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A HEDONIC PRICE APPROACH TO FLOOD RISK AND PROPERTY VALUE IN THE GREATER MIAMI AREA

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Abstract

This study investigates the relationship between property value and flood risk in Miami-Dade County Florida. Miami-Dade County has gained a lot of attention in the media for its high risk of catastrophic flooding. As climate change predictions have grown more severe, flood risk is a factor property buyers may want to consider.

This study uses hedonic pricing to see if the flood risk in the county affects the price of the home. In Miami-Dade County, properties near a public beach are considered desirable. This paper specifically looks at the interaction between distance from the beach and flood risk. This paper found Low flood risk homes have significantly lower prices than high flood risk homes if they are close to the beach (less than 45 miles), but have significantly higher prices than high risk homes that are far from the beach (at least 45 miles away). *Specifically, when a home is that far away from the water, being flood safe adds a positive value to a property by around 14%. Similarly, being in a high flood risk (FEMA AE) has a positive marginal effect on the price of a home if it is close enough to a public beach.*

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I. Introduction

This paper aims to look at flood risk and property values in Miami-Dade County Florida. The motivations behind this study are that flooding and flood risks are worsening nationally. Flooding is the most common natural disaster that occurs in the United States. FEMA has rated it as the #1 Natural Hazard and this risk is getting higher over the years. Climate change has dramatically increased the rate of flooding and future flood risks. As ice caps melt due to an increased global temperature, sea levels rise, creating a greater risk of flooding in coastal areas (NOAA 2019). Unpredictable and severe weather patterns also increase the chance of flooding. Since the 1970s, the occurrence of Category 4 and Category 5 hurricanes has nearly doubled (NOAA 2017). In 2017, Hurricane Harvey produced a record amount of rainfall ever recorded in the United States, reaching a maximum of 60.58 inches of rainfall (NOAA 2017). As the risk and severity of flooding continues to grow there are new implications and risks for the average homeowner.

Miami-Dade County Florida, the most highly populated county in Florida, is an area that faces a specifically high risk of catastrophic damages due to flooding (US Census Bureau, 2019). Miami Florida has gained a lot of attention in the media and from climate specialists for its severe flood risks. The National Oceanic and Atmospheric Association predicts that by 2070, Miami streets will flood every day (Sweet et al, 2018). The Union of Concerned Scientists (UOCS) found that within the next 30 years roughly 64,000 houses in Miami will be flooded (UOCS, 2018). This means that a typical family buying a home in Miami should be wary of their potential future flood risks.

There is a lot of attention paid to Miami's impending threat of flooding in the media and popular culture, as well. In 2017, the state of Florida had a GDP of 967,337 million dollars (US Census Bureau, 2019). This makes up five percent of total GDP in the United States making it the state with the fourth highest GDP (US Census Bureau, 2019). Miami generates almost one-third of Florida's GDP so Miami as a city is a major economic powerhouse. Damages from severe flooding would not only hurt the average homeowner but create large economic losses to industries in Miami, the state of Florida, and the United States as a whole.

Major news networks like the CNBC and BBC have published numerous concerning reports about Miami's flooding (Ruggeri, 2017; Olick & Posse, 2018). Local organizations like the Miami Climate Alliance and South Florida Water Management District have formed to help bring social and political attention towards the issue of flooding. Some of these efforts have been successful as current Florida politicians have used plans at mitigating flood risk as a major talking point for elections. In the 2018 governor elections, Ron Desantis beat the longtime Florida governor Rick Scott. This is largely due to Governor Scott's denial of climate change and the fire he went under for ordering budget cuts to the environmental protection programs during his governorship (Staletovich, 2019). The election shows a shift in priorities for the state of Florida regarding prioritizing flood safety and climate mitigation (Staletovich, 2019).

Miami was founded as a Spanish territory in 1566 and has been built up as a major US city ever since. From hundreds of years of infrastructure, Miami-Dade has grown into a massive settlement (Loria, 2018). Many areas in Miami that were developed by the shore were built without the worry of rising sea levels and flood risk (Loria, 2018). The ground under Miami-Dade county is mostly made up of limestone from fossilized ancient coral reefs. The porous nature of this limestone makes it so even when precautions are taken water is likely to eventually rise up through the ground (Loria, 2018). Nevertheless, efforts to mitigate flooding have been engineered throughout the city and county. Numerous pumps have been installed to pump water back into the ocean. Although the pumps have been successful in small areas like Miami Beach, most engineers agree that it would be impossible to implement throughout a larger peninsula (Loria, 2018). Raising roads has been another method practiced in order to mitigate flood risk (Loria, 2018). Infrastructure upgrades are incredibly expensive and require an extensive amount of labor. Although these innovations help give Miami hope, there is a question of how these dark predictions of flood risk could affect Miami-Dade County's housing market

This study aims to look at how FEMA rated flood zones affect the price of homes for sale in Miami-Dade County. The Federal Emergency Management Association (FEMA) categorizes areas all over the United States into flood zones based on their potential risk of flooding. These flood zones are found by taking into account local data, hazard assessment and risk assessments of a given area (FEMA, 2019). Flood Zones help property owners gauge their own personal risk. This also asserts whether or not a homeowner must buy mandatory flood insurance and the type of flood insurance policy he or she must buy. FEMA flood risk ratings will be used in this study because they are the most accessible and general ratings. FEMA flood zones are the government approved ratings so they are expected to reflect a more general analysis and not the work of a niche group of researchers (FEMA, 2019). General information is important because if the risk ratings are not well-known it is unlikely there would be an effect on housing prices because people would have to be aware of the risk in order for it to affect the market (Wheatley, 2010).

