**"Flooded with Possibilities: Analyzing Flood Insurance as a Catalyst for Development in Southeast Florida"**

by

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**ABSTRACT**

Florida stands as one of the most critical residential markets in the United States, with residential sales reaching an impressive $468.5 billion and real estate residential investment amounting to $6.8 billion in 2022. However, the question arises whether this seemingly perpetual growth can withstand the tightening flooding policies. Is the residential market immune to the decisions made by insurance companies and the National Flood Insurance Program (NFIP)? These uncertainties form the basis of this thesis, which delves into the factors influencing insurance premium rates in Miami-Dade and Broward Counties, with a specific focus on geographic factors and independent variables.

Through the utilization of regression models, incorporating data from First Street Foundation and the US Census Bureau, the study analyzes the intricate relationship between these variables and premium rates. A key finding is the pivotal role played by geographic factors, particularly census tracts, in accurately predicting and comprehending premium rates. The inclusion of census tract data enhances accuracy and data normalization.

Moreover, several independent variables, such as flood risk, property values, mortgages, and rental affordability, emerge as significant influencers of premium rates. Time series data analysis reveals a steady upward trajectory in premium rates over time, accentuating the urgency for proactive measures in addressing the surge in insurance costs.

The research further identifies residential arbitrage opportunities, whereby developers can strategically acquire land in areas disproportionately affected by high premium rates. Approximately 15% of single-family homes within the census tracts of Broward and Miami-Dade Counties pay double the insurance dollar value compared to their peers in areas with similar characteristics, as depicted by FEMA. By considering demographic characteristics and purchasing power parity, developers can navigate the evolving real estate market and contribute to sustainable urban development.

These valuable insights into the factors influencing insurance premium rates open avenues for future research. Expanding the analysis to other geographic areas, incorporating additional variables, assessing the impact of climate change, and analyzing the effectiveness of mitigation measures are all potential directions for further exploration. Ultimately, this research sheds light on the intricate dynamics of insurance premium rates and paves the way for more informed decisions in the realms of residential real estate and urban development.

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## Chapter 1: Introduction

Floods pose a significant risk to various assets in the market and have been known to incur substantial costs for the government, real estate developers, landlords, and insurance companies, averaging $4.6 billion[1] per event. In recent years, the attention towards this risk has intensified in states highly susceptible to flooding during hurricane and rainy seasons. As a consequence of the rising costs for the federal government, new policies have been implemented, burdening insurance companies, who subsequently transfer these costs to buyers, landlords, and developers.

In response to insurance companies dropping customers and increasing rates due to financial challenges, Florida's Senate Bill 2-A was enacted in December 2022. This legislation established the Florida Optional Reinsurance Assistance Program (FORA), a billion-dollar fund designed as a financial safety net to assist insurance companies in the event of major catastrophes like hurricanes. The law also aims to reduce reliance on the Citizens Property Insurance program, originally intended as a last-resort insurer for property owners unable to obtain coverage in the private market. Under the new law, property owners are required to purchase flood insurance and transition to a private policy if it costs no more than 20%[2] above the price of a Citizens policy. However, this requirement may lead to gentrification if insurance costs become unaffordable for property owners with lower household incomes.

Considering the continuous growth of developments in Florida, in this paper we comprehensively analyze the evolution of residential property insurance in 21st-century Florida, keeping in mind the ongoing growth of developments in the region. Our approach involves examining FEMA flood zone designations and integrating key variables, including demographics, household income, and property value, to construct a robust model for forecasting insurance cost changes related to flood risk. We employ a dual-stage methodology, commencing with an analysis of NFIP redacted claims data, which has geographic limitations, and subsequently complementing it with the FSF dataset containing specific geographic factors like latitude and longitude. This distinctive approach allows us to identify specific opportunities in Miami Dade County and Broward County, marking them as having a "potential for acquisition" at discounted prices due to the required assessments these blocks or lots must undergo for development.

[1] NOAA

[2] The Florida Senate. (2022). Bill analysis and fiscal impact statement: Prepared by the Professional Staff of the Commit ee on Banking and Insurance. SB 2-A

# Chapter 2: Background

## 2.1 National Flood Insurance Program: Foundation and Functions

The National Flood Insurance Program (NFIP) was established in 1968 under the National Flood Insurance Act[3]. It is overseen by the Federal Emergency Management Agency (FEMA) and provides federally backed flood insurance coverage to over five million households and small businesses in more than 22,000 communities across the United States.

The NFIP was created to offer an insurance alternative to disaster assistance and protect communities from the increasing costs of flood damage. It also provides floodplain advice and building code regulations in participating communities. The program requires flood insurance for all loans or lines of credit secured by existing buildings, new buildings, or buildings under construction within NFIP-participating communities.

The foundation for the NFIP can be traced back to the Great Mississippi Flood of 1927, which prompted discussions on how to manage flood risks in the country. However, it was Hurricane Betsy in 1965, one of the deadliest storms in US history, that brought attention to the need for a comprehensive flood solution. As a result, the NFIP was established, incorporating private sector support, and involving participation from American communities.

The NFIP operates through a public-private partnership. FEMA collaborates with Write Your Own (WYO) private insurance providers, allowing participation property and casualty insurance companies to write and service the standard flood insurance policies under their names. FEMA retains responsibility for covering losses, while WYO companies receive an expense allowance for policies written and claims processed.

Residents and businesses in high-risk areas, known as Special Flood Hazard Areas (SFHA), can obtain flood insurance from the NFIP. Those acquiring loans from federally regulated and insured lenders within SFHA are required to carry flood insurance for the duration of their loan. Additionally, individuals outside of SFHA may purchase NFIP insurance[4], and policyholders in moderate to low-risk areas may be eligible for lower-cost policies called preferred risk policies.

[3] FEMA, “50 years of the NFIP”
[4] Fannie Mae, “B7-3-06 Flood Insurance Requirement for All Property Types”

Over time, Congress has enacted legislation to modify and strengthen the NFIP. For example, the Flood Disaster Protection Act of 1973 made flood insurance mandatory for properties in SFHAs that secured mortgages from federally backed lenders or received federal assistance for acquisition or construction. In 1983, FEMA introduced the Write Your Own (WYO) Program[5], allowing private insurance companies to sell and service NFIP policies alongside their own lines of insurance.

The NFIP's history reflects the recognition of the private insurance industry's reluctance to cover flood peril due to various challenges. The NFIP was established as a government program to pool risks, provide initial funding, subsidize existing homeowners while charging actuarial rates to new construction, and link insurance to land-use changes that could reduce risks. It also has the capacity to borrow money from the federal government to cover deficits, which private insurers cannot do.

### 2.1.1 Determining Insurance Risk Premiums

The National Flood Insurance Program (NFIP) follows a specific process for underwriting a property and writing an insurance policy, as outlined in the NFIP Flood Insurance Manual. The key steps involved in this process are:

1. Property Evaluation: The first step is to assess the property's flood risk. This includes determining its location within a flood zone and evaluating the elevation in relation to the Base Flood Elevation (BFE). The property's flood zone designation and BFE are crucial factors in determining the insurance premium.
2. Application Submission: Property owners or their insurance agents submit an application for flood insurance coverage. The application includes details about the property, such as its location, value, construction type, and occupancy.
3. Underwriting Review: NFIP underwriters review the application and assess its eligibility for coverage. They analyse the property's flood risk characteristics, including its location, flood zone, elevation, and any past flood damage. The underwriters also verify the accuracy of the information provided in the application.
4. Rating: Based on the property's flood risk, the underwriters determine the appropriate insurance premium. The premium calculation considers factors such as the flood zone, BFE, occupancy type, and coverage limits requested by the property owner.

[5] FEMA, “Write Your Own Program”

5. Policy Issuance: Once the application is approved, the underwriters issue the flood insurance policy. The policy outlines the coverage details, premium amount, deductible, and policy period.
6. Policy Delivery: The NFIP provides the policy documents to the property owner or their insurance agent. The property owner should carefully review the policy to understand the coverage, limitations, and responsibilities.
7. Renewals and Endorsements: Flood insurance policies typically have an annual term. The NFIP sends renewal notices to policyholders, allowing them to renew their coverage. Policyholders can also request policy endorsements or changes to their existing policies when needed.
8. Claims Processing: In the event of a flood, the property owner can file a claim with the NFIP for flood-related damages. The NFIP has specific procedures for claims handling, including damage assessment, documentation, and payment disbursement.

This process also involves differentiating between the insured value of the building and the contents of a property. The building insured value represents the coverage provided for the physical structure of the property. It encompasses the cost required to repair or rebuild the building in the event of flood damage. Several factors are considered in determining the insured value of the building, including the construction type, size, features, and replacement cost. The replacement cost estimation is based on rebuilding the structure using similar materials and quality, without accounting for depreciation. The insured value of the building is typically specified in the policy, indicating the maximum amount the insurance company will pay to repair or rebuild the structure.

On the other hand, the contents insured value refers to the coverage provided for the personal belongings and possessions inside the property. This includes furniture, appliances, electronics, clothing, and other items. The insured value for contents is based on the estimated cost to replace these items if they were damaged or destroyed by a flood. The policyholder is responsible for determining the value of their contents and providing an accurate estimate to the insurance company. It's essential to evaluate the value of each item and consider factors such as age, condition, and market value when determining the insured value for contents.

**PROVISIONAL RATING EXAMPLE 1**
**REGULAR PROGRAM, POST-FIRM CONSTRUCTION**

Essential Data to Determine Appropriate Rates and Premium:

**REGULAR PROGRAM:**

- Flood Zone: A with BFE, AE, A1–A30, AO, or AH
- Occupancy: Single-Family Dwelling
- Number of Floors: 3 or More Floors
- Basement/Enclosure: Basement
- Deductible: $3,000/$2,000
- Deductible Factor: .900
- Contents Location: Basement and Above
- Date of Construction: Post-FIRM
- Elevation Difference: N/A
- Floodproofed (Yes/No): No
- Building Coverage: $250,000
- Contents Coverage: $100,000
- ICC Premium: $6
- CRS Rating: N/A
- CRS Discount: N/A
- Reserve Fund Assessment $1,273
- Probation Surcharge: $50
- HFIAA Surcharge: Primary Residence $25
- Federal Policy Fee $50

**DETERMINED RATES:**

Building: 3.00 / 2.00 Contents: 3.00 / 2.00

**ESTIMATED BUILDING REPLACEMENT COST (INCLUDING FOUNDATION): $** **DEDUCTIBLE:** BUILDING $ 3,000 CONTENTS $ 2,000

| | | BASIC LIMITS | | | ADDITIONAL LIMITS (REGULAR PROGRAM ONLY) | | | DEDUCTIBLE | |
|---|---|---|---|---|---|---|---|---|---|
| INSURANCE COVERAGE | TOTAL AMOUNT OF INSURANCE | AMOUNT OF INSURANCE | RATE | ANNUAL PREMIUM | AMOUNT OF INSURANCE | RATE | ANNUAL PREMIUM | PREMIUM REDUCTION/ INCREASE | TOTAL PREMIUM |
| BUILDING | $250,000 | $60,000 | 3.00 | $1,800 | $190,000 | 2.00 | $3,800 | –$560 | $5,040 |
| CONTENTS | $100,000 | $25,000 | 3.00 | $750 | $75,000 | 2.00 | $1,500 | –$225 | $2,025 |

**RATE CATEGORY:** ☐ MANUAL ☐ SUBMIT FOR RATE ☐ PROVISIONAL RATING

**PAYMENT METHOD:** ☐ CHECK ☐ CREDIT CARD ☐ OTHER: _____

| | |
|---|---|
| ANNUAL SUBTOTAL | $7,065 |
| ICC PREMIUM | $6 |
| SUBTOTAL | $7,071 |
| CRS PREMIUM DISCOUNT ____ % | $0 |
| SUBTOTAL | $7,071 |
| RESERVE FUND ____ % | $1,273 |
| SUBTOTAL | $8,344 |
| PROBATION SURCHARGE | $50 |
| HFIAA SURCHARGE | $25 |
| FEDERAL POLICY FEE | $50 |
| **TOTAL AMOUNT DUE** | **$8,469** |

**NOTICE:** BUILDING COVERAGE BENEFITS – EXCEPT FOR A RESIDENTIAL CONDOMINIUM BUILDING – ARE NOT AVAILABLE IF OTHER NFIP BUILDING COVERAGE HAS BEEN PURCHASED BY THE APPLICANT OR ANY OTHER PARTY FOR THE SAME BUILDING.

THE ABOVE STATEMENTS ARE CORRECT TO THE BEST OF MY KNOWLEDGE. I UNDERSTAND THAT ANY FALSE STATEMENTS MAY BE PUNISHABLE BY FINE AND/OR IMPRISONMENT UNDER APPLICABLE FEDERAL LAW. SEE REVERSE SIDE OF COPIES.

_____ SIGNATURE OF INSURANCE AGENT/PRODUCER _____/_____/_____ DATE (MM/DD/YYYY)

_____ SIGNATURE OF INSURED (OPTIONAL) _____/_____/_____ DATE (MM/DD/YYYY)

**PREMIUM CALCULATION:**

1. Multiply Rate × $100 of Coverage: Building: $5,600 / Contents: $2,250
2. Apply Deductible Factor: Building: .900 × $5,600 = $5,040 / Contents: .900 × $2,250 = $2,025
3. Premium Reduction: Building: $5,600 – $5,040 = $560 / Contents: $2,250 – $2,025 = $225
4. Subtotal: $7,065
5. Add ICC Premium: $6
6. Subtotal: $7,071
7. Subtract CRS Discount: N/A
8. Subtotal: $7,071
9. Add Reserve Fund Assessment: $1,273 (18%)
10. Subtotal: $8,344
11. Add Probation Surcharge: $50
12. Add HFIAA Surcharge: $25
13. Add Federal Policy Fee: $50
14. **Total Amount Due:** **$8,469**

Image 1: Provisional Rating Example for a Single-Family Dwelling (NFIP Flood Insurance Manual, pg. 3-76)

By differentiating between the insured value of the building and the contents, flood insurance policies provide coverage for both the physical structure and personal belongings. It ensures that policyholders can receive appropriate compensation in the event of flood-related damage or loss, whether it affects the building itself or the contents within it.

In the National Flood Insurance Program (NFIP), there exists a capped coverage limit of $250,000 for residential properties. This means that for homeowners with properties valued above this cap, the NFIP insurance would only cover up to $250,000 of the property's value in case of flood damage. To ensure full coverage, homeowners with more expensive properties would need to seek additional coverage from a private insurer to account for the difference between the uninsured value and the NFIP's coverage limit. This scenario often arises in high-value real estate markets, such as those in Florida, where property values can far exceed the NFIP's coverage cap.

In the capital stack of flood insurance coverage, the NFIP's insured value occupies the first loss position, covering up to $250,000 for eligible properties. However, due to its capped coverage and relatively lower rates, the NFIP is limited in its ability to fully protect high-value properties from extensive flood-related losses. As a result, private insurers typically occupy the second loss position in the capital stack, offering excess coverage above the NFIP's limit. Private insurers are willing to take on this higher risk and offer coverage at a higher rate, allowing homeowners to protect their valuable properties fully. This two-tiered approach, with the NFIP at the first loss position and private insurers at the second loss position, ensures that homeowners have comprehensive coverage against flood-related damages, irrespective of the value of their properties.

## 2.2 Historic flooding evolution in Southeast Florida

Southeast Florida has a long history of flooding, with hurricanes and tropical storms causing significant damage over the years. The region has been hit by numerous storms, making Florida the most storm-affected state in the US. Hurricane Harvey and Hurricane Irma in 2017 highlighted the issue of inadequate flood insurance coverage, with up to 80% of home damages involving flooding being uninsured[6].

Some notable historic flooding events in Southeast Florida include[7]:

1. 1928 Okeechobee Hurricane: This hurricane caused breaches in dikes surrounding Lake Okeechobee, resulting in widespread flooding and the loss of at least 2,500 lives. The floodwaters covered hundreds of square miles and caused extensive damage.

[6] Webel et al., “Congressional Research Service NFIP Introduction” (2023)
[7] Florida Flood Insurance, “Major Floods to Impact Florida”

2. Hurricane George (1947): This hurricane struck metropolitan Miami as a Category 4 storm, causing significant flooding and erosion of beaches. Over 40,000 people sought refuge in Red Cross shelters, and damages reached an estimated $31.6 million.
3. Hurricane Andrew (1992): Hurricane Andrew, a Category 5 storm, made landfall in Homestead and caused extensive damage throughout Florida. With $25.5 billion in damage, it was the most destructive hurricane in the state's history at the time. Stricter building codes were implemented following this hurricane.
4. Hurricane Irma (2017): Hurricane Irma, a Category 4 storm, made landfall in the Florida Keys and caused major flooding throughout the peninsula. It resulted in the destruction of 25% of homes in Key West, widespread power outages, and an estimated total cost of $50 billion, with a significant portion of flood losses being uninsured.

In response to these historic flooding events, Florida has implemented various measures to mitigate future risks. These include insurance reforms, such as the creation of the Florida Hurricane Catastrophe Fund and Citizens Property Insurance Corporation, to provide coverage to residents who cannot obtain private-market insurance. Stricter construction standards were also introduced, requiring buildings to withstand hurricane-force winds and installing shutters or impact-resistant glass.

