurance claims are discussed. In addition, the potential advantages of longer-term insurance contracts for property that has a loss distribution that is changing over time is discussed.

6. Acknowledgements

The researchers' deepest gratitude goes to those without whose efforts this project could not have come to fruition. We especially thank the Project Oversight Group for their diligent work overseeing, reviewing, and contributing ideas to the report. We especially appreciate the work of Robert Montgomery who kept us on schedule and made numerous helpful suggestions. Any errors belong to the authors alone.

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Appendix

Table A1

SUMMARY STATISTICS FOR STATE NET MIGRATION RATES FROM 2005-2022

State	Mean	Stdev	Min	Max
AK	-4.22%	3.12%	-9.30%	0.50%
AL	0.29%	0.24%	-0.10%	0.80%
AR	0.32%	0.40%	-0.30%	1.10%
AZ	1.04%	0.49%	0.20%	2.30%
CA	-0.46%	0.26%	-1.10%	-0.20%
CO	0.61%	0.29%	-0.20%	0.90%
CT	-0.32%	0.59%	-1.10%	1.60%
DC	-1.18%	0.98%	-2.50%	1.00%
DE	0.80%	0.50%	0.00%	1.50%
FL	0.55%	0.35%	-0.10%	1.10%
GA	0.47%	0.39%	0.00%	1.60%
HI	-0.49%	0.63%	-1.50%	0.90%
IA	0.11%	0.16%	-0.10%	0.40%
ID	0.82%	0.62%	-0.10%	2.10%
IL	-0.75%	0.26%	-1.20%	-0.40%
IN	0.05%	0.17%	-0.20%	0.40%
KS	0.06%	0.37%	-0.50%	0.80%
KY	0.30%	0.23%	0.00%	0.70%
LA	-0.51%	1.14%	-4.30%	0.30%
MA	-0.37%	0.26%	-0.80%	0.10%
MD	-0.31%	0.33%	-1.10%	0.30%
ME	0.18%	0.61%	-0.80%	1.80%
MI	-0.38%	0.29%	-0.90%	0.00%
MN	-0.25%	0.18%	-0.80%	0.00%
MO	0.13%	0.18%	-0.40%	0.40%
MS	-0.11%	0.28%	-0.80%	0.40%
MT	0.56%	0.36%	0.00%	1.30%
NC	0.72%	0.31%	0.30%	1.40%
ND	0.68%	0.80%	-1.10%	2.10%
NE	0.00%	0.29%	-0.50%	0.50%
NH	0.27%	0.46%	-0.80%	0.90%
NJ	-0.79%	0.21%	-1.00%	-0.20%
NM	-0.06%	0.58%	-0.90%	1.10%
NV	0.81%	0.57%	-0.30%	1.70%
NY	-0.94%	0.28%	-1.40%	-0.50%
OH	-0.13%	0.13%	-0.40%	0.10%
OK	0.46%	0.30%	-0.10%	0.90%
OR	0.53%	0.44%	-0.70%	1.20%
PA	0.04%	0.15%	-0.20%	0.20%
RI	0.04%	0.58%	-1.40%	1.00%
SC	0.94%	0.31%	0.60%	1.70%
SD	0.04%	0.28%	-0.40%	0.50%
TN	0.42%	0.27%	-0.20%	1.00%
TX	0.46%	0.15%	0.20%	0.80%
UT	0.39%	0.42%	-0.50%	1.20%
VA	0.16%	0.21%	-0.20%	0.40%
VT	0.23%	0.72%	-0.70%	2.30%
WA	0.42%	0.36%	-0.60%	0.90%
WI	-0.03%	0.16%	-0.30%	0.20%
WV	0.04%	0.29%	-0.50%	0.50%
WY	-0.19%	0.70%	-1.40%	1.20%

Net migration rates are calculated as the number of people moving into a state minus the number of people moving out of a state in a given year divided by the population in the prior year.

