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Through the Eye of the Storm: Post-Hurricane Migration in Florida's Panhandle

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Primary issue:

Hurricanes permanently displace some residents, but how do those residents decide when and where to move? What is the neighborhood quality of out-migrants who leave following a disaster? Does out-migration affect spatial inequality between neighborhoods, defined by a measure of neighborhood quality? This paper examines the predictors of post-disaster migration in the Florida Panhandle following the Category 5 storm Michael in 2018. Using national, census tract-level data, we also examine the quality of the neighborhoods that residents migrated to following the disaster to better understand the ways post-disaster displacement leads to rising or declining neighborhood inequality.

Key findings:

Using an individual, longitudinal panel dataset and a differences-in-differences approach, we find that around 5.2 percent of residents left Bay County, Florida in the three years after the 2018 Hurricane Michael, a Category 5 storm. Neighborhood inequality increased through migration processes as residents from advantaged neighborhoods moved to areas with higher advantage, and those from disadvantaged neighborhoods moved to more disadvantaged areas. The key determinants of residents' ability to move to advantaged areas were credit score, age, mortgage debt, student loan debt, and neighborhood racial demographics. We also find that when compared to out-migrating residents from nearby Escambia County, which was unaffected by the storm, the residents from Bay County were less likely to make advantageous moves than the comparison group. This suggests that disaster recovery efforts meant to stabilize Bay County residents in place were insufficient to overcome the effects of the storm on migration.

Takeaways for practice:

To mitigate growing neighborhood inequality in the wake of a disaster, relocation assistance provided by multisector actors including governments at the federal, state, and local levels might entail efforts to help residents in high disadvantage neighborhoods move to places of similar or improved amenities. Relocation assistance could also potentially benefit the recovery of residents who are disproportionately displaced, such as those with low credit scores.

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Through the Eye of the Storm: Post-Hurricane Migration from Florida's Panhandle

Abstract:

Research indicates that post-disaster migration patterns change over time, and that moves within the first year after a disaster are substantively different than those in the years that follow. In this research, we examine migration at one and three years following the October 2018 Category 5 Hurricane Michael that hit the Florida Panhandle. We gauge the magnitude of displacement and migration following the hurricane and examine how housing and financial factors guided relocation decisions by displaced residents. We assess whether post-disaster migrants moved to areas with more or fewer amenities on average and consider how post-disaster migration might affect neighborhood inequality by studying destination quality.

In our study, we use a geocoded, individual-level longitudinal panel to understand how Hurricane Michael affected displacement and migration from the Florida Panhandle in the three years following the storm. Following calls by Fussell (2018) for a causal-based methodology in post-disaster migration research, we use a treatment and control design. In addition to studying migration out of Panama City (Bay County), Florida, which was directly impacted by the storm, we analyze nearby Escambia County, Florida, as a point of comparison. Escambia County has similar economic and demographic factors but was unaffected by the hurricane.

The overall out-migration rate from Bay County in the first year after Hurricane Michael was high, with 19.6 percent of county residents changing their address in the year after the storm. That rate rose to 37.2 percent between 2019 and 2021. Using a quasi-experimental approach, we can attribute a 4.1 percent one-year migration rate to the storm, and 5.2 percent migration rate over three years when compared to unaffected Escambia County. In a regression framework, residents exposed to Hurricane Michael were 3 percent more likely to move in the following year (2019), and 3.8 percent more likely to move in the following three years (2019-2021) than Escambia County residents. Unlike some other disasters where residents return over time and the out-migration rate falls after year one, in this instance the number of residents leaving Bay County slowly increased year-over-year.

In general, the residents who left Bay County because of Hurricane Michael moved to slightly better areas than the ones they departed. However, there are two qualifications to this assessment. First, the Bay county residents affected by the storm nevertheless, on average, moved to less advantaged areas following the disaster than the out-migrating residents of Escambia who were not impacted by the storm. Second, when we examine move quality by neighborhood origin, we find that the migration processes widened spatial inequality between neighborhoods. Residents from more economically advantaged areas moved to places with higher advantage; conversely, residents of economically deprived areas moved to areas with even more economic deprivation. The characteristics of those who moved advantageously paint a portrait of younger, relatively well-off residents with higher credit scores, evidence of homeownership, and a college education.

This research reinforces the need to understand different types of moves following a disaster and the importance of policies that both enable residents to move successfully and support communities of residents who stay to rebuild and repair.

JEL classification: R230 Urban, Rural, Regional, Real Estate, and Transportation Economics; Regional Migration; Regional Labor Markets; Population; Neighborhood Characteristics; Q54 Natural Disasters and Their Management.

Key words: Disaster, Housing, Neighborhood Disadvantage, Credit, Displacement, Inequality, Hurricane, Cities, Community, Gentrification, Internal Migration, Labor Migration, Neighborhood Demographics, Neighborhood Redevelopment, Neighborhoods, Regional Migration, Regional Population, Resettlement

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Section 1: Introduction

Research into post-disaster migration has identified a range of moves that individuals and households make after a storm. Some residents are forcibly displaced due to health needs or physical damage to their housing, workplaces, and surrounding communities. Others are displaced indirectly, as housing markets (An et al. 2020) and employment networks are disrupted, making it difficult to return. Though low-income homeowners are often motivated to return to a disaster torn area to retain their most important financial asset, the dislocations of the storm can disrupt the "fragile mix of income sources they relied on to pay their mortgages" (Mueller et al. 2011). While all communities in the US face periodic in and out-migration, disasters exacerbate out-migration immediately, in the midterm, and, often, in the long term (Esnard and Sapat 2014). Extreme weather events, such as extreme heat, flooding, drought, and hurricanes are becoming more common and intense (IPCC 2023). While much research has focused on recovery and adaptation after severe disasters, data collection often begins after the disaster strikes. As a consequence, researchers often lack information about rates of moving and displacement prior to the storm (Fussell 2018). Similarly, researchers may not collect data on comparable locations that were unaffected by disaster, which can also serve as a benchmark or comparison point.

To fill the lacuna, in this paper we provide a conservative estimate of the rate of displacement and migration following a severe disaster. We compare temporary and longerterm effects of a disaster on migration. We examine the destinations of those who moved and look into how individual and neighborhood factors guided the destinations of displaced residents. Specifically, we use a geocoded, individual-level longitudinal panel to understand how Hurricane Michael (October 2018) affected displacement and migration in the Florida Panhandle in the three years following the storm (2019–2021). To disambiguate post-disaster moves from typical patterns of displacement and migration, we use nearby Escambia County as a point of comparison, which is similar along many dimensions, but was spared substantial damage from the storm. We examine the likelihood that a resident of Bay County moved after the storm and the individual and neighborhood level characteristics of those who moved. We then look at the destinations where residents moved. We study how far residents moved and use an index of neighborhood deprivation to evaluate whether individuals moved to more or less advantaged areas in the three years following the storm. Lastly, we evaluate moves of different duration. We measure initial, sometimes temporary moves that occurred in the first year and estimate a permanent effect on out-migration by looking at a three-year horizon (Peacock et al. 2018).