Furthermore, emergency management response and evacuation procedures have been overhauled to ensure better coordination and faster distribution of supplies during recovery efforts. Florida also experiences excess rainfall, particularly during the rainy season from May to October, with several record rainfall totals being observed in the state[8].

## 2.3 FEMA flood designation and risk factors

Flood risk designations and zones play a crucial role in determining the vulnerability of an area to flooding and establishing appropriate regulations and insurance requirements. These designations are based on flood maps created by FEMA (Federal Emergency Management Agency) and are used by communities and lenders to assess flood risks and make informed decisions.

Flood maps categorize areas into high-risk, moderate-risk, and low-risk zones. The high-risk areas, also known as Special Flood Hazard Areas (SFHAs), are indicated on FEMA's flood maps with zones starting

[8] NOAA, “Florida Thunderstorm Season”

with the letters A or V. These zones represent 100-year floodplains, meaning there is a 1% chance of flooding in any given year. In high-risk zones, there is at least a one in four chance of experiencing a flood during a 30-year mortgage period. Home and business owners located in SFHAs and have mortgages from federally regulated or insured lenders are required to purchase flood insurance.

Moderate and low-risk areas, referred to as non-SFHAs, are depicted on flood maps with zones starting with the letters B, C, or X (or a shaded X). Flood insurance is not mandatory in these areas, but FEMA strongly recommends obtaining it to mitigate potential risks. Some flood maps may also include zones labelled with the letter D, representing areas that have not been studied or have undetermined flood hazards.

FEMA invests significant resources in updating flood maps, with a budget of over $200 million in recent years[9]. However, a study published in February 2018 by Environmental Research Letters revealed that the actual number of people exposed to significant flood risk at the 100-year flood level is much higher than what FEMA's flood maps indicate. The study estimated that more than 40 million Americans are exposed to serious flood risk, approximately three times the number indicated by FEMA's maps. Consequently, FEMA is facing pressure to enhance the accuracy of its flood maps and provide a more comprehensive assessment of flood risks across the country. In Table 1 you can see an example of how the designation of Flood Zones are directly correlated on how insurance premium is calculated depending on the flood risk, knowing that this is only one of the variables considered while writing a flood policy.

| **Flood Zone** | **Eligible for CRS Premium Discount** | **Not Eligible for CRS Premium Discount** |
|---|---|---|
| All Flood Zones | Pre-Flood Insurance Rate Map (FIRM) Buildings | N/A |
| B, C, X, D, A99, AR, and AR Dual Zones (AR/A, AR/AE, AR/ A1–A30, AR/ AH, and AR/AO) | Post-FIRM Buildings | N/A |
| A Zones (AE, A1–A30, Unnumbered A, AO, AH) | Post-FIRM **Non-Elevated** Buildings where the elevation difference used for rating is 0 feet or higher or with subgrade crawlspace certification from a community official | Post-FIRM **Non-Elevated** Buildings where the elevation difference used for rating is –1 foot or lower or with no subgrade crawlspace certification from a community official |

[9] U.S General Accounting Office, “Flood Map Modernization”

| | | |
|---|---|---|
| A Zones (AE, A1–A30, Unnumbered A, AO, AH) | Post-FIRM **Elevated** Buildings[1] where the elevation difference used for rating is 0 feet or higher | Post-FIRM Elevated Buildings where the elevation difference used for rating is –1 foot or lower |
| V Zones (VE, V1–V30, Unnumbered V) | ’75–’81 and Post–’81 Post-FIRM **Non-Elevated** Buildings where the elevation difference used for rating is 0 feet or higher | ’75–’81 and Post–’81 Post-FIRM **Non- Elevated** Buildings where the elevation difference used for rating is –1 foot or lower |

Table 1: SFHAs zone designations and insurance premium influence example. (NFIP Insurance Manual April 2021)

## 2.4 Insurance and housing in Miami Dade/Broward County

Florida's domestic property insurers have experienced significant financial losses from 2017 to the present. According to the Florida Office of Insurance Regulation (OIR), these insurers accumulated net underwriting losses exceeding $3 billion from 2017 to 2021. In 2020 and 2021, their combined net income was over negative $1 billion, and they haven't reported positive net income since 2016[10]. Property insurance claims in 2020 exceeded initial estimates by approximately $676 million. These financial challenges have led to a growing trend of rate increases, with homeowners seeing annual rate hikes of around 33 percent, expected to rise to 40 percent next year[11].

One of the major issues affecting domestic property insurers is adverse claim development. Insurers set claim reserves to allocate funds for expected claim payouts. However, when comparing these initial reserves to the actual claim costs, insurers found discrepancies. In 2021, claim costs were approximately $481 million higher than estimated at one year, and $337 million higher at the two-year mark[12]. These losses have been attributed to factors such as claims with litigation, claims solicitation, and adverse loss reserve development.

The uncertainty in the property insurance market has also impacted reinsurance capacity and rates for insurers. To mitigate Florida's significant catastrophic risk, insurers rely on the global reinsurance market. Fitch Ratings expects reinsurance prices to increase by over 10% in 2023, with the highest increases in areas like Florida that were affected by natural catastrophe events in 2022. The cost of reinsurance for Florida increased by 54% in 2020-2021 compared to 2019 figures, and by 28%[13] in 2021-2022 compared to 2020 figures, according to the OIR.

[10] Altmaier, D. Office of Insurance Regulator. “Property Insurance Stability”. (2022)
[11] Altmaier, D. Office of Insurance Regulator. “Property Insurance Stability”. (2022)
[12] WUSF. (2022, December 5). Property Insurance Market is Facing Multiple Challenges.
[13] Altmaier, D. Office of Insurance Regulator. “Property Insurance Stability”. (2022)

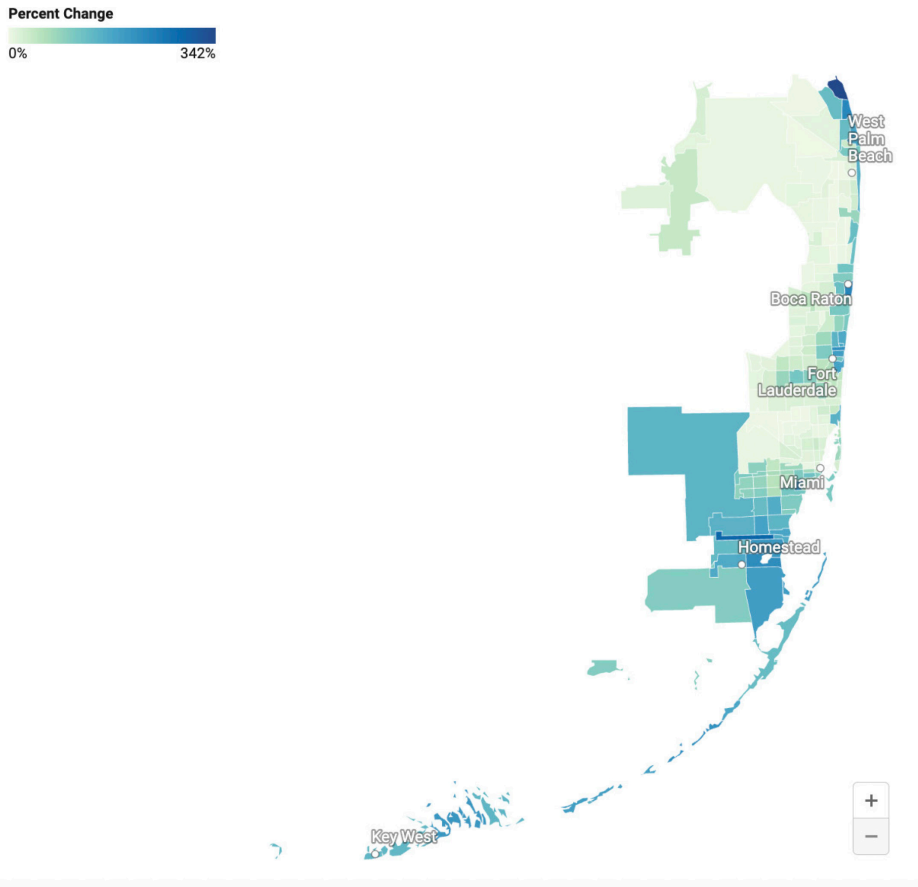


Image 2: Miami Dade County, Palm Beach County and Broward County projected Insurance Premium Projected Percentual Change 2022-2023 (https://www.miamiherald.com/news/local/environment/climate-change/article275058126.html#storylink=cpy)

Moreover, several property insurers have recently become insolvent and were placed into liquidation. Some notable examples include Florida Specialty Insurance Company, American Capital Assurance Corporation, Gulfstream Property and Casualty Insurance Company, St. Johns Insurance Company, Avatar Property and Casualty, Southern Fidelity Insurance Company, Weston Property & Casualty Insurance Company, and FedNat Insurance Company.[14]

### 2.4.1 Citizens Property Insurance Corporation and FHCF

Citizens Property Insurance Corporation (Citizens) is a state-created, not-for-profit, tax-exempt governmental entity in Florida. Its purpose is to provide property insurance coverage to those who cannot find affordable coverage in the voluntary admitted market. Citizens was established in 2002

[14] The Florida Senate. (2022). Bill analysis and fiscal impact statement: Prepared by the Professional Staff of the Commit ee on Banking and Insurance. SB 2-A

by combining the Florida Residential Property and Casualty Joint Underwriting Association (RPCJUA) and the Florida Windstorm Underwriting Association (FWUA).

Citizens operates under the provisions of Section 627.351(6), F.S., and is governed by an eight-member Board of Governors. The board administers Citizens' Plan of Operations, which is reviewed and approved by the Financial Services Commission. The corporation is regulated by the Office of Insurance Regulation (OIR).

Citizens offers property insurance through three different accounts: the Personal Lines Account (PLA), the Commercial Lines Account (CLA), and the Coastal Account. The PLA provides comprehensive, multi-peril coverage for personal lines residential policies statewide, excluding coastal areas. The PLA also offers policies that exclude coverage for wind in coastal areas. The CLA offers commercial lines residential and non-residential policies statewide, excluding coastal areas, with similar coverage provisions. The Coastal Account provides personal and commercial policies specifically for coastal areas, with options for wind-only policies or multi-peril policies.

Citizens' policyholder eligibility clearinghouse program, established in 2013, allows participating private insurers to review and make offers of coverage for new and renewal policies before they are placed with Citizens. If the premium offered by an authorized insurer is at or below the eligibility threshold, the applicant or insured is not eligible for coverage from Citizens. There are additional provisions for applicants who were declared ineligible by Citizens in the previous 36 months.

As of December 31, 2021, Citizens reported 759,305 policies in-force with a total exposure of $232,502,323,529. By October 31, 2022, the number of policies in-force increased to 1,111,283, with a total exposure of $398,857,062,260 and premium with surcharges of $3,023,462,297.[15] Image 1 is a clear example of the exposure that companies as Citizens have to natural disaster as well as public funds such as the FHCF.

[15] The Florida Senate. (2022). Bill analysis and fiscal impact statement: Prepared by the Professional Staff of the Commit ee on Banking and Insurance. SB 2-A

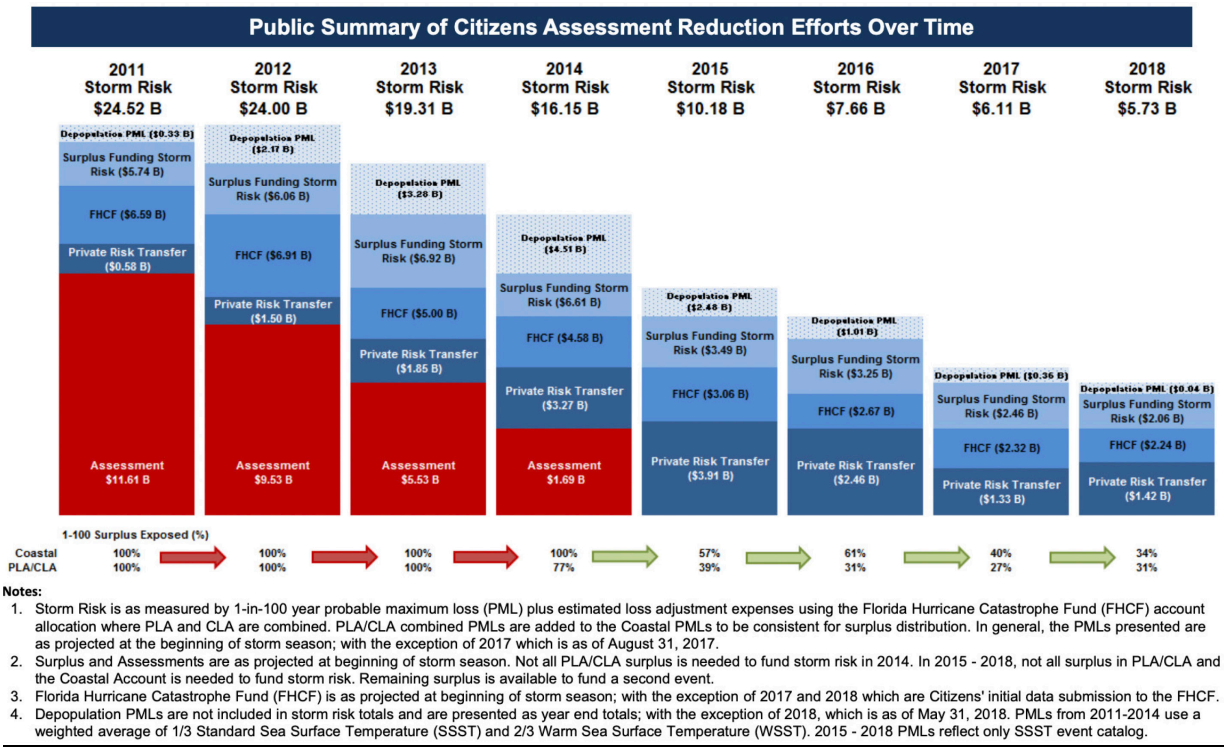


Image 3: Citizens and FHCF exposure assessment example (Citizens Property Insurance Corporation Overview, 2019)

The Florida Hurricane Catastrophe Fund (FHCF) is a tax-exempt fund created in 1993 to provide reinsurance for residential property catastrophic hurricane losses. Its purpose is to protect and maintain insurance capacity in Florida by reimbursing insurers for a portion of their catastrophic losses. The FHCF is administered by the State Board of Administration and offers stable and relatively inexpensive reinsurance compared to private reinsurance.

The FHCF provides mandatory coverage for insurers writing residential property insurance that includes wind coverage. Insurers must purchase reimbursement coverage (reinsurance) on their residential property exposure through the FHCF. The FHCF charges insurers the actuarially indicated premium based on hurricane loss projection models approved by the Florida Commission on Hurricane Loss Projection Methodology. The cost of FHCF coverage is generally lower than private reinsurance due to its non-profit status and absence of risk load for overhead and operating expenses.

## 2.5 Neighbourhoods at risk with potential for development

The housing market in South Florida, specifically in Miami-Dade and Broward counties, is experiencing strength and resilience. Home prices continue to climb while inventory remains limited, creating a

seller's market where sellers can command top dollar for their properties. This market strength can be attributed to several factors.

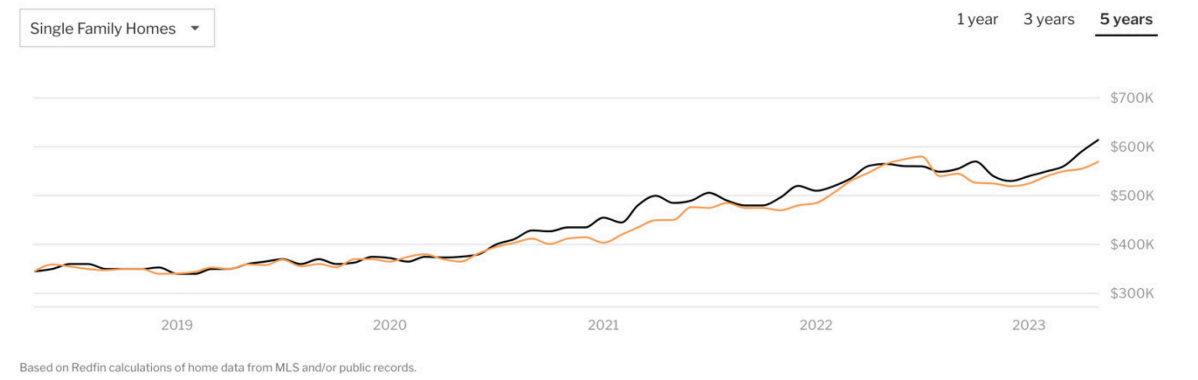


Image 4: Miami Dade County (Black) vs Broward County (Orange) price per unit evolution (2018-2023) (Source: www.redfin.com)

Firstly, there is an influx of people and businesses relocating from high-tax and high-density areas to South Florida, drawn by the absence of state income tax and the pro-business environment[16]. Additionally, foreign purchasers are contributing to the state's property market.