Table A2

FEMA DISASTER DECLARATIONS AND FEMA APPROVED FUNDS UNDER THE INDIVIDUAL AND HOUSEHOLD PROGRAM (IHP) FROM 2005-2022

State	# of Declarations	Annual Mean	Max	Total
AL	30	24.4	200	440
AK	30	2.8	30	50
AZ	15	2.2	40	40
AR	28	5.0	30	90
CA	36	27.8	280	500
CO	9	4.4	60	80
CT	14	4.4	30	80
DE	8	0.6	10	10
DC	8	0.6	10	10
FL	25	168.9	1160	3040
GA	17	13.3	130	240
HI	16	1.1	10	20
ID	14	0.6	10	10
IL	17	45.0	370	810
IN	14	11.1	100	200
IA	33	12.8	140	230
KS	33	3.3	30	60
KY	29	16.7	110	300
LA	27	482.8	5770	8690
ME	20	0.6	10	10
MD	14	2.8	50	50
MA	16	8.9	70	160
MI	8	28.9	200	520
MN	23	3.3	40	60
MS	31	81.1	1290	1460
MO	33	12.8	70	230
MT	16	1.1	10	20
NE	33	2.8	30	50
NV	7	1.1	20	20
NH	27	1.1	10	20
NJ	21	56.1	420	1010
NM	16	1.7	20	30
NY	30	95.0	1010	1710
NC	20	22.8	130	410
ND	27	6.7	100	120
OH	11	11.1	150	200
OK	47	8.9	50	160
OR	18	3.3	50	60
PA	14	26.1	170	470
RI	8	2.8	40	50
SC	11	12.8	90	230
SD	35	1.7	10	30
TN	31	17.2	170	310
TX	27	205.6	1660	3700
UT	10	1.1	20	20
VT	26	1.7	30	30
VA	19	5.6	70	100
WA	26	3.9	20	70
WV	28	5.6	40	100
WI	15	11.1	60	200
WY	7	-	-	-
Total	1,078	1,476	5,770	26,570

Table A3

REGRESSION RESULTS FOR NET MIGRATION RATE

	(1)	(2)	(3)	(4)
FEMA_p25 $_{t-1}$	-0.002**			
	(-2.43)			
FEMA_p50 $_{t-1}$		-0.002**		
		(-2.41)		
FEMA_p75 $_{t-1}$			-0.002**	
			(-2.12)	
FEMA_number $_{t-1}$				-0.001***
				(-3.08)
State_GDP_gw $_{st-1}$	0.034***	0.034***	0.034***	0.035***
	(3.25)	(3.19)	(3.22)	(3.28)
Unemployment $_{st-1}$	-0.095***	-0.095***	-0.098***	-0.104***
	(-4.36)	(-4.41)	(-4.56)	(-4.83)
Housevalue $_{st-1}$	-0.011***	-0.011***	-0.010***	-0.010***
	(-2.75)	(-2.17)	(-2.63)	(-2.67)
TaxBurden$_{st-1}$	-0.003***	-0.003***	-0.003***	-0.003***
	(-17.81)	(_17.78)	(-17.70)	(-17.82)
LessUrban	-0.002***	-0.002***	-0.002***	-0.002***
	(-2.86)	(-2.88)	(-2.88)	(-2.65)
Year Fixed Effects	YES	YES	YES	YES
Observations	796	796	796	796
R-squared	0.36	0.36	0.36	0.36

FEMA_pXX$_{t-1}$ is a dichotomous variable equal to one if the state experienced FEMA approved payments under its Individual and Households Program (IHP) above the XX percentile value of the payments over the period from 2005 to 2022, and zero otherwise. FEMA_number$_{t-1}$ equals the number of FEMA declared disasters in the prior year. State_GDP_gw$_{t-1}$ is the value of the state's GDP growth rate, Unemployment is the state's unemployment rate, Housevalue is the state's average home value, TaxBurden is the revenue from state and local taxes divided by personal income in the state, and LessUrban is a dichotomous variable equal to one if the state's urban population rank is below the median of all states.