Flood insurance policies are designed to provide protection for homeowners in areas with high risk, like in Miami-Dade County. The largest flood insurance program in the country is the National Flood Insurance Program (NFIP), which is run by FEMA (Lingle & Kousky, 2018).

The NFIP provides insurance to participating communities across the country and high risk homes with federally backed mortgages are required to purchase insurance. Flood insurance is run on a state-wide basis and Florida has the largest flood insurance program in the country, making up about 35% of NFIP policies (Lingle & Kousky, 2018). The NFIP almost entirely dominates the flood insurance industry, making up about 95.5%-96.5% of all flood insurance policies (Howard, 2019).

There is a growing concern about large gaps in the flood insurance market especially concerning the hold over the market that the NFIP has (Howard, 2019). Many homeowners who are not required to purchase flood insurance may still be at risk (Lingle & Kousky, 2018). There is also speculation that the NFIP may not have ratings that are sufficient enough to pay for losses. This idea is backed up by the fact that the NFIP had to borrow over 30 billion dollars all together to pay for claims from hurricanes Katrina, Sandy, Harvey, and the Louisiana floods in 2016 (Howard, 2019). Private flood insurance markets have tried to break through and serve as a solution to the gap in coverage, but this is very difficult considering how large and widespread the NFIP is (Lingle & Kousky, 2018).

This study will consider how FEMA ratings affect the value of a home. Therefore, this study will use hedonic pricing in order to find out how valuable flood safety is in Miami-Dade County. Hedonic pricing is a method used in environmental cost-benefit analysis to assess the economic values of environmental attributes of properties in the housing market. Hedonic pricing attempts to find the price of a non-market good or service by disentangling the total value of a good (house) into the value of its individual attributes. The method considers multiple different qualities of a home, such as size, socioeconomic characteristics, location attributes and environmental quality or risk and then evaluates how each quality contributes to the total price.

This study aims to see if different levels of flood risk will affect the price of a home in Miami. This information is important to a larger body of literature coming out about flood risk and its impact on property price. This is to investigate whether the dire predictions on flood risk in the area affect the prices of properties. It is likely a bad investment for buyers to purchase homes in areas of Miami-Dade County that have a high flood risk. This paper aims to see if the price reflects that bad investment.

This paper will use hedonic regressions in order to evaluate the relationship between flood risk and property value. The data is a sample of houses in the county. Size, location, socioeconomic and environmental characteristics were collected for all of the homes in the sample and included in the data. The findings of this study will contribute to a greater body of literature about flood risk and property value in Miami-Dade County. The findings will make it clear if people are valuing flood safety in their purchases. This information can help lead to more research and programs intended to educate about flood risk and flood safety.

This paper proceeds as follows. Section II reviews relevant literature to this study and compares findings and methods of this study compared to others. Section III reviews the theoretical and empirical framework for the study. An in-depth discussion of hedonic pricing and the theory behind it will take place in that section. Section IV discusses the data used in this study and how it was collected and analyzes the descriptive statistics of the sample. Section V interprets the results of the regression. Section VI is the conclusion. Section VII is the discussion and limitations of the study.

II. Literature Review

Non-econometric studies are useful to set up a framework for this paper. Studies regarding recent findings in the scientific community help show a clearer understanding of climate change and flood risk. *Climate Change driven accelerated sea level rise detected in the Altimeter region* by Nerem et al (2018) looks into Florida specific flooding. The article has less to do with property value prices and more to do with specific measurements of flood risk in Florida. The study uses satellite data to show that the rate of sea level rise is accelerating. The researchers predict that by 2100 sea level rise could be between 53 and 77 centimeters (Nerem et al, 2018). The article stresses the variability in flooding of different areas and notes geography as a likely cause. These sort of measurements are important to gauge different ratings of flood risk in Miami. This also provides a strong scientific backbone for the research in this thesis and allows the focus to be economics and not scientific fact-checking.

There is a growing number of published works on flood risk and property value. Climate change has become a global problem within the last few years. Flood risk has always been a nightmare for homeowners but with recent statistics citing more coastal cities at risk, the problem has become widespread. Papers before this thesis have used hedonic pricing to evaluate the effects of flood risk on cost. A very similar study done by Dei-Tutu (2002), uses hedonic pricing to find a value on housing prices in floodplains in North Carolina, which have high flood risks. The paper compares this price with the value of flood insurance available in 2002 by the NFIP. Property records from sales in Pitt County North Carolina were used coupled with floodplain data that was collected combining local floodplain mapping data, property parcel data and local geographic information systems (GIS) data.

Dei-Tutu’s (2002) paper and this thesis both include the distance from water as a variable. This is because distance from the beach or a large body of water can add a significantly higher value onto the price of a home. Studies on real estate valuations have shown that coastal areas and views receive significant upturns in price when the market is healthy (Hansen & Benson, 2013). People are often willing to pay high prices to be close to the beach. Pitt County is not on the beach like Miami-Dade County, but the county has a river called the Tar River which branches out directly from the Atlantic Ocean. Dei-Tutu (2002) found that proximity to the Tar River increased the value of a home and conclude that proximity to that body of water adds an amenity value to a home.