The Miami metropolitan area, encompassing Miami-Dade, Broward, and Palm Beach counties, is a significant and populous region. It is the seventh-largest metropolitan area in the United States and comprises the financial and cultural core of the metropolis.

Price appreciation has been notable in the Miami-Fort Lauderdale-West Palm Beach Metro, with home values rising by 13.5%[17] over the past year. The market is expected to see a further 2.0% increase in the next twelve months. Despite higher interest rates, the Miami real estate market is predicted to be one of the few major housing markets that will not experience a decline in house prices in 2023.

The Miami-Dade County real estate market had a successful year in 2022, with strong sales numbers for both homes and condos. The market displayed resilience and maintained high demand despite rising mortgage rates. While inventory is increasing overall, it is primarily concentrated in the luxury segment, and there is still a shortage of inventory in the $400K to $600K price range.

[16] Wong, Natalie. “NYC Wealth Exodus Drives Billionaire’s Bet on South Florida Boom”, Bloomberg. (2023)
[17] Santarelli,Marco. “Miami Real Estate Market”. Norada Real Estate Investment (2023)

But it is well known that these counties have not only experienced significant growth and development but also face a substantial exposure to flood risk in both the short and long term. This reality poses a considerable risk to current single-family homeowners who endure annual flooding due to hurricanes and torrential rains. The high flood risk levels in Miami and Broward County serve as potential indicators of gentrification, as they can influence the dynamics of the housing market and contribute to neighbourhood transformations.

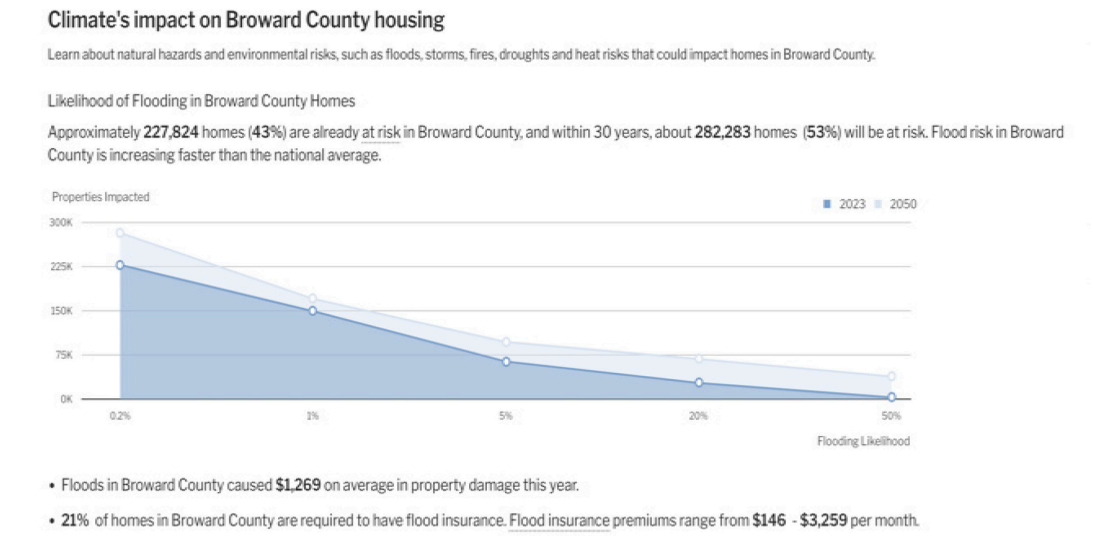


Image 5: Properties flooding likelihood (%) in Broward County, Florida (Source: www.redfin.com)

One possible sign of gentrification is the increased attention and investment directed towards mitigating flood risks in these areas. As flood events become more frequent and severe, local governments, community organizations, and even private developers may prioritize the implementation of flood protection measures. This could include the construction of flood barriers, improved drainage systems, and investments in infrastructure resilience. The allocation of resources to address flooding issues often signals an interest in preserving and enhancing the value of properties in these neighborhoods, attracting new investments and potentially leading to rising property prices.

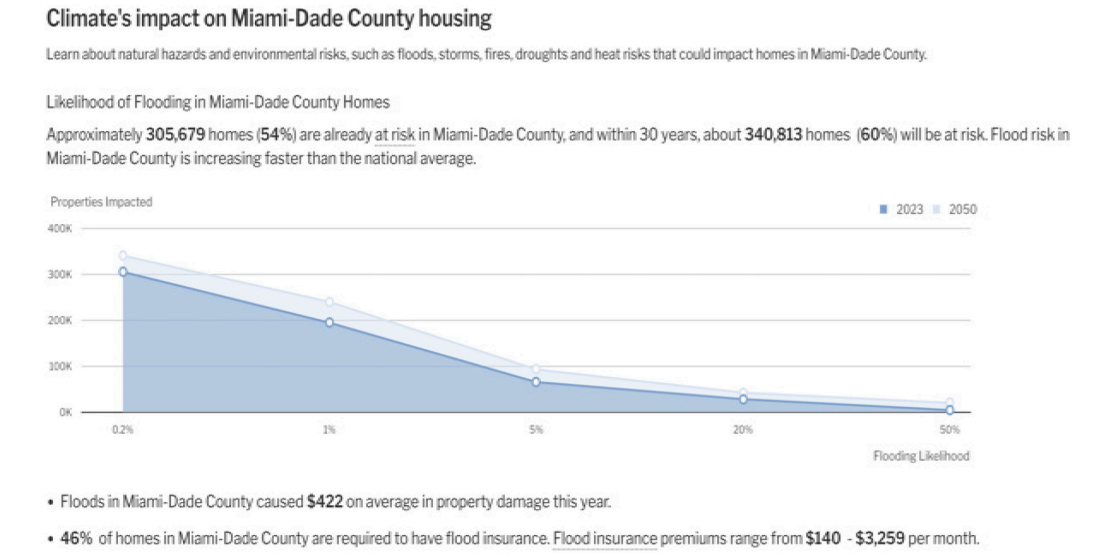


Image 6: Properties flooding likelihood (%) in Miami Dade County, Florida (Source: www.redfin.com)

Moreover, the presence of flood risk can impact property affordability and accessibility, contributing to the displacement of lower-income residents. As flood insurance premiums rise and the costs of flood damage repairs increase, homeowners with limited financial resources may find it increasingly challenging to afford or maintain their properties. This can result in the forced sale of homes or the inability to afford necessary repairs, leading to the gradual displacement of long-term residents.

Corelated to this possibility, we have that current prices of condos in various neighborhoods present an attractive opportunity for developers, with the potential for significant growth in the future. Among the listed neighborhoods as seen in Table 1, there is a range of prices per square foot, offering diverse investment possibilities. For instance, neighborhoods like Coral Gables, Aventura, and Sunny Isles currently have relatively lower prices per square foot, making them potentially appealing for developers seeking more affordable opportunities. These neighborhoods may experience an upward price trajectory as demand increases, driven by factors such as their desirable locations, amenities, and proximity to commercial hubs. On the other hand, neighborhoods like Bal Harbour and Brickell exhibit higher prices per square foot, reflecting their premium status and exclusivity. Despite the higher entry costs, these neighborhoods still present an enticing prospect for developers due to their reputation, luxurious offerings, and potential for continued growth in demand. Additionally, emerging neighborhoods like Wynwood and Edgewater, with their lower to mid-range prices, provide an interesting investment landscape, given their evolving urban development and artistic ambiance. Overall, the diverse pricing across these neighborhoods offers developers an opportunity to tap into different market segments and capitalize on the potential for future price appreciation as these areas continue to flourish and attract buyers.

| Neighbourhood | Price per Sqft |
|---|---|
| Coral Gables | $379 |
| Coconut Grove | $505 |
| Aventura | $246 |
| Sunny Isles | $366 |
| Bal Harbour | $1,070 |
| Downtown Miami | $410 |
| Brickell | $372 |
| Edgewater | $354 |
| Wynwood | $280 - $436 |
| Buena Vista | $431 |
| Miami Gardens | $138 |
| Upper East Side | $304 |
| Little Havana | $248 |
| Pinecrest | $272 |
| South Beach Miami | $226 |

Table 2: Average condo price per sqft. in different neighbourhoods of Miami and Broward County.

All of the above factors point towards the possibility of flood-induced gentrification in Miami and Broward County. The high exposure to flood risk, coupled with efforts to mitigate flooding and potential impacts on property affordability and building regulations, create an environment where neighborhoods may undergo significant transformations. While flooding poses risks to current single-family homeowners, it also presents opportunities for development and gentrification.

## Chapter 3: Data

Information obtained for the statistical analysis presented in this paper are extracted from: the NFIP Open FEMA Redacted Policy dataset, First Street Foundation and the United States Census Information through StateBook. This chapter describes how each data set was used to build up the analysis, samples and models which's methodology will be presented in the next chapter.

## 3.1 FEMA NFIP Redacted Policy Data

The Open FEMA NFIP Policy Data is a vast and valuable dataset that provides in-depth information about flood insurance policies in the United States. With over 50,000,000[18] policy transactions, it offers comprehensive coverage and detailed insights into flood insurance across participating communities in the National Flood Insurance Program (NFIP).

This dataset contains a wealth of information, including policyholder demographics, property locations, coverage limits, effective dates, and expiration dates. By making this data publicly accessible, FEMA promotes transparency and enables researchers, policymakers, and analysts to study flood insurance patterns and make informed decisions.

The dataset's significance lies in its contribution to flood risk management. It serves as a critical resource for identifying high-risk areas, evaluating the effectiveness of flood mitigation measures, and developing strategies to enhance community resilience. For this paper we will narrow down the scope of study to Miami Dade County and Broward County with 4,633 data points located in these areas, which will be matched with the First Street foundation data through its Census Tracts, characteristic which both data sets share.

In addition to its research implications, the Open FEMA NFIP Policy Data also plays a crucial role in policy analysis and decision-making processes. By analysing the data, policymakers can gain valuable insights into insurance trends, assess the impact of policy changes, and devise strategies to protect policyholders and communities from flood-related losses.

## 3.2 First Street Foundation Data

The First Street Foundation is a non-profit organization focused on improving flood risk awareness and resilience. This dataset provides detailed information and analysis on flood risk across the United States, including historical and projected flood risk data for individual properties.

[18] FEMA NFIP' "Data Facts", v. Oct 2021

The First Street Foundation Data combines various sources of information, including property-level data, climate and weather data, hydrological models, and other relevant data sets. By integrating these sources, the First Street Foundation aims to provide accurate and accessible flood risk information to individuals, communities, and decision-makers.

The dataset includes flood risk assessments, flood projections, and other relevant metrics such as the flood factor, which aids to assess and understand flood vulnerability. It can be utilized by homeowners, insurers, lenders, local governments, and other stakeholders to evaluate flood risk, make informed decisions about property investments, and develop strategies for flood mitigation and adaptation. This data set includes 570,945 data points in the Miami Dade County Area and 528,227 in the Broward County Area[19].

The flood factor will be of utmost importance for the upcoming analysis. The calculation of the latter provided by First Street Foundation goes beyond traditional flood risk assessments by incorporating various factors and historical flooding events to quantify the risk over a 30-year period. This long-term perspective allows property owners and stakeholders to better understand and prepare for potential flood hazards.

[19] First Street Foundation, Miami-Dade County and Broward County Historic Flood Data, 2023

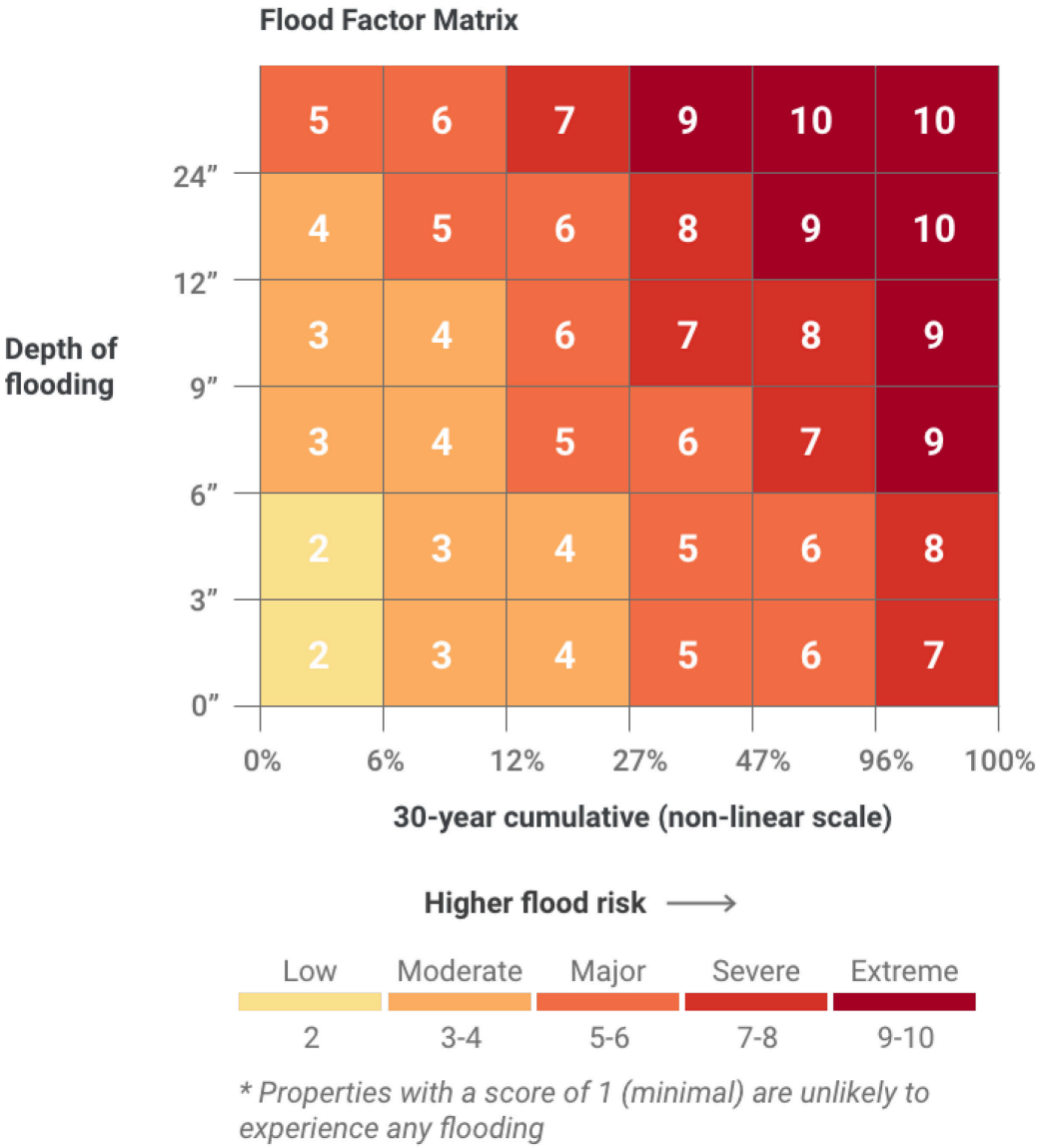


Image 7: First Street Foundations Flood Factor Matrix (https://firststreet.org/research-lab/published-research/flood-model-methodology_overview/)

Unlike the FEMA Special Flood Hazard Areas (SFHA) that focus on specific flood events with a 1-in-100 or 1-in-500-year probability, the flood factor calculation considers all major flood types, including pluvial (rainfall), fluvial (riverine), and coastal surge flooding. This holistic approach provides a more complete and nuanced view of flood risk, capturing the potential impact from different flood sources. One of the key strengths of the Flood Factor™[20] calculation is its ability to interpret future environmental factors. By integrating global climate model projections, the calculation incorporates anticipated changes in flood risk due to climate change and sea-level rise. This forward-looking aspect enhances the accuracy and relevance of the flood risk assessment, helping individuals and communities make informed decisions about flood mitigation, insurance, and preparedness.

[20] First Street Foundation, “Flood Model 2022 Methodology Addendum”

In the case of Miami-Dade and Broward County, the calculation proves particularly valuable. While FEMA SFHA zones provide a standard measure of flood risk based on specific probability events, the model offers a more detailed evaluation specific to each property. Comparing the Flood Factor™ 1-in-100 hazard layer to the same-probability FEMA SFHA zones, the Flood Factor™ model captures approximately triple the flood risk.

### 3.3 StateBook (United States Census Bureau Data)

Statebook is an online platform that leverages United States census data to provide users with easy access to compare and analyze various demographic and economic indicators across different states and regions. By utilizing census data, Statebook offers a comprehensive and interactive platform for users to explore and understand the characteristics of different areas within the United States.

One of the primary features of Statebook is its ability to present census data in a user-friendly and visually appealing manner. The platform employs interactive maps, charts, and graphs to display information, making it easier for users to interpret and compare data across different geographies.

Statebook enables users to select specific states or regions and compare various metrics side by side. For example, users can examine population statistics, income levels, education levels, housing data, and other demographic and economic indicators for multiple states simultaneously. This functionality facilitates quick and efficient comparisons, which will be used in this paper to compare different areas based on a Census Tract level in Miami Dade and Broward County relative to housing costs variation YoY and Demographics of given areas.

