Do Minorities Pay More to Avoid Flood Risk?

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Abstract

Persons of color are more likely to live in high flood risk areas. African American and Hispanic individuals also pay significantly more than whites for equivalent housing, and there is significant spatial heterogeneity in these differentials. Do racial housing price differentials vary in ways that could incentivize persons of color to live in high flood risk areas? What factors exacerbate or alleviate differentials in safe versus risky areas? I assemble a dataset combining a panel of 26M repeat-sales housing transactions, buyer race, and flood zone changes between 2000-2020 across the United States. I identify price differentials by race and flood zone status using a repeat-sales model and plausibly exogenous changes in flood zone status at the property-level. I find that, while persons of color pay over 3% more than white buyers for equivalent housing outside flood zones, these premiums are reduced to approximately 1% inside flood zones. Where flood risk is most salient and supply of safe housing is lowest, premiums for Black and Hispanic buyers to live in safe areas are highest, reaching approximately 5%. Using variation in the supply of safe housing at the county-level, I find that all buyers pay a premium for safe housing in counties with large shares of unsafe housing. However, Black and Hispanic buyers face double the price premium of an equivalent white buyer in such counties. As climate change continues to make more areas vulnerable to natural disasters, access to safe housing for minorities may be further restricted, reinforcing inequality. Flood mapping as is currently designed in the United States may contribute to environmental injustice.

Key words: Housing Discrimination, Flood Zones, Repeat-Sales Method, Environmental Justice

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Introduction

This paper is motivated by three stylized facts. First, persons of color are more likely than whites to live in and move into high flood risk areas (Bakkensen and Ma, 2020, Hardy and Hauer, 2018, Sanders et al., 2023, Smith et al., 2006, Wing et al., 2022). Second, African American and Hispanic individuals tend to pay significantly more than whites for equivalent housing (Bayer et al., 2017, Ihlanfeldt and Mayock, 2009, Myers, 2004) and there is significant spatial heterogeneity in these differentials, which may influence housing location decisions (Box-Couillard and Christensen, 2024). Third, in the presence of discriminatory constraints in the housing market, price differentials for minority buyers are likely to be highest where competition for housing is most fierce and lowest where competition and search costs are low (Becker, 1971, Courant, 1978, Yinger, 1997). Thus, any factor that facilitates access to housing inside high flood risk areas relative to low-risk areas for persons of color is likely to lead to lower differentials in at-risk areas and higher differentials in safe areas. In this paper, I pose three questions related to these facts: (1) Are racial housing price differentials higher for homes with low flood risk compared to homes with high flood risk? (2) What factors exacerbate or alleviate differentials in safe versus risky areas? (3) What are potential implications of my findings for access to safe housing among minority populations?

I construct a dataset linking 26M repeat-sales property transactions between 2000-2020, changes in Special Flood Hazard Areas (SFHAs, henceforth referred to as flood zones), and algorithmically-imputed homebuyer and seller race or ethnicity. Specifically, I retrieve Federal Emergency Management Agency (FEMA) flood maps valid in 1999, 2011 and 2022 along with the universe of flood map change dates in each U.S. county between 1999 and 2022. I merge the national flood maps, flood map change dates and housing transaction data. This results in a dataset where, for each housing transaction, the race of the buyer and seller, flood zone status and the latest date at which there was a flood zone change are known.

I build on methodologies used to identify flood zone premiums and racial price differentials introduced by Hino and Burke (2021), Bayer et al. (2017) and Box-Couillard and Christensen (2024). I estimate a model that exploits plausibly exogenous changes in flood zone designations resulting from FEMA flood map updates, combined with property fixed effects and census-tract-by-year fixed effects. This design allows for the comparison of prices for properties across time as they are zoned from outside to inside a flood zone and as the race of the homebuyer changes. The inclusion of property and tract-by-year fixed effects control for property-level unobservables and neighborhood-level changes in unobservables that may be correlated to prices. These estimates are identified as long as time-varying unobservables at the property level are uncorrelated with rezoning into floodplains, buyer race and housing prices.

I find that, over the past twenty years in the 35 states in my sample, Black and Hispanic homebuyers pay 3.3-3.6% more than white buyers for equivalent housing outside flood zones. Flood zone status reduces these premiums by 60% to approximately 1% for both African American and Hispanic buyers. While African American and Hispanic buyers pay a “tax” of approximately $7,700-8,500 to buy the median home outside flood zones, this amount is reduced to less than $2,000 inside flood zones.

I conduct several robustness checks to address identification concerns. First, I show that my results are robust to the use of different name-to-race algorithms as well as to the imposition of strict name-to-race certainty cutoffs. Second, I show that my results hold for the sample of homes that underwent a remodel. Third, I show that excluding homes that undergo a flood zone change through a community-initiated process that could be considered endogenous, instead of through the normal federal zoning process, does not alter my estimates. Fourth, I find that excluding properties that are only in a flood zone in 2011 and are outside of flood zones in all other flood maps does not materially affect my estimates. Finally, to allay concerns about differential sorting into newly minted flood zones, I show that changes in buyer race from one sale to another are uncorrelated to flood zone status changes.

Theoretical models of discrimination predict higher price differentials in markets where competition for housing is strongest (Becker, 1971). I examine a series of mechanisms that could increase competition for housing in low flood risk relative to high flood risk areas, their effect on price differentials, and implications for access to safer housing for persons of color. First, I examine the role that information provision plays in price differentials by estimating results separately for states where flood risk disclosure is required. Premiums inside flood zones are identical in both cases. Premiums outside flood zones, however, are significantly higher in disclosure states. This is likely to reflect greater competition for "safe" housing in states where flood risk is more salient.

Next, I study the role played by recent flooding events. If flooding further increases competition for housing in safer areas, it would be expected that differences in premiums inside and outside flood zones would be even larger in the aftermath of a major flooding event. I find that in counties that experienced some flooding in the past three years, premiums to live outside flood zones are much larger for Hispanic and Black homebuyers. In these areas, premiums reach approximately 5% for Hispanic and Black homebuyers.

Beliefs about the potential harm caused by climate change is another potential source of variation in competition for safe housing. It has been shown that beliefs about climate change have effects on housing markets in the context of sea level rise (Baldauf et al., 2020, Barrage and Furst, 2019, Bernstein et al., 2019). Thus, it is likely that competition for safer housing is more intense in areas with a higher share of individuals worried about the threat of climate change. I find that this is indeed the case, as price differentials outside flood zones for Black and Hispanic homebuyers are approximately 1 p.p. higher in counties with a high proportion of individuals worried about climate change.

I devise a test for the effect of increased competition for safe housing. I match flood zone status with United States Geographical Survey (USGS) data on single-family housing structures. This allows me to construct a panel of "safe" and "risky" housing that varies as flood zones expand or contract over time. This provides a way to formally test the hypothesis that constrained access to "safe" housing drives up housing costs. My results imply that, compared to white buyers, Black and Hispanic buyers pay more for safe housing as the supply of safe housing decreases. White buyers pay 2.6% more for safe housing in counties in the top 10 percentiles of flood risk compared to white buyers in counties without flood risk. Black and Hispanic buyers pay over 6% more for safe housing in these same counties compared to white buyers in very low risk areas.

Motivated by previous findings that price differentials differ substantially by neighborhood racial composition and seller race (Box-Couillard and Christensen, 2024), I examine heterogeneity in flood zone differentials by census-tract racial composition and seller race. Results indicate that there are lower premiums inside flood zones compared to outside flood zones across the distribution of neighborhood racial composition. Asian, Hispanic and Black buyers all pay lower premiums (and sometimes receive discounts) relative to white buyers buying from white sellers when they transact with a seller of their own group. Black buyers pay less for housing inside flood zones regardless of the race of the seller. For Hispanic buyers, however, premiums inside and outside flood zones are identical after taking into account the race of the seller. Despite this, Hispanic buyers pay much less overall for housing in flood zones. These two results are reconciled by the fact that Hispanic buyers are much likelier to transact with a Hispanic seller inside a flood zone.

I highlight limitations of my analysis. First, Texas, Louisiana and Mississippi, three states with a high proportion of at-risk homes and large minority populations, are excluded from my sample because transaction prices are not of public record in these states.[1] Second, I do not have the universe of flood maps between 2000-2020. This means that from a possible 37M observations, I can only use 26M. Third, to truly study the effect these differentials have on housing outcomes, one would need to observe the choice set of each potential buyer. While my results are consistent with a pattern of restricted access to housing in less risky areas compared to inside flood zones, they do not constitute proof that this is indeed the case.

This work contributes to four main strands of literature. First, I show that there are significant interactions between price differentials, flood risk and entrenched patterns of segregation. Work over the past twenty years has established that African American and Hispanic homebuyers pay a premium for equivalent housing compared to white buyers (Bayer et al., 2017, Ihlanfeldt and Mayock, 2009, Myers, 2004). More recent work shows

[1]Other excluded states include: Alaska, Idaho, Kansas, Maine, Missouri, Montana, New Mexico, North Dakota, South Dakota, Utah and Wyoming.

that there is significant spatial heterogeneity in price differentials and that neighborhood segregation significantly increase these differentials (Box-Couillard and Christensen, 2024). The role of environmental factors in shaping patterns of racial price differentials is, as of yet, unexplored.

Second, this paper contributes to building an understanding of the factors that lead individuals of color to live in areas at disproportionate risk of flooding, and more generally, with greater environmental hazards. The environmental justice literature has long noted that racial minorities are likelier to live in more polluted areas (Banzhaf et al., 2019, Bowen, 2002, Currie et al., 2015, Hsiang et al., 2019, Mohai and Bryant, 1992). There is also evidence that people of color and disadvantaged populations may be disproportionately exposed to catastrophic flooding and sea level rise (Hardy and Hauer, 2018, Sanders et al., 2023, Wing et al., 2022), that they sort into hazardous flood zones (Bakkensen and Barrage, 2017, Smith et al., 2006) and are less likely to move out of risky areas following a flood (Sheldon and Zhan, 2022). In addition, redlined homes display higher flood risk than their non-redlined neighbors and are located in areas with more pervious soils that increase the risk of flooding (Conzelmann et al., 2022). Recent working papers also show important interactions between socio-demographic characteristics, housing markets, flood zones and flood insurance (Jowers et al., 2022, Varela Varela, 2023, Weill, 2023). The evidence presented in this paper points to a mechanism beyond that of income inequality and Tiebout sorting (Banzhaf and Walsh, 2008). Housing is disproportionately cheaper for Hispanic and African Americans inside flood zones and disproportionately dearer in the safest areas. In this way, my findings are related to work showing the role of discriminatory constraints and information failures in steering individuals toward environmental disamenities (Christensen and Timmins, 2022, Hausman and Stolper, 2021).

Third, this research contributes to the growing number of studies evaluating the impact of flood risk on housing prices (Beltrán et al., 2018, Bin et al., 2008, Bin and Landry, 2013, Gibson and Mullins, 2020, Gourevitch et al., 2023, Hino and Burke, 2021, Ortega and Taspinar, 2018, Shr and Zipp, 2019, Zhang, 2016, Zhang and Leonard, 2019). Only two of these studies utilize a national panel of home sales similar to mine (Gourevitch et al., 2023, Hino and Burke, 2021). These studies find average flood zone discounts of 2.8% and 2.1%, respectively. In my preferred specification, I find an overall discount of 1.1%. The present study contributes to this literature in two ways. First, I nuance the overall findings found above by showing that, while white buyers pay a slight discount for housing in flood zones compared to outside flood zones, Black and Hispanic buyers obtain a large discount. This is the first study to examine racial disparities in flood risk discounts and potential mechanisms underlying these disparities. As such, it begins to address distributional implications of flood zoning in ways that previous work cannot. Second, methodologically, I replace the county-year fixed effects used in previous work with census-tract-by-year fixed effects. Previous work involving repeat-sales methodologies has shown that omitting such fixed effects risks biasing estimates as housing market trends can be very localized (Bayer et al., 2017, Box-Couillard and Christensen, 2024). As such, the inclusion of county-year fixed effects is unlikely to capture unobserved variation in neighborhood attributes that are likely to be correlated to flood zone status, race and housing prices.