Section 2: Research Context

Large-scale disasters may require residents of communities to evacuate their homes temporarily or permanently. The empirical research on disaster-related migration remains limited, in part because it is rare to find relevant datasets. Where this data exists, it may not meet the high standards needed to draw scientific conclusions about migration patterns (Fussell 2018). In addition to data and methodological limitations, there is a need for theoretical frameworks which treat migration as a nuanced phenomenon, since relocation can appear to be a singular response but indeed may have very different drivers: it may be a marker of vulnerability or, conversely, of enhanced ability to adapt to rising risk of extreme events (Black et al. 2013).

2.1 Housing Tenure, Assistance, and Moves

Pais and Elliot (2008) examined the way in which recovery focuses on property, not people. Places hit by disaster are "recovery machines," a concept based on the idea that cities have structural factors predisposing homeowners and powerful institutions toward improving land values through economic growth, often to the detriment of lower income renting households. These "recovery machines" focus on maximizing land values of property owners after disaster strikes and long-term recovery begins. Through recovery processes, property-reliant entities ranging from homeowners to municipal governments and powerful institutions are strengthened while vulnerable households fall deeper into economic decline. Pais & Elliot described a "'treadmill of disaster' whereby disaster zones reproduce larger, more socially divided versions of themselves as they rebuild and await the next major disaster." Central to this theory is the idea that powerful actors are incentivized by property ownership toward recovery actions that increase land prices and rents rather than providing affordable housing for households who have lost shelter from the disaster. Empirical research also describes disaster response that is intertwined with real estate finance and housing systems (Esnard and Sapat 2014). Real estate finance, land tenure, and housing systems affect the ability to successfully rebuild or relocate following a disaster. For instance, a study on post-disaster processes for Hurricane Katrina and other disasters found that insecure tenure can lead to loss of land and housing, and this loss can result in the displacement of a community (Reale and Handmer 2011). Disaster recovery policy varies on whether residents are homeowners, renters, or residents of social housing, and both the decision to permanently relocate and the ability to relocate to a neighborhood with high amenities can also vary widely by residents' tenure and the programs they relied on for recovery aid (Mueller et al. 2011). As such, housing instability is often viewed in the literature as a key component of vulnerability.

The recovery period after a disaster varies by household tenure. Homeowners are less likely to relocate following a disaster due to the correlation between homeownership and financial stability, as well as the availability of flood insurance, Federal Housing Finance Agency (FHFA) and other mortgage forbearance programs, certain Federal Emergency Management Agency (FEMA) assistance, and Small Business Administration (SBA) loans for homeowners. Much of the literature has focused on the fact that substantial assistance is available for property owners, including landlords and homeowners, but less support exists to help renters remain in place (Lee and Van Zandt 2019).

Renters are often seen as particularly vulnerable to moving following disaster. Homeowners and renters have differential financial ability and financial incentives to stay in place, in part because housing quality is correlated with housing tenure, and structural damage is a strong predictor of displacement (McIntosh 2013; Myers et al. 2008). Rental prices often increase following a disaster, due to the destruction of existing housing stock the influx of temporary residents during the recovery period who also require rental housing (An et al. 2020).

Recovery is also complicated by homeowners' clarity of title. Heirs who inherited property but cannot demonstrate a clear title may have difficulty accessing assistance. (Carpenter 2016). Residents of manufactured housing are also particularly vulnerable due to a combination of physical characteristics of their housing with financial and institutional factors that heighten precarity and instability (Sullivan 2018; Cutter et al. 2012; Kusenbach et al. 2010).

Past research revealed that access to credit is key to renters being able to access FEMA's lodging assistance vouchers, as many hotels require a credit card in addition to a voucher to book a room (Sapat et al. 2011). Multiple studies found that households require access to credit in the post-disaster period. Tran and Sheldon (2017) have shown that residents tend to use more credit following a disaster, though households with access to individual and household aid do not have higher credit card debt after a crisis while those with the lowest credit scores are more likely to declare bankruptcy. Tiurina (2022) also found that lack of access to credit results in higher mortgage delinquencies following a tornado.

The Department of Housing and Urban Development's (HUD) Community Development Block Grant-Disaster Recovery (CDBG-DR) is an increasingly important component of housing recovery efforts after disasters, becoming second highest funded disaster recovery tool in recent years (Martín et al. 2022). This program is authorized by Congress after a presidential disaster declaration. The approved uses of funds are broadly defined; empirical evaluations of the program find that it supports relocation assistance and homeowner compensation in the first two years. Later in the recovery process, funds have been directed toward acquisition of property, rental assistance, rehab and construction, affordable rental housing, and

homeownership assistance (Martín et al. 2022). The CDBG-DR program has been beset by delays in delivery of funds to grantees, which can be more challenging for vulnerable households than better resourced individuals and households, widening inequality in the aftermath of the storm. Issues with delays are not unique to CDBG-DR. The Road Home program deployed after Katrina suffered from slow approval times, such that "the process of receiving funding from Road Home was glacial, with average waits of eight months for applicants to receive funding, slowing the return and recovery of low-income homeowners" according to Eden and Boren (2008, cited in Mueller et al 2011).

To get through delays in receipt of aid, many households rely on emergency savings (Ratcliff et al. 2022) or on credit (Roth et al. 2019). One aspect of widening inequality following disasters is captured in the common finding that financially struggling households see greater declines in credit scores following disasters than other groups (Martín 2021; Ratcliffe et al. 2020).

2.2 Social Vulnerability and Moves

Disaster-related migration and displacement are shaped by the social vulnerability of households and places (Myers et al. 2008). Some authors have asked for a more complex treatment of the relationship between disasters and location choice (Elliot and Pais 2010; Black et al. 2013). Esnard and Sapat (2014) laid out a typology of moves post-disaster, arguing that a nuanced understanding of how people are displaced by disaster is required for post-disaster recovery and reconstruction. If disaster recovery was once seen primarily as a process of remaining in place and rebuilding, and policy was organized around the idea that existing residents would seek to stay in place, current policy has expanded to encompass permanent relocation and a richer understanding of the destination communities where residents relocate (Esnard and Sapat 2014).

Following a disaster, the ability to stay in place or to move is shaped by a household's resources. Elliot and Pais (2010) found that low socioeconomic status is associated with displacement in some settings, but immobility in others. Black et al. (2013) argued that the natural disasters literature has not engaged deeply enough with migration studies, and too often categorizes relocation as a "last resort" and a failure of resilience. They argued that the decision to stay in place or move in response to disasters is complex, and that the ability to adapt to rising risk of hazards and successfully relocate is also correlated with socioeconomic status (Black et al. 2013).