The paper found that there is a discrepancy between flood insurance premiums and house price in the area. Homes in floodplains received a 6.6 percent discount rate on price while capitalized insurance premium value represents approximately 4 percent of the house's selling price (Dei-Tutu, 2002). This allows the authors to conclude that there are substantial non-insurable costs to flood risk perceived by homeowners that are not being realized in the insurance premiums (Dei-Tutu, 2002).

A major difference between Dei-Tutu's (2002) paper and this thesis is that this thesis will look at three different binary measures of flood risk to see whether a property is in one of three categories of flood risk. Although this thesis has a different focus, seeing other researchers utilize such similar methodology will be helpful when beginning the hedonic analysis. Dei Tutu's (2002) paper will be used to model important methods of Hedonic pricing for this thesis.

A major difference between Dei-Tutu's (2002) paper and this thesis is that further evaluation of flood risk and distance from the beach will take place in this thesis. Miami-Dade County has areas on the beach and areas that are quite far from the beach. The wealthiest areas in the county are also the areas closest to the water. Distance from the beach will be interacted with flood risk to analyze which component of value is prioritized in the valuation of a property.

Environmental Determinants of Housing Prices: The Impact of Flood Zone Status by Harrison et al (2001) uses hedonic valuing to see how much value homes on flood plains lose because of their status and how insurance from NFIP reflects that. The researchers found that homes on flood plains in Alachua County Florida tend to sell for less money and that property taxes have over assessed on valuing. The study used FEMA flood maps in order to assess if a property had a flood risk. This risk was then coded as a binary dummy variable. A home with flood risk was given the value of 1. The paper found that homes located in 100-year floodplains (areas with a 1% risk of flooding each year), were about $1,000 lower in price than observationally equivalent homes (Harrison et al, 2001). The paper concludes that the evidence suggests that the present value cost of future flood insurance premiums is higher than the market value discount applied to flood zones. This is opposite to the findings of Dei-Tutu (2002).

Both Harrison et al (2001) and this paper utilize hedonic pricing on flood risk that takes place in the state of Florida. A large difference between the two studies is that Harrison et al (2001) researches Alachua County Florida. This county is entirely landlocked and does not include any variable on distance from the beach.

This thesis offers a much more recent look at real estate and flood risk. The previously mentioned papers are all written before 2003. Since then, climate change and flood predictions have become far more severe. There is a need for more up to date information in the literature. Both papers were concerned with comparing loss in value from risk due with flood insurance premiums. Due to the complexity of that analysis and lack of up to date data on insurance premiums and risk, this paper will not compare insurance premiums in Miami-Dade County with risk, but will discuss attributes of the Miami-Dade County flood insurance market in the discussion section. These papers are also both written before the 2008 recession. This may have little effect on the implicit value of flood risk, but it could affect a buyers willingness to pay for a risky property. It could also decrease the total number of buyers in Miami who are willing to buy a property in general.

Climate change, Flood risk, and property values: Evidence from New York City by Gibson et al (2017) also uses a hedonic methodology to gauge property value change and flood risk. The paper examines the risk in New York City which is a major city like Miami. The paper also looks at the validity of flood risk maps. The researchers found that Hurricane Sandy decreased the value of houses by 3-5%. This data lines up with what is predicted to occur in Florida but at a possibly more dramatic rate. What is especially interesting about this study is that it considers the attitudes of people about flooding and how that may have reduced value. This is an impact that this thesis will not directly look at but is an interesting factor to consider about the real estate market. It also means that any value concluded in this thesis could actually result in much higher levels of loss when personal attitudes about the market are taken into account.

Gibson et al (2017) focus on the effects Hurricane Sandy specifically had on flood risk. To do this, prices are looked at pre and post-Sandy. Gibson et al also include data about FEMA floodplain risk in the area. After Hurricane Sandy, areas in New York City were added to FEMA flood plains.

Gibson et al (2017) and this paper share key main features: they use hedonic pricing to measure the value of flood risk, they use FEMA ratings, they are recent, and they both take place in major cities. The previous papers do not deal with major American cities. Cities like New York City and Miami are valuable places to buy real estate so the effect that flood risk has on properties could be very different. The results from Gibson et al, show a smaller reduction in price due to flood risk than the previous studies. This could be because of the desirability to have a property in New York City in general. Miami-Dade County may show similar results. Both studies are recent so they can take into account buying trends and flood risk threats that may not have been realized in the early 2000s.

Hedonic pricing is a method that has been effectively used to analyze the dollar value of other environmental qualities as well. Michael et al (2000) discuss and analyze how environmental quality is valued in hedonic pricing. The study focuses on water quality in Maine (Michael et al, 2000). The author points out that general awareness about water quality plays an important role in hedonic pricing. If consumers believe that the water is clean, then they will assign more implicit value to a property even if it turns out that the water quality was lower than they believed (Michael et al 2000).