Fourth, I provide evidence of potential adverse consequences from providing explicit flood risk information in a context where Black and Hispanic homebuyers may face discriminatory constraints. There has been much discussion as to the potentially adverse effect of providing subsidized flood insurance on sorting into flood zones and development in at-risk areas (Browne et al., 2019, Peralta and Scott, 2024). My results imply that strict flood zone boundaries, as they are currently designed, may contribute to particularly difficult access to housing in low-risk areas for African American and Hispanic individuals. In this way, it is related to work outlining the distortions created by SFHA boundaries as compared to continuous measures of flood risk (Pollack et al., 2023).

The remainder of this paper is organized as follows. First, I provide background on FEMA flood maps and the map updating process. Second, I provide an overview of the theoretical predictions underlying my hypotheses. Third, I outline the data used in this study. Fourth, I present the empirical method in greater detail. Fifth, I present results. Sixth, I conclude with a discussion of the implications of my findings.

Background: FEMA Flood Maps and Map Updating

Founded in 1968 by an act of Congress, the National Flood Insurance Program (NFIP) aims to provide flood insurance for individuals and businesses, as well as identify areas of high and low flood risk. Within high-risk areas, the NFIP encourages communities to adopt hazard mitigation measures. FEMA organizes its flood maps by community. Communities are towns, counties or cities that elect to participate in the NFIP. Areas are divided into three broad categories. Special Flood Hazard Areas (SFHAs), or 100-year flood zones, are areas where it is estimated that the probability of experiencing a flood in any given year is 1%. In these areas, flood insurance is mandatory for homeowners with federally-backed mortgages. 500-year flood zones are areas with a 0.2% risk of flooding in any given year and have no insurance requirement. Areas outside either of these zones are classified as having "minimal flood risk". Beginning in 2000, FEMA began a process of map modernization ("Map Mod"). The goal of this exercise was to create new flood maps for 97% of the US by 2009 and to produce periodical updates thereafter (FEMA, 2005). This process is the source of plausibly exogenous variation in this study.

There are two principal processes by which a community can see its flood maps updated. The first process is referred to as a FEMA-led update. While FEMA aims to update flood maps every 5 years, funding constraints hamper FEMA's ability to do so (Pralle, 2019). In fact, more than 50% of flood maps in my data are updated only once during the period 2000-2020. Therefore, FEMA uses a cost-benefit approach based on where housing development is greatest and where existing maps are most outdated to prioritize flood map updates (FEMA, 2021b). Re-zoning decisions are then made based on changes in geography, precipitation patterns, population size and new construction patterns (Pralle, 2019).[2] FEMA releases proposed map changes and allows for a review process that can be challenged both at the community-level and by individual homeowners. While challenges are often successful, they involve substantial costs and are unlikely to be undertaken by most households (Pralle, 2019). The second process is referred to

[2]Note that census tracts are always more granular than communities. Thus, census tract-by-year FEs will capture factors that may be correlated to re-zoning timing, racial composition and housing prices (such as new housing developments).

as a community-initiated update. As the name implies, these updates are not initiated by FEMA but instead are initiated by local communities. Community-led updates often reflect new flood-mitigation measures put in place by communities or a request for re-zoning in order to facilitate new development in existing flood zones. Typically, this results in small areas being zoned-out of an SFHA (FEMA, 2021b).

Theoretical Motivation

Beginning with the seminal work of Becker (1971), economists have sought to study the causes and consequences of discrimination. Becker's principal insight was that taste-based discrimination can only persist where there are barriers that limit competition among sellers and increase competition among buyers. Arrow (1972) and Phelps (1972) argued that, even in the absence of "tastes for discrimination", profit-maximizers were likely to discriminate based on informational asymmetries that systematically disadvantaged racial and ethnic minorities. Taken together, these neoclassical models yield two important predictions. First, price differentials are more likely in settings where the "costs" of discrimination are low. Second, price differentials are more likely in markets where information is costly to acquire.

Another group of papers uses search models to characterize how and why racial price differentials arise. Masson (1973) describes a process where, in the presence of discrimination, Black buyers of durable goods are less confident that additional search efforts will lead to lower prices. This leads to more inelastic demand on the part of Black buyers. Knowing this, all profit-maximizing sellers charge a higher price to Black buyers. Applying and extending this framework to housing markets, Courant (1978) describes a model where search costs are systematically higher for non-whites if a portion of white sellers are averse to selling their home to non-white buyers. This fraction changes by neighborhood and search costs thus depend on neighborhood-specific discrimination. This leads to premiums paid by minority buyers as well as segregation into neighborhoods where discrimination is less prevalent. Yinger (1995) extends the Courant model to encompass realtor and lender behavior. He shows that, at every stage of the housing search process, discrimination may restrict the choices of minority households, increasing search costs and leading to lower surpluses for minority buyers. This second set of models implies that minority buyers may experience differing levels of search costs in different types of neighborhoods. This may lead to segregation, as well as price differentials that differ by neighborhood characteristics.

If persons of color face more competition for housing or higher search costs outside flood zones than inside them, they are likely to pay more for housing in relatively safe areas than in hazardous areas. Specific mechanisms that may increase competition for housing in safer areas include: flood risk salience and availability of safe housing at any point in time. Factors that may increase search costs in safer areas include: the likelihood of buying a home from a buyer of one's own group and realtor steering. In subsequent sections, I show that racial price differentials for Black and Hispanic buyers are indeed higher outside flood zones and that Hispanic buyers are less likely to transact with a Hispanic seller in such areas, leading to potentially higher search costs. Conversely, price differentials are highest in areas where competition for safe housing is most intense and where flood risk is most salient.

Data

Zillow ZTRAX

I make use of a novel method developed by Box-Couillard and Christensen (2024) to match property transactions and buyer and seller race or ethnicity. Specifically, I use the Ethnicolr algorithm (Sood and Laohaprapanon, 2018) to assign a probability that buyer and seller names present in the ZTRAX data (Zillow, 2020) are of a given race or ethnicity. The Ethnicolr model assigns probabilities that a given name belongs to one of four races/ethnicities: non-Hispanic (NH) white, non-Hispanic Black, Asian, and Hispanic. The algorithm is trained on Florida voter registration data that contains both first and last names, as well as self-identified race/ethnicity. The use of first names is important in a U.S. context where African American and white persons often have more differentiable first names than last names (Fryer Jr and Levitt, 2004).

After cleaning the Zillow data,[3] keeping only repeat sales, and merging flood zone status, my sample is comprised of approximately 26M transactions over 34 states and the District of Columbia.[4] For each transaction, I observe the transaction price, date of sale, year the home was built, location of the home, property characteristics (e.g., number of bedrooms, bathrooms, etc.), buyer name and seller name. Table A.1 presents descriptive statistics of the sample used in this study, broken out by flood zone status and race. While the overall sample is large, it is worth noting that homes sold inside flood zones represent a small share of the housing market, and especially so for Black buyers.[5] The racial composition of homebuyers inside and outside flood zones is similar. With the notable exception that Hispanic buyers are over-represented in flood zones and white buyers are slightly under-represented. Home prices are higher, on average, inside flood zones across all racial groups except Hispanic buyers. This may reflect amenity values from living near a body of water, but it may also reflect the fact that these homes are, on average, newer. These differences point to the importance of implementing a repeat-sales model that will partial out all time-invariant differences in home characteristics.

FEMA Flood Zone Data

I retrieve three sets of publicly available FEMA flood zone maps, the FEMA Q3 maps and the National Flood Hazard Layer (NFHL) as of December 2011 and 2022. All three maps represent the flood hazard in the contiguous United States at different points in time. The NFHL is continuously updated and can be downloaded state by state from the FEMA Map Service Center (FEMA, 2021a), however only the latest version is readily available for download at any given time. The Q3 maps represent the first digitized versions of the NFHL and are based on scanned paper maps that were in force between 1996-

[3]For details on data cleaning, see Box-Couillard and Christensen (2024) Appendix 1.

[4]Note that the remaining US states are so called "non-disclosure" states where home sales prices are not public record and thus are not collected by Zillow. Nevertheless, the states in my sample cover over 80% of the US population.

[5]Note that this may reflect the absence of Mississippi, Louisiana and Texas from my sample, all of which contain large African American populations and high shares of homes exposed to flood risk.

2000 (FEMA, 2000). I obtain the Q3 map from replication data published by Hino and Burke (2021). I obtain the 2011 NFHL from data used in An et al. (2023) who, in turn, download this data from the University of Wisconsin-Milwaukee Library.[6] I download the December 2022 data myself from FEMA's Flood Map Service Center. Figure A.1 presents an illustration of the three different flood maps for Lee County, Florida. Areas in blue were already designated as flood zones in 1999, areas in green and red represent the zoned-in regions that I observe in 2011 and 2022.

Since flood maps are continuously updated, I do not know the flood zone status of all properties at all points in time. In order to impute the correct status to each property on each date, one would have to download the universe of flood maps between 2000-2020. There is no easily accessible historical record of all flood maps between 2000 and now. However, there does exist a county-level record of flood zone *changes*. Using FEMA's map service center, I am able to manually retrieve the date of each flood zone change for every county in the contiguous United States.

Flood zone status is imputed as follows. If there is never a flood map update, 2000 status is assigned.

For transactions between 2000-2011: If there is one flood map update between 2000-2010:

$$\text{flood zone} = \begin{cases} \text{2000 Status, if date of sale} < \text{date of map update} \\ \text{2011 Status, if date of sale} \geq \text{date of map update} \end{cases}$$

If there is more than one flood map update between 2000-2010:

$$\text{flood zone} = \begin{cases} \text{2000 Status, if date of sale} < \text{earliest date of map update} \\ \text{2011 Status, if date of sale} \geq \text{latest date of map update} \\ \text{NA, Otherwise} \end{cases}$$

For transactions between 2011-2022: If there is one flood map update between 2011-

[6] Note that this data contains more unknown flood zone statuses than the 1999 or 2022 data. If flood zone status is known in both 1999 and 2022 and does not change between these periods, I conservatively assume that the property was in the same flood zone in 2011.

2022:

$$\text{flood zone} = \begin{cases} \text{2011 Status, if date of sale} < \text{date of map update} \\ \text{2022 Status, if date of sale} \geq \text{date of map update} \end{cases}$$

If there is more than one flood map update between 2011-2022:

$$\text{flood zone} = \begin{cases} \text{2011 Status, if date of sale} < \text{earliest date of map update} \\ \text{2022 Status, if date of sale} \geq \text{latest date of map update} \\ \text{NA, Otherwise} \end{cases}$$

I drop all observations where flood zone status is unknown and keep only properties where flood zone status is known for at least two transactions (ie. only repeat-sales). This leaves me with approximately 26 million observations across over 11 million properties.

In Figure 1, I present the counts of switches into flood zones over my study period. This represents the identifying variation that I exploit. The distribution of switches into flood zones is much more sparse. The majority of switches into flood zones are located in Florida, California, Arizona and around the New York City metropolitan area.[7]

Flood Zone Disclosure Status

I use data from Lee (2021) to determine which states have flood risk disclosure laws. Of the 35 states in my sample, 11 have no disclosure laws. Notably, Florida does not require any flood risk disclosure. The implementation of flood risk disclosure laws occurred progressively between 1990-2003. In my sample, the last state to implement a disclosure law did so in 2002. Since my sample spans the years 2000-2020, very few repeat-sales with a flood zone switch occur before 2002. This should allay concerns that my estimates capture changes in flood risk disclosure laws instead of the effects of flood zoning.