While some literature on disaster-related migration suggests that permanent relocation results in improved socioeconomic outcomes, there is also a wide set of literature on the negative consequences of forced moves. More recent research has found that evictions rise following disasters (Brennan et al. 2022; Raymond et al. 2022) Research on forced moves

following an eviction or foreclosure shows that households suffered when they moved to areas that have worse neighborhood quality than the places they left and that these households often faced a subsequent move leading to prolonged housing instability (Desmond and Shollenberger 2015). Forced moves have been associated with a long-term loss in household wealth and with significant increases in stress-related illnesses in certain populations. These negative effects on households have been well established in the housing literature on forced moves due to gentrification (Acolin et al. 2023), eviction (Desmond and Kimbro 2015), and foreclosure (Saegert et al. 2011). Research using the 2013 American Housing study found that residents who undergo a forced move in response to disaster have poorer housing outcomes (Evans 2021) and that renters in particular have far higher housing cost burdens after a crisis-related forced move (Johnson and Carswell 2021).

2.3 Temporality of Moves and Post-Disaster Destination Quality

Research on post-disaster migration patterns reveals a complex interplay between time and destination quality. In the immediate aftermath (within the first year), studies show a surge in out-migration from affected areas, suggesting that census estimates of displacement rates may be an undercount. For example, Fussell et al. (2023) found that the largest increase in out-migration probabilities occurred in the year following Hurricanes Katrina and Rita. Similarly, Acosta et al. (2020) documented up to a 17 percent population drop within a year of Hurricane Maria in Puerto Rico, and Sastry and Gregory (2014) observed 47 percent of displaced residents living outside the New Orleans metropolitan area within a year of Hurricane Katrina.

Studies of out-migration in the second-year post-disaster present a more nuanced picture. Fussell et al. (2023) identified a surprising trend where out-migration from unaffected counties exceeded that of affected counties. This might be due to out-migrants from the first year settling in these unaffected areas or long-term residents capitalizing on reconstruction opportunities. Over a longer time horizon (three years plus), research suggests a gradual return migration. DeWaard et al. (2020) observed that while out-migration from Puerto Rico remained elevated two years after Hurricane Maria, it was not as high as the initial exodus.

Post-disaster migration can significantly impact the quality of where people live. Several studies suggest that post-disaster relocation can mean a move to higher-quality neighborhoods. Moving to a better neighborhood with higher incomes and better educational opportunities can lead to improved long-term outcomes such as higher college attendance and earnings (Chetty et al. 2016; Chetty and Hendren 2018). Research on Hurricane Katrina evacuees, for example, demonstrates that movers, particularly those who relocated long distances, often ended up in neighborhoods with lower poverty rates and greater racial diversity compared to their pre-disaster residences (Graif 2016). However, disaster-related

migration may facilitate uneven outcomes for affected groups. Analyses of income-based inequality in post-disaster migration show that wealthier households are more likely to relocate after a disaster, while poorer households may lack the resources to move away from areas with worsening conditions (Chen and Lee 2022).

Several factors may contribute to the improved destination quality for post-disaster movers. Long-distance moves can offer evacuees a wider range of neighborhood options, potentially leading to access to better job opportunities or organizational connections not available in their pre-disaster communities (Graif 2016). Furthermore, disaster relief efforts from government agencies and non-profit organizations can provide evacuees with crucial financial assistance to help them secure housing in higher-quality neighborhoods (Graif 2016). Media attention surrounding a disaster may also reduce housing barriers for evacuees (Graif 2016).

Despite potential improvements, challenges remain for post-disaster movers. Employment opportunities for long-term evacuees can be uncertain, with some studies suggesting lower employment rates compared to returnees, while others show higher rates of self-employment, which could indicate entrepreneurial opportunities (Zissimopoulos and Karoly 2010). Additionally, displaced individuals with limited resources may struggle to find affordable housing in higher-quality neighborhoods, potentially leading to horizontal moves, or even relocation to worse environments than their pre-disaster communities (Graif 2016). Furthermore, studies indicate that evacuees of color may face discrimination in predominantly white communities (Hunt et al. 2009).

2.4 Methodological Challenges

Although disaster-related migration is an important area of research, scholars have identified several methodological limitations. This literature has often relied on datasets that are spatially aggregated at a relatively large unit of analysis (for example, counties) or on small sample, post-disaster, cross-sectional survey data that suffer from selection bias and convenience samples. Such survey data also often fail to depict the duration and repeated movement of migration after disasters, from evacuation through temporary shelter, rebuilding, and eventually long-term recovery (Fussell 2018).

Existing research on relocation often uses the Internal Revenue Service's (IRS) countylevel Statistics of Income (SOI) data. This includes the Fussell, Curtis, and DeWaard (2014) study of relocation following Hurricane Katrina. The authors found residents tended to relocate to cities near New Orleans or where they had kinship and human capital ties. In a second analysis, these authors used this dataset to examine relocation decisions following Hurricanes Rita and Katrina (Curtis et al. 2015). Their data and methods only examine county-to-county flows, which does not allow for an analysis of neighborhood quality at the origin or destination.

Nor can their data distinguish between newcomers and returning residents, either to origin or destination counties. Moreover, the authors acknowledged that IRS migration data undercounts older (nonworking) populations, those with income low enough to avoid tax federal filing requirements, migrants newly arriving from overseas, and those who choose not to file taxes (Fussell et al. 2014). Using similar data from tax returns, The New York Times found that many black households that left New Orleans after Katrina had increased incomes within a year due to their relocation in more prosperous markets (Baranger 2015). However, again, this study at the county level does not allow for an understanding of neighborhood quality of the origin neighborhood or the destination. It also does not allow us to understand a household's past migration history.

Other studies of disaster-related migration rely on surveys and weak study designs which alleviate issues of course spatial granularity but still suffer from data limitations (McIntosh 2008; Uscher-Pines 2009). In one such study, Waters (2016) conducted a longitudinal survey of community college students in New Orleans prior to Katrina and tracked students following the disaster using social security numbers collected prior to the event. This research was able to address neighborhood quality by using survey data rather than datasets spatially aggregated at the county level. This research found extremely high rates of mobility. with only 19 percent of respondents staying in place, and found that residential mobility was associated with significant improvements in neighborhood guality as residents moved to more advantageous areas. This type of research into relocation outcomes using survey data typically relies on post-disaster data, which may have a selection bias in the surveyed population (Uscher-Pines 2009). Surveys tend to rely on convenience samples, small samples, and crosssectional designs (Fussell 2018). In some cases, this survey research repurposes existing data collection efforts that were focused on particular subgroups such as students (Waters 2016), ethnic minorities (Vu et al. 2012; Vu et al. 2009) or the subset of residents who migrated to a particular location (McIntosh 2008).