Michael et al (2000) evaluated the market for water quality by producing a survey for potential buyers and residents at lakefront properties. The survey asked questions about the assumed water quality of the lake and the impact that water quality has when making a decision about buying a property. The survey results showed that people were generally interested in the current water clarity and historical water clarity before purchasing a property. The researchers used this survey to design a hedonic price model that interacted historical water quality (noted as clarity in the study) and current water clarity (Michael et al 2000). The paper concludes that there is significant evidence that water quality affects implicit prices drawn from hedonic equations. The paper also concludes that it is important to measure an environmental quality using data the public has access to. If people are unaware of the environmental hazard in an area it may not affect prices (Michael et al 2000).

Michael et al (2000) set up some very important framework regarding hedonic pricing. The paper concludes that hedonic pricing is an effective means of finding implicit values of environmental quality. A similarity between this paper and Michael et al (2000) is that this thesis takes into account the conclusion Michael et al (2000) makes, and uses FEMA flood ratings as an indicator of flood risk because it is accessible information and property buyers are aware of their FEMA rated flood risk.

Michael et al (2000) chose to interact historical water clarity and current water clarity in the hedonic equation. They chose to interact the variables for two reasons. First, a person's perception of water clarity may rely on historical, or past water clarity. Second, the two variables are highly correlated (Michael et al 2000). This thesis will interact distance from the beach and flood risk in order to greater understand the value of being close to the beach and flood safe and vice versa.

Where this thesis greatly differs from Michael et al (2000) is the environmental quality being tested. This paper aims to look at flood risk which can cause external and internal damage to properties. This paper will also include air quality as an environmental quality but the main quality being tested is flood risk. This paper will not utilize surveys as a way to gauge information.

Like many previous works discussed above, this study used a hedonic approach to capture the value of flood risk. Like Harrison et al (2001) this paper uses hedonic price analysis to find the marginal effect flood risk has on price. Both this paper and Harrison et al (2001) use samples of houses from the state of Florida which has a considerably high flood risk. Like Dei-Tutu (2002), this paper will capture distance from a body of water which is a location attribute to a property. This is because distance from the beach is considered an amenity to a property.

Similar to Gibson (2017) this paper looks at a major metropolitan city. Like Michael et al (2000), this study recognizes that the hedonic price of an attribute may be related to the value of another attribute. Michael et al (2000), interacted opinions on historic and current water clarity because current water clarity values are different at different historic water clarity values. In this paper the two attributes of interest to interact are the distance to the beach and flood risk. The distance from the beach has both an amenity (access) and disamenity (risk) component. At different levels of distance from flood risk may have a different marginal effects on price. Therefore, the interaction term will indicate the marginal effect flood risk has on price with distance. Without including the interaction the model could result as a model misspecified.

III. Framework

III.A. Theoretical Framework

The hedonic pricing model implies that composite goods, like houses, are valued by numerous qualities that the house has. The qualities of a home cannot be sold individually so they cannot receive value on their own (Boardman et al, 2006). Instead, the marginal price of a characteristic can be implicitly determined by the price of a house (Boardman et al, 2006). This allows willingness to pay for a specific quality of a home to be determined. In this paper, the main characteristic studied is FEMA flood risk, hedonic regressions are used to find the elasticity of price to flood risk.

In a hedonic price model, the price of a home represents an equilibrium of supply and demand for that home (Conroy & Milosch, 2011). The model assumes that the price is dependent on the characteristics of a home. This can simply be represented that there is a price function of $P(Z)$ (Gilbert 2013). In this function, Z is a vector of all of the characteristics that determine the price that consumers pay. It is also assumed that consumers have a utility function. Each utility function is dependent on Q, which denotes all goods that are not housing and housing qualities. Each individual will choose where to live by maximizing utility, U(Q, Z) subject to the budget constraint Y - P - Q = 0, where Y is income (Dei-Tutu, 2002). The key assumption that a hedonic price model makes is that the function *P(Z)* exists (Gilbert 2013).

With that one key assumption comes three more basic assumptions: market power, completeness, and availability (Gilbert 2013). Market power assumes that no consumer or producer has market power. This would be violated if the market was a monopoly and the prices in the market were fixed by a monopolist (Gilbert 2013). This is not an issue in the housing market.

Completeness is the notion that all possible combinations of products are available for sale. This is so all consumers can choose a property that has their ideal combination so they can choose their optimal bundle. This assumption directly relates to the limitation of information in hedonic pricing. If consumers do not have full information, they may not know what their optimal bundle is (Wheatley, 2010). Conversely, if buyers are not well-informed about the features of their home they could purchase a home with an externality that could prevent them from maximizing their bundle (Wheatley 2010). Market limitations can also block a model from satisfying the completeness assumption. If a potential buyer wants to live in a specific neighborhood in a four-bedroom house with a pool and no home on the market is available at that time, a buyer will not be able to satisfy their optimal bundle. As the limitations show, in reality, the assumption of completeness is rarely met. In housing studies, it is almost impossible to find an entirely complete market and this condition can be safely ignored, but it is important to note in order to grasp the basic framework (Gilbert 2013).

The last assumption is availability. This means that the products are available to any population that would like to participate. In other words, no party who would partake in the market is being blocked by an institution. This could artificially change prices. Market limitations can also block availability (Wheatley 2010). If there are not enough homes on the market for people who want them due to limitations, prices could artificially rise.