Table A4

REGRESSION RESULTS OF NET MIGRATION RATE FOCUSING ON STATES FREQUENTLY HIT BY NATURAL DISASTERS

FEMA_Disaster Variable =	FEMA_p25$_{t-1}$	FEMA_p50$_{t1}$	FEMA_p75$_{t-1}$	FEMA_Number$_{t-1}$
Quartile1$_s$	0.003***	0.003***	0.003***	0.002**
	(3.43)	(3.49)	(3.65)	(2.27)
Quartile4$_s$	-0.000	-0.000	0.000	-0.001
	(-0.10)	(-0.04)	(0.25)	(-0.45)
FEMA_Disaster	-0.002*	-0.002*	-0.002*	-0.001***
	(-1.81)	(-1.82)	(-1.81)	(-2.71)
FEMA_Disaster*Quartile1$_s$	-0.000	-0.000	0.001	0.001
	(-0.00)	(-0.05)	(0.28)	(0.84)
FEMA_Disaster*Quartile4$_s$	0.001	0.001	0.001	0.001
	(0.99)	(0.91)	(0.49)	(1.43)
lessurban1$_s$	-0.002**	-0.002**	-0.002**	-0.001**
	(-2.42)	(-2.38)	(-2.35)	(-2.08)
chg_gdp$_{st-1}$	0.034***	0.034***	0.034***	0.034***
	(3.21)	(3.19)	(3.25)	(3.26)
um_lag$_{st-1}$	-0.102***	-0.102***	-0.103***	-0.106***
	(-4.72)	(-4.73)	(-4.82)	(-4.94)
housevalue3$_{st-1}$	-0.011***	-0.011***	-0.011***	-0.010**
	(-2.78)	(-2.78)	(-2.73)	(-2.50)
taxburden$_{st-1}$	-0.003***	-0.003***	-0.003***	-0.003***
	(-17.53)	(-17.55)	(-17.49)	(-17.63)
Year Effects	Yes	Yes	Yes	Yes
Observations	796	796	796	796
R-squared	0.372	0.372	0.372	0.375

FEMA_pXX$_t$ is a dichotomous variable equal to one if the state experienced FEMA approved payments under its Individual and Households Program (IHP) in year t above the XX percentile value of the payments over the period from 2001 to 2023, and zero otherwise. FEMA_Number$_t$ is the number of declared disasters in year t. Quartile1 (Quartile4) equals 1 if the state is in the 1st (4th) quartile with respect to the number of FEMA declared disasters from 2005 to 2022.

Table A5

REGRESSION RESULTS OF NET MIGRATION RATE IN HIGH LOSS STATES

FEMA_Disaster Variable =	FEMA_p25$_{t-1}$	FEMA_p50$_{t-1}$	FEMA_p75$_{t-1}$	FEMA_Number$_{t-1}$
High_Loss_State$_s$	-0.001	-0.001	-0.001	-0.002
	(-1.17)	(-1.15)	(-1.08)	(-1.59)
FEMA_Disaster	-0.002**	-0.002**	-0.002**	-0.001***
	(-2.36)	(-2.33)	(-1.97)	(-3.21)
FEMA_Disaster*High_Loss_State$_s$	-0.000	-0.000	-0.000	0.001
	(-0.03)	(-0.02)	(-0.07)	(0.98)
Lessurban1$_s$	-0.002***	-0.002***	-0.002***	-0.002***
	(-2.98)	(-3.01)	(-3.09)	(-2.81)
chg_gdp$_{st-1}$_	0.034***	0.034***	0.034***	0.034***
	(3.25)	(3.19)	(3.22)	(3.27)
unemployment$_{st-1}$	-0.098***	-0.099***	-0.102***	-0.108***
	(-4.50)	(-4.55)	(-4.68)	(-4.97)
housevalue3$_{st-1}$	-0.010**	-0.009**	-0.009**	-0.010**
	(-2.37)	(-2.34)	(-2.28)	(-2.37)
Taxburden$_{st-1}$	-0.003***	-0.003***	-0.003***	-0.003***
	(-17.83)	(-17.80)	(-17.71)	(-17.83)
Year Effects	Yes	Yes	Yes	Yes
Observations	796	796	796	796
R-squared	0.360	0.360	0.359	0.364