Census tracts in the United States are geographic subdivisions that are used by the U.S. Census Bureau for collecting and organizing demographic data. These tracts are smaller and more localized compared to larger administrative units such as counties or states. Census tracts typically contain a population range of 1,200 to 8,000 people, with an optimal size of around 4,000 residents[21].

Demographic data collected at the census tract level provides detailed insights into the characteristics of a specific area. This includes information on population size, age distribution, racial and ethnic composition, housing types, educational attainment, income levels, employment status, and more. By

[21] US Census Bureau, “Census Tract and Block Numbering Area”

analysing these demographic variables at the census tract level, we will try to stablish a corelation between certain part of the population that will suffer from natural gentrification due to the rising cost of insurance premium vs HHI.

The Household Income (HHI) is a statistical indicator that represents the combined income of all individuals living in a household. It provides insights into the economic well-being of a particular area. Census tracts capture HHI data by aggregating the income information reported by households within the tract.

## Chapter 4: Analysis methodology

To analyze the relationship between FEMA's flood designations, insurance rate premiums over time, and their impact on Miami-Dade and Broward County areas at a census tract level, we developed a comprehensive model using the data presented in Chapter Three. This model allows us to identify the effects of the variables mentioned earlier and examine how potential increases in insurance premiums may lead to the displacement of minorities from attractive areas coveted by developers.

Specifically, we examine the influence of FEMA flood designations on insurance premiums and assess how these rates have evolved over time. This analysis allows us to understand the financial burdens faced by property owners in flood-prone areas and investigate any opportunities that insurance affordability and accessibility may pose for real estate developers and current single family homes landlords.

### 4.1 First Street Foundation and NFIP Redacted Policy Data.

We initiated our analysis by filtering the data obtained from the Open FEMA Dataset: FEMA NFIP Redacted Policies - v1. After identifying Miami-Dade and Broward County as the target areas for analysis, we established common variables across the datasets to select the primary layer of analysis, which in this case is the Census Tract. These tracts, as depicted in Image 9, exhibit a relatively consistent size and population, with each tract typically encompassing a specific number of households or a defined geographic area.

It’s important to point out that the National Flood Insurance Program (NFIP) incorporates various factors such as flood risk, property elevation, and other flood-related characteristics to calculate insurance premium values. However, the NFIP's approach primarily focuses on assessing the flood risk

and insuring the property against potential flood damages. The premium calculation does not consider the actual value of the property but rather imposes a maximum coverage limit of $250,000.

Additionally, it doesn't account broader neighborhood characteristics in terms of flood vulnerability unrelated to ocean flooding e.g. Natural Disasters. This limitation means that the premium calculations may not fully reflect the potential risks associated with the property's location within a flood-prone neighborhood or the broader flood dynamics in the area. As a result, the NFIP's approach may not capture the full extent of the flood-related risks and potential damages for properties located in high-risk neighborhoods or areas with recurring flooding issues.

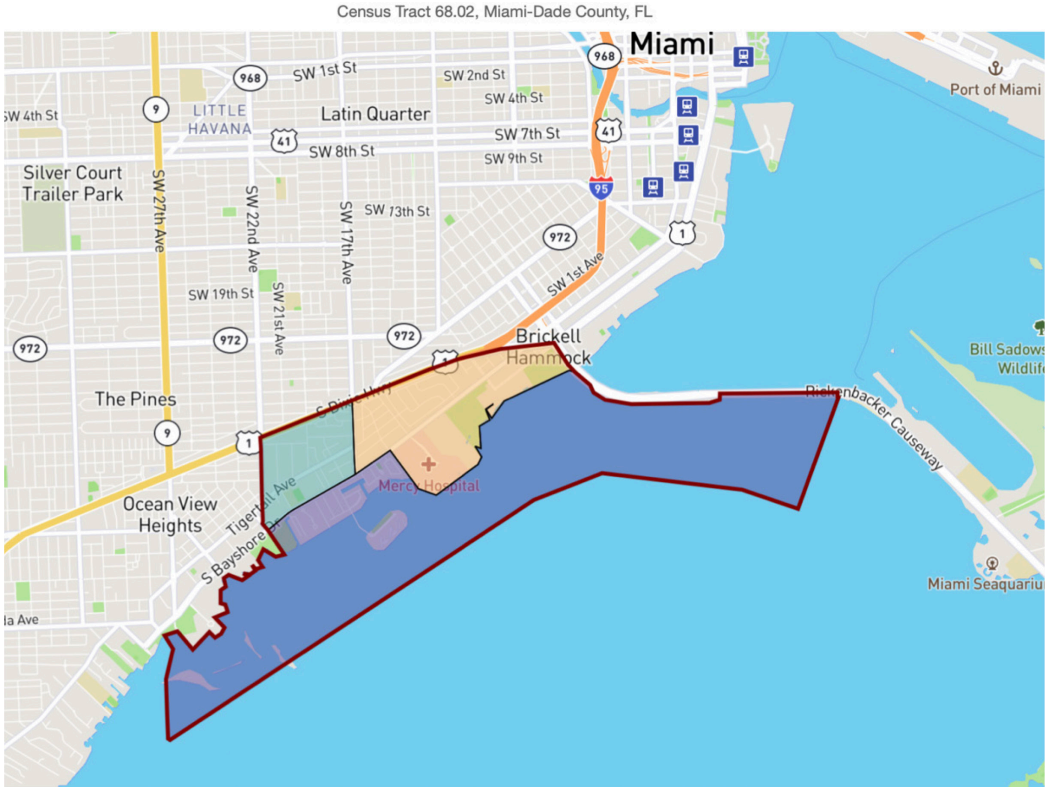


Image 8: Census Tract 68.02, Miami Dade County Florida
(https://www.statebook.com/region/ct12086006802/idc/)

We will complement the NFIP data using the First Street dataset, where we accessed property-level information, which we utilized to further refine our analysis. By considering various flood factors and historic flood events associated with individual properties within the identified census tracts, we intend to identify those tracts that experienced a high increase in premium rates and see if they are correlated with these factors. It is important to note that the NFIP dataset incorporates 2010 census tracts, whereas the FSF data includes tracts updated as of 2020. This disparity arises from the rapid

growth experienced in the county, resulting in an increase from 519 census tracts in 2010 to 707 census tracts in 2020.

## 4.2 Variable Selection

Our selected method of analysis is through numerical regressions. But before running them, variables had to be selected from the broad range of them at hand, focusing on those that influenced the Insurance Premium rate.

Initially, we filtered the data provided by the NFIP Open FEMA dataset (Section 3.1). Firstly, we computed the rate by dividing the policy cost (policyCost) by the building insurance value (totalBuildingInsuranceCoverage). It is important to clarify that the insured value is typically obtained from the property's mortgaged value, as this policy serves as collateral for the lender, protecting the loan value from potential flood damage.

Next, we narrowed down the dataset to include only single-family homes (occupancyType = 1), as the paper focuses exclusively on this property type. It is worth noting that the analysis of condominiums and multifamily properties is excluded since their insurance premium behaviour differs due to their distinct physical characteristics and higher mortgage values.

Additionally, we removed data points identified as outliers from the sample, and missing data points for variables such as baseFloodelevation, elevationDifference, and lowestFloorElevation were filled with the calculated mean values of the sample.

| Variable | Meaning | Unit | Description |
|---|---|---|---|
| censusTract | Census Tract | text | US Census Bureau defined census Tracts; statistical subdivisions of a county or equivalent entity that are updated prior to each decennial census. The NFIP relies on our geocoding service to assign census tract code |
| deductibleAmountInBuildingCoverage | Deductible Amount in Building Coverage | text | The total deductible amount in dollars for buildings, both main and appurtenant, that can be applied against the loss. Standard Deductibles: 0 - $500; 1 - $1,000; 2 - $2,000; 3 - $3,000; 4 - |

| | | | |
|---|---|---|---|
| | | | $4,000; 5 - $5,000; 9 - $750; A - $10,000; B - $15,000; C - $20,000; D - $25,000; E - $50,000; F - $1,250; G - $1,500; H : $200 |
| lowestAdjacentGrade | Lowest Adjacent Grade | decimal | Lowest natural grade adjacent to the insured structure prior to excavating or filling. The difference in feet of the lowest natural grade adjacent to the building from the reference level of the building |
| lowestFloorElevation | Lowest Floor Elevation | decimal | A building's lowest floor is the floor or level (including basement/enclosure/crawl space/subgrade crawlspace) that is used as the point of reference when rating a building. This includes the level to which a building is floodproofed*. |
| numberOfFloorsInTheInsuredBuilding | Number of Floors in Insured Building | smallint | Code that indicates the number of floors in the insured structure. 1 - One floor; 2 - Two floors; 3 - Three or more floors; 4 - Split-level; 5 - Manufactured (mobile) home or travel trailer on foundation; 6 - Townhouse/Rowhouse with three or more floors (RCBAP Low-rise only); |
| occupancyType | Occupancy Type | smallint | Code indicating the use and occupancy type of the insured structure. One-digit code: 1 = single family residence; 2 = 2 to 4 unit residential building; 3 = residential building with more than 4 units; 4 = Non-residential building |
| originalConstructionDate | Original Construction Date | date | The original date of the construction of the building. |
| originalNBDate | Original NB Date | date | The original date of the flood policy. |
| policyCost | Policy Cost | decimal | Calculated in dollars by adding together calculated premium, reserve fund assessment, federal policy fee, and HFIAA surcharge |
| policyEffectiveDate | Policy Effective Date | date | The effective date of the flood policy. |
| policyTeminationDate | Policy Termination Date | date | Date upon which the cancellation of a flood insurance policy becomes effective - either because it was cacelled or lapsed. |

| | | | |
|---|---|---|---|
| postFIRMConstructionIndicator | Post Firm Construction Indicator | boolean | Yes (Y) or No (N) Indicator on whether construction was started before or after publication of the FIRM. Yes is indicated with either a 'true' or '1'. No is indicated with either a 'false' or '0'. |
| primaryResidenceIndicator | Primary Residence Indicator | boolean | Indicates whether or not the insured building/condominium unit is the primary residence of the insured. Yes is indicated with either a 'true' or '1'. No is indicated with either a 'false' or '0' |
| totalBuildingInsuranceCoverage | Total Building Insurance Coverage | decimal | Total Insurance Amount in dollars on the Building |
| totalContentsInsuranceCoverage | Total Contents Insurance Coverage | decimal | Total Insurance Amount in dollars on the Contents |
| totalInsurancePremiumOfThePolicy | Total Insurance Premium of the Policy | decimal | Total Insurance Premium of the Policy in dollars. Negative values indicate a refund |

Table 3: NFIP Open FEMA variable definitions and descriptions (NFIP Open FEMA Dictionary v1.)

Having sorted out the NFIP data, we now have the First Street Foundation dataset in which we will be focusing on the flood factor and historic flood events. This data points are given on a property level layer but given that the NFIP data is given in a Census Tract layer as its most detailed layer of analysis, we will clean out the data and categorize by CTs as well.

| Field Name | Meaning | Type | Description |
|---|---|---|---|
| tract_fips | US Census Tracts | int | US Census Tract FIPS Code |
| county_fips | County FIPS | int | County FIPS Code |
| state_fips | Zip Code | int | State FIPS Code |
| floodfactor | Flood Factor | int | The property's Flood Factor, a numeric integer from 1-10 (where 1 = minimal and 10 = extreme) based on flooding risk to the building footprint. Flood risk is defined as a combination of cumulative risk over 30 years and flood depth. Flood depth is calculated at the lowest elevation of the building footprint (largest if more than 1 exists, or property centroid where footprint does not exist) |
| hist1_id | Historic Storm event #1 ID | int | A unique First Street identifier assigned to a historic storm event modelled by First Street |
| hist1_event | Historic Storm event #1 Name | string | Short name of the modelled historic event |
| hist1_year | Historic Storm | int | Year the modelled historic event occurred |

| | | | |
|---|---|---|---|
| | event #1 Year | | |
| hist1_depth | Historic Storm event #1 Depth | int | Depth (in cm) of flooding to the building from this historic event |
| hist2_id | Historic Storm event #2 ID | int | A unique First Street identifier assigned to a historic storm event modelled by First Street |
| hist2_event | Historic Storm event #2 Name | string | Short name of the modelled historic event |
| hist2_year | Historic Storm event #2 Year | int | Year the modelled historic event occurred |
| hist2_depth | Historic Storm event #2 Depth | int | Depth (in cm) of flooding to the building from this historic event |

Table 4: NFIP Open FEMA variable definitions and descriptions (NFIP Open FEMA Dictionary v1.)

## 4.3 Regressions, Calculations and Results

Before starting the regression analysis, it is crucial to understand the relationship between the insurance premium rate (dependent variable) and the other independent variables. Upon examining the NFIP data, it became apparent that the insurance premium rate does not exhibit linear growth over the years but rather follows a proportional percentage growth pattern. As a result, the regression analysis cannot be conducted based on a linear relationship but instead requires a logarithmic approach to account for the premium rate behaviour.

Based on this understanding, our analysis involved developing six models to examine the relationship between the premium rate and various factors. In the first four models (Table 3), we used the Natural Logarithm of the Premium Rate as the dependent variable. The key difference between these models is the inclusion or exclusion of the Census Tract variable in the regression calculations.

In order to examine the annual evolution of insurance rates, we created 13 dummy variables spanning from 2009 to 2021. It is important to note that while we have data from as early as 2008, none of the properties in the specific areas analysed had valid policies starting from that year. Additionally, we excluded the year 2022 from the model to avoid issues with multicollinearity in the regression analysis (k-1).

Models 1 and 2 did not consider the Census Tract variable, while models 3 and 4 included it. The purpose was to evaluate the impact of adding a geographical variable and observe how it influenced the dependent variable.

| **Regression Model 1 Zip12086 (Dependent variable = Ln policyCost/totalBuildingInsuranceCoverage)** | **Regression Model 2 Zip12011 (Dependent variable = Ln policyCost/totalBuildingInsuranceCoverage)** | **Regression Model 3 Zip12086 (Dependent variable = Ln policyCost/totalBuildingInsuranceCoverage)** | **Regression Model 4 Zip12011 (Dependent variable = Ln policyCost/totalBuildingInsuranceCoverage)** |
|---|---|---|---|
| ageBuilding_2023_0 | ageBuilding_2023_0 | ageBuilding_2023_0 | ageBuilding_2023_0 |
| baseFloodElevation | baseFloodElevation | baseFloodElevation | baseFloodElevation |
| elevationBuildingIndicator | elevationBuildingIndicator | elevationBuildingIndicator | elevationBuildingIndicator |
| floodZoneSFHAs | floodZoneSFHAs | floodZoneSFHAs | floodZoneSFHAs |
| ln_Insuredvalue | ln_Insuredvalue | ln_Insuredvalue | ln_Insuredvalue |
| lndeduction | lndeduction | lndeduction | lndeduction |
| lowestAdjacentGrade | lowestAdjacentGrade | lowestAdjacentGrade | lowestAdjacentGrade |
| lowestFloorElevation | lowestFloorElevation | lowestFloorElevation | lowestFloorElevation |
| numberOfFloorsInTheInsuredBuilding | numberOfFloorsInTheInsuredBuilding | numberOfFloorsInTheInsuredBuilding | numberOfFloorsInTheInsuredBuilding |
| postFIRMConstructionIndicator | postFIRMConstructionIndicator | postFIRMConstructionIndicator | postFIRMConstructionIndicator |
| primaryResidenceIndicatorMod | primaryResidenceIndicatorMod | primaryResidenceIndicatorMod | primaryResidenceIndicatorMod |
| Dummy Variables year 2009-2022 | Dummy Variables year 2009-2022 | Dummy Variables year 2009-2022 | Dummy Variables year 2009-2022 |
| - | - | Dummy Variables Census Tracts 12086 (178 CTs) | Dummy Variables Census Tracts 12011 (183 CTs) |

Table 5: Model 1, Model 2, Model 3 and Model 4 independent variables

Moving forward, models 5 and 6 (Table 5) utilized the coefficients obtained from models 3 and 4. These models integrated the data provided by First Street Foundation (FSF) and the US Census Bureau to delve deeper into the fixed effects of specific data points and their correlation with the behavior of the premium rate.

By combining the FSF data and Census Bureau data with the coefficients from the previous models, we aimed to gain a more comprehensive understanding of how each individual data point contributes to the variations in the premium rate. This allowed us to identify significant factors that impact the premium rate and explore their relationships in greater detail.

| Regression Model 5 (Dependent variable = Coefficients regressions Model 3 and 4) |
|---|
| FloodFactorAvg |
| HistDepth1Avg |
| HistDepth2Avg |
| House_Value |
| Mortgage_Value |
| Rent_as_a__HHI |

Table 6: Model 5 - Variables for regression from obtained coefficients from Models 3 and 4

Both models encompass a total of 4,633 property data points, with 3,159 properties belonging to Broward County and 1,471 properties belonging to Miami-Dade County. These data points serve as the basis for our analysis, providing a comprehensive representation of the selected areas and allowing us to draw meaningful conclusions regarding the relationship between insurance rates, dollar values, and other independent variables.