There are three more limitations of using a hedonic model. These limitations are measurement validity, multicollinearity, and price changes (Wheatley 2010). Measurement validity refers to the fact the measurements used for the independent variable must be of high quality and valid. If the measurement validity of the independent variables is not up to standard, the coefficient generated could be inaccurate (Wheatley 2010). Multicollinearity refers to the problem that may arise when two or more independent variables are strongly correlated. This can make it nearly impossible to separate out the two variables from each other (Wheatley 2010). An example could be a sample where homes with poor air quality are only in neighborhoods with low median incomes and vice versa. Lastly, price changes refer to the fact that prices do not change instantaneously due to changes in attributes (Wheatley 2010). Natural logs are used to help with this.

The first step in creating a hedonic price model is to build the price *P(Z)* function. Following the literature, the function of price will be composed of three main components including size, socioeconomic characteristics, environmental quality, and location attributes (Boardman et al 2006). The simplified equation is:

$lnP = f(SIZE, SE, ENVT, LOC)$

SIZE: denotes the vector of size and physical characteristics

SE: denotes the vector of socioeconomic characteristics

ENVT: denotes the vector of environmental characteristics

LOC: denotes the vector of location characteristics

III.B. Empirical Model

The basic framework can be summarized in this equation:

$$\ln price = \alpha + \sum_{i=1}^{n} SIZE + \sum_{i=1}^{n} SE + \sum_{i=1}^{n} ENVT + \sum_{i=1}^{n} LOC + \mu$$

Equation 1 will be estimated using an ordinary least squares model (OLS). The right side of the equation represents all explanatory variables that can explain a house price. If the variables are linear the coefficients of the explanatory variables represent the marginal effect each of the explanatory variables has on the price of the home. These four categories of explanatory variables are the key determinants of house price used in the literature; (Boardman et al, 2006; Dei-Tutu, 2002; Harrison et al, 2001; & Gibson et al, 2017). As is standard in the literature, the dependent variable and most independent variables will be expressed in natural log (Dei-Tutu, 2002; Harrison et al, 2001; & Gibson et al 2017), so that each coefficient can be interpreted as an elasticity. Flood risk will be represented as a dummy variable and interpreted as a percentage difference in price between properties that have a safe rating vs an unsafe rating as is standard in the literature (Dei-Tutu, 2002; & Gibson et al 2017). Distance will not be expressed in log form, therefore the coefficient multiplied by 100 is interpreted as how every mile increase in distance will result in a percentage change in price. The rest of the explanatory variables will be in natural log form because price will not change with respect to flood risk at a linear rate. The literature also states that log-based models are appropriate when there is no available information on the square footage of the lot (Haan & Diewert, 2013). In this model, the housing market data did not provide square footage of the lot and only of the house itself, which makes a natural log model the best method of application.

Size characteristics are valuable contribution to the price of a home because they indicate exactly how much the home offers. In this analysis, size measure will be the square footage of the house and not the lot. This is due to lack of availability on data that includes the size of a lot. The number of bedrooms will also be considered. Square footage of the property and number of bedrooms are expected to have a positive marginal effect on price. This is because the willingness to pay for a home will go up with the home's size.

Socioeconomic characteristics (SE) about specific areas in Miami will be used to get a better idea of property values in the area. The median income of Miami neighborhoods by zip code will be taken into account. Crime rates will be measured here as well because it has been an effective indicator of property value in past hedonic models (Dei-Tutu, 2002; Harrison et al, 2001; & Gibson et al, 2017). The coefficient of socioeconomic information will vary by home and neighborhood. A classic quality measure used in previous studies is the quality of local schools in a district (Conroy & Milosch, 2011). This will not be used in the sample due to lack of accessible data on school quality in Miami-Dade County neighborhoods. Being in an area with a high crime rate is expected to reduce the value of a property. A home in an area with a high median income is expected to add to the value of a property.

Environment (ENVT) contributes to the price of a home because a poor environment will reduce the value of a home. This is why homes on the highway or next to a power plant have lower prices; they have a lower environmental quality. The two environmental variables looked at are flood risk and air quality. The flood risk in an area could reduce the value of a home because of the added costs and damages of flooding. Flood insurance on average in Florida is about $394 per year through NFIP in Miami (Lendingtree, 2019), but can only cover up to $250,000 dollars in losses through NFIP (Howard, 2019). The costs and potential losses of flood risk even with insurance, could reduce the value of a property. The marginal effect of flood risk is expected to be negative in an area where there is any FEMA flood risk.

Location (LOC) contributes to the price of a home because people value the location that they live in. Distance from the beach can make the surrounding environment of a property more desirable, but also more prone to flood risk. Distance from the beach will be included in this analysis and interacted with flood risk to see how the two variables change depending on the value of one another. Distance from the beach is expected to have a negative marginal effect because the further a property is from the beach the less buyers can get the benefit of visiting the beach. Another environmental quality added to this analysis is air quality. Miami-Dade County has varying degrees of air quality so this will be captured in the regression as well.

This model attempts to capture the basic characteristics of value by modeling the variables after other successful hedonic price models. Some of the assumptions for hedonic models are not realistic in the real world so the results of this paper can be helpful in understanding the relationship between flood risk and housing prices but should not stand alone in the evaluation of housing markets and flood risk.