Flooding Data

To identify where and how severe flooding may influence these price differentials, I utilize FEMA data on disaster aid recipients. Specifically, I download FEMA's Individuals

[7]For a map of all homes sold in flood zones see Figure A.2.

and Households Program data (FEMA, 2023). This dataset provides information on aid provided by FEMA to households following a presidential disaster declaration from 2003 onwards. I aggregate damage amounts from flooding by disaster declaration date and by county. I then merge all county-level flood damage amounts to each observation in my main dataset. Seventy-six percent of properties are located in a county that experienced at least one flood between 2003-2020.

Climate Opinions Data

I use the 2020 iteration of the Yale Climate Opinion Maps (YCOM) data to merge climate change beliefs at the county level (Howe et al., 2015). I use this data to assess the importance of beliefs about climate change and its consequences in driving up premiums in less risky areas. This analysis assumes that beliefs were the same at the beginning and end of my sample. This is clearly inaccurate. Awareness of climate change and its consequences has progressed over time. However, my analysis focuses on differences across counties, not over time. Of specific concern is the possibility that climate opinions converge or diverge across geographies over time. Recent work shows that, overall, Americans are becoming more aware and concerned about climate change and its consequences. However, relative differences in climate change beliefs across space remain broadly consistent over time (Marlon et al., 2022).

Single Family Housing Structures

Since 2010, the USGS has provided decennial shapefiles for the location of all structures in the United States, by type of structure (USGS, 2023). I download this data for the year 2020 and restrict the sample of structures to single-family homes. I then spatially merge the structures to the 1999, 2011 and 2022 flood zones and flood zone change dates. This allows me to know the flood zone status of each single-family home in the US between 2000-2020. I aggregate this data to the county level and create a county-level indicator of unsafe housing supply. This indicator represents the share of homes in a flood zone in any given month in any given county.

Methods

I utilize a repeat-sales approach, combined with plausibly exogenous changes in flood zone status over time to estimate the effect of flood zones on racial housing price differentials. This empirical strategy combines recent methods used to estimate racial housing price differentials and flood zone housing price discounts (Bayer et al., 2017, Box-Couillard and Christensen, 2024, Gourevitch et al., 2023, Hino and Burke, 2021, Shr and Zipp, 2019).

In my base specification, I estimate equation 1, where i indexes a transaction, j indexes a property and t indexes time. The dependent variable is the log of the sales price for transaction i and house j at time t. Indicator variables for racial/ethnic groups take a value of one if a homebuyer belongs to the Black, Asian and Hispanic groups and zero for the white group (omitted category). The coefficients $\beta_{1,2,3}$ identify the racial housing price differential *outside* flood zones. The flood zone indicator, $Fldzn_{it}$, switches from 0 to 1 as properties are zoned from outside a flood zone in 1999 to inside a flood zone. This coefficient identifies the flood zone discount for white buyers.

$$\begin{aligned} ln(p_{ijt}) = &\beta_0 + \beta_1 Black_{it} + \beta_2 Asian_{it} + \beta_3 Hisp_{it} + \beta_4 Fldzn_{it} + \\ &\beta_5 Black_{it} * Fldzn_{it} + \beta_6 Asian_{it} * Fldzn_{it} + \beta_7 Hisp_{it} * Fldzn_{it} + \\ &\mu_j + \theta age_{ijt} + cty_t + m_t + \epsilon_{ijt} \end{aligned} \tag{1}$$

Interactions between the racial group indicators and flood zone indicator identify the group-specific flood zone discount. The premium paid by buyers of any racial group inside a flood zone is then obtained by summing $\beta_{1,2,3}$, β_4 and $\beta_{5,6,7}$. These estimates can be interpreted as the percent difference in purchase price for buyers from each of these groups relative to the white group buying a home outside a flood zone. I include property fixed effects, μ_j, to control for time-invariant property characteristics. Age of house, age_{jt}, and calendar month, m_t, fixed effects control for depreciation associated with property age and seasonality in housing prices. Census-tract-by-year fixed effects, cty_t, control for neighborhood-level trends or shocks that could confound our estimates. Examples of such trends and shocks include gentrification, changes in building codes (Bakkensen and Blair, 2022) or past flooding. Following best practices, I cluster standard errors at the level of treatment assignment, which is the property level in this setting (Abadie et al., 2023, Bishop et al., 2020).

This design allows for the comparison of prices for properties across time as they are zoned from outside to inside a floodplain and as the race of the homebuyer changes, while controlling for neighborhood-level changes in unobservables that may be correlated to prices. These estimates are identified as long as, absent a change in race or flood zone and conditioning on fixed effects, home prices are on parallel trends. Identifying variation comes from homes for which both buyer race and flood zone status changes, after controlling for differences in housing prices at the census-tract-by-year level.[8] Census-tract-by-year fixed effects take on additional importance in a context where decisions about flood-zoning depend on neighborhood characteristics that could themselves influence housing prices. For example, substantial new home construction is likely to change housing market dynamics in a neighborhood. It may also influence the timing of flood map updates as well as neighborhood racial composition. Tract-by-year fixed effect will absorb variation in prices at the census-tract level that may be correlated to re-zoning timing, racial composition and housing prices.

I highlight a few remaining identification concerns. Although my overall sample is very large, Table A.1 shows that the number of Asian or Black buyers in a Flood Zone is low at 13,089 and 7,496, respectively. This is especially problematic in analyses that study subsets of the original sample, where I may not have enough power to detect an effect. Another potential concern pertains to the accuracy of the Ethnicolr algorithm. In Table A.2, I address these concerns by comparing results using an alternate algorithm and limiting my sample to observations for which the Ethnicolr algorithm is very confident about its prediction. My results are robust to these alternate specifications.

While most homes are rezoned as part of the normal FEMA-led process, a small portion of flood zone changes are initiated by communities requesting a flood zone change.

[8]Note that homes without a change in race or in floodzone status are still included in the regression as they identify the fixed effects.

These modifications are less likely to be plausibly-exogenous. In Panel A of Table A.3 I address these concerns by removing properties that undergo this type of flood zone change. My results are almost identical. Another concern stems from the fact that some flood zone change patterns are unusual. I observe that a subset of properties are outside a flood zone in the 1999 map, then inside in the 2011 map and then back outside in the 2022 map. In Panel A of Table A.3 I show that my results are robust to excluding these properties. As highlighted in Nowak and Smith (2018), home remodels or renovations may bias results as they are not captured by property fixed effects and may vary by race and flood zone status. For example, homes in flood zones may be more likely to be "flipped", and these flipped homes may be more likely to be sold from white sellers to white buyers. This may lead to an overestimation of the flood zone discount for non-white buyers. In Panel B of Table A.3, I utilize information in the ZTRAX data to show that, if anything, ignoring home remodels appears to bias my results toward zero. Limiting my sample only to homes that are remodeled at some point actually increases both the outside of flood zone price differentials and the inside flood zone discount.

Finally, it is possible that groups differentially sort into newly-minted flood zones. While general sorting into flood zones is not a concern due to the nature of my identification strategy (ie. only relying on homes that switch into a flood zone), sorting into switched-in homes would be problematic. For example, if Hispanic buyers are more likely to buy a home that switched from being outside to inside a flood zone and homes inside flood zones sell for less on average, then my estimates will overestimate the flood zone discount for Hispanic buyers. To check whether this type of sorting is occurring, I regress an indicator of seller to buyer race switch on an indicator for whether a home was switched-in to a flood zone, property fixed effects, a house age control, tract-by-year and calendar month fixed effects. In Table A.4 I show that, conditional on the aforementioned fixed effects, switches in buyer race are not correlated to re-zoning into a flood zone.

Results

Overall

I begin the analysis by measuring the effect of flood zone status on racial housing price differentials. Table 1 presents estimation results from three different specifications. In the first column, I estimate a specification that interacts buyer race with 2022 flood zone status, controlling for house age, property, tract-by-year and calendar month fixed effects. The uninteracted coefficients represent the premium (or discount) paid by Asian, Hispanic or Black buyers to buy a home outside an area that was in a flood zone in 2022. The interacted coefficients represent the additional premium (or discount) that an Asian, Hispanic or Black buyer would pay inside a flood zone. Note that these estimates cannot be interpreted causally, since flood zone status is likely to be correlated to a host of other factors that may be associated to housing prices. Also, the overall flood zone discount cannot be identified in this specification as it is absorbed by the property fixed effect. Nevertheless, they serve as a useful benchmark since I can include the full repeat-sales sample in this regression. Results from this specification imply that Hispanic and Black homebuyers pay premiums of 3.1 and 3.2% outside flood zones compared to white buyers. Asian buyers obtain a 0.6% discount. Inside flood zones, the premiums for Hispanic and Black buyers are reduced by approximately 20% to 2.4 and 2.5%, respectively.

In the second and third columns of Table 1, I present causal estimates of the effect of flood zone status on racial price differentials. In the second column, I replace census-tract-by-year fixed effects with county-year fixed effects in order to benchmark my results with previous work on flood zone discounts (Gourevitch et al., 2023, Hino and Burke, 2021). In this specification, I find that the uninteracted flood zone discount is not statistically different from zero. That is, a white buyer pays the same price for housing inside vs. outside flood zones. Asian, Black and Hispanic buyers receive discounts of 1.8%, 2.6% and 5.1% inside relative to outside flood zones, respectively. Considering Black and Hispanic buyers pay premiums of over 3% outside flood zones, these results imply that the premium is totally erased inside flood zones. A weighted average of these estimates yields a total discount of 1% inside flood zones for all buyers, compared to the approximately 2% discount found in previous work (Gourevitch et al., 2023, Hino and Burke, 2021).[9]

If home prices appreciate at different rates in different neighborhoods within a county, the estimates in column 2 are likely to be biased. Indeed, it is possible that homes rezoned into flood zones are also located in census-tracts with below-average appreciation, for example due to past flooding events or degentrification. Specifications without tract-by-year fixed effects would then overestimate the effect of flood zones in lowering prices by conflating lower price growth with the effect of flood zones. Results presented in the third column imply that this is indeed the case, especially for Hispanic and NH Black minorities, who may be particularly likely to purchase homes in these areas. The estimates presented in this column imply a 2.3% (-0.008-0.015) flood zone discount for Hispanic buyers and a 2.6% (-0.008-0.018) discount for Black buyers. White buyers obtain a 0.8% flood zone discount while Asian buyers obtain a 2.5% discount. For the remaining analyses in this paper, I use this specification as my baseline model.

Figure 2 presents, graphically, the premiums paid by different racial and ethnic groups compared to a white buyer purchasing a home outside a flood zone. White buyers in a flood zone obtain a 0.5% discount compared to white buyers outside flood zones. Theory predicts that, in the presence of discrimination against Black and/or Hispanic minorities, one would expect both groups to pay premiums relative to white buyers regardless of flood zone status, but lower premiums inside than outside flood zones. My results imply that this is indeed the case. African American buyers pay a 3.6% premium outside flood zones, but pay a significantly lower premium of 1.0% inside flood zones. Similarly, Hispanic buyers pay a 3.3% premium outside flood zones and a 1.1% premium inside flood zones. Asian buyers obtain a discount regardless of flood zone status, but pay significantly less inside flood zones (-3.1%) than outside flood zones (-0.07%). Taken together, these results imply that housing may be easier to access in risky areas (inside SFHAs) than in safe areas (outside SFHAs).

[9]Note that these estimates are not based on the same samples. Both previous studies have data on homes sold in all US states. In fact, major states that are omitted in my study include Texas and Louisiana, states where flood zone discounts are very large as reported in Gourevitch et al. (2023).

Flood Risk Disclosure Status

Previous work has shown that information plays an important role in mediating environmental injustice. Hausman and Stolper (2021) show that even in cases where information is uniformly limited among groups, low-income households sort into higher-pollution neighborhoods. In the context of flood risk, Weill (2023) shows that Black and Hispanic populations are disproportionately more likely to live in areas with inaccurate flood maps. Using the theoretical framework proposed by Becker (1971), if increased awareness of flood risk leads to increased demand for housing in safe areas, then price differentials for Black and Hispanic buyers are likely to be higher in areas that mandate more stringent flood risk disclosure.