## Chapter 5: Insurance Premium Rate Analysis and Results

We will conduct a comparative analysis between the results of Model 1 and Model 3, focusing on Miami-Dade County, as well as between Model 2 and Model 4, with a specific focus on Broward County. By examining these different models, we aim to understand the impact of incorporating census tract data on the regression results. This comparison will provide insights into how the inclusion of census tract information affects the relationship between variables in the regression models.

Furthermore, we will explore the influence of fixed effects in Model 5, which are considered to be highly relevant factors. These fixed effects are integrated into the models to account for specific characteristics and conditions that may vary across different areas or regions within the counties. By incorporating these fixed effects, we can assess how they modify or influence the results obtained from the regression analyses.

### 5.1 Insurance Premium Rate Miami Dade County

Upon evaluating the sample data for Miami-Dade County, it becomes apparent in Model 1 that there is a significant disparity between the data points and the corresponding residuals. Charts 1 and 2

clearly illustrate a substantial number of high predicted rates, indicating that a considerable portion of the data is not normalized. Despite this observation, Model 1 still achieves a relatively decent **R2 value of 0.44**, which suggests a moderate level of accuracy in the model's predictive ability.

| Variables | Model 1 | Model 3 |
|---|---|---|
| ageBuilding_2023_0 | -0.000532 | 0.012 |
| baseFloodElevation | 0.124 | -0.004974 |
| elevationBuildingIndicator | -0.056 | 0.784 |
| floodZoneSFHAs | 0.370 | 0.155 |
| ln_Insuredvalue | -0.447 | -0.791 |
| lndeduction | 0.120 | -0.086 |
| lowestAdjacentGrade | -0.038 | -0.001748 |
| lowestFloorElevation | -0.079 | -0.038 |
| numberOfFloorsInTheInsuredBuilding | -0.031 | -0.061 |
| postFIRMConstructionIndicator | -0.487 | 0.159 |
| primaryResidenceIndicatorMod | 0.236 | 0.195 |

Table 7: Results of regressions Model 1 and 3

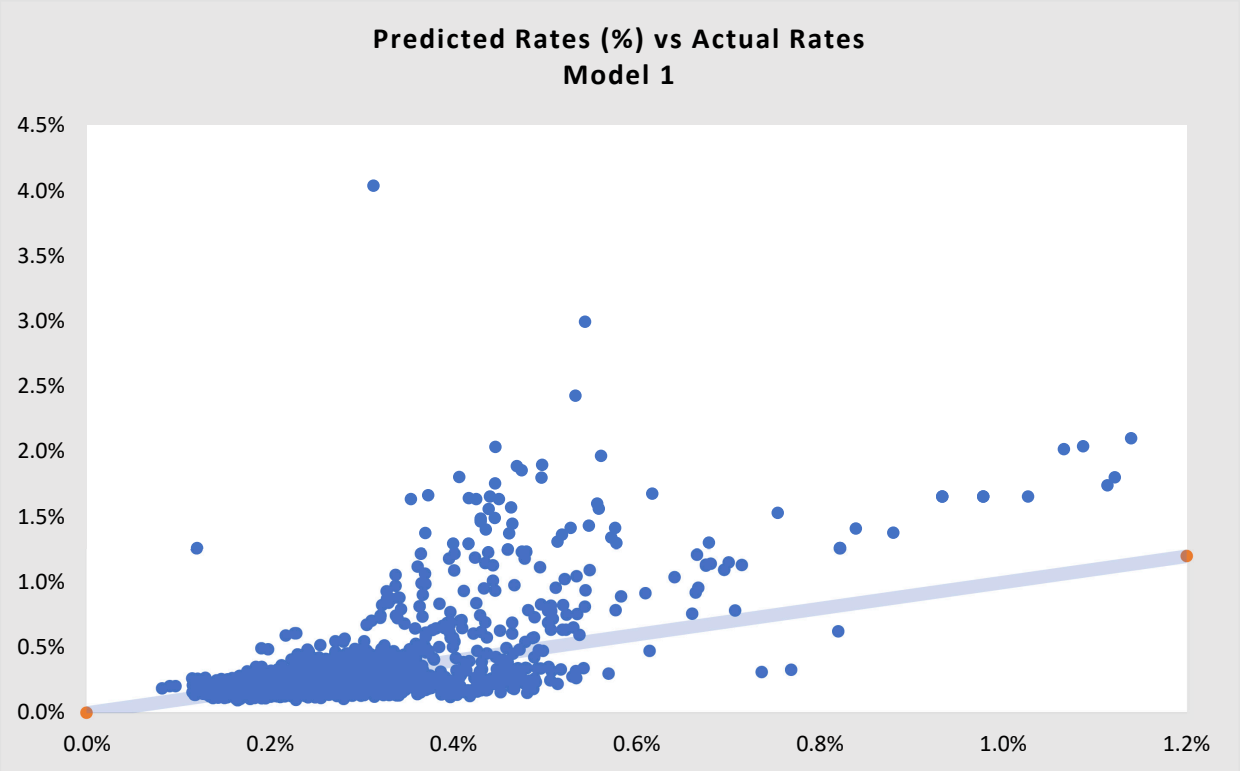


Chart 1: Predicted Rates (%) vs Actual Rates Model 1 Miami Dade County

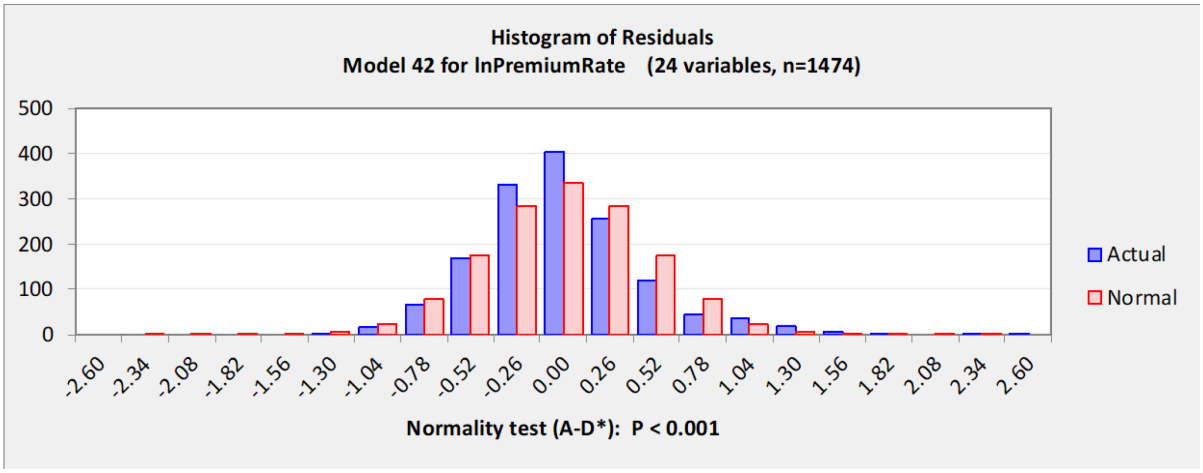


Chart 2: Histogram of Residuals Model 1 Miami Dade County

To assess the impact of geographic location on premium rate predictions, we incorporated Census Tracts into our regression analysis. The results yielded a markedly improved model with an **R2 value of 0.87**, indicating a higher level of accuracy compared to the initial model. This suggests that the inclusion of Census Tracts as a geographic factor is highly influential in understanding and predicting premium rates.

When examining the Residual vs. Predicted premium rates in Chart 3, we notice a more tightly clustered distribution of data points. This indicates a more normalized pattern, further supporting the notion that incorporating geographic factors, specifically Census Tracts, enhances the accuracy and reliability of our predictions. The tighter clustering suggests that the inclusion of location-based data helps to capture and account for variations in premium rates that can be attributed to specific geographic areas.

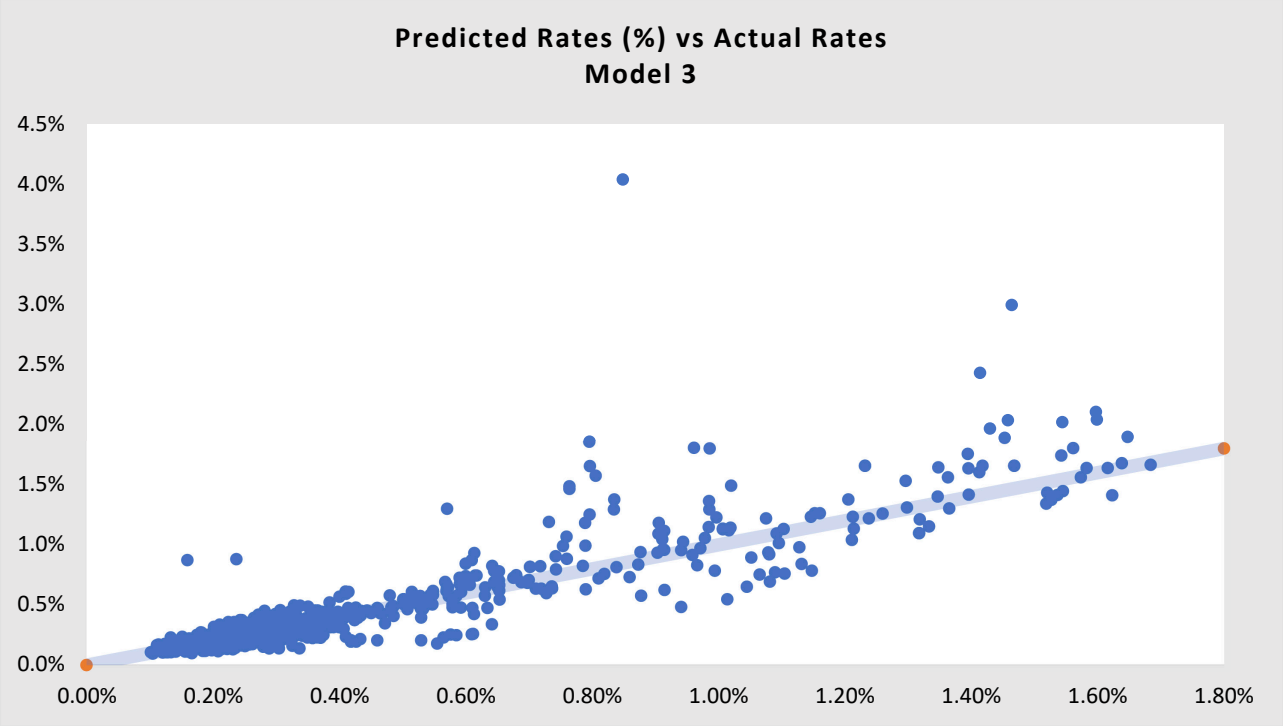


Chart 3: Predicted Rates (%) vs Actual Rates Model Model 3 Miami Dade County

Additionaly, when comparing the histograms from Chart 2 and Chart 4, the effect of incorporating Census Tracts becomes evident. In Model 1, which did not account for geographic factors, we observed around 400 data points with residuals close to zero. However, in Model 3, where Census Tracts were included, we saw a significant increase to approximately 700 data points, representing about 50% of the data sample. This substantial increase highlights the meaningful impact of Census Tracts on our analysis and reinforces the importance of considering geographic location in predicting premium rates.

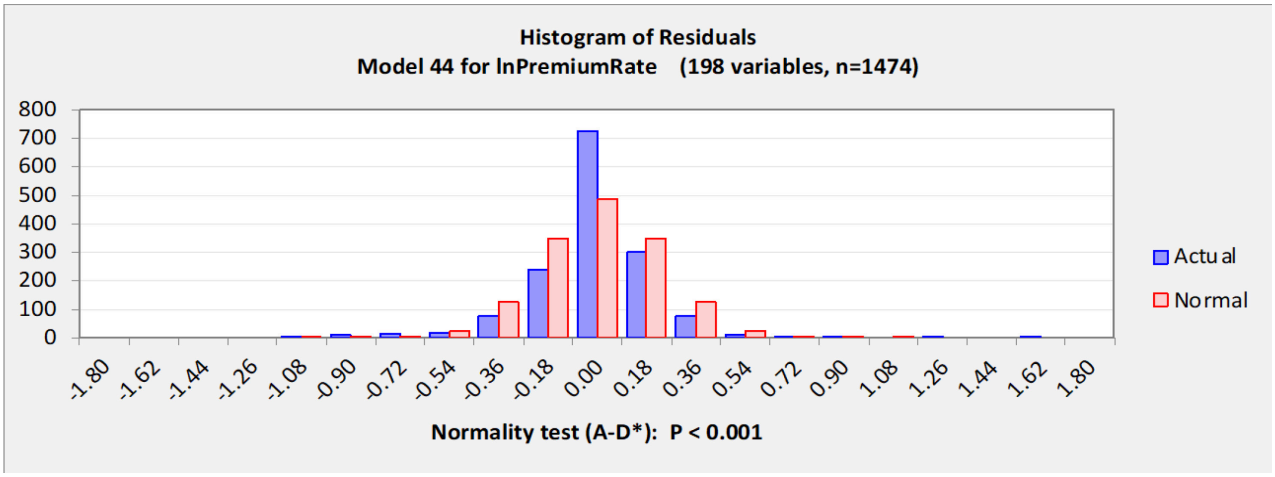


Chart 4: Histogram of Residuals Model 3 Miami Dade County

## 5.2 Insurance Premium Rate Broward County

The data sample f or Broward County appears to be more extensive, likely due to a higher number of insurance claims filed in this county compared to Miami-Dade County during the analysis period. Model 2, which did not incorporate geographic factors, yielded an R2 value of 0.55, indicating a reasonably accurate prediction model. However, the scatterplot of residuals vs. predicted data points in Chart 5 demonstrates a significant level of denormalization. The data points are widely scattered, indicating a greater variability in the predictions for Broward County compared to Miami-Dade County.

| Variables | Model 2 NO CT | Model 4 CT |
|---|---|---|
| ageBuilding_2023_0 | 0.000117 | -0.000136 |
| baseFloodElevation | 0.058 | 0.046 |
| elevationBuildingIndicator | -0.011 | 0.057 |
| floodZoneSFHAs | 0.638 | 0.685 |
| ln_Insuredvalue | -0.634 | -0.669 |
| lndeduction | 0.093 | 0.037 |
| lowestAdjacentGrade | -0.048 | -0.055 |
| lowestFloorElevation | -0.033 | -0.018 |
| numberOfFloorsInTheInsuredBuilding | -0.045 | -0.102 |
| postFIRMConstructionIndicator | -0.134 | -0.061 |
| primaryResidenceIndicatorMod | -0.001010 | -0.068 |

Table 8: Results of regressions Model 2 and 4

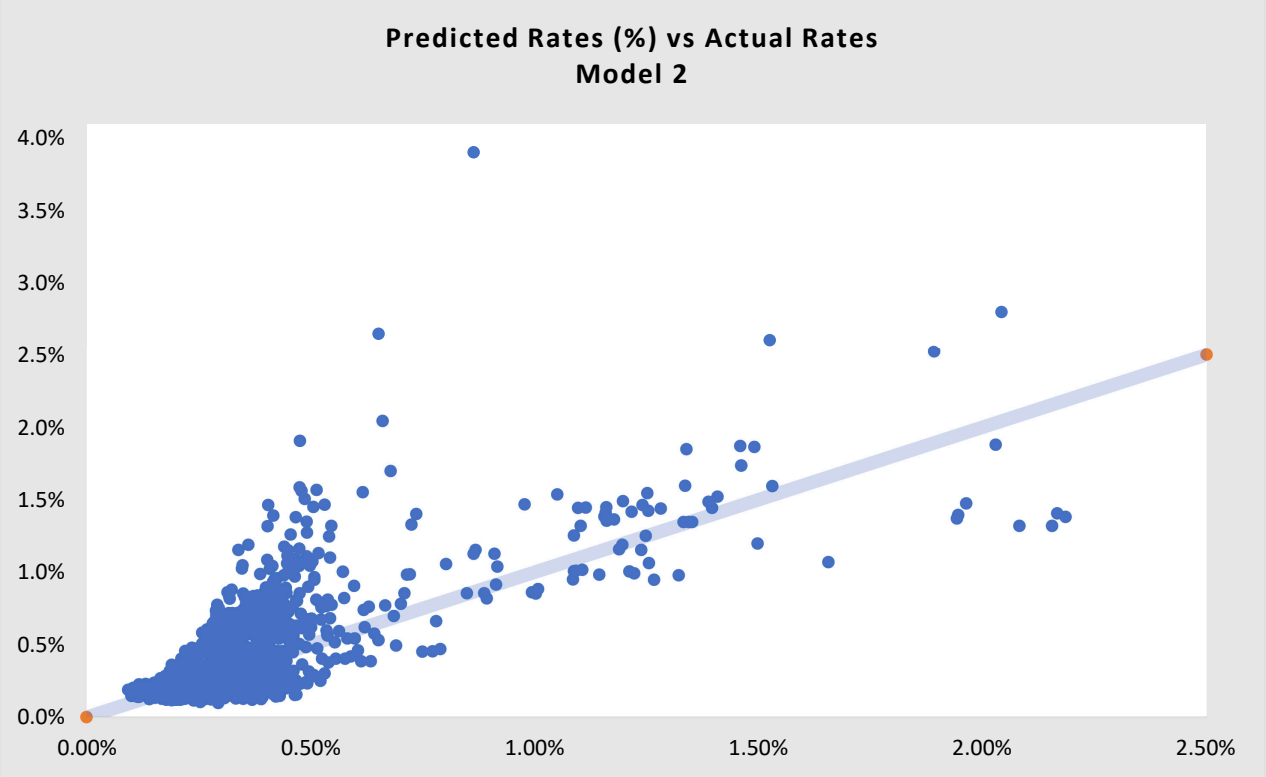


Chart 5: Predicted Rates (%) vs Actual Rates 2 Broward Dade County

Additionally, the histogram of residuals reveals that only around 800 data points out of the sample are near zero, representing approximately 25.3% of the total. The remaining data points are dispersed across values ranging from -1.6 to 1.6. This distribution further highlights the lack of normalization and the wider range of prediction deviations in Broward County compared to Miami-Dade County.