IV. Data

IV.A Sample and Variable Description and Data Sources

The sample for this study consists of 85 homes listed for sale on November 24, 2018, in Miami-Dade County, Florida from Zillow. The price for 100 homes was originally collected but due to various reasons described below, 15 observations were dropped from the analysis. The different variables for characteristics about homes were collected from numerous different resources which will be named below. The sample this paper uses is smaller than many other samples in the literature. This is due to time and resource constraints. Miami-Dade County has nineteen cities, six towns, and nine villages. This was labeled as "Neighborhood" in the data. Out of the 34 neighborhoods the sample of 85 houses included 18 neighborhoods. Miami was by far the most common neighborhood that a home for sale in the sample was from. According to data compiled from Bestplaces.net, the neighborhood of Miami accounted for 43 out of 88 homes listed in the sample (48.9%). Miami has an actual population of 443,007 and Miami-Dade County has a total population of 2,702,602 (Bestplaces.net). Miami actually only accounts for about 16.4% of the population in Miami-Dade County. It is important to note that this sample is heavily skewed toward properties in Miami.

Dependent Variable

The first piece of data collected was for the dependent variable: price. Zillow archives were used to get a sample of 100 houses in Miami-Dade County, Florida. The method of collection was to simply check the listing on a given day with no price or size limits set to the house. The search was set so there were no apartments and the properties had to be for sale and not for rent. The price recorded was the asking price for the home. This was done in order to get an accurate depiction of what homes were actually on the market at that given time. The first 100 houses were collected and their price was taken down. Three homes from the sample were dropped because their prices were over $4,000,000 and it skewed the sample data much higher than the actual average property prices in the area.

Independent Variables

Size Characteristics

The Zillow listings contained size characteristics along with the asking price of every home. With each home added to the sample, the square footage, and the number of bedrooms was recorded. The number of bathrooms was not included in this analysis because it was too closely correlated with the number of bedrooms, so it was dropped due to multicollinearity. Both variables collected are expected to have a positive coefficient. The zip code and full address of each house were included in order to track each property to collect data for neighborhood characteristics and environmental attributes.

Socioeconomic Characteristics

Socioeconomic information (neighborhood characteristics) was collected through Bestplaces.net. Bestplaces.net compiles publicly available data from resources like the US Census Bureau, the US Geologic Service, and the National Hurricane Center. The website takes this data and organizes it by location. This allows for users to search a zip code and have access to numerous data-sets and statistics on that zip code. A benefit of using Bestplaces.net is that it is a common tool that potential property buyers also use when deciding where to purchase a home. This means that the data collected for this study represents the knowledge that a potential buyer would also have access to.

As mentioned earlier, the socioeconomic characteristics of a neighborhood can affect the price of a home. Certain neighborhoods like Key Biscayne, have no public or private schools in the area. Due to high retirement rates in the state of Florida, many desirable neighborhoods in Miami-Dade are not considered "family-friendly", meaning they are not centered around people with children (US Census, 2018). The gaps in information about schooling in Miami-Dade County made school quality an unreliable variable to include as a vector of price. Instead, the median income, given by zip code on Bestplaces.net was used as a variable for socioeconomic information of a home. The violent crime rate was also collected from Bestplaces.net. The violent crime rate was rated by Bestplaces.net on a scale of 0 - 100.

Environmental Quality

The environmental quality of a home was analyzed using a few variables. Bestplaces.net provided scores for both air and water quality throughout different zip codes in Miami-Dade County. Water quality had little variation within the county, so it was dropped as a variable. Air quality saw a fair amount of variation, so air quality scores were recorded by zip code. Air quality was rated on a scale of 0 -100, with 0 being the worst and 100 being the best. The ratings for air quality on Bestplaces.net comes from new measures of hazardous pollutants from EPA which is called National Air Toxics assessment. This measurement system follows respiratory illness and cancer rates by zip code which helps provide greater precision and insights on air quality than previous measurements. Air quality is expected to have a positive marginal effect, but the significance that air quality may have is uncertain. Miami is not known as a place with highly polluted air like Beijing or New York City, so the general consumer may not be very concerned about small differences in air quality throughout the county.

Flood risk was the second environmental quality taken into account. As discussed, this paper used FEMA rated flood risks. The FEMA flood risk of each property was found using a FEMA flood map provided by arcgis.com. The map provided the ability to enter the exact address of a home in Miami-Dade County which then showed the property's FEMA flood risk rating. The first is a FEMA X rating which means the area has a 0.2% probability of flooding each year. This is considered the lowest flood risk a house in the United States could have. This FEMA X rating means that the property owner is not required to buy flood insurance.

The next rating is FEMA AH which means that there is a 1% risk of shallow flooding every year. This means flooding would not be expected to get over 3 feet. This rating is categorized as a medium level of flood risk. The highest rating is a FEMA AE rating, meaning that there is a 1% chance of heavy flooding per year. All of this information can be found in Table 1. Twelve of the 100 homes listed in the Zillow sample could not be found on the FEMA flood risk map, so they were dropped from the sample. Each flood risk was recorded as a dummy variable.

Some FEMA X rated homes would include its distance from a higher risk area. This is because FEMA flood zones can be dispersed unexpectedly. A home can be rated as flood safe but be 50 feet from a FEMA AE (high risk) rated zone. Figure 1 presents a screenshot of the flood map showing the amount of variability in flood zones there are. A home with a FEMA X flood risk could be next door to a home with a worse rating. Figure 2 shows a home that is marked safe within a flood zone but is under 200 feet away from a FEMA AH flood zone. In this case, property owners may feel inclined to purchase flood insurance at their own will.