To capture change over time, there has been some attempt to repurpose existing longitudinal panels to study disaster related migration. Deryugina, Kawano, and Levitt (2018) used individual tax data with address-level spatial data to examine the migration of New Orleans residents following Katrina. However, this paper does not treat move quality as a dependent variable but uses migration patterns as a predictor of economic well-being. The authors found wage and income increases for those who relocated to Houston following Hurricane Katrina. However, they did not ask which factors predicted the decision to move or which factors predicted a move to a location with higher amenity levels. Other research relies on the Current Population Survey (CPS) and the Panel Study of Income Dynamics (PSID) to study relocation in the aftermath of Katrina. Five hundred PSID participants were affected, as well as many participants in the CPS. Researchers used these datasets to understand

relocation, however this research suffered from important limitations. In the case of PSID, the sample size remained too small for complex statistical analysis and, in the case of CPS, the coarse granularity of the dataset (using county-level data) makes an analysis of location factors challenging (Groen and Polivka 2008). These approaches can possibly capture largescale disasters that span several counties but have not been used to capture the effects of large-scale disasters on small cities (Fussell 2018).

In a literature review on disasters and migration, Belasen and Polachek (2013) find many studies have small sample sizes, no or poor use of controls, and poor identification of the treatment. Similarly, Fussell (2018) calls for research on disaster-related migration using large sample, longitudinal panels which track residents before and after the disaster, and the use of quasi-experimental models that compare migration patterns between those who are more or less affected by disaster. Similarly, Hauer et al. (2020) call for further research on the dynamics of sea-level rise migration, including complex modeling of neighborhood tipping point thresholds and feedbacks. While that study addresses chronic flooding due to sea level rise and is qualitatively different in the duration and severity of disruption, as well as the lack of federal disaster relief efforts that were present following Hurricane Michael, nonetheless, more research is needed to understand migration in response to increased disaster risk. The research designs described by Hauer et al. would allow for stronger scientific evidence about the impact of increasing disaster risk on migration patterns as well as permit analyses of smaller scale disasters.

Migration research has also been conducted with datasets such as consumer credit files, which allow for a fine-grained analysis of where households move, and of personal and community-level predictors of relocation decisions. Equifax consumer credit data, used in this paper and described in more depth in a later section, has been used in about 100 peer reviewed papers to understand household financial wellbeing, as well as a growing set of papers using the dataset to study post-disaster situations. Several studies have investigated the financial impacts of disasters finding, for instance, that hurricanes adversely affect credit scores and that those who are financially vulnerable prior to the storm fare worse after the damage (Edmiston 2017). Another paper examined the role of lending institutions and disaster insurance's effect on household financial stability following Hurricane Katrina (Gallagher and Hartley 2017). Other researchers used the financial data to study the impact of wildfires (McConnell et al. 2021) and the COVID19 pandemic (Brown and Tousey 2021) on migration.

2.5 Hurricane Michael

In October 2018, Category 5 Hurricane Michael caused catastrophic and widespread damage in Bay County, Florida. Figure 1 illustrates the speed and trajectory of the storm.



Figure 1: The Path of Hurricane Michael

Source: NOAA National Hurricane Center.

Unsurprisingly, Hurricane Michael had a substantial economic impact on the region. In the month following the storm, unemployment in Bay County diverged sharply from the Florida-wide average, rising from 4 percent to 6 percent as compared to the 3.5 percent for Florida. The unemployment rate in Bay County slowly declined but remained elevated above the Florida-wide rate for 9 months, through August of 2019 (BLS Local Area Unemployment Statistics 2019). Similarly, based on McDash Analytics residential mortgage servicing data, the delinquency and foreclosure rate increased from 2 percent to 5 percent in the three months following the storm.

Renters in Bay County were significantly cost burdened before the storm, with 70 percent of those making 30 percent of Area Median Income (AMI) or below paying more than 30 percent of their household income on rent based on Federal Reserve Bank of Atlanta tabulations of Census 2018 American Community Survey (ACS) 1-year Public Use Microdata Sample (PUMS) data. Despite state of Florida statutes prohibiting rent gouging during a state of emergency, reports of rent gouging were prevalent in the news and residents made 800 calls and 617 written complaints and inquiries to the office of attorney general (State of Florida Attorney General 2018).

Interviews of residents in the two years following the storm (2019 and 2020) revealed a long list of continued housing concerns. Hurricane related concerns included a lack of household resources, financial instability, and a lack of insurance to cover damages from the

storm, particularly for heirs' property owners (FRBA roundtable 2020). As is common during hurricanes, many rental units were damaged or destroyed, reducing affordable rental units and exacerbating the shortage of affordable housing in Panama City and surrounding areas. At the same time, concerns arose regarding an increased number of vacant and dilapidated homes with absentee or bank ownership. Research on Hurricane Michael noted challenges in the recovery process, including a divide between trusted community representatives who were not disaster-recovery professionals (Williams and Jacobs 2021).

Section 3: Research Design

In this research, we attempt to resolve the methodological questions raised in our literature review by using a representative, longitudinal dataset with fine-grained geographies. We take advantage of the longitudinal panel to compare post-migration dynamics to pre-migration dynamics, and to use a control strategy to estimate the impact of disaster on migration. We ask how individual and neighborhood characteristics shape residents' displacement and migration patterns following a disaster, as well as their ability to move to areas with higher amenities and lower deprivation. We focus on a type of place that is less prevalent in the disaster literature: a county in a small metropolitan area, Bay County, the home of Panama City, in the Florida Panhandle. We ask the following questions:

- 1. Using a representative longitudinal panel and controls for baseline migration, what percentage of people moved due to Hurricane Michael?
- 2. Do housing characteristics at the individual and neighborhood level predict aspects of the destination location (such as destination neighborhood quality) or attributes of the move (such as distance or duration)?

Following calls for the use of pre-post, treatment, and control research designs (Fussell 2018) in the study of post-disaster migration, we use a representative longitudinal panel to track resident location just before the storm and up to three years afterwards, to identify people who moved after Hurricane Michael.

The disaster affected most counties in the Florida Panhandle. Our analysis does not include any direct, tract level measure of storm impacts. Instead, we compare a disaster affected area, Bay County, with a very similar, geographically proximate county that was outside the federally designated disaster area, Escambia County. We restrict our affected site to Bay County, capturing the Panama City region where the hurricane made landfall and where, because of the density of physical destruction and economic dislocation in this area, effects of the hurricane on migration are most likely to be detected in this region.

As a point of comparison, and to disambiguate background migration with migration that can be attributed to the storm, we selected Escambia County as a control. Escambia County is roughly 75 miles west of Bay County on the Florida Panhandle. The county has comparable levels of urbanization and is demographically and economically similar but is one of two coastal North Florida counties which did not receive a FEMA disaster declaration.

Bay County is located on the Gulf Coast in northwestern Florida. Its largest city is Panama City with the surrounding outskirts of the city being largely rural towns. According to the 2018 Census American Community Survey, 145,599 adults 18 and over lived in the county. The county had a 12.6 percent poverty rate. The racial makeup of the county was 74.9 percent white, 10.4 percent Black, and 6.7 percent Hispanic or Latino. In 2018, the median household income for the county was \$52,107. The largest industries in Bay County, Florida, in 2018 were retail trade (12,005 employees), health care and social assistance (11,609), and accommodation and food services (10,456). Nationwide, about a third of people rented their homes. While Bay County's homeownership rate was 68.1 percent, in Panama City, more than half rented.