In this section, I examine the role that information provision plays by splitting my sample by flood risk disclosure status. There are 10 states in my sample that require no flood risk disclosure of any kind. In the 24 other states and the District of Columbia flood risk disclosure requirements vary, but at minimum sellers must disclose whether the home is located inside an SFHA.

Figure 3 presents, graphically, the premiums paid inside and outside flood zones by homebuyers of different groups compared to a white buyer outside a flood zone. The leftmost panel presents the overall estimates obtained in column 3 of Table 1, the middle and right panels present the results by flood zone disclosure status. The flood zone discount for white buyers is small and not statistically significant in non-disclosure states (-0.04%) but is larger and significant in disclosure states (-0.9%). Premiums in flood zones for Black, Hispanic and Asian buyers in non-disclosure states are not statistically different from these same premiums in disclosure states. However, premiums in safer areas outside flood zones are significantly higher in disclosure states than in non-disclosure states. Hispanic buyers pay a 3% premium to live in safe areas in non-disclosure states but this premium rises to 3.5% in disclosure states. Black buyers' premiums in safe areas rise from 3.3% in non-disclosure states to 3.7% in disclosure states. Asian buyers' discount is also reduced in disclosure states, from 1.5% to 0.4%. These results are indicative of a pattern whereby, where information is most salient, there may be more competition for housing in safer areas thereby driving up premiums for minority homebuyers.

Flooding

I continue my exploration of the role of information and salience by studying the role of recent floods in shaping price differentials. Recent work has shown that hurricanes in Florida drive up housing prices by restricting the supply of available housing in the three years following a hurricane (Zivin et al., 2023). If recent flooding events make flood risk more salient and further increase demand for housing outside flood zones, then it is likely that price differentials will be even higher outside flood zones in areas that experienced flooding. Using FEMA data on disaster aid recipients, I identify counties where flooding occurred in the three years prior to a home sale.[10]

In Figure 4, I present the price differentials paid by white, Asian, Hispanic and Black buyers by flood zone status and by flooded status for my entire sample. Due to a reduced sample size, flood zone discounts for white buyers are non-existent in both flooded and unflooded areas. Outside of flood zones, Hispanic and African American buyers pay substantially more for housing in counties that experienced a flood in the past three years than in counties that did not. Premiums for safe housing in flooded counties are of 5.3% and 4.9% for Hispanic and Black buyers, respectively. Compared to 3.2% and 3.4% in unflooded counties. These results point to increased competition for housing that is considered "safe" in neighborhoods or housing markets that recently experienced a flood. This increased competition drives up premiums for minorities in these areas.

Beliefs

Recent work has shown that beliefs can play an important role in determining home values in areas at risk of inundation. Discounts for living in risky areas are generally larger in neighborhoods where residents are more worried about climate change (Baldauf et al.,

[10]Previous studies have shown that the effect of flooding on housing prices or flood insurance take-up lasts for about three years (Beltrán et al., 2019, Gallagher, 2014, Gibson and Mullins, 2020, Ortega and Taspinar, 2018, Zivin et al., 2023). Note that using 2 years or 5 years instead does not significantly alter my results. Similarly, using only very damaging floods does not materially change results.

2020, Barrage and Furst, 2019, Bernstein et al., 2019). In these areas, it is likely that there is more competition for safer housing, once again driving up premiums for racial minorities. I utilize data from the YCOM to split my sample by beliefs about climate change. Specifically, I split my sample by the share of individuals in a county that believe climate change will personally harm them.[11]

Figure 5 presents these results. Results inside flood zones are imprecisely estimated and confidence intervals across groups overlap in most cases. Outside flood zones, however, differences become more stark. Consistent with previous results, Hispanic and African American buyers pay the most for housing in safe areas. Hispanic and Black buyers pay a 2.7% and 2.6% premium compared to white buyers outside flood zones in counties with a relatively low proportion of individuals who worry that climate change could personally harm them. In contrast, in counties where a relatively large proportion of individuals believe climate change will harm them, Hispanic and Black buyers pay premiums of 3.5 and 3.4% compared to white buyers in these same counties. Although these estimates do not imply that beliefs drive premiums, they are again indicative of a pattern whereby salience of flood risk may increase competition for housing in safer areas and drive up differentials for disadvantaged minorities outside SFHAs.

A formal test for the effect of increased competition for safe housing

I have presented evidence that is consistent with the hypothesis that increased competition for safe housing may impose important barriers for African American and Hispanic buyers looking to buy a home in safer areas. In this section, I attempt to test this mechanism more formally. I construct a variable, $\%Fldzn_{ct}$, that reflects the share of single-family homes inside a flood zone in any given county in any given month. This can be interpreted as the share of "unsafe" housing in any given county at any given time.

I estimate, for the sample of homes that are located outside of flood zones ("safe

[11]Note that the county is the most granular geography for which the YCOM is available.

homes").:

$$
\begin{aligned}
ln(p_{ijt}) = & \beta_0 + \beta_1 Black_{it} + \beta_2 Asian_{it} + \beta_3 Hisp_{it} + \beta_4 \%Fldzn_{ct} + \\
& \beta_5 Black_{it} * \%Fldzn_{ct} + \beta_6 Asian_{it} * \%Fldzn_{ct} + \beta_7 Hisp_{it} * \%Fldzn_{ct} + \\
& \mu_j + \theta age_{ijt} + cty_t + m_t + \epsilon_{ijt}
\end{aligned} \tag{2}
$$

where i indexes a transaction, j indexes a property, c indexes a county and t indexes time. The dependent variable is the log of the sales price for transaction i and house j at time t. Indicator variables for racial/ethnic groups take a value of one if a homebuyer belongs to the Black, Asian and Hispanic groups and zero for the white group (omitted category). The coefficients $\beta_{1,2,3}$ identify the racial housing price differential in counties where there are no homes inside flood zones. The coefficients β_4 and $\beta_{5,6,7}$, identify the effect of increasing the share of homes inside a flood zone in a county by 1 percentage point for a white, Black, Asian or Hispanic buyer, respectively. I include the same controls and fixed effects as in previous specifications. $\%Fldzn_{ct}$ varies plausibly-exogenously, conditional on the included fixed effects, as homes are zoned into and out of flood zones over time. This specification allows for a test of the effect that a restriction on the safe supply of housing has on the relative prices of safe housing.

In Figure 6, I present results from the above regression. Since interpreting the coefficients directly is of little practical use, I apply the delta method to obtain estimates of premiums paid by different racial groups in different types of counties. All estimates in this figure are relative to a white buyer in a county where there are no homes in a flood zone. Compared to this baseline scenario, white buyers in a county at the median share (2%) of flood zoned homes ("median risk county") pay 0.4% more for housing. White buyers in a county at the 90th percentile (14.25%) of share of flood zoned homes ("high risk county") pay a 2.6% premium. Strikingly, Black and Hispanic buyers in high risk counties pay over 6% more than whites in no risk counties for safe housing and more than double the premium that Asian or white buyers face in similar counties. As flooding becomes more frequent due to climate change, flood zones expand, further restricting access to safe housing for Black and Hispanic buyers.

There are a few concerns with this measure, as it may not perfectly capture the supply of safe housing at any given time. First, the USGS data is not updated yearly and as such my measure implictly assumes that housing supply in 2020 is the same as in 2000. This is not likely to be the case. It is likely that there are more housing units in 2020 than in 2000 and that this housing was built outside formal flood zones. This implies that my measure of unsafe housing supply is likely to underestimate the true share of safe housing, especially in earlier years of my sample. In addition, characteristics of homes on the market at any given time may differ from the overall housing stock in a county. It is possible that homes in flood zones are more or less likely to be on the market than the average home. In general, classical measurement error will lead to a bias toward 0, but it is not possible to anticipate the exact direction of the bias if the measurement error is not random. Nevertheless, this measure acts as a convincing proxy for the true supply of unsafe housing.

Neighborhood Racial Composition and Seller Race

Box-Couillard and Christensen (2024) show important interactions between neighborhood racial composition and racial and ethnic price differentials. Specifically, they find that premiums are highest in high own-share neighborhoods. This evidence is consistent with recent work on homophily preferences, showing that individuals have preferences for living in areas with high own-group representation (Aliprantis et al., 2022, Caetano and Maheshri, 2019, Davis et al., 2023). In Figure 7, I explore interactions between neighborhood racial composition and flood zone price differentials.

Consistent with previous work, I find that racial minorities pay more for housing in areas with a high share of residents of their own group.[12] Premiums are highest for homes in census-tracts with a high proportion of own-group inhabitants and outside flood zones. The premiums reach 4% for Hispanic buyers and 4.8% for black buyers, compared to 1.8% for both groups outside flood zones in low own-share neighborhoods. This may

[12]Note that here a "high" own-group share is defined as a census tract where more than 5% of the population is of one's own group.

have important implications for sorting into flood zones. For example, a Hispanic buyer who would like to live in a neighborhood with a relatively larger share of Hispanic residents can do so much more cheaply by moving to a flood zone, where they would pay a 1.1% premium. This premium is similar to that in low Hispanic share neighborhoods. It has been shown that homophily preferences may play a role in neighborhood sorting (Aliprantis et al., 2022, Caetano and Maheshri, 2019, Davis et al., 2023) and that Hispanic buyers may have a lower willingness-to-pay to avoid flood risk (Bakkensen and Ma, 2020). These observations, combined with the result that price differentials are much lower in high Hispanic share neighborhoods inside flood zones may explain the higher shares of Hispanic residents in high flood risk areas.

In Figure 8, I interact buyer and seller race. I define any sale from a seller to a buyer of a different race/ethnicity as an "outgroup" sale and a sale between members of the same group as an "ingroup" sale. I find that outgroup premiums are higher, no matter their flood zone status. This may reflect lower discriminatory barriers when transacting with an own-group buyer. For Black buyers, premiums remain lower inside flood zones than outside them. However, for Asian and Hispanic buyers, ingroup and outgroup premiums are virtually identical inside vs. outside flood zones. That is, for example, a Hispanic buyer buying a home from a non-Hispanic seller *inside* a flood zone pays the same premium as a Hispanic buyer buying a home from a non-Hispanic seller *outside* a flood zone.

I further investigate this finding by studying how the probability of buying a homes from a seller of one's own race/ethnicity differs by flood zone status. In Table 2, I present results from a regression of ingroup seller status (any sale where the seller and buyer are of the same race) on flood zone status for all minority groups and for each group separately. Overall, 23% of buyers from minority groups buy homes from sellers of their same race/ethnicity, however this proportion increases by 7.5 p.p. or 33% inside floodzones. This increase is driven exclusively by Hispanic buyers, whose probability of transacting with a fellow Hispanic seller rises from 28% outside flood zones to 39% inside them. Taken together, these results point to a mechanism whereby Hispanic buyers obtain a significant discount (on average) inside flood zones because they are much likelier to transact with Hispanic sellers in these areas.

Discussion

In the United States, persons of color are predicted to bear the brunt of costs from increased flooding due to climate change (Wing et al., 2022). The role that housing discrimination plays in influencing households' decisions to live in higher risk areas is, as of yet, unexplored. This paper provides the most comprehensive evidence to date on how environmental (dis)amenities are related to housing price differentials and housing discrimination in the U.S. housing market. I assemble a sample of 26M home sales spanning the period 2000-2020, matching the flood zone status, housing characteristics and race of the buyers and sellers involved in each transaction.