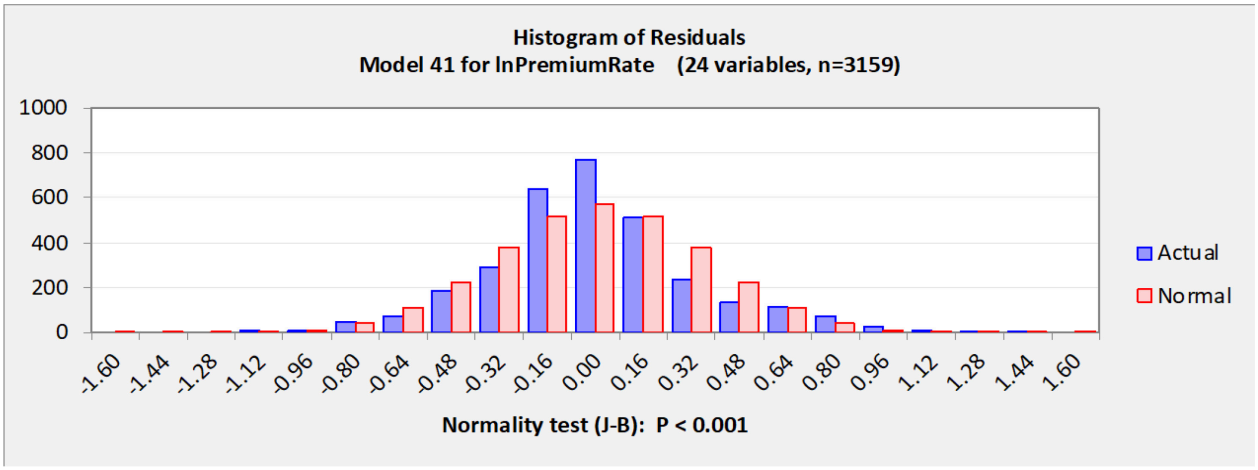


Chart 6: Histogram of Residuals Model 2 Broward Dade County

However, when we incorporate the geographic factor into the analysis for Broward County, we observe a significant normalization of the data, as shown in Chart 7 and Chart 8. The data points become more concentrated around the vertical axis at zero, indicating a better alignment between

the predicted and actual premium rates. Moreover, the histogram of residuals indicates a substantial increase in data points clustered around the range of -0.2 to 0.2, with the count rising by approximately 250 data points.

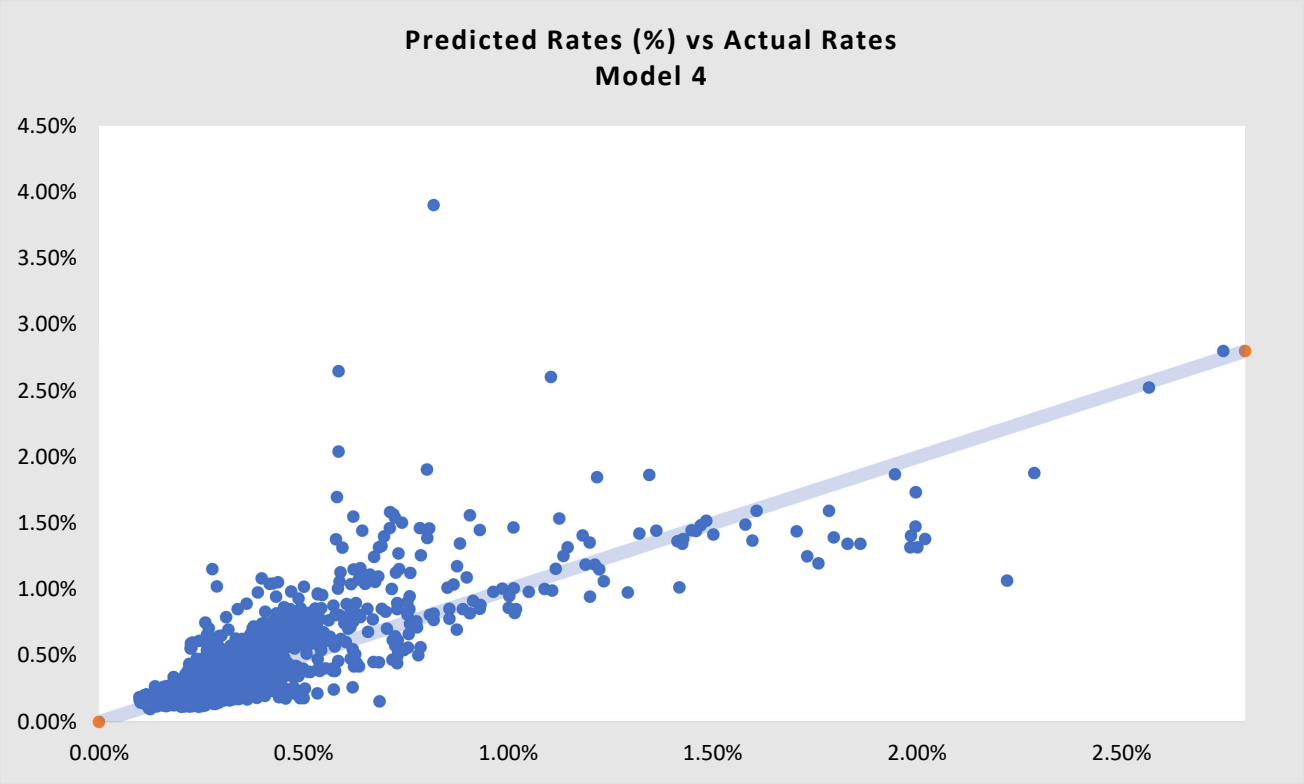


Chart 7: Predicted Rates (%) vs Actual Rates 4 Broward Dade County

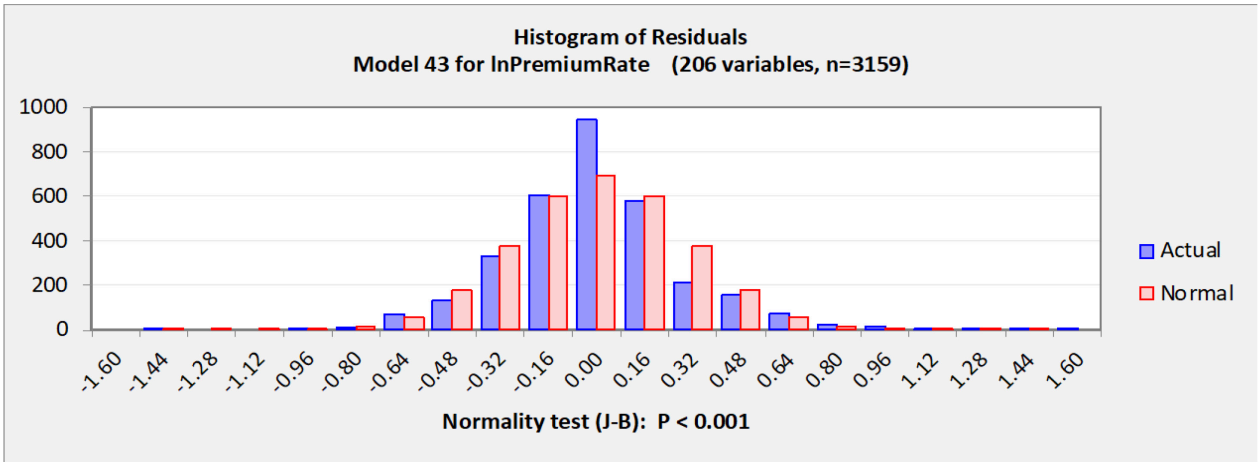


Chart 8: Histogram of Residuals Model 4 Broward Dade County

By incorporating the geographic factor, specifically Census Tracts, in our analysis for Broward County, we achieve a notable improvement in normalizing the data and reducing prediction deviations. This enhanced normalization is reflected in both the scatterplot and the histogram of residuals. The tighter

clustering of data points around the zero axis signifies a closer alignment between predicted and actual premium rates, indicating a more accurate prediction model.

## 5.3 Insurance Premium Rate Coefficients and Fixed Effects Influence

Recognizing the significant role of geographic characteristics in our models, we expand our analysis by incorporating additional factors that we deem relevant for predicting Premium Rates. These factors go beyond what is typically considered in the formulation of premium policies, as outlined in Chapter 3. Specifically, we incorporate three variables from the First Street Foundation's dataset and calculate their average for each census tract. This approach enables us to capture specific flood events by considering a more granular location layer. Additionally, we integrate the Flood Factor, which encompasses a broader range of flooding factors compared to FEMA risk designations.

Furthermore, we incorporate variables sourced from the Census Bureau that are correlated with house values, mortgages, and rent. These variables offer insights into factors that appear to be associated with premium rates and provide a glimpse into the purchasing power parity (PPP) of the population in various areas. By incorporating these additional variables into our analysis, we aim to enhance the accuracy and comprehensiveness of our Premium Rate predictions.

| Variable | Coefficient | Std. Error | t-Statistic | P-value |
|---|---|---|---|---|
| Constant | -0.510 | 0.100 | -5.117 | 0.000 |
| FloodFactorAvg | 0.111 | 0.018 | 6.077 | 0.000 |
| HistDepth2005 | -0.001028 | 0.001754 | -0.586 | 0.558 |
| HistDepth2017 | 0.002152 | 0.002543 | 0.846 | 0.398 |
| House_Value | 9.332E-07 | 1.976E-07 | 4.722 | 0.000 |
| Mortgage_Value | -0.000162 | 0.000072 | -2.243 | 0.026 |
| Rent_as_a__HHI | 0.003605 | 0.002215 | 1.628 | 0.105 |

Table 9: Regression results for model 5

Here are the descriptions and relevance of each of the variables as seen on table 6:

1. FloodFactorAvg (First Street Foundation): FloodFactorAvg is a significant variable that measures the average flood risk for a specific location. It takes into account various factors such as historical flood data, elevation, and proximity to water bodies. A higher FloodFactorAvg value indicates a greater vulnerability to flooding. In our analysis, we observe a positive coefficient of 0.111 with a high t-stat of 6.07, indicating its strong impact on the variation of insurance premium rates.

2. HistDepth2005 (First Street Foundation): HistDepth2005 represents the historical depth of flooding in a location during the year 2005. It provides insights into the severity of past flood events and helps assess the historical flood risks faced by an area. Although it shows a negative correlation, the significance is relatively lower with a t-stat of -0.58, which may be attributed to the limited available information for this specific flooding event.
3. HistDepth2017 (First Street Foundation): Similar to HistDepth2005, HistDepth2017 quantifies the historical depth of flooding in a location, but specifically for the year 2017. It allows us to evaluate changes in flood risks over time and assess the effectiveness of flood mitigation measures. This variable proves to be more meaningful than the 2005 event, generating a positive fluctuation in the premium rate value.
4. House Value (Census Bureau): House Value represents an estimate of the worth of residential properties in a given area. It reflects the market or assessed value of houses and provides valuable information on property wealth, market trends, and economic conditions. As expected, House Value demonstrates high significance with a low coefficient. However, it should be noted that the dollar value range of $120,000 to $1,300,000 for house values contributes to the relatively low coefficient.
5. Mortgage Value (Census Bureau): Mortgage Value represents the total value of outstanding mortgages on residential properties in an area. It provides insights into the overall debt associated with property ownership and offers valuable information about borrowing patterns and the mortgage market. The results show a negative impact on the premium rate value, indicating that higher mortgage values are associated with lower insurance rates. This relationship can be attributed to the fact that expensive mortgages are typically found in areas with higher property values. Since the NFIP insures only a fraction of the property value (capped at $250,000), there is a lower risk of total loss for insurers.
6. Rent as a % of HHI (Census Bureau): Rent as a % of HHI measures the proportion of household income allocated to rental payments in a specific area. It helps evaluate housing affordability and the financial burden of rent on residents, providing insights into rental market conditions. This variable reflects part of the purchasing power parities (PPPs) and confirms that areas with higher rent as a % of HHI are associated with higher premium rate values.

After analyzing the results presented in Table 6, our attention turns to charts 9 and 10, which provide insights into the behavior of residual values for each data point representing a specific census tract within Miami Dade and Broward County.

Examining chart 9, we observe a significant portion of data points with predicted insurances close to 0. However, there are also noticeable outliers with values above 700%, which warrant further investigation. It is important to note that these residuals are presented in a logarithmic scale. Interpreting the calculations, higher residuals indicate areas with interest rates that are multiplicatively higher than the average interest rate of the entire data sample, with these equation we transform in what we see as percentages:

$$(1)\ Predicted\ Coefficients = -0.510 + 0.111 * FloodFactorAvg - 0.001028 * HistDepth2005 + 0.002152 * HistDepth2017 + 9.332E-07 * HouseValue - 0.000162 * MortgageValue + 0.003605 * Rentasa\%ofHHI$$

$$(2)\ Predicted\ Coefficients = \ln(\%InterestRate)$$

$$(3)\ Residuals = Coefficients - Predicted\ Coeffcients$$

$$(4)\ e^{Residuals} = Multiplicative\ Value\ of\ Interest\ Rate\%$$

From equation (4) we can then calculate what residuals mean in face off the insurance rate premia. The range of residuals extends from 2.05 to -1.04, suggesting that certain tracts have insurance rates up to 7.795 times higher than the average premium rate observed across the analyzed census tracts.

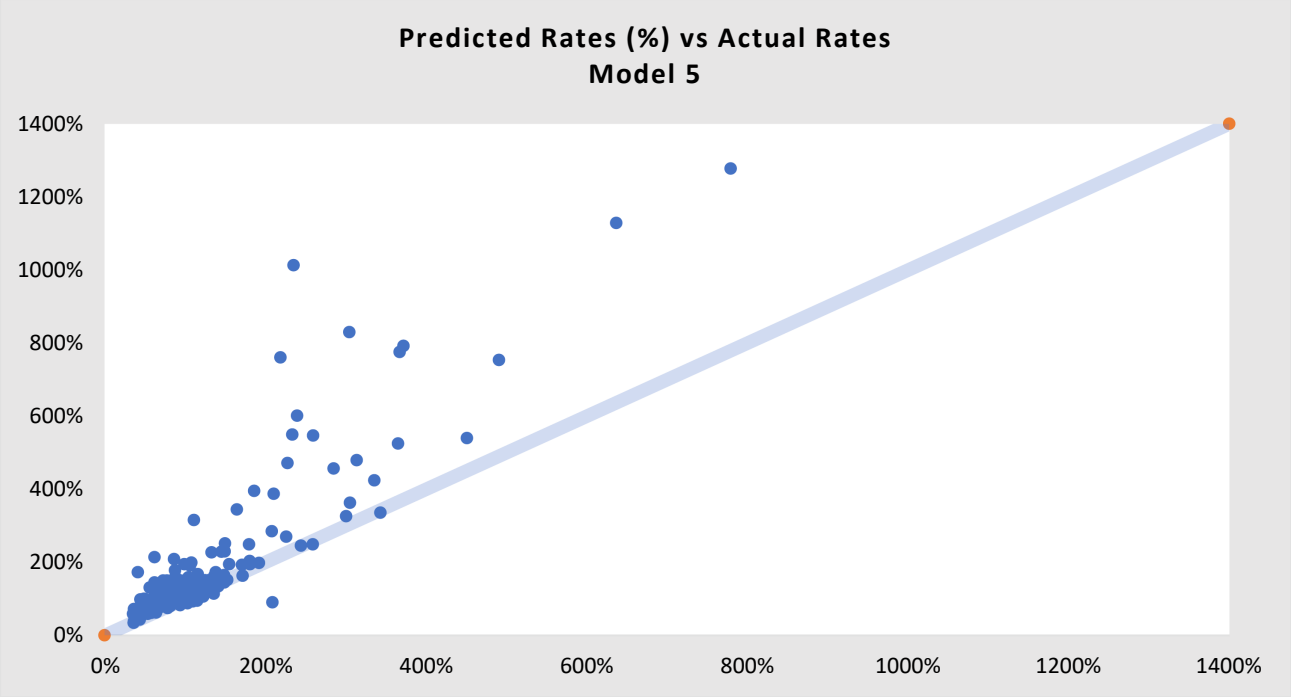


Chart 9: Predicted Rates (%) vs Actual Rates 5 Coefficients vs Fixed Effects

To better understand the distribution of these outliers, we turn to the histogram, which provides insights into their prevalence. Out of the 274 analyzed census tracts, approximately 165 have residuals near 0, while the remaining tracts exhibit either positive or negative fluctuations. Positive values above 0 indicate that these areas are paying at least 1x the insurance premium rate expected based on their characteristics. This is a crucial aspect that aligns with the core concept of this thesis. It prompts us to consider where the opportunities lie in Miami and Broward County, where tenants and property owners are potentially overpaying for insurance, and where this overpayment may grow exponentially in the future. In the upcoming chapters, we will delve further into time metrics and strategy to gain deeper insights into these opportunities.