FEMA_pXX is a dichotomous variable equal to one if the state experienced FEMA approved payments under its Individual and Households Program (IHP) above the XX percentile value of the payments over the period from 2001 to 2023, and zero otherwise. FEMA_number_lag1 equals the number of FEMA declared disasters from 2005 to the prior year. High_Loss_St equals one if the state is LA, TX, FL, NY, or MS, and zero otherwise.

Table A6

REGRESSION ANALYSIS OF NET MIGRATION RATES, 2005-2012 VERSUS 2013-2022

	(1)	(2)	(3)	(4)
$Post_t$	0.001**	0.001**	0.002**	0.001**
	(1.98)	(2.02)	(2.21)	(2.07)
$FEMA\_p25_{t-1}$	0.000			
	(0.08)			
$FEMA\_p25_{t-1}$* $Post_t$	-0.001			
	(-1.14)			
$FEMA\_p50_{t-1}$		0.000		
		(0.30)		
$FEMA\_p50_{t-1}$* $Post_t$		-0.002		
		(-1.23)		
$FEMA\_p75_{t-1}$			0.001	
			(1.31)	
$FEMA\_p75_{t-1}$* $Post_t$			-0.003*	
			(-1.83)	
$FEMA\_number_{t-1}$				0.000
				(0.08)
$FEMA\_number_{t-1}$* $Post_t$				-0.001*
				(-1.86)
Other Controls	YES	YES	YES	YES
Observations	894	894	894	894
R-squared	0.713	0.713	0.712	0.711

$Post_t$ is a Dummy variable equal to one if the year t is after 2013, and zero otherwise.