I find that Black and Hispanic homebuyers pay 3.3-3.6% more than white buyers for equivalent housing outside flood zones. Flood zone status reduces these premiums by 60% to approximately 1%. Information about flood risk and flood risk salience play an important role in moderating these premiums. Premiums for homes in safe areas are highest for Black and Hispanic buyers in states that require flood risk disclosure, in neighborhoods that recently experienced flooding or in counties where a large proportion of individuals is worried about climate change. I also find that as the supply of safe housing is reduced in any given county, the price of safe housing increases and more so for Black and Hispanic buyers. These results are indicative of a pattern whereby price premiums for homes in areas with lower flood risk are highest where flood risk is most salient and where competition for safe housing is fiercest.

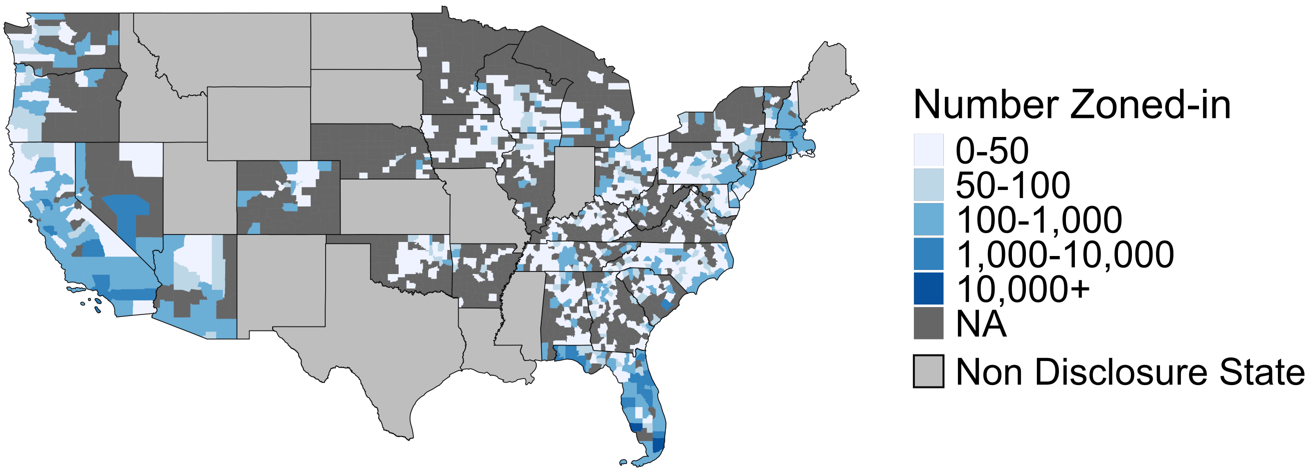
I further examine mechanisms underlying these results. Consistent with homophily preferences, buyers pay more for housing in areas with higher concentrations of own-group residents and pay the most for housing that is both in a high own-share neighborhood and outside a flood zone. I also analyze seller-buyer interactions. I find that buyers pay lower premiums when purchasing a home from a seller of their own race, but that these premiums vary little by flood zone. Further, I find evidence that there are substantial differences in the racial composition of sellers inside flood zones. Hispanic buyers in particular are much likelier to purchase a home from a member of their own racial/ethnic group inside a flood zone and obtain a discount relative to Hispanic buyers buying from a non-Hispanic seller. Taken together, this evidence points to important interactions between discriminatory constraints, location choice and flood risk.

These results imply that minority homebuyers are likely to face less constraints in purchasing a home in areas that are at higher risk of flooding. This may encourage persons of color to relocate or remain in riskier areas. This is likely to cause important welfare losses. First, due to direct costs related to flooding and insurance. Second, due to reduced home equity as flood risk becomes more salient and demand for housing in risky areas falls as a result of climate change.

Policies aimed at reducing discrimination more generally are likely to decrease barriers to homeownership outside flood zones and make purchasing a home outside a flood zone easier for minority individuals. In regards to flood risk communication and policy, providing accurate and unbiased flood maps is likely to be welfare improving. Given the impact that FEMA flood maps have in shaping price differentials and location choices, it is important that flood risk be mapped accurately. The pertinence of continuing to use discrete (high/low/no risk) flood risk designations is also questionable in as much as flood is risk not discontinuous and the creation of discontinuous risk zones may implicitly encourage segregation. In addition, when designing buyout programs, policymakers should be aware of the fact that Black and Hispanic buyers are likely to pay much more for housing outside flood zones than whites (as well as receiving less for their home than whites (Jowers et al., 2022)). This may further discourage such buyers from accepting a buyout offer.

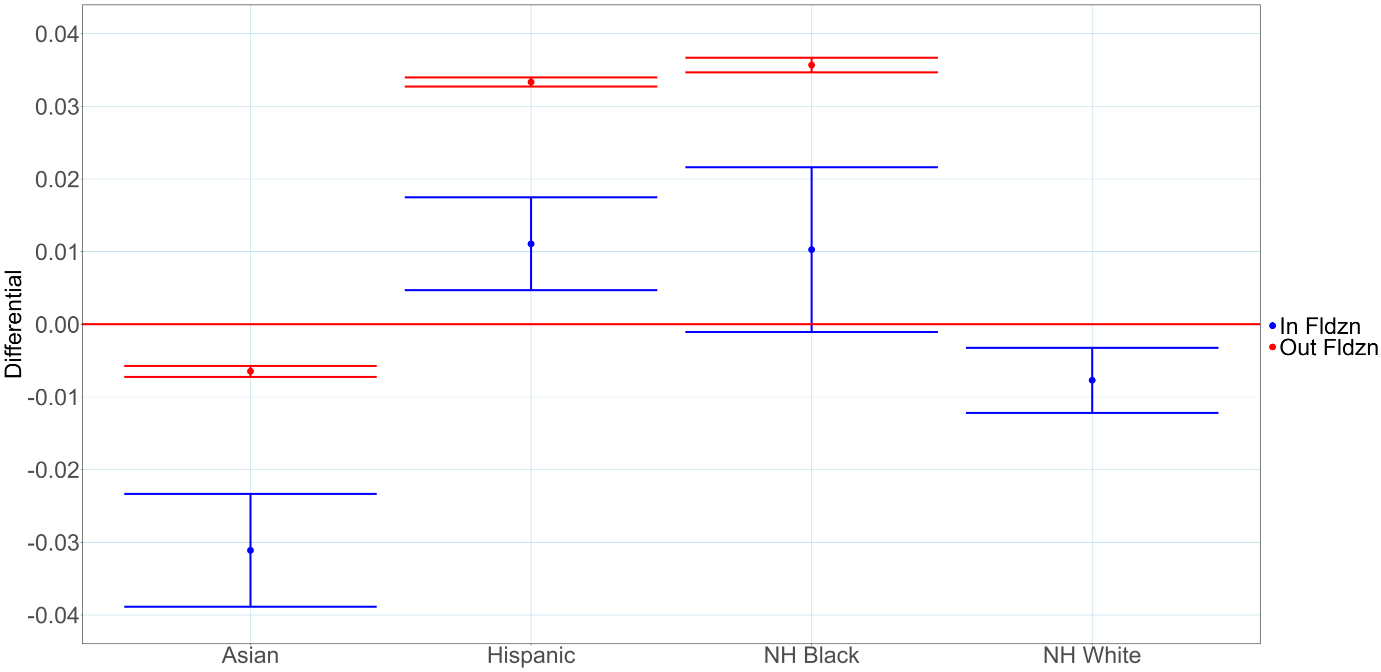
Figures

Figure 1. Source of Variation: Number of properties zoned into a Flood Zone



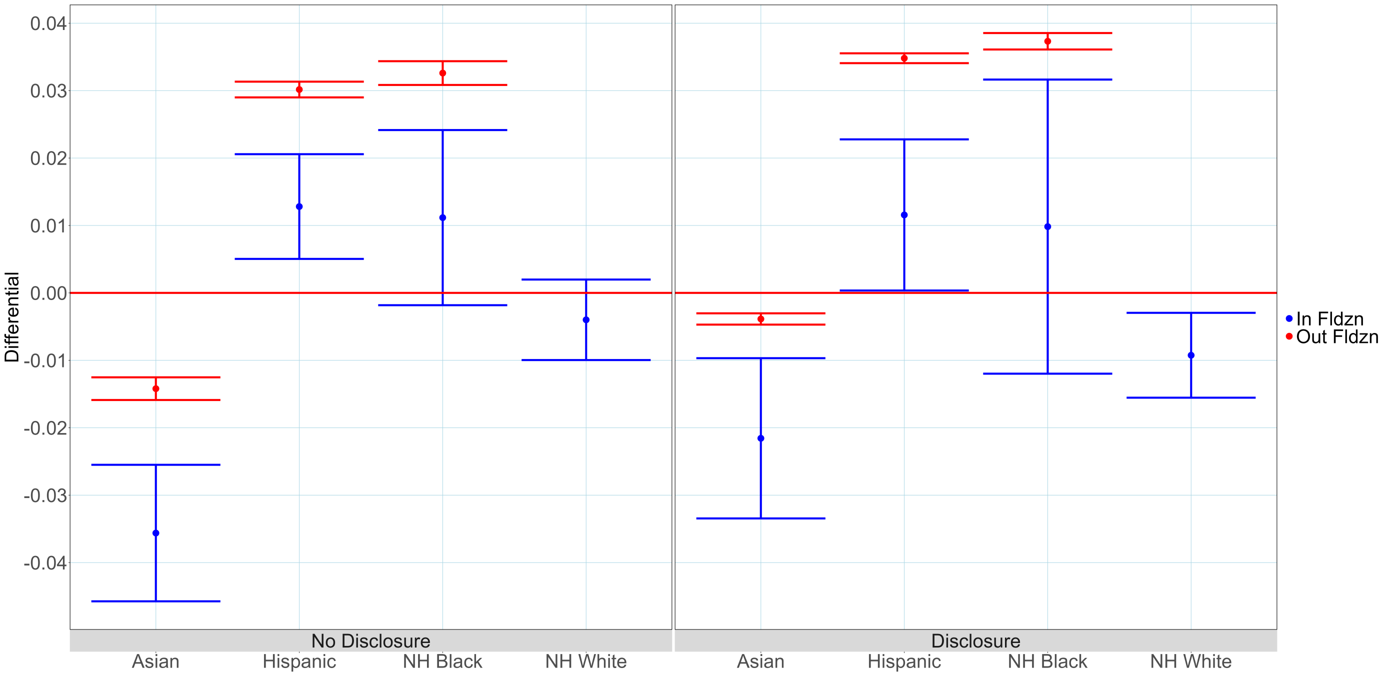
Notes: This figure shows the number of homes sold in each county that are zoned into a flood zone between 1999 and 2020. States in light-gray are non-disclosure states that are not included in my sample.