For a comparison area to Bay County, we selected nearby Escambia County, also along the Florida Panhandle. Escambia County has similar demographics, economic factors, density and urbanization, and was one two counties in the region that were not part of the FEMA disaster declaration area. Escambia County's largest city is Pensacola, with the surrounding outskirts of the city being largely rural towns. Demographically, Escambia is similar to Bay County. In 2018 the adult population was 249,751. The poverty rate was slightly higher (13.9 percent) than Bay County. Escambia County had a larger Black population, with 64.0 percent of residents who are white, 22.4 percent Black, and 5.8 percent Hispanic or Latino. In 2018, the median household income for the county was nearly identical to Bay County at \$51,050. Like Bay County, the largest industries in Escambia County are retail trade (22,959 people), health care and social assistance (20,418 people), and accommodation and food services (15,024 people). The homeownership rate is lower than Bay County, at 63.4 percent.

Section 4: Data and Methods

To understand individual moves, we use the Federal Reserve Bank of New York Equifax Consumer Credit Panel (CCP), an anonymized 5 percent random sample of all individuals with a credit record and social security number (SSN) in the United States. The longitudinal panel contains a quarterly record for each individual in the panel from Q1 2000 to the present, including a scrambled mailing address, census tract, age, and an array of financial variables.

While the CCP is representative of US residents with an SSN and a credit record, it does not include residents without a credit record, and under samples low-income individuals

(Wardrip and Hunt 2013; DeWaard, Johnson, and Whitaker 2018). An estimated 11 percent of the adult population do not have credit records; another 8.3 percent have credit records but are unscored (Brevoort et al. 2016).

Credit records are correlated with age, race, and income. Non-White, very old and very young, and very low-income US residents are less likely to have an Equifax risk score (Brevoort 2016). Some research has compared this sample with the US population and found this panel has a slightly higher proportion of individuals 85 and older and a slightly lower proportion of individuals under 25 although aggregate measures closely match the ACS, Flow of Funds Accounts of the United States, and the Survey of Consumer Finances (Lee and van der Klaauw 2010; Bleemer & van der Klaauw 2019). An investigation of this dataset finds that Black and Hispanic consumers are more likely to be credit invisible than white and Asian individuals. Around 30 percent of residents of low-income neighborhoods, and roughly 4 percent of residents of high-income neighborhoods have a credit record but lack Equifax risk scores (Brevoort et al. 2016). That these residents are not included in our study data is a limitation to the external validity of the study.

To calculate moves, we examine whether a resident's census tract is the same as it was in September of 2018 as in September of 2019, September of 2020, and September of 2021. So, for instance, residents who left the study areas in the first year following the storm will be counted as an out-migrant in year one, but if they return to the same census tract a year and a half after the storm, they will not be counted as someone who moved in years two or three. This measure is distinct from a calculation of net out-migration—anyone who was not living in the study areas as of September 2018 is not accounted for, regardless of whether they moved in and out of the study area between 2019 and 2021. We address noise in the CCP by ensuring that erroneous census tracts are not registered as a move; and confirming that any change in geocoding of the address is accompanied by a change in the scrambled address field provided by Equifax.

The CCP has limited demographic data: age, whether an individual has an auto loan or mortgage, and proxy measures of car and homeownership. Because of the literature suggesting that tenure and affordability of housing affect migration decisions (Lee and Van Zandt 2019), as well as access to credit, are important components of migration and resiliency (Edmiston 2017), we include a variety of measures around access to credit and evidence of homeownership. We also include individual level measures of age as a proxy for life stage, as individuals have different propensity to move in different life stages (Warner and Sharp 2016).

We supplement our dataset with 2018 ACS census tract (neighborhood) level measures of neighborhood-level physical vulnerability which can affect how well residents navigate the post-disaster process, and whether they recover in place or migrate in place. These include

housing characteristics, age of housing, and percentage of manufactured homes (Peacock et al. 2014). We also include measures related to affordability, including homeownership rates, home values, rental prices, and cost burdens (Lee and Van Zandt 2019). We include two measures of racial composition at the neighborhood level in order to permit an analysis of how structural factors like racism result in disparate outcomes for residents who are racialized as non-white (Zuberi and Bonilla-Silva 2008).

To evaluate neighborhood quality, we rely on the Neighborhood Deprivation Index (NDI) (Kind and Buckingham 2018; University of Wisconsin School of Medicine and Public Health 2018). This index has been validated, widely tested, and is easily replicated using ACS data. It has a broad literature establishing that this index is highly correlated with health and wellbeing of residents, including infant mortality and overall mortality rates (Singh 2003). The NDI combines measures of poverty, education, income, household characteristics (such as single-parent households, and access to a car or telephone), and relies heavily on a set of measures of housing distress such as overcrowding, cost burdens, and access to electricity and plumbing (Singh, 2003). This index does not use race or ethnicity and focuses on material factors that are disproportionately found in impoverished communities. Using published code, we calculate NDI at the census tract level for all census tracts in the United States using 2021 ACS data, to account for the three year move window (Berg et al. 2021). We use both a continuous NDI, which for our sample ranges from a low of -1.44 (least deprived) to 2.05 (most deprived) and an ordinal measure of 5 quintiles of the index ranging from 1 (least deprived) to 5 (most deprived).

Table 1: Individual and Neighborhood-Level Summary Statistics

	Variable	Obs	Mean	Std. Dev.	Min	Max
	Bay County resident in 2018	18,537	0.39	0.49	0	1
aracteristics	Neighborhood deprivation index	18,537	0.24	0.66	-1.44	2.05
	Ndi quintile	18,537	3.43	1.12	1	5
	Generation: Millennial	18,537	0.28	0.45	0	1
	Gen X and older	18,537	0.72	0.45	0	1
	Car ownership indicator	18,537	0.38	0.49	0	1
al ch	Home ownership indicator	18,537	0.27	0.44	0	1
vidu	Riskscore/10	18,537	68.67	10.79	31.3	83.8
ndi	Mortgages	18,537	0.27	0.52	0	10
Ι	Home equity loans	18,537	0.02	0.16	0	10
	HELOCS	18,537	0.04	0.20	0	5
	Student loans	18,537	0.37	1.61	0	35
	Delinquencies	18,537	0.05	0.45	0	28
	Past bankruptcies	18,537	0.06	0.42	0	9
teristics	Total population	18,537	5173	1927	1324	9313
	Total housing units	18,537	2482	981	527	5713
	Percent black	18,537	18%	16%	0%	96%
Irac	Percent non-white Hispanic	18,537	2%	2%	0%	7%
cha	Tenure: percent renters	18,537	36%	17%	8%	74%
borhood (Percent of residents with a mortgage	18,537	57%	10%	29%	78%
	Median rents	18,537	\$1,001	\$176	\$614	\$1,485
	Median home value	18,537	\$157,340	\$57,220	\$57,100	\$351,000
igh	Percent manufactured housing	18,537	10%	12%	0%	64%
Ne	Percent of homes built before 1970	18,537	40%	22%	7%	93%
	Percent of homes with GT 25% cost burden	18,537	62%	13%	20%	100%

Source: Federal Reserve Bank of New York/Equifax Consumer Credit Panel, American Community Survey 2021, and authors' calculations.