Table 1. FEMA Flood Risk Key

FEMA Flood Zone	Definition	Risk Level
FEMA X	0.02% chance of flooding each year	Safe
FEMA AH	1% chance of shallow flooding each year	Medium
FEMA AE	1% chance of heavy flooding each year	High

Location

The distance from each house from a local beach was included as a location variable because the distance from the beach can affect the price of a home (Conroy & Milosch, 2009). Distance from the beach was found using Google Maps. Each address was searched into google maps and the closest beach was located. The distance from the beach was recorded in miles. One shortcoming of this method is that google maps can only accurately locate the nearest public access beach and not distance from any available coastline. Properties that have private beach access may be marked as having further access to the beach than they realistically do. Miami-Dade County has numerous public access beaches. Homes on the coast with private beach access are unlikely to be marked as significantly further from the beach because of the sheer amount of public beaches on the coastline.

The dependent variable *price* and the following independent variables: *square footage*, *bedrooms*, *median income*, *violent crime rate*, and *air quality* will all be in natural logs for the analysis. FEMA flood risk values will be included as dummy variables. Distance will be presented in miles and not in a logged form for analysis.

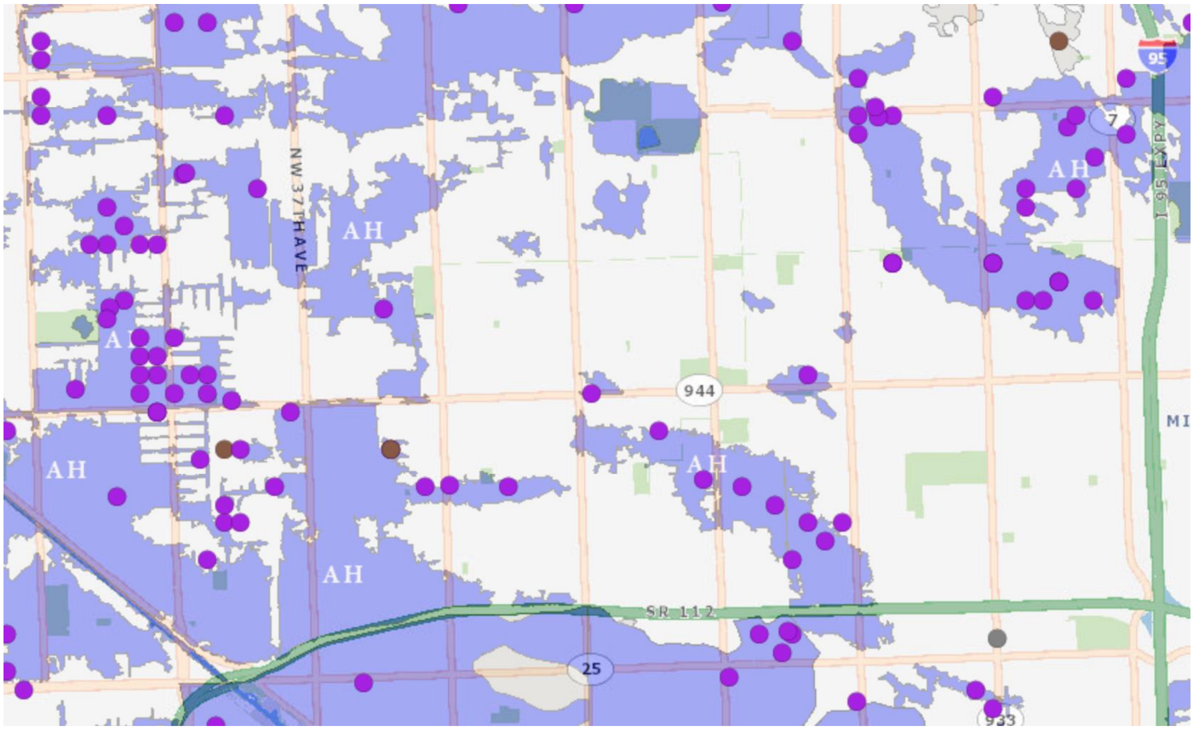

Figure 1. Screenshot of FEMA Flood Map (Source: arcgis.com)