Figure 2. Average Price Premiums by Flood Zone



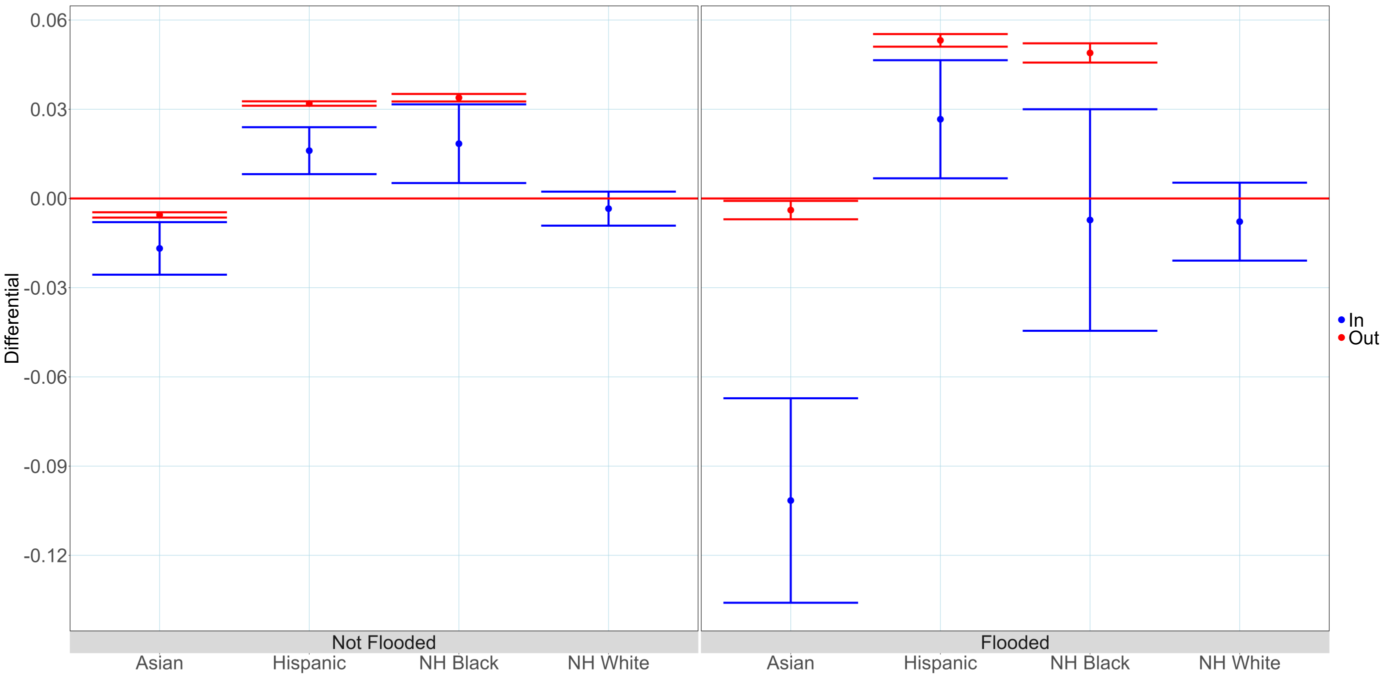
Notes: This figure shows, graphically, the results from Table 1 column 3 estimating equation 1. Regression includes property, tract-by-year and calendar month FEs as well as a house age control. 95% confidence intervals are based on cluster-robust standard errors at the property level.

Figure 3. Average Price Premiums by Flood Zone and Flood Risk Disclosure



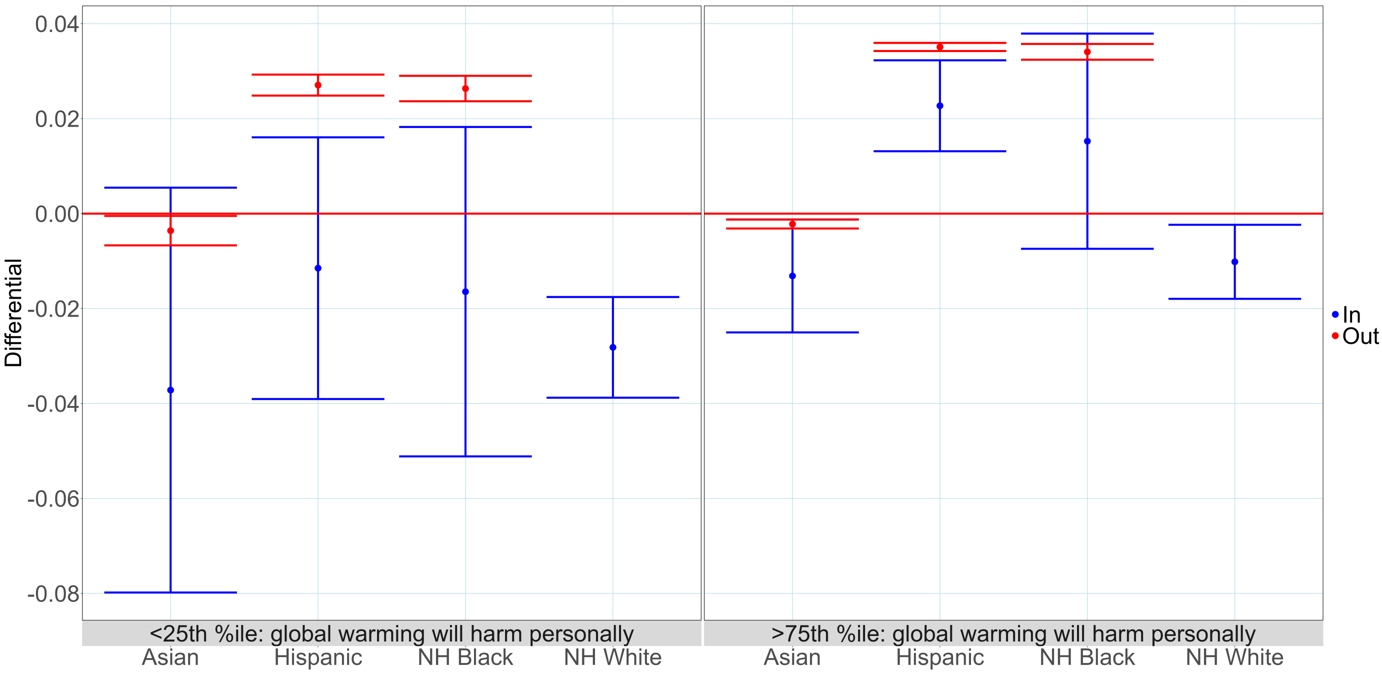
Notes: This figure shows, graphically, the results from estimating equation 1 separately for homes in flood risk disclosure and non-disclosure states. Regression includes property, tract-by-year and calendar month FEs as well as a house age control. 95% confidence intervals are based on cluster-robust standard errors at the property level.

Figure 4. Average Price Premiums by Flood Zone and Flooding: County-level Flooding Indicator



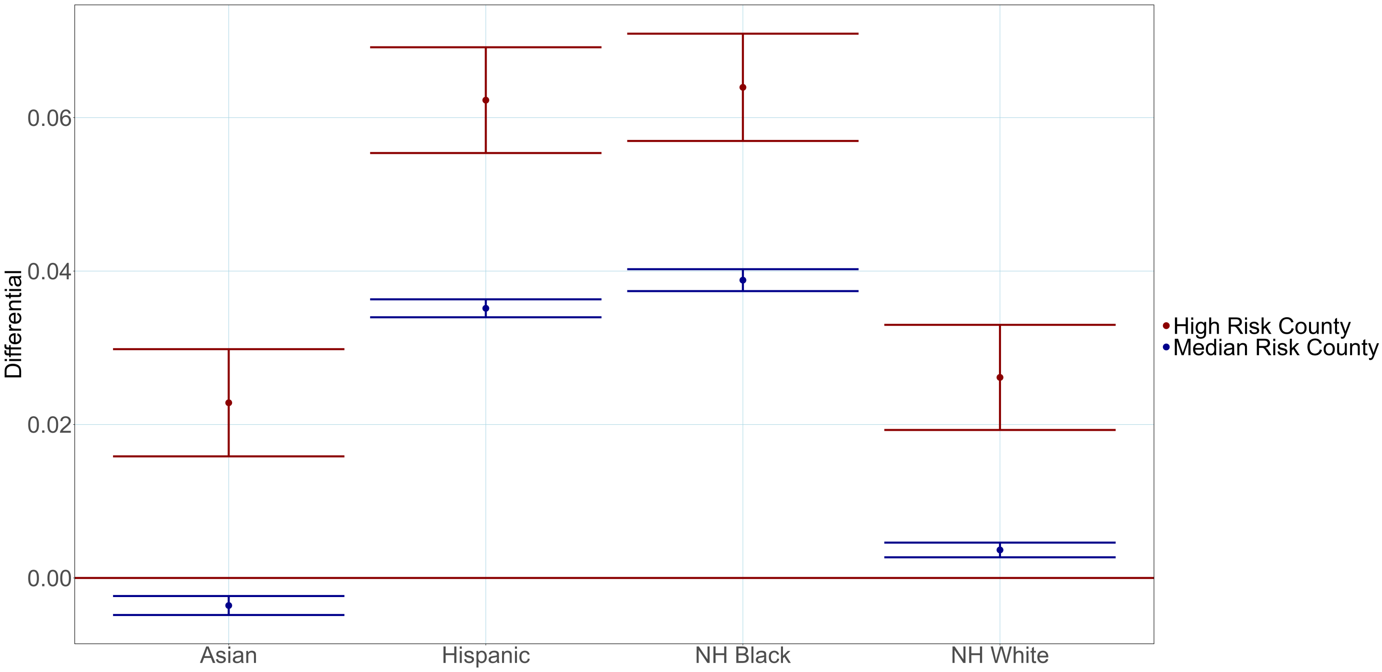
Notes: This figure shows premiums paid by buyers of each group inside and outside floodzones and by flooded status. Flooded status is defined as any home in a county that experienced some flooding in the past 3 years. Regression includes property, tract-by-year and calendar month FEs as well as a house age control. 95% confidence intervals are based on cluster-robust standard errors at the property level.

Figure 5. Average Price Premiums by Flood Zone and Belief That Climate Change will Harm Personally



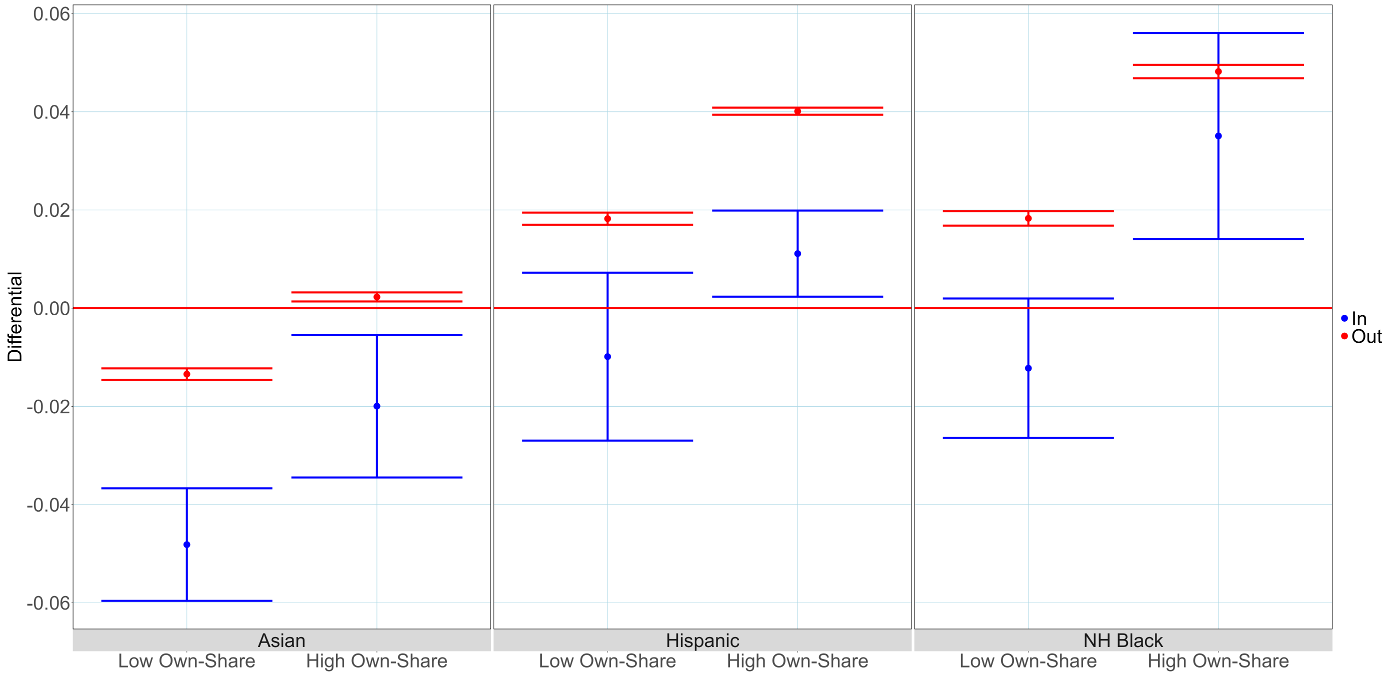
Notes: This figure shows premiums paid by buyers of each group inside and outside flood zones above or below the 75th and 25th %iles of county-level proportion of individuals who believe global warming will harm them personally a moderate amount or a great deal. Regression includes property, tract-by-year and calendar month FEs as well as a house age control. 95% confidence intervals are based on cluster-robust standard errors at the property level.