Figure 1A

LA FEMA AMOUNT ($ MILLION) AND NET MIGRATION RATE

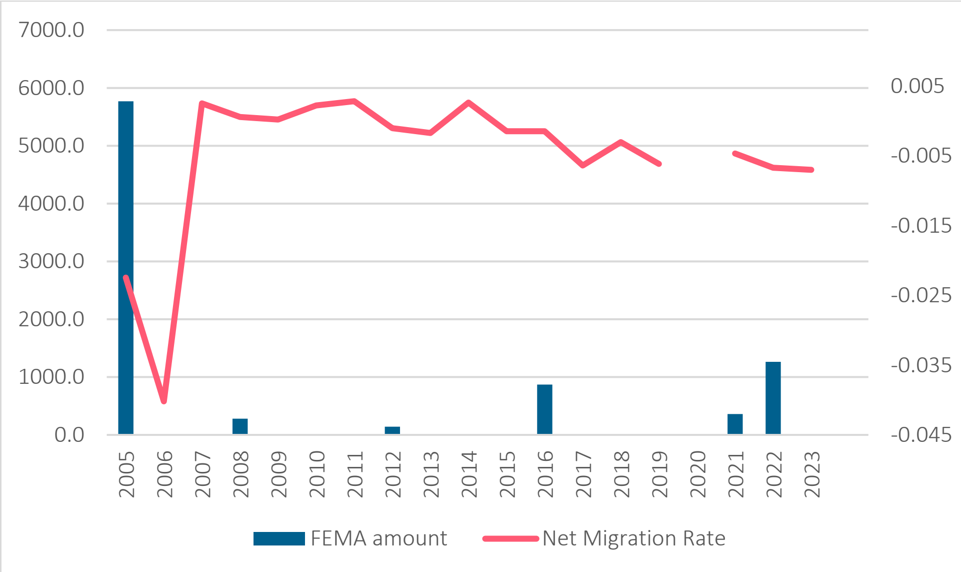


Figure 1B

FL FEMA AMOUNT ($ MILLION) AND NET MIGRATION RATE

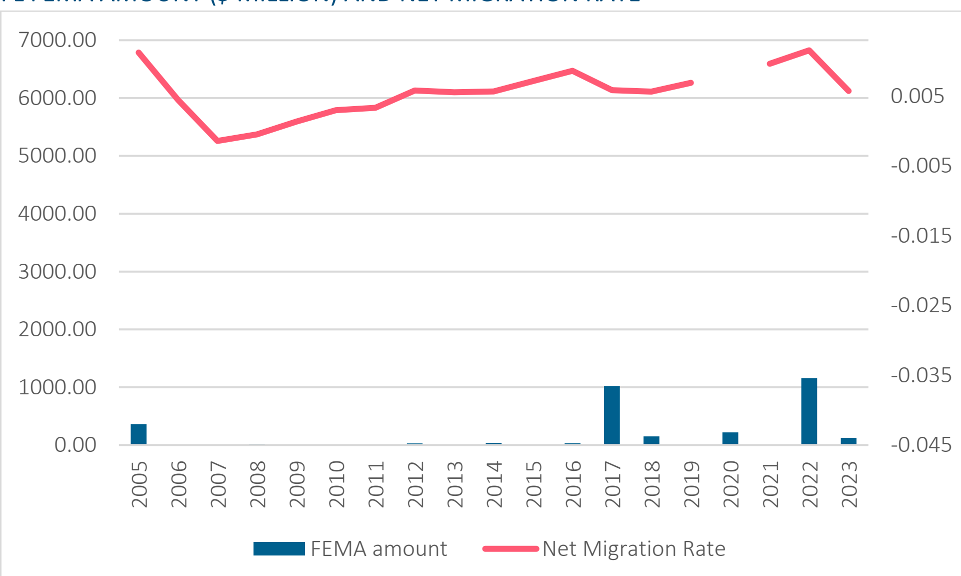


Figure 1C

MS FEMA AMOUNT ($ MILLION) AND NET MIGRATION RATE