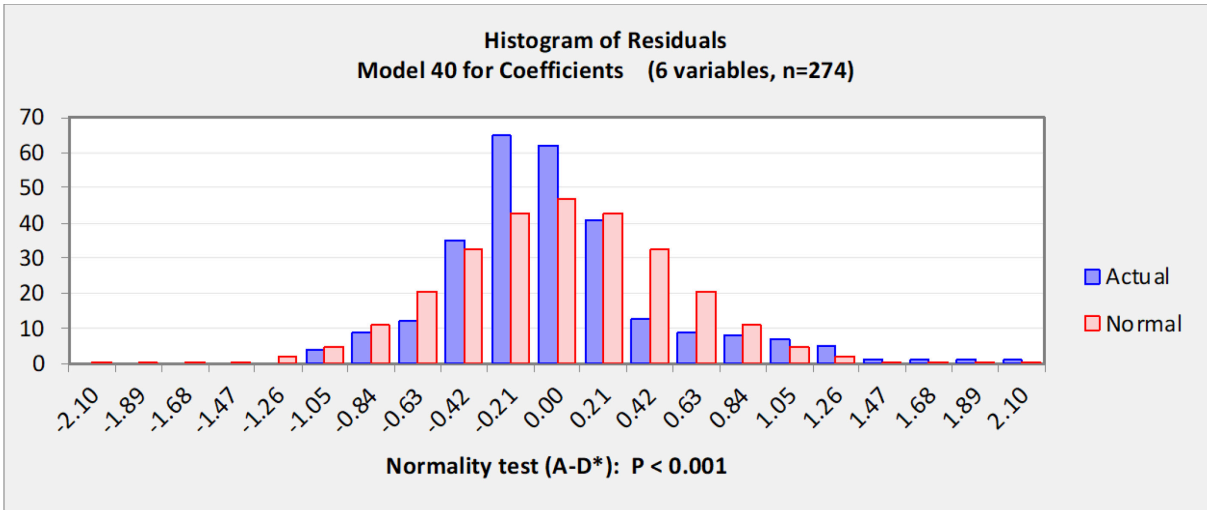


Chart 10: Histogram of Residuals Model 5 Coefficients vs Fixed Effects

## Chapter 6: Insurance Premium Rate Time Series

Gaining an understanding of the variation in insurance premium rates from one tract to another is undoubtedly valuable. However, it is equally important to examine the annual evolution of these rates over time. Therefore, as the second part of our results, we delve into the growth patterns of the insurance premium rates relative to the reference year of 2008. The graphs presented in the subsequent subchapters are derived from regression coefficients obtained both with and without considering the census tracts. By doing so, we aim to emphasize the significance of this variable, building upon the insights we explored in Chapter 5.

### 6.1 Premium Rates Series for Miami Dade County

The influence of geographic location on insurance premium rates is undeniably significant, as evident from our findings. In Miami Dade County, when considering the census tracts, the premium rates have experienced a substantial increase of 60.4% since 2008, as depicted by the orange line. In contrast, without taking the census tracts into account, the increase is only 29% as of 2022.

By generating an exponential trendline, we can extrapolate that the future growth of insurance rates will be even more pronounced than what our current results suggest. If this trend persists, it is conceivable that over the next ten years, insurance rates could rise by well over 100% compared to the rates observed in 2008. It is important to note that these projections are based on the average factors derived from our data sample.

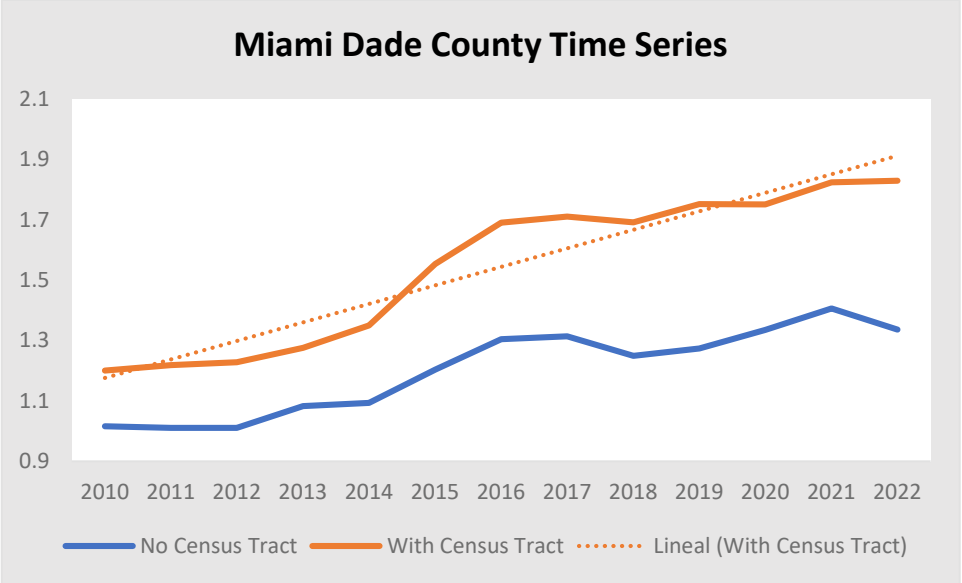


Chart 11: Miami Dade County Time Series with obtained coefficients from regressions of model 1 and 3

These findings highlight the escalating trajectory of insurance rates and emphasize the potential for substantial future increases. This information carries significant implications for homeowners, insurers, and policymakers, underscoring the need for proactive measures to address rising insurance costs and the evolving risk landscape in the region.

## 6.2 Premium Rates Series for Broward County

Similar trends can be observed in Broward County. Despite having a larger data sample than Miami Dade County, the findings indicate that insurance rates in Broward County have increased by approximately 42.8% since 2008. Without considering the geographic variable, the result would have

been a much lower increase of 12.7%, failing to capture the valuable insights that the census tracts provide to our analysis.

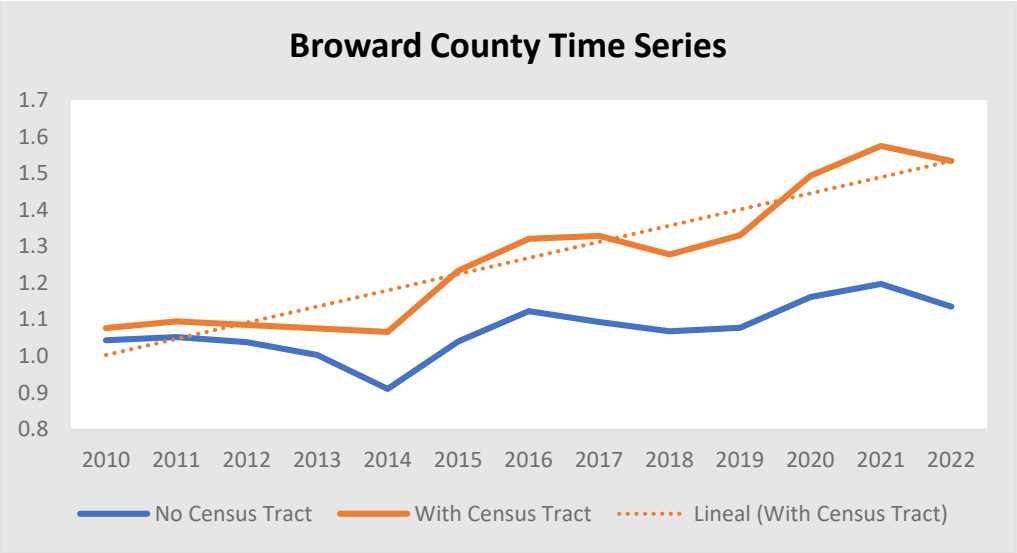


Chart 12: Broward County Time Series with obtained coefficients from regressions of model 2 and 4

When examining the exponential trend line, we observe a slightly less steep growth trajectory compared to Miami Dade County. However, it is important to consider that Broward County has experienced significant development over the past 14 years, with a growing population driven by high real estate and land prices. If Broward County follows a similar pattern to Miami Dade County in previous years, it is likely that insurance rates will exhibit an even steeper growth than what our current results suggest. Consequently, the effects of gentrification in various areas within Broward County are expected to be more pronounced. This aspect will play a crucial role in our strategy, which will be explored further in the subsequent chapter.

Understanding the dynamics of insurance rate growth in Broward County, along with the underlying factors contributing to this trend, is essential for policymakers, developers, and stakeholders involved in the real estate market. Recognizing the potential implications of rising insurance rates on affordability, neighborhood transformation, and socio-economic dynamics is paramount in devising effective strategies to mitigate the challenges associated with this emerging trend.

## Chapter 7: Residential Arbitrage Opportunities

The observed increase in premium rates is indicative of an impending natural gentrification process, a phenomenon that has been studied and analyzed from various perspectives. In the context of our

thesis, we aim to demonstrate that the rising insurance costs present an underlying opportunity for developers in areas that are disproportionately affected by high premium rates, likely due to the inherent risks identified by FEMA and insurance companies. What sets our analysis apart is that we have incorporated a comprehensive set of variables to assess the evolution of insurance rates, enabling us to pinpoint specific areas with distinct demographic characteristics.

By considering factors such as population purchasing power parity (PPP), we can identify opportunities for land acquisition in these areas. Moreover, the PPP of the population can also act as a constraint for individuals or families seeking to relocate from these high-risk areas. This interplay between demographic characteristics and insurance rates opens up a range of possibilities for developers, as they can strategically navigate the evolving real estate landscape driven by the dynamics of flood-induced gentrification. The complex interrelationships between insurance rates, demographic characteristics, and opportunities and challenges presented by gentrification; stakeholders can devise strategies that balance the economic potential with the need for sustainable and inclusive urban development.

## 7.1 Most Affected areas in Broward and Miami Dade County

Using the results from Chapter 6, particularly focusing on Model 5, we can visualize the impact of Census Tracts on insurance rates by examining the converted residuals. These residuals represent the multiples of the average insurance rate within different areas, as reported by homeowners who have filed for NFIP insurance relief over the past 13 years. Image 9 displays a color-coded scale to illustrate the variations in premium rates across Census Tracts.

The scale ranges from light green, indicating areas with insurance rates below the average, which suggests lower risk or lower property values that do not warrant high premiums. Moving into the mid-range, orangish scales indicate multiples between 2 and 4, representing higher risk factors and home values. Finally, the purplish areas with multiples ranging from 4 to 7.8 are characterized by very expensive real estate and significant flood risk.

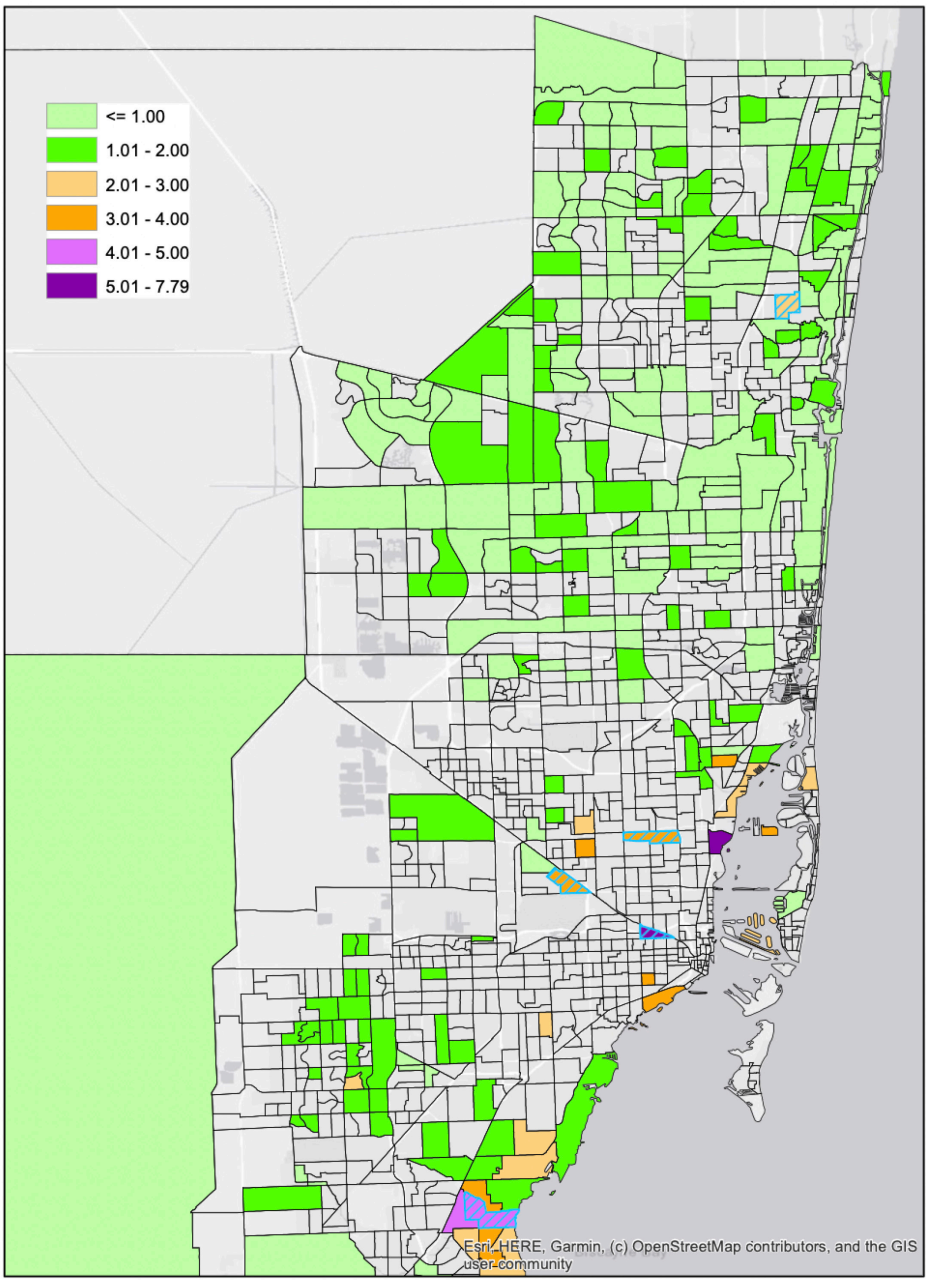


Image 9: GIS map defining Census Tracts areas with high multiples on insurance rates vs average insurance.

Our focus will primarily be on areas falling within the orange to purple scale range, as these regions demonstrate substantial variations in premium rates. However, it is crucial to consider areas in the green scale as well, as they may be on the cusp of experiencing rising premium rates. Furthermore, it is important to note that Miami-Dade and Broward Counties exhibit contrasting real estate values, with Miami featuring ultra-luxurious homes and luxurious condos, leading to higher price per square footage, as highlighted in Chapter 2. Broward County, on the other hand, is expected to undergo a more aggressive evolution in real estate prices due to the increasing unaffordability of Miami-Dade County's market for a significant portion of the population.

| Census Tracts | ZIP | Area | Insurance Premia Multiplier |
|---|---|---|---|
| 12086008209 | 12086 | Palmetto Bay | 4.908 |
| 12086004703 | 12086 | Miami Springs | 3.654 |
| 12086001004 | 12086 | Gladeview | 3.434 |
| 12011050702 | 12011 | Oakland Park | 2.261 |
| 12086005102 | 12086 | Little Havana | 7.795 |

Table 10: Sample of Census Tracts paying 2x + of Insurance Premium Rate.

In the upcoming section, we will delve into the specific characteristics of the census tracts mentioned in Table 7. By examining these areas, we aim to gain a deeper understanding of their unique attributes, including the variables considered in Model 5, as well as other fixed effects. Moreover, we will explore the demographic and economic factors of the population residing within these census tracts, which can provide valuable insights into potential opportunities for real estate development and arbitrage. By analyzing this comprehensive set of data, we can uncover hidden potential in these areas and identify strategic avenues for maximizing returns in the evolving real estate market.

## 7.2 Characteristics in Affected Areas

Based on our comprehensive analysis of specific areas in Miami and Broward, we have observed consistent characteristics and trends across the census tracts, reaffirming the potential for natural gentrification and real estate development arbitrage due to the overpayment of insurance rate premia.

In Chart 13, we can discern notable differences in population changes between 12086 (Miami Dade County) and 12011 (Broward County) neighborhoods. Population in the Miami Dade areas has experienced a decline over time, possibly driven by the steep increase in real estate and living costs in this region compared to the more affordable options available in Broward. The stagnant population growth in Miami Dade is also correlated with diminishing households, as evidenced in CT12066001004, possibly due to high living costs or the effects of natural gentrification. Additionally, these areas face high flooding risks, as indicated by the data from the First Street Foundation (FSF) in Image 10.