Figure 6. Price Differentials for Safe Housing by Share of Risky Housing



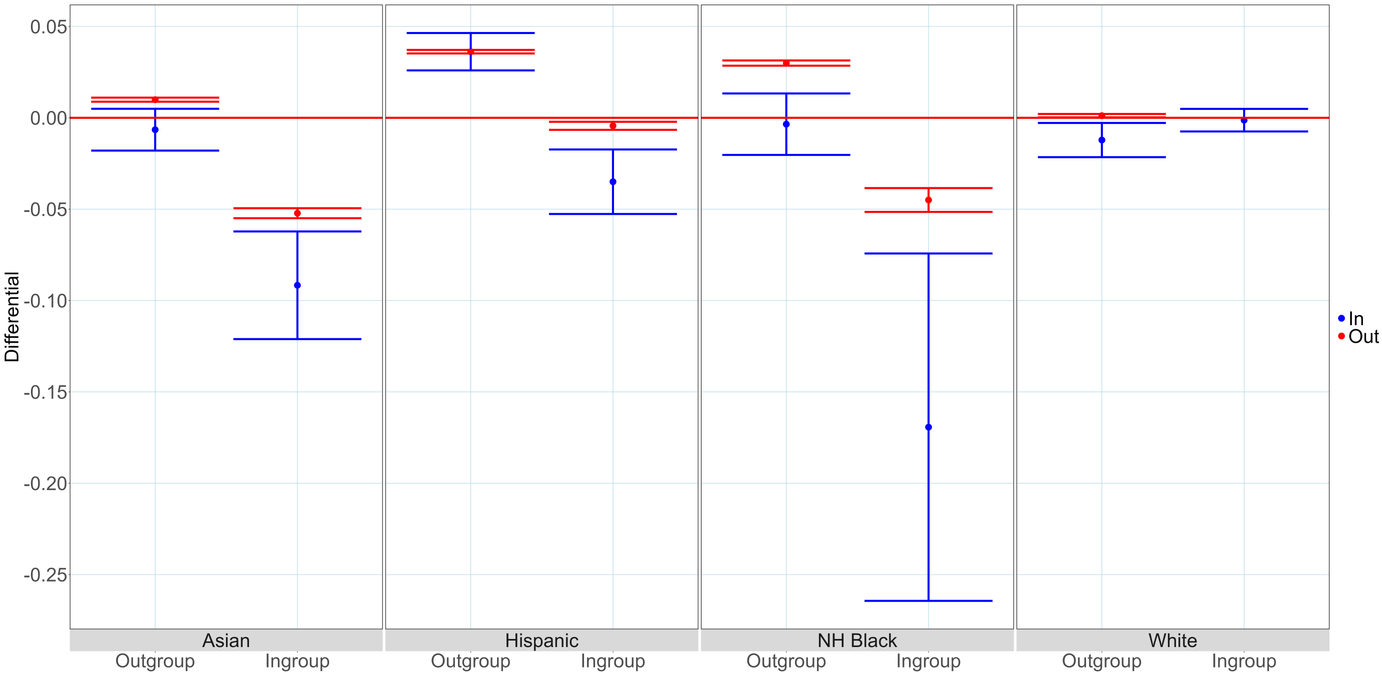
Notes: This figure shows premiums paid by buyers of each racial group outside floodzones, by the share of housing stock in each county that is inside a flood zone. The reference category is a white buyer in a county where 0% of the housing stock is in a flood zone. The median proportion of single-family households located in a flood zone in any given county is 2% ("Median Risk County"). The 90th percentile is 14.25% ("High Risk County"). Regression includes property, tract-by-year and calendar month FEs as well as a house age control. 95% confidence intervals are based on cluster-robust standard errors at the property level.

Figure 7. Average Price Premiums by Flood Zone and Neighborhood Racial Composition



Notes: This figure shows premiums paid by buyers of each group inside and outside flood zones and by census-tract racial composition. High own-share neighborhoods are defined as those with a greater than 5% share of own-race individuals. Regression includes property, tract-by-year and calendar month FEs as well as a house age control. 95% confidence intervals are based on cluster-robust standard errors at the property level.

Figure 8. Average Price Premiums by Flood Zone and Seller Race



Notes: This figure shows premiums paid by buyers of each group inside and outside flood zones and by seller race. High own-share neighborhoods are defined as those with a greater than 5% share of own-race individuals. Regression includes property, tract by year and calendar month FEs as well as a house age control. 95% confidence intervals are based on cluster-robust standard errors at the property level.

Tables

Table 1. Effect of Flood Zone Status on Racial Housing Price Differentials

	Heterogeneity by Flood Zone	Causal Estimates: County*Year FE	Causal Estimates: Tract*Year FE
Flood Zone		−0.0001	−0.008***
		(0.002)	(0.002)
Asian	−0.006***	−0.010***	−0.006***
	(0.0003)	(0.0004)	(0.0004)
Hispanic	0.031***	0.035***	0.033***
	(0.0002)	(0.0003)	(0.0003)
NH Black	0.032***	0.036***	0.036***
	(0.0004)	(0.001)	(0.001)
Asian * Flood Zone	0.0004	−0.018***	−0.017***
	(0.002)	(0.004)	(0.004)
Hispanic * Flood Zone	−0.007***	−0.051***	−0.015***
	(0.001)	(0.003)	(0.003)
NH Black * Flood Zone	−0.007***	−0.026***	−0.018***
	(0.002)	(0.006)	(0.006)
Comparison Mean	251,045	234,445	234,445
Property FE	Yes	Yes	Yes
House Age Control	Yes	Yes	Yes
Tract x Year FE	Yes	No	Yes
County x Year FE	Yes	Yes	No
Calendar Month FE	Yes	Yes	Yes
Properties	15,443,005	11,047,558	11,047,558
Observations	37,165,079	25,413,668	25,413,668

Notes: This table presents estimates for the effect of SFHA zoning on racial housing price differentials. First column presents estimates based on the entire ZTRAX sample, matched to 2020 flood zones. Second column presents causal estimates based on switches in flood zone status over the period 2000-2020, in this specification I keep only observations that were not in a flood zone in 2000 and for which the flood zone status is known throughout our 20 year sample. All regressions include property, tract by year and calendar month FEs as well as a house age control. Cluster-robust standard errors at the property level in parentheses. *p<0.1; **p<0.05; ***p<0.01

Table 2. Probability of Ingroup Seller for Minorities

	All Minority Groups	Asian	Hispanic	NH Black
Flood Zone	0.075***	−0.015***	0.112***	−0.020***
	(0.003)	(0.005)	(0.004)	(0.003)
Comparison Mean	0.23	0.22	0.28	0.08
Property FE	Yes	Yes	Yes	Yes
House Age Control	No	No	No	No
Tract x Year FE	No	No	No	No
Calendar Month FE	No	No	No	No
Observations	3,357,486	924,729	1,786,608	646,149

Notes: This table presents estimates for the effect of flood zone status on the probability that a non-white buyer purchases a home from a member of their own group. *p<0.1; **p<0.05; ***p<0.01

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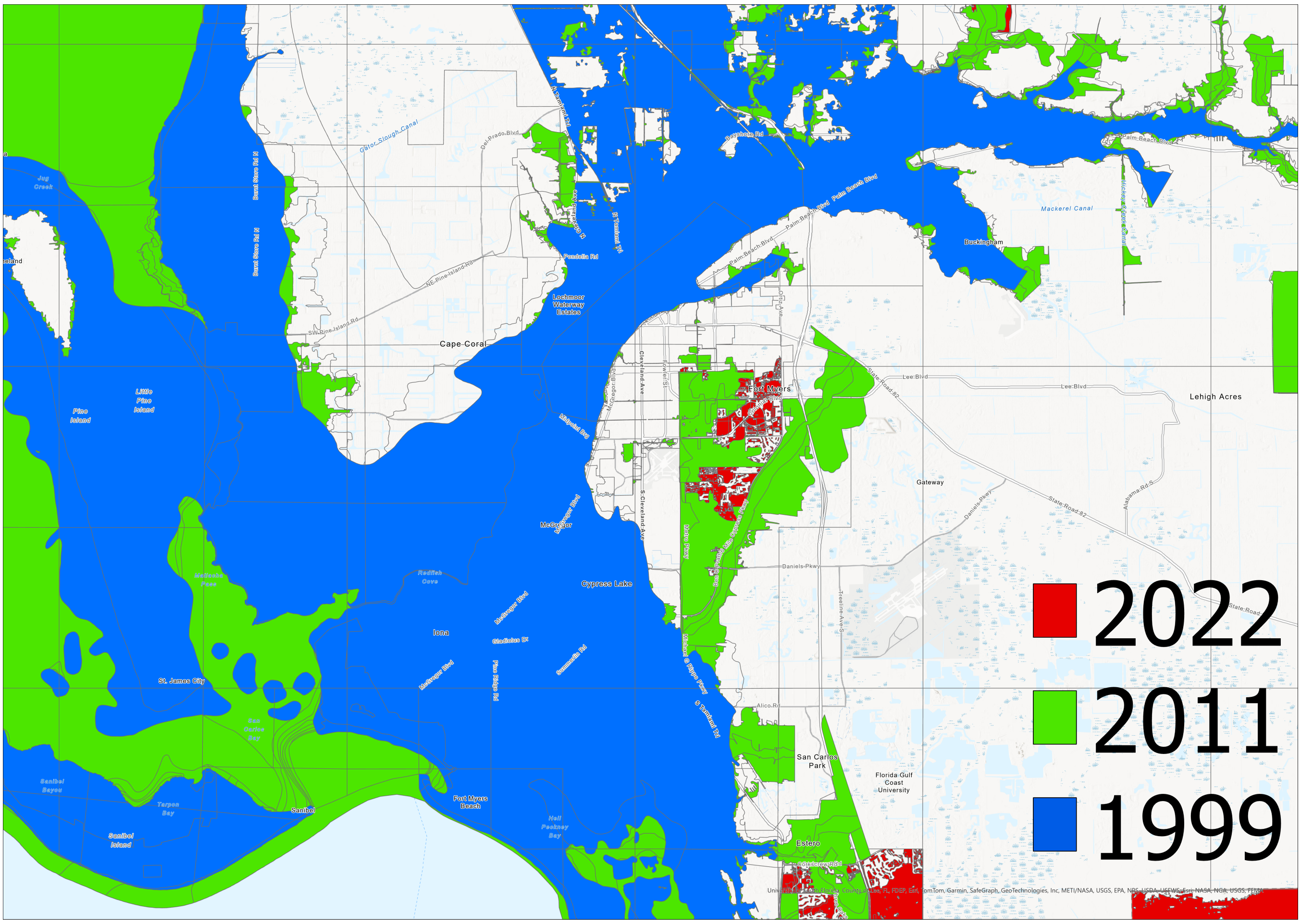
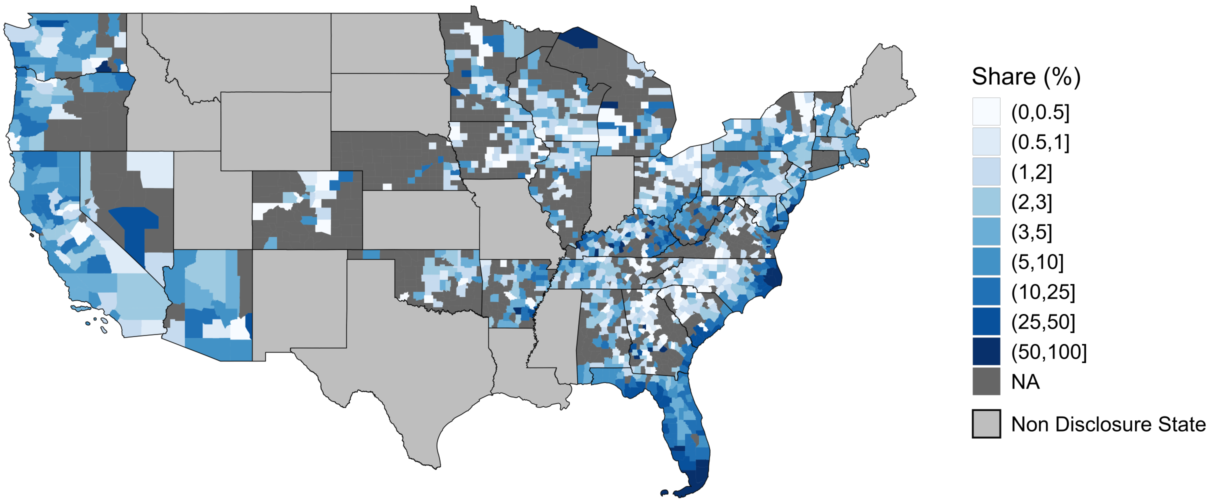
Appendix

Figure A.1. Flood Map Changes in Lee County, FL



Notes: This figure shows the areas mapped as SFHAs in the 1999, 2011 and 2022 versions of the FEMA flood maps for Lee County, FL.