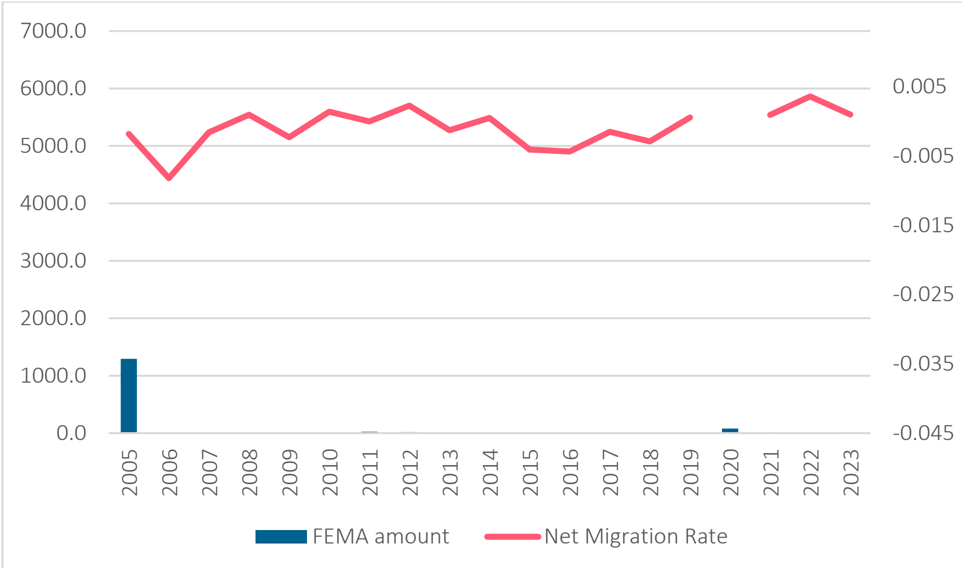


Figure 1D

TX FEMA AMOUNT ($ MILLION) AND NET MIGRATION RATE

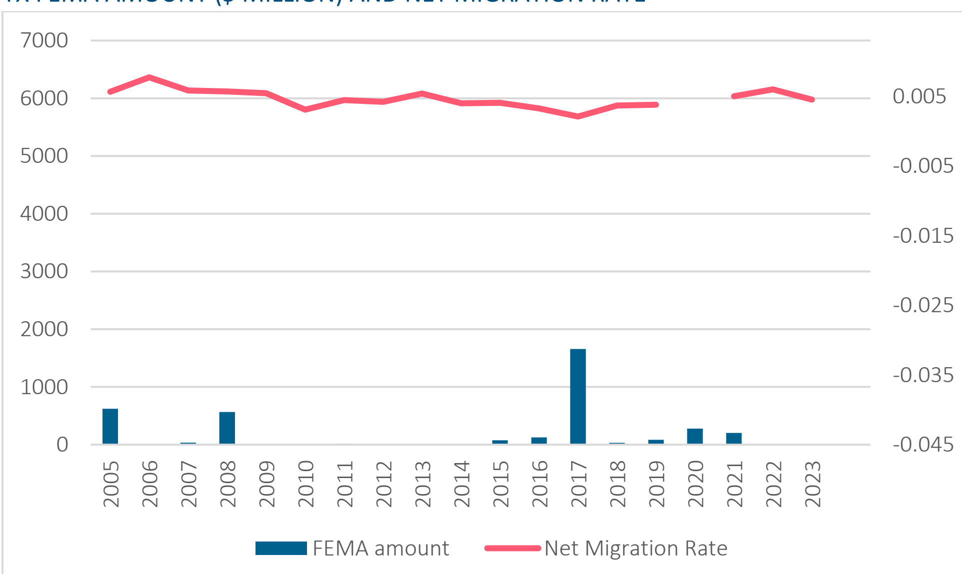


Figure 1E

NY FEMA AMOUNT ($ MILLION) AND NET MIGRATION RATE

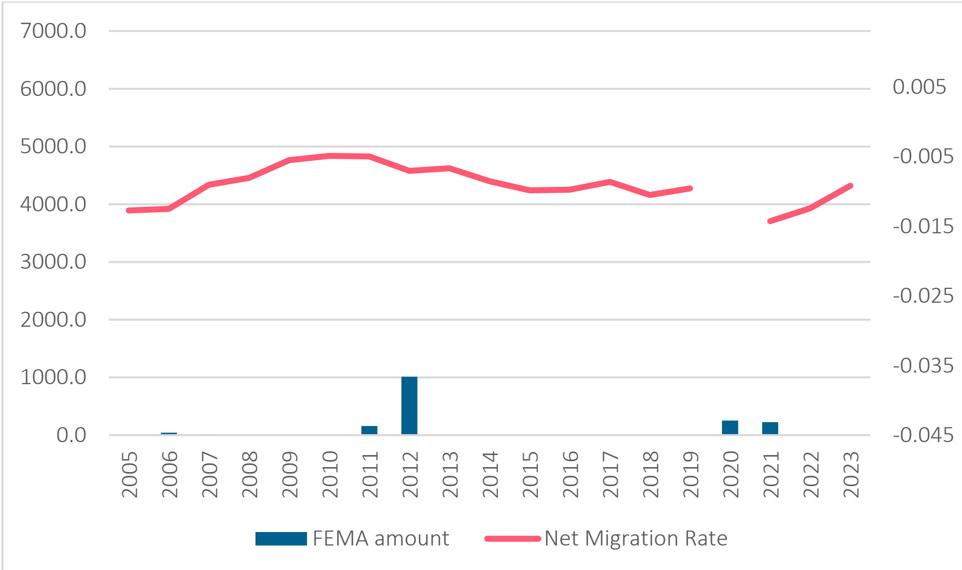