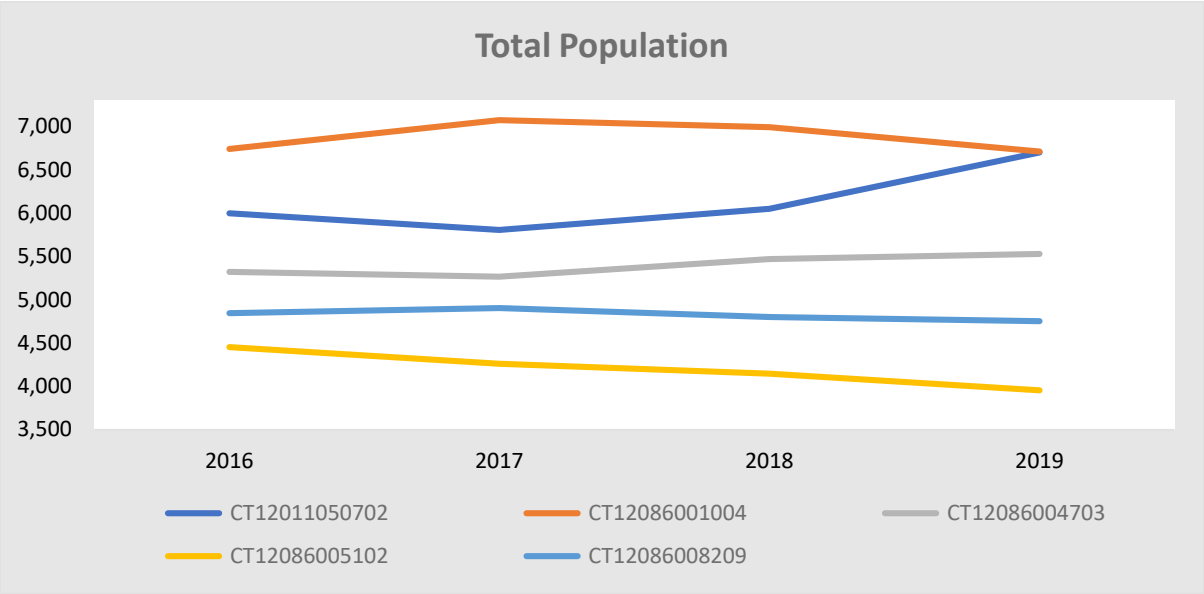


Chart 13: Population trend for sample Census Tracts

Chart 14 provides further insights, showing how households have decreased over time in CTs like 12086001004, 12086005102, and 12086004703. Interestingly, household incomes have remained stable over this period (as depicted in Chart 15), suggesting that new residents with higher incomes have not migrated to these areas due to a lack of real estate supply. These locations, often boasting bayfront or seafront views, seem to be attractive to current residents who are willing to relocate for a different real estate offering, without experiencing a significant increase in age demographics.

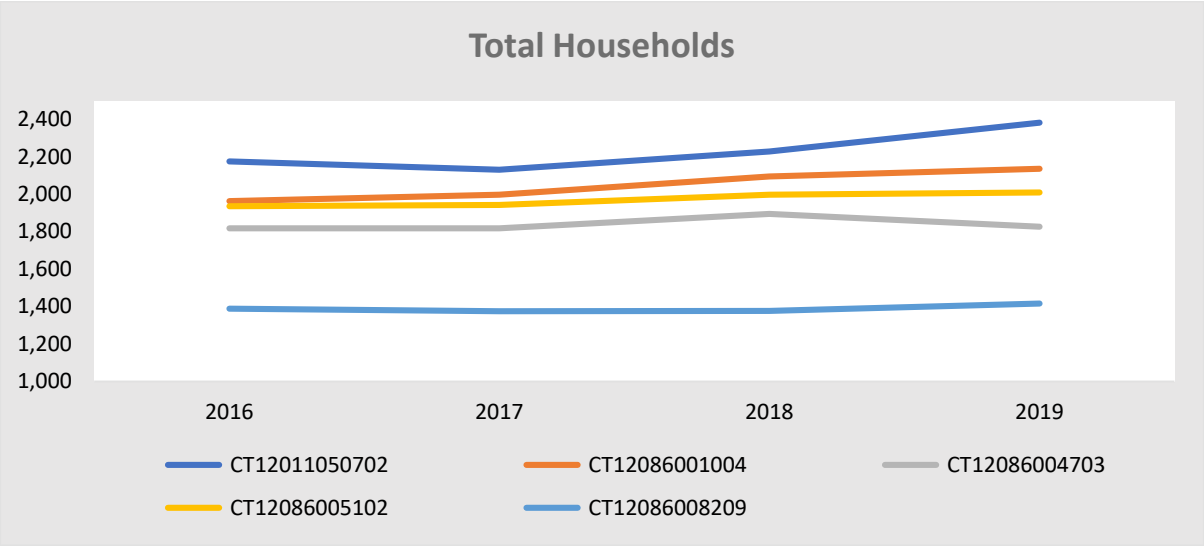


Chart 14: Household trend for sample Census Tracts

These consistent patterns in the census tracts highlight the potential for strategic real estate development and investment in areas where a natural gentrification process is unfolding. By capitalizing on the demand for housing in these desirable locations, developers can leverage the existing demographic and economic trends to maximize returns on their investments. Additionally, understanding the interplay between insurance rate premia, demographics, and real estate dynamics in these areas offers valuable insights for stakeholders to make informed decisions and navigate the evolving market landscape successfully.

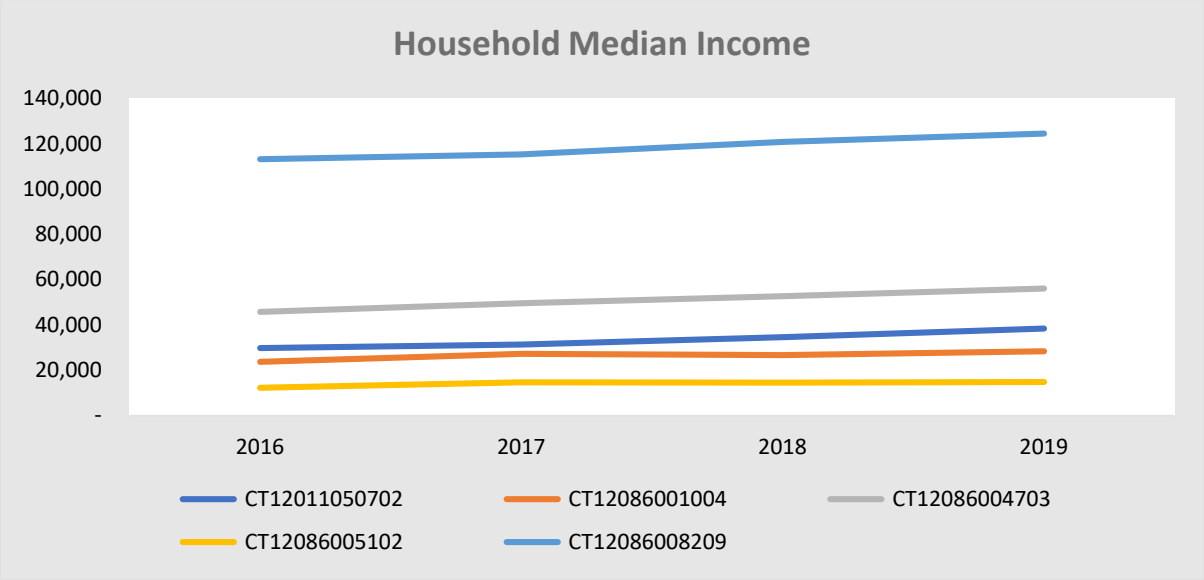


Chart 15: Household Median Income trend for sample Census Tracts

Lastly, let's delve into CT 12086008209, where we observe a notable rise in both wages and households. This indicates that the area has already undergone an arbitrage opportunity, attracting affluent individuals to invest in new real estate while some families, unable to afford the increasing living costs, have moved out. The high concentration of single-family homes and the soaring real estate value in this specific location are evident. However, despite the positive changes in the area's economic landscape, it is essential to acknowledge the potential risks associated with flooding, which could pose threats to property owners and insurance companies in the mid-term.

Considering the high value of real estate and its desirability, there exists an opportunity for ultra-luxury real estate development in this coveted zone. Nevertheless, such development should be mindful of the flooding risks to ensure the safety and resilience of the properties and protect both the investment of homeowners and the interests of insurance companies. By striking a balance between luxurious development and flood mitigation strategies, the area can sustainably grow, attracting affluent residents while safeguarding against potential future challenges.

## 7.3 Evidence and Strategy

Based on the comprehensive data analysis we have conducted; our strategy will revolve around the following steps:

1. Identify High Flood Risk Blocks: Building upon the insights from the FSF data, as depicted in Image 10, we will focus on specific blocks with high flood risk. By utilizing local zoning laws and engaging in discussions with the local administration, we aim to secure permits for potential development in these targeted areas.

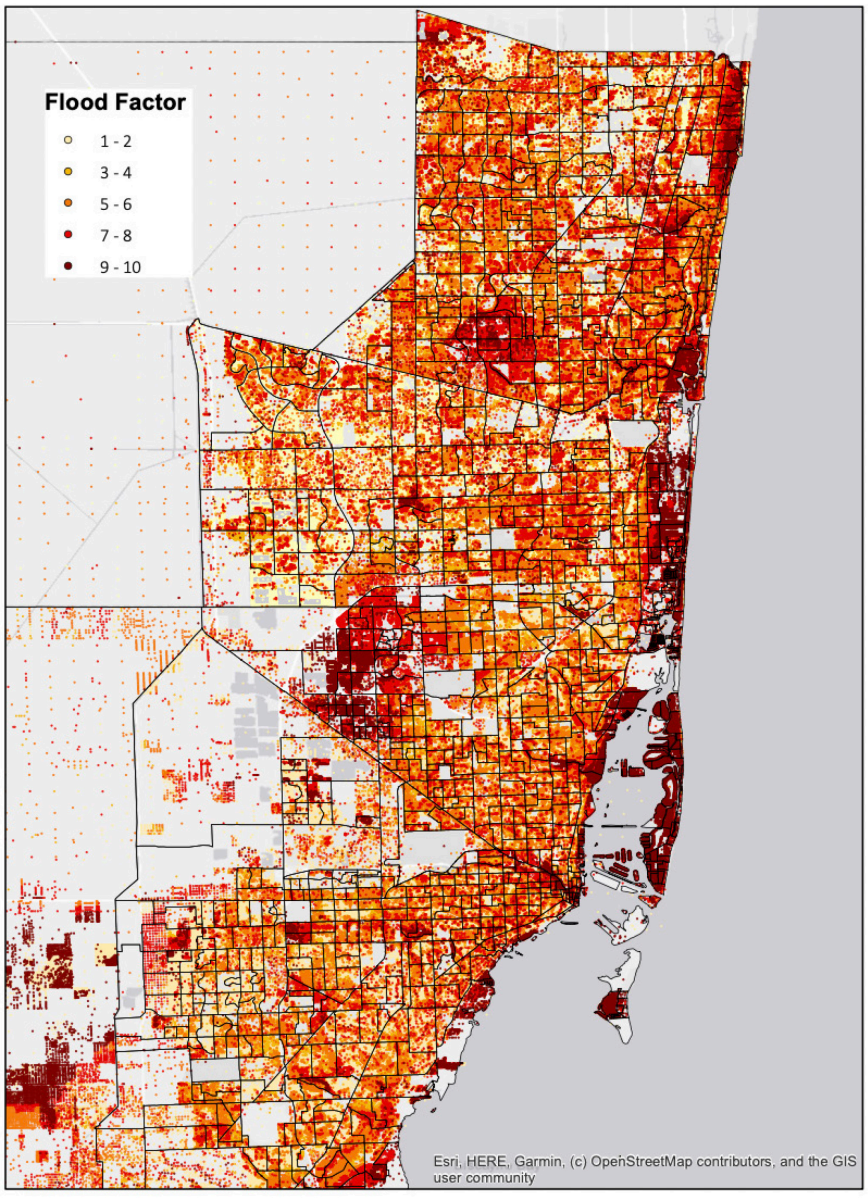


Image 10: GIS Map of FSF Flood Risk distribution for Miami Dade and Broward County.

2. Engage Property Owners and Brokers: We will arrange meetings with the owners of single-family residences in the identified areas and collaborate with experienced brokers familiar with the local real estate market. During these meetings, we will present evidence regarding the risks associated with flood-prone locations and the significant proportion of their income allocated to house-related costs.
3. Evidence Presentation: After initially engaging with landlords and brokers, it is crucial to provide them with compelling visual data, showcasing the key findings of this thesis. The focus should be on demonstrating how specific areas are currently paying a multiplicative amount of dollars per $1 cost compared to other regions. This visual aid should clearly illustrate how these costs are likely to continue rising over time, along with the potential risks that may impact their properties in the next 5, 10, and 15 years.
4. Strategic Parcel Acquisition: To execute the plan, we will bid for the parcels of interest, seeking discounts whenever possible. Short-term financing options will be pursued to facilitate the acquisition of the parcels, with a crucial condition being the successful obtaining of Letters of Map Amendment (LOMAs) and Letters of Map Revision (LOMRs). These letters will ensure that the insurance risk is permanently mitigated, providing a solid foundation for the development of a condo or multifamily product (ranging from midscale to luxury) that can be brought to the market for sale.

From all the above, evidence presentation can include comprehensive charts, graphs, and maps derived from the extensive data analysis conducted in this thesis. For instance, presenting the scatter plots and histograms of residuals, as seen in Charts 9 and 10, would visually depict the variations in insurance premium rates among different census tracts. By contrasting areas with fair insurance rates (light green) against those with substantially higher multiples (orange and purple), landlords and brokers can grasp the scale of overpayment in specific locations.

Additionally, utilizing time series data from Chart 11 and Chart 12 can effectively demonstrate the historical growth of insurance rates in Miami-Dade and Broward Counties. By extrapolating future trends based on the models, the presentation can emphasize the potential for even steeper rate increases, alerting stakeholders to the evolving risk landscape.

Furthermore, including flood risk data, as shown in Image 10, will provide a visual representation of high-risk flood zones, pinpointing specific blocks that require further analysis and mitigation

strategies. This evidence will highlight the importance of obtaining Letters of Map Amendment (LOMAs) and Letters of Map Revision (LOMRs) to permanently mitigate insurance risk, which will be crucial for future real estate development.

By presenting this evidence to landlords and brokers, they will gain a comprehensive understanding of the financial implications and risks associated with their properties. This evidence-driven approach will enable them to make informed decisions about the future of their investments and be more receptive to the possibilities of real estate arbitrage and development in response to the changing flood insurance landscape. Implementing this strategy, we aim to capitalize on the opportunities presented by natural gentrification and the overpayment of insurance rate premia. Through careful selection of high-potential areas, engaging with stakeholders, and securing the necessary approvals, we can unlock the potential for profitable real estate development while safeguarding against flood risks for both property owners and insurers.

## Chapter 8: Conclusion

This investigation has provided valuable insights into the complex dynamics of insurance premium rates in Miami-Dade and Broward Counties. Through a comprehensive analysis of geographic factors, independent variables, and time series data, we have unraveled significant patterns and trends that have significant implications for homeowners, insurers, developers, and policymakers.

The inclusion of census tract data in our regression models proved to be instrumental in enhancing the accuracy and reliability of our predictions. By accounting for specific geographic characteristics, we were able to gain a deeper understanding of the variations in premium rates among different areas. This insight emphasized the importance of location in predicting insurance costs, particularly in flood-prone regions.

Moreover, our analysis of the coefficients of the regression models shed light on the critical factors influencing premium rates. Flood risk, property values, mortgages, and rental affordability emerged as key variables significantly impacting insurance costs. The steady increase in premium rates over time underscores the urgency of proactive measures to address rising insurance expenses and plan for future challenges.

One of the most crucial findings of this investigation lies in the identification of residential arbitrage opportunities. By pinpointing specific census tracts with disproportionately high insurance premium rates, we uncovered potential areas for real estate development and investment. Understanding the interplay between demographic characteristics and insurance rates offers a strategic advantage for stakeholders seeking to capitalize on the evolving real estate market.

As we move forward, the evidence presented in this investigation will serve as a foundation for stakeholders to make informed decisions and devise effective strategies. Property owners and brokers can use the visual data and insights to assess the financial implications and risks associated with their properties. Developers can leverage this knowledge to navigate the real estate landscape and identify areas with high potential for sustainable urban development.

However, it is crucial to acknowledge the challenges and risks associated with flood-prone regions. The potential impact of climate change on flood risks requires careful consideration in any development strategy. Proactive measures to mitigate flood risks through obtaining Letters of Map Amendment (LOMAs) and Letters of Map Revision (LOMRs) will be vital for safeguarding both property owners and insurers.

In conclusion, this investigation serves as a starting point for further research and informed decision-making in the real estate and insurance sectors. The continuous monitoring of premium rates and the evolving risk landscape will be essential for adapting to the changing environment. By taking proactive measures and considering the comprehensive set of variables explored in this investigation, stakeholders can pave the way for sustainable and resilient urban development in Miami-Dade and Broward Counties.

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