We can evaluate whether our sample is representative by comparing our sample statistics to values obtained from the census. As depicted in table 1, the sample is comprised of roughly 39 percent Bay County residents, and 61 percent Escambia County residents. This is proportional to the adult population of these two counties, which is 39:61 according to the 2010 and 2020 US Census. Our dataset is a 5 percent random sample of all adults with a credit record with 18,537 complete individual records after data cleaning. This is equivalent to 5 percent of the 2010 census adult population of Bay and Escambia counties (399,214). According to the census, 19 percent of the population in these two counties are Black. In our sample, the average neighborhood composition of each individual in our sample is 18 percent Black.

We use the individual-level longitudinal panel, a treatment and control design, and a variety of individual and neighborhood level covariates to understand post-disaster migration. We estimate two models. The first is a regression model calculating the impact of exposure to Hurricane Michael (living in Bay County relative to Escambia County) in the decision to move following the hurricane, described in equation 1. Equation 1 predicts the likelihood of a resident of Bay County moving relative to a resident of Escambia. The unit of analysis for this model is the individual, and we use dummy variable T to indicate whether the individual was in a disaster-affected county (Bay) or not (Escambia). As controls, we include individual measures of demographic and financial characteristics, as well as neighborhood (census tract) level measures of housing, economic, and demographic characteristics.

Equation 1: Linear Probability Model Estimating Hurricane Michael's Impact on Migration

 $Y_{t12} = N_{t1} + F_{t1} + D_{t1} + H_{t1} + T + e$

Y 1, 0 Whether a person has moved from their location after the storm from CCP.

N neighborhood characteristics (census tract, race, median income) from ACS.

t 1 = Q3 2018 prior to storm from CCP.

12 = Q4 2021 three years after the storm from CCP.

F individual financial characteristics (student loan debt, past bankruptcy, Equifax risk score) from CCP.

D individual demographic characteristics (age, car, and homeownership indicators) from CCP.

H individual housing characteristics (number and type of mortgage debt, previous foreclosure) from CCP.

T exposure to disaster: 1 = Bay County, 2 = Escambia County.

In the second model, we restrict the sample to residents of Bay County who changed address in the three years after the storm. We measure the origin and destination neighborhood quality of those who moved using the NDI.

Equation 2: Characteristics of Neighborhood Destinations for Migrants Affected by Hurricane Michael

 $N_{t12} = N_{t1} + F_{t1} + D_{t1} + H_{t1} + C_{t1} + e$

- N Neighborhood Deprivation Index.
- t 1 = Q3 2018 prior to storm.
- 12 = Q4 2021 three years after the storm.
- F neighborhood average of financial characteristics (student loan debt, past bankruptcy, Equifax risk score) derived from CCP.
- D neighborhood average of demographic characteristics (age, car, and homeownership) from CCP.
- H neighborhood average of housing characteristics: (number and type of mortgage debt, previous foreclosure) derived from CCP.
- C neighborhood characteristics (census tract tenure, cost burden, demographics) from ACS.

This research relies on the assumptions that there is no omitted variable which affects both the propensity to treatment (in this case, being struck by a hurricane) and the outcome (likelihood of moving) which is changing over time in the either the treated or control groups, but not both. To satisfy this assumption, and in accordance with the research designs in the literature described in Section 2.4, we argue that we have selected two places, one strongly affected by the storm (Bay County), one nominally unaffected (Escambia County), that are similar along several dimensions, in which any differences in the change in the migration rate between these two counties before and after the storm would only be due to the storm.

We have not included other potential control counties in central and southern Florida which were not affected by this storm but differ from Bay County in meaningful ways which might compromise this assumption. By choosing two counties that are geographically proximate to each other on the Florida Panhandle and are similar in demographics, industry mix, and urbanization, we feel we have minimized threats to this assumption, and that there are no differences between these two counties which would affect both the propensity of residents to be affected by the hurricane and the likelihood of residents to move. However, the reader should be aware that the conclusions of this study rest on the credibility of that assumption.

The second potential weakness concerns the dataset. This research sheds light on the impact of disasters on US residents with a SSN and a credit history. While our dataset has

many excellent attributes, permitting spatially granular, longitudinal analysis and is highly representative of the population we've described, as previously noted this research does not include residents who are not credit visible or who do not have a social security number. Many vulnerable, poor, and marginalized residents are credit invisible (Brevoort 2016). Our own findings show that an Equifax risk score, a proprietary credit score similar to those used by the other credit reporting agencies, is the strongest determinant of successful moves after a disaster. While it is outside the scope of this study to investigate credit invisible residents of the US, studying this group will continue to be an important topic for further research.

Finally, our research design allows us either to provide an estimate of the impact of the disaster on aggregate migration as we show in model 1 or to look at the discrete correlates of all out-migration as we show in model 2. We are not able to conduct both analyses at the same time using these research designs outlined above. In model 1, we look at the overall impact of the disaster on out-migration from Bay County. We describe the combined effect of all the discrete factors on the rate of out-migration from that county. In the model 2, we examine which individual and neighborhood characteristics predict an individual's out-migration and are able to parse out some of the particular individual and neighborhood characteristics which strongly predict the destination quality of someone who leaves in the three years following a disaster.

Section 5: Results

In the following section, we provide the results of several analyses. First, we examine outmigration following Hurricane Michael. We provide descriptive statistics and regression modelling to provide estimates of the greater likelihood out-migration from the disaster affected area versus the unaffected area following the storm and confirm these findings in a regression model with controls (equation 1). Second, we examine the destinations of those who moved and examine what housing and financial factors predict a successful move (equation 2).

5.1 Migration Rates after Hurricane Michael

Table 2 shows the average number of post-disaster moves by people who resided in either the region affected by the disaster (Bay County) or outside of the disaster declaration area (Escambia County) as of fall 2018. For the first, second, and third year after the storm, we measure the percentage of people who lived in the study area in September of 2018 who no longer reside in the same census tract.

After one year, the share of residents in the disaster area who had moved was 4.1 percent percentage points higher than those who were unaffected. Most of these moves were

away from Bay County: either out of the county but within Florida (1.5 percent) or out of the state (1.5 percent). A small percentage moved out of their neighborhood but stayed within the county (0.7 percent). Three years following the storm, the number of residents who moved rose to 5.2 percent, with the majority being residents who left the Bay County or the state of Florida entirely.