Figure 1F

NJ FEMA AMOUNT ($ MILLION) AND NET MIGRATION RATE

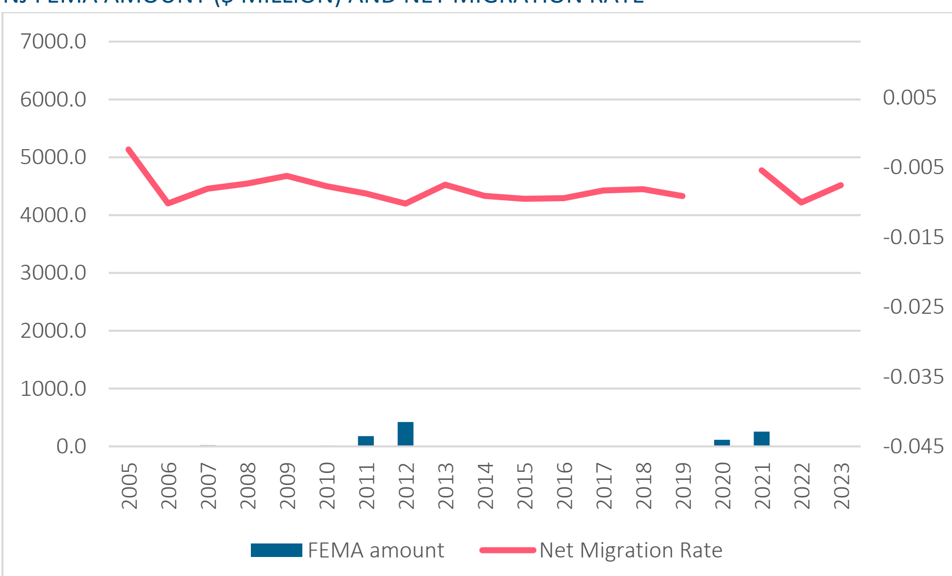
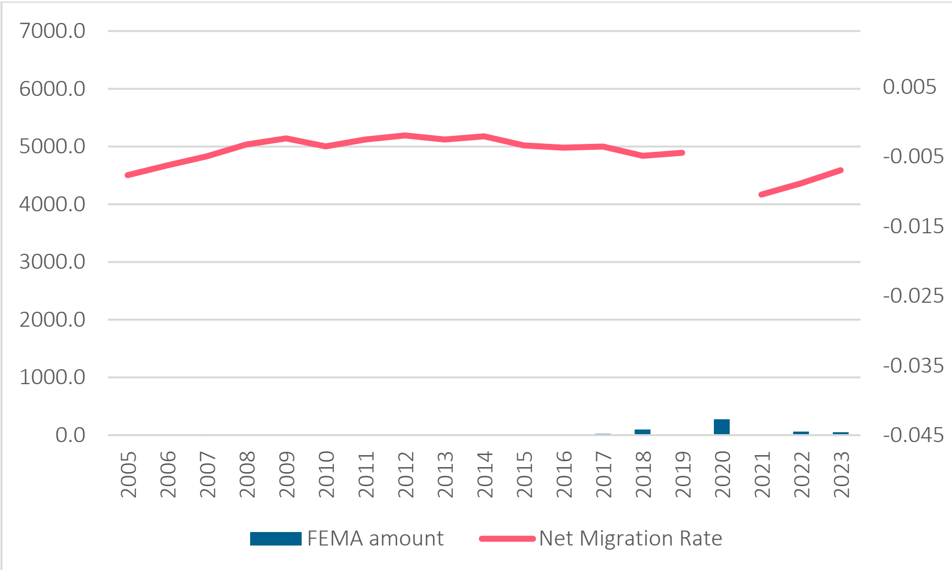


Figure 1G

CA FEMA AMOUNT ($ MILLION) AND NET MIGRATION RATE



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