Figure A.2. Percent of Homes in Dataset Sold in a Flood Zone



Notes: This figure shows the percent of homes sold per county in the raw Zillow ZTRAX data that are in an SFHA at any point in my sample. States in light-gray are non-disclosure states that are not included in my sample.

Table A.1. Descriptive Statistics

Panel A: Outside Flood Zone

	All	NH White	Asian	Hispanic	NH Black
# of Observations	26,334,499	21,380,602	1,337,826	2,646,595	969,476
# of Properties	10,997,483	10,286,883	1,099,617	2,025,029	881,182
Fraction of Obs.	1	0.81	0.05	0.10	0.04
Mean Sales Price ($)	234,386	229,153	350,139	228,971	204,862
Median Sales Price ($)	183,900	180,000	283,000	188,000	164,000
Mean # of Bedrooms	2.88	2.88	2.88	2.91	2.90
Median # of Bedrooms	3	3	3	3	3
Mean # of Full Bathrooms	1.79	1.79	1.90	1.77	1.78
Median # Full Bathrooms	2	2	2	2	2
Mean House Age	32.16	32.10	29.29	33.99	32.37
Median House Age	24	23	21	29	24
Mean Ethnicolr Certainty	0.86	0.87	0.83	0.81	0.69
Median Ethnicolr Certainty	0.91	0.92	0.89	0.86	0.66

Panel B: Inside Flood Zone

	All	NH White	Asian	Hispanic	NH Black
# of Observations	258,501	203,339	13,089	34,577	7,496
# of Properties	171,555	141,618	11,786	30,038	7,193
Fraction of Obs.	1	0.79	0.05	0.13	0.03
Mean Sales Price ($)	240,389	243,881	326,257	192,223	217,890
Median Sales Price ($)	185,000	189,000	234,000	155,690	175,000
Mean # of Bedrooms	2.65	2.66	2.44	2.69	2.68
Median # of Bedrooms	3	3	3	3	3
Mean # of Full Bathrooms	1.90	1.92	1.84	1.82	1.86
Median # Full Bathrooms	2	2	2	2	2
Mean House Age	28.01	27.45	25.39	32.06	28.54
Median House Age	21	20	17	29	20
Mean Ethnicolr Certainty	0.86	0.87	0.84	0.81	0.67
Median Ethnicolr Certainty	0.91	0.92	0.90	0.87	0.63

Notes: This table presents descriptive statistics for the dataset used the main specification. This dataset includes all repeat-sales of housing in the ZTRAX data for which for which floodzone status is known at all times and that begin outside flood zones in 1999. Column 1 presents statistics for the entire dataset, columns 2-5 present statistics by buyer race/ethnicity is predicted. The number of properties per race/ethnicity refers to the number of unique properties with at least one buyer of a given race/ethnicity.

Table A.2. Robustness to Name Imputation

Panel A: Robustness to Alternate Name Imputation

	Main	WRU	Omit Diff. Black/White
Fld Zone	−0.008***	−0.008***	−0.008***
	(0.002)	(0.002)	(0.002)
Asian	−0.006***	−0.003***	−0.0003
	(0.0004)	(0.0004)	(0.0004)
Hispanic	0.033***	0.036***	0.039***
	(0.0003)	(0.0003)	(0.0003)
NH Black	0.036***	0.025***	0.046***
	(0.001)	(0.001)	(0.001)
Asian * Flood Zone	−0.015***	−0.014***	−0.015***
	(0.003)	(0.003)	(0.004)
Hispanic * Flood Zone	−0.018***	−0.014***	−0.014***
	(0.006)	(0.003)	(0.003)
NH Black * Flood Zone	−0.017***	−0.023***	−0.033**
	(0.004)	(0.007)	(0.013)
Comparison Mean ($)	234,445	234,445	235,813
Properties	11,047,515	11,047,515	11,001,525
Observations	25,413,668	25,413,625	24,266,619

Panel B: Robustness to Ethnicolr Predictions

	Main	Continuous Race (100%)	Above Median Cert.
Flood Zone	−0.008***	−0.004	−0.006
	(0.002)	(0.002)	(0.004)
Asian	−0.006***	−0.005***	−0.0002
	(0.0004)	(0.0005)	(0.001)
Hispanic	0.033***	0.051***	0.051***
	(0.0003)	(0.0004)	(0.001)
NH Black	0.036***	0.060***	0.056***
	(0.001)	(0.001)	(0.001)
Asian × Flood Zone	−0.017***	−0.023***	−0.027***
	(0.004)	(0.004)	(0.007)
Hispanic × Flood Zone	−0.015***	−0.024***	−0.020***
	(0.003)	(0.004)	(0.006)
NH Black × Flood Zone	−0.018***	−0.030***	−0.030**
	(0.006)	(0.007)	(0.012)
Comparison Mean ($)	204,962	204,962	341,289
Mean Ethnicolr Certainty: Asian	0.83	0.83	0.97
Mean Ethnicolr Certainty: Hispanic	0.81	0.81	0.91
Mean Ethnicolr Certainty: NH Black	0.69	0.69	0.83
Mean Ethnicolr Certainty: NH White	0.87	0.87	0.96
Properties	11,047,558	11,047,558	3,892,953
Observations	25,413,668	25,413,668	8,189,556

Notes: Panel A presents estimates for the effect of SFHA zoning on racial housing price differentials using an alternate name imputation algorithm. In the first column, I present estimates of the baseline model estimated using Ethnicolr race/ethnicity predictions. In the second and third columns, I replace race/ethnicity predictions from Ethnicolr with those from WRU. In the third column, I omit from the sample those transactions that are imputed as White buyers using WRU but Black buyers using Ethnicolr and vice versa. Panel B presents estimates for the effect of SFHA zoning on racial housing price differentials using alternative configurations of the Ethnicolr name prediction algorithm. In the first column, I present estimates of the baseline model, in which I include all transactions for which I have a name. In the second column, I replace race/ethnicity dummies with the Ethnicolr estimated probability each buyer is of a given race/ethincity and show coefficients assuming 100% ethnicolr certainty. In the fourth column, I restrict the sample to observations with race/ethnicity predictions that fall above the 50th percentile of “certainty” for each race. Note that the samples in the last column is much smaller due to the repeat-sales design requiring that I drop any property where dropping a “less certain” prediction results in only one observation for that property. All regressions include property, tract-by-year and calendar month FEs as well as a house age control. Cluster-robust standard errors at the property level in parentheses. *p<0.1; **p<0.05; ***p<0.01

Table A.3. Robustness to Sample Selection and Home Remodels

Panel A: Sample Selection

	Main	Excl. LOMR	Excl. Unusual Zone Changes
	−0.008***	−0.008***	−0.012***
	(0.002)	(0.002)	(0.003)
Flood Zone	−0.006***	−0.006***	−0.006***
	(0.0004)	(0.0004)	(0.0004)
Asian	0.033***	0.033***	0.033***
	(0.0003)	(0.0003)	(0.0003)
Hispanic	0.036***	0.036***	0.036***
	(0.001)	(0.001)	(0.001)
NH Black	−0.017***	−0.017***	−0.016***
	(0.004)	(0.004)	(0.006)
Asian * Flood Zone	−0.015***	−0.015***	−0.012***
	(0.003)	(0.003)	(0.004)
Hispanic * Flood Zone	−0.018***	−0.018***	−0.016**
	(0.006)	(0.006)	(0.008)
Comparison Mean	234,445	234,196	236,821
Properties	11,047,558	10,946,561	10,596,580
Observations	25,413,668	25,175,875	24,421,389

Panel B: Remodels

	Main	Remodeled Sample	Remodeled Control
Flood Zone	−0.008***	0.008	0.006
	(0.002)	(0.005)	(0.005)
Asian	−0.006***	−0.011***	−0.011***
	(0.0004)	(0.002)	(0.002)
Hispanic	0.033***	0.041***	0.041***
	(0.0003)	(0.001)	(0.001)
NH Black	0.036***	0.040***	0.039***
	(0.001)	(0.002)	(0.002)
Asian * Flood Zone	−0.017***	−0.042**	−0.049***
	(0.004)	(0.017)	(0.017)
Hispanic * Flood Zone	−0.015***	−0.026***	−0.025***
	(0.003)	(0.009)	(0.009)
NH Black * Flood Zone	−0.018***	−0.030*	−0.030*
	(0.006)	(0.016)	(0.016)
Remodeled			0.317***
			(0.002)
Comparison Mean	234,445	229,961	229,961
Properties	11,047,558	870,976	870,976
Observations	25,413,668	2,129,321	2,129,321

Notes: This table presents various robustness checks that pertain to sample selection in Panel A and homs remodels in Panel B. The first column of both panels presents the estimates from the main specification in the paper. The second column of Panel A removes properties that are zoned into a flood zone by ways of a Letter of Map Change Review (LOMR). The third column of Panel A removes properties that have an unusual flood zone change in the 2011 flood map. These are properties whose flood zone status goes from 0,1,0, (ie. they are outside a flood zone in 1999, inside in 2011 and back outside in 2020). In Panel B, I present estimates for the effect of SFHA zoning on racial housing price differentials for the subsample of properties that are remodeled. In the second column, a remodeled control is included. All regressions include property, tract-by-year and calendar month FEs as well as a house age control. Cluster-robust standard errors at the property level in parentheses. *p<0.1; **p<0.05; ***p<0.01

Table A.4. Effect of Flood Zone Switch on Race Switch

	Any Race Switch	NH White − > NH Black	NH White − > Hispanic	Any − > NH White
	(1)	(2)	(3)	(4)
Switched In	0.001	0.0003	−0.004	0.002
	(0.004)	(0.002)	(0.003)	(0.004)
Property FE	Yes	Yes	Yes	Yes
House Age Control	Yes	Yes	Yes	Yes
Tract x Year FE	Yes	Yes	Yes	Yes
Calendar Month FE	Yes	Yes	Yes	Yes
Observations	15,545,442	15,545,442	15,545,442	15,545,442

Notes: This table presents estimates for the effect of SFHA zoning on switches in buyer race. All regressions include property, tract by year and calendar month FEs as well as a house age control. *p<0.1; **p<0.05; ***p<0.01