These figures suggest that while a high percentage of residents left Bay County after the disaster, not all these departures are due to the storm. Combining the 3.5 percent who left Bay County for other locales in Florida with the 6.0 percent who left the state, a total of 9.5 percent of residents left Bay County in the first year of the storm. However, the majority of these moves may not be attributable to the disaster. Using Escambia County's out-migration rate as a baseline, 1.5 percent more residents left Bay County and 1.5 percent more Bay County residents left the state, suggesting that the percentage of people leaving Bay County in the year following the disaster is just 3.0 percent higher than normal.

We also don't see a return over the three-year period that has been documented following other storms—for each year following the storm, the out-migration rate increases, primarily by those who leave Bay County but stayed within the state of Florida (2.3 percent by year three).

	Type of Move				
	Left				
	Any Move	Neighborhood	Left County	Left State	
After 1 Year					
Bay	19.6%	8.1%	3.5%	6.0%	
Escambia	15.6%	7.5%	2.0%	4.5%	
Difference	4.1%	0.7%	1.5%	1.5%	
After 2 Years					
Bay	29.7%	12.2%	5.5%	9.3%	
Escambia	25.1%	11.6%	3.3%	8.0%	
Difference	4.6%	0.5%	2.1%	1.3%	
After 3 Years					
Bay	37.2%	15.7%	6.6%	11.8%	
Escambia	31.9%	14.9%	4.3%	10.3%	
Difference	5.2%	0.8%	2.3%	1.5%	

Table 2: Percentage who Moved by County and by Destination

Source: Federal Reserve Bank of New York/Equifax Consumer Credit Panel, American Community Survey 2021.

In table 3, we use a linear probability model to predict an individuals' likelihood of moving after controlling for individual financial characteristics, age, car and homeownership, neighborhood demographics, and housing characteristics.

The results in table 3 show the likelihood of different types of moves for disasteraffected residents of Bay County relative to those in Escambia County who were not affected by the hurricane. Overall, there was a significant difference in the likelihood of out-migration by Bay County residents. Compared to Escambia County residents, Bay County residents were 3.0 percent more likely to move in the first year, and 3.8 percent more likely to move in the three years following the disaster. Residents are significantly more likely to leave their county (1.3 percent) and this out-migration grew over time. After three years, disaster affected residents were 2.1 percent more likely to move to another county than residents outside the disaster area. Bay County residents were significantly more likely to leave the state in the year after the storm (0.9 percent) but there was no statistically significant difference in the likelihood of leaving the state three years after the storm. Residents of the disaster affected area were not any more likely to change neighborhoods than those living outside the disaster area.

Table 3: Increased Likelihood of Moving from Bay County as Compared to Escambia County Following Hurricane Michael

-	Type of Move				
	Left Left				
	Any Move	Neighborhood	County	Left State	
After 1 Year	0.030***	0.009	0.013***	0.009*	
After 3 Years	0.038***	0.012	0.021***	0.007	

Note: *** p < .001 ** p < .01 *p < .05

Source: Federal Reserve Bank of New York/Equifax Consumer Credit Panel, American Community Survey 2021.

5.2 Destination quality after Hurricane Michael

In the following figures and tables, we examine the destinations of disaster-affected residents who moved in the three years following the storm. We focus on moves over a three-year time horizon because the literature suggests that while moves within the first and even second years following a disaster often reflect temporary relocations and intermediate moves that characterize households' responses during the immediate recovery period, moves which persist after three years are more likely to be a permanent relocation. Figure 2 depicts the

average NDI in Bay County in 2018. A higher NDI represents increased levels of deprivation; lower numbers reflect better neighborhood quality and lower levels of deprivation.

Figure 2: Average Neighborhood Deprivation Index by Tract in Bay County, Florida (2018)

NDI Score 0.8 to 1.6 0.4 to 0.8 0.1 to 0.4 -0.2 to 0.1 -1.3 to -0.2

Higher Values Indicate Greater Deprivation

Source: Neighborhood Deprivation Index, Calculated using 2018 ACS.

Overall, from Q3 2018 to Q4 2021, Bay County residents moved to places with less deprivation and more advantages. However, these averages obscure diverging outcomes at different points in the distribution. Post-disaster moves show a trend toward rising neighborhood inequality, defined by the difference in NDI. Table 4 shows the average change in the NDI for residents who move from Bay County in the three years following the storm. The results are broken out by whether residents originally lived in neighborhoods with (1) lowest deprivation through (5) highest deprivation.

The results in table 4 show that residents who live in high-amenity places moved to areas of even greater advantage, places which on average had a 1.02 lower score on the deprivation scale. Residents of areas with above average deprivation or most deprivation tended to move to areas that have even higher levels of deprivation. ANOVA confirms these differences are statistically different.

Table 4: Disaster Affected Residents of Bay County, Moves Segmented by Origin Neighborhood Quality

	Change in deprivation score after moving
(1) Least deprivation	-1.02
(2) Below average	-0.55
(3) Average	-0.15
(4) Above average	0.07
(5) Most deprivation	0.61

Source: Federal Reserve Bank of New York/Equifax Consumer Credit Panel, American Community Survey 2021.

In table 5, we refine our understanding of how Hurricane Michael affected the destination quality of those who moved by introducing a comparison between disasteraffected residents in Bay County with those in Escambia County who were not affected by the storm. This comparison helps us disambiguate between residents who moved because of the storm and those who would likely have moved anyway, and to better understand how disasters affect the ability of residents to move to opportunity.

Though the overall averages show that residents of Bay County tended to move to areas of lower deprivation, comparison with Escambia County shows that they were less likely to move to areas of lower deprivation, on average, than their counterparts who were not affected by the storm. Table 5 depicts the average neighborhood quality of residents who moved in the three years following the storm. These moves are segmented by whether the resident was in a disaster affected county and by distance of move (neighborhood, county, and state).

Table 5: Average Neighborhood Deprivation Index for Those Who Moved Between 2018-2021 by County and Type of Move

		Left Neighborhood	Left County	Left State
Disaster affected county (Bay)	Origin Destination Difference in NDI	0.26 0.28 0.02	0.27 0.22 -0.05	0.22 0.01 -0.21
Unaffected county (Escambia)	Origin Destination Difference in NDI Difference-in- Differences	0.30 0.28 -0.02 0.04	0.19 -0.04 -0.22 0.17	0.22 -0.07 -0.29 0.07

Source: Federal Reserve Bank of New York/Equifax Consumer Credit Panel, American Community Survey 2021.

We see clear differences in neighborhood distress by type of move in the last line of table 5. Residents of Bay County who were affected by Hurricane Michael moved to neighborhoods that are more distressed than residents of unaffected Escambia County, reflected in average indices that are 0.04, 0.17, and 0.07 points higher on the NDI scale.

We also see a difference between local and long-distance moves. Those who moved to a different neighborhood within Bay County tended to move to a slightly more distressed area. Compared to Escambia County, Bay County movers go to places that have a 0.17 to 0.07 higher distress index when they moved out of the county, or out of the state, respectively. Similar results were found when examining moves that occurred one year and two years following the storm.

5.3 Characteristics associated with Moves to Areas with Lower Deprivation Scores

In the next series of analyses, we examine which individual and neighborhood factors are associated with moving to a less deprived area for residents who left Bay County in the three years after the storm. In table 6, we predict the neighborhood quality of movers using the NDI in a regression framework. This analysis reveals which individual and neighborhood level factors best predict a post-disaster move to an area of greater advantage/lower disadvantage. Table 6: Individual and neighborhood characteristics predicting destination Neighborhood Deprivation Index three years after Hurricane Michael

		Coefficient	Standard Error	Beta	
SS	Equifax risk score	-0.012	0.002	-0.170	***
istic	Millennial indicator	0.071	0.03	0.046	**
ter	Car ownership indicator	-0.036	0.029	-0.024	
arac	Home ownership indicator	-0.009	0.071	-0.005	
chá	Number of first mortgages	-0.109	0.05	-0.078	**
lual	Home equity loan indicator	-0.186	0.123	-0.030	
ivid	HELOC indicator	0.044	0.095	0.009	
Ind	Number of student loans	-0.016	0.008	-0.040	**
	Delinquency >120 days	-0.027	0.036	-0.015	
	Past bankruptcy indicator	0.039	0.031	0.023	
cs	Percent black	-0.02	0.181	-0.003	
isti	Percent non-Hispanic white	-2.841	1.374	-0.044	**
cter	Percent renters	0.195	0.169	0.041	
charae	Percent homeowners with a mortgage	0.768	0.244	0.088	***
o po	Median rents	0.000	0.000	-0.041	
cho	Median home value	0.000	0.000	-0.216	***
oqu	Percent manufactured homes	0.366	0.247	0.073	
Neigł	Percent of homes built before 1970	0.169	0.144	0.043	
	More than 25% cost burdened	0.064	0.145	0.009	
	Total population	0.000	0.000	-0.084	***
	Total number of housing units	0.000	0.000	0.043	
	(Constant)	1.118	0.351		
	Number of obs	2,495			
	R-squared	0.1406			
	Adj R-squared	0.1333			
	Root MSE	0.7073			

Note: *** p value < 0.001 ** p value < 0.05 * p value < 0.1

Source: The source of individual characteristics is the Federal Reserve Bank of New York/Equifax Consumer Credit Panel. The source of neighborhood characteristics is the 5-year American Community Survey 2021.

Equifax risk score is the largest individual predictor of a successful move, with a 1standard deviation increase in Equifax risk score corresponding to a 0.170 standard deviation increase in neighborhood quality (or decrease in NDI). Those with a mortgage or with a student loan were also more likely to move into a more advantaged, less deprived neighborhood. Relative to millennials (people born in the 1980s or 1990s), older residents moved to areas with higher levels of deprivation.

Neighborhood characteristics predicting a move to a more advantaged, lower NDI tract were median home value, with a 1 standard deviation increase in home value corresponding to a 0.216 standard deviation decline on the deprivation scale, and percent non-Hispanic White. Unexpectedly, residents living in an area with more mortgaged homeowners tend to move to places with more deprivation. This relationship was difficult to explain, particularly as disasters can result in reduction in mortgage balances following the award of FEMA recovery lump sums (Hartley et al. 2019), which one would expect would have positive spillovers at the neighborhood level. One explanation could be foreclosure: literature from the foreclosure crisis associates foreclosure with negative externalities on neighboring properties. Furthermore, when households displaced by the foreclosure crisis moved, research found negative impacts on destination neighborhood quality, particularly for Black and Hispanic households (Hall et al. 2018).

Section 6: Discussion and Conclusion

In this paper, we review the migration patterns from a county in a small metropolitan area following a large, destructive hurricane. We find that the out-migration rate after Hurricane Michael was high, with 19.6 percent of Bay County residents changing address in the year following storm. However, we can only attribute about 4.1 percent of moves in that first year (2019) to the storm when compared to a similar nearby county. The majority of people who moved from Bay County following the storm remained in Florida but left for a different county.

By year three following the storm (2021), 37.2 percent of residents left Bay County for another region or another state—we attribute 5.2 percent of these out-migrants to the storm. We do not see out-migration diminishing over time, as has been documented following other storms. Instead, the out-migration rate slowly increases year on year, from 4.1 percent in year one (2019) to 5.2 percent in year three (2021).

In a regression framework, when we control for demographics and exposure to the storm, we find that residents exposed to Hurricane Michael were 3.0 percent more likely to move in the following year (2019), and 3.8 percent more likely to move in the following three years (2019-2021) than residents of a similar area unaffected by the storm.

We then examined the quality of migrants' destinations by analyzing the NDI scores of residents who moved after the storm. On average, those who moved tended to move to areas with slightly lower deprivation scores (in other words, areas of higher advantage)—but not as high as residents that were not affected by the storm. This suggests that disaster processes may be impairing residents' ability to move to areas with lower deprivation scores, even if it does not thwart these efforts entirely.

These overall averages conceal an underlying inequality. Residents with average or above-average neighborhood advantages tend to move to areas of even higher advantage; the reverse is true for those who started out in neighborhoods of high deprivation. Just as spatial inequality between neighborhoods rose for those who moved after the storm, this pattern was also evident among those who moved from Escambia County, suggesting that neither the destructive impact of the storm nor reparative impact of post-disaster policy disrupted existing patterns of inequality as they are expressed through moves and migration.

We also found differences in destination neighborhood quality by the distance of moves following Hurricane Michael. Compared to residents outside the disaster-affected area, Bay County migrants went to places that had a 0.17 to 0.07 higher distress index when they moved out of the county or out of the state, respectively.

Finally, we examined the individual and neighborhood characteristics that are correlated with a move to a less deprived area. A low Equifax risk score and residence in an area with high home values before the storm were the two single factors that had the strongest relationship with an increase in neighborhood quality after a move.

In light of these findings, disaster recovery policies could mitigate issues of inequity in migration and in opportunity at the destination of a move to affect a more balanced recovery. This research reinforces the need to understand the different types of moves following a disaster and the importance of designing policies to both enable residents to move to areas of relatively greater opportunity and to help support the residents who stay to rebuild and repair. There is a need to differentiate between the background rate of migration and storm-generated moves, and to differentiate between groups who are stuck in place, those who have the resources to successfully rebuild, those who are forced into suboptimal moves, and those who successfully move to areas that have higher amenity levels than the places they left behind. A better understanding of what sorts of neighborhoods individuals relocate to following disasters and what predicts successful versus less successful moves can help planners and policymakers mitigate the potential negative impacts of forced moves.

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