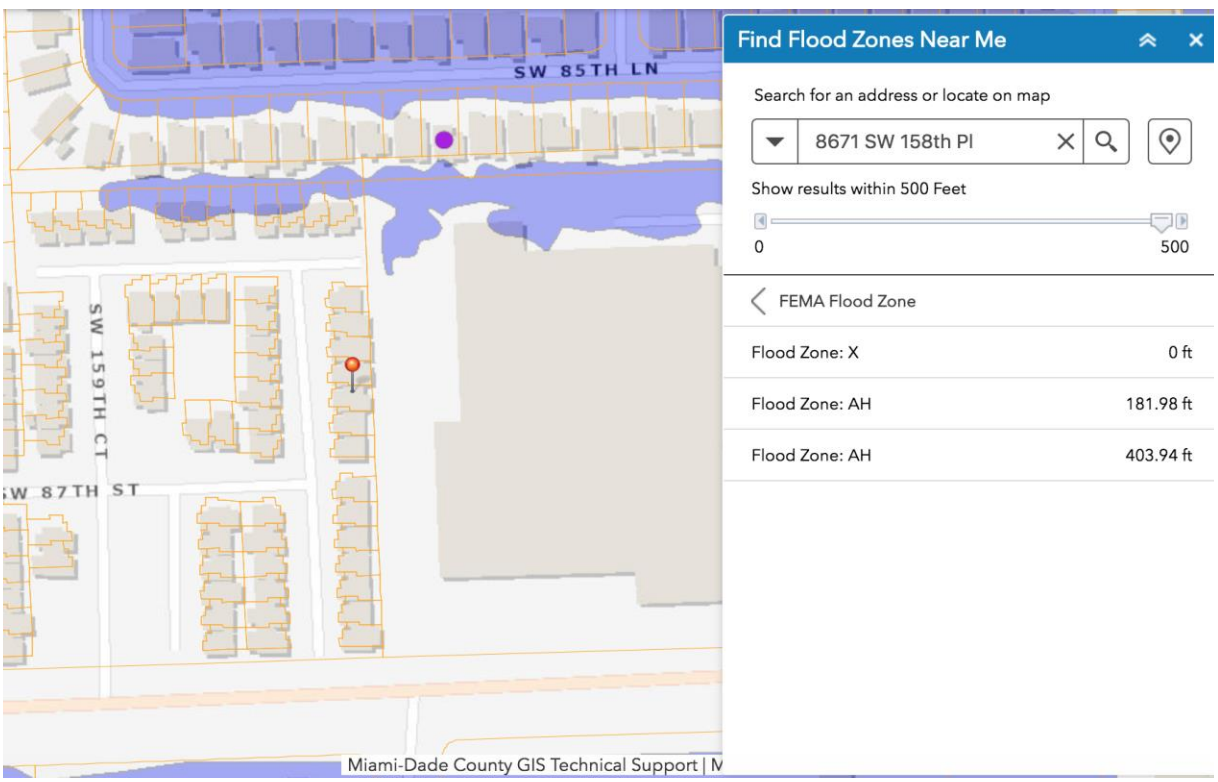

Figure 2. Nearby Flood Zones (Source: arcgis.com)

IV.B Descriptive Statistics

Table 2 presents the descriptive statistics of the variables within the sample. The table allows for a better idea of the statistics within the sample. Table 3 presents averages from variables in the sample compared to national and county-wide averages. There was no national or Miami data on the average square footage, the average distance from the beach, the average bedrooms, and the average bathrooms so they were excluded from the table.

The average price of a home in the sample is $575,223. This is fairly high compared to the national average home price being $367,100 as of November 2018 (US Census 2018). The average price in Miami-Dade, which is $305,200. The median price in the sample is 419,500 and the median home price for Miami-Dade County is about $339,700 according to Zillow. The sample used for this paper has an upward skew on prices, especially from the more expensive lots in the sample that are going for over a million dollars.

The median income in the sample is $51,768.71 which is slightly lower than the national median income which is $53,482. The actual median income of Miami-Dade County is much lower than the national median and is around $43,099. It should be noted that median income may not be the best indicator of wealth in this area due to the high number of retirees. The wealth within Miami-Dade County and areas with large retirees could be much higher. The sample is skewed with a slightly higher median income for Miami-Dade County, meaning the sample may draw more heavily from higher-income neighborhoods than is represented by the county as a whole. Interestingly, even though the sample is heavily based in Miami, Florida, the median income for Miami as a whole is $30,858. Of course, there are multiple different zip codes in Miami which could account for the difference. The lowest median income is $22,127 from zip code 33142 in Miami, Florida. The Islands, which is a neighborhood in Miami, has the highest median income of $170,500 (Bestplaces, 2019).

The violent crime rate was measured on a scale of 0 – 100. The average crime rate in this sample was 49.12 which is much higher than the national ratings of 22.7, likely because Miami-Dade County is a largely urban county and Miami is one of the largest cities in the United States which pulls up the crime rate. Interestingly, the violent crime rate in the sample is much higher than the Miami-Dade average. It is unclear why this may be, considering that the homes in the sample are skewed towards higher income areas. This may be because the majority of homes in the sample are from the city of Miami itself. Although the violent crime rate varies within smaller subsets of Miami, the overall violent crime rate is 48.8, accounting for the higher rating within the sample.

The air quality within the sample was slightly higher than both the Miami-Dade County average and the national average.

Table 2. Descriptive Statistics

Variables	Mean	Median	Standard Deviation
Price (Dollars)	$575,223.5	$419,500	$428,206
Square Footage	2,060	1,839	967.2218
Bed	3.56	3.00	.89
Violent Crime	49.12	45.75	13.68
Median Income	$51,768	$49,945	$17,236.1
Air Quality	60.28	60.00	11.82
Distance (Miles)	19.82	20.00	10.26

(Sources: Bestplaces.net, US Census Bureau, Zillow)

Table 3. Sample Averages Compared to National and County Averages

Variable	US	Miami-Dade County	Sample (average)
Median Income	$53,482	$43,099	$51,768
Violent Crime Rate	22.7	29	49.12
Average Price	$367,100	$305,200	$575,223
Air Quality	58	58	60.28

(Sources: Bestplaces.net, Zillow, US Census Bureau)

V. Results

The regression on housing price showed many revealing aspects of how specific qualities are related to housing price. Table 4 presents the results of the regressions. Models 1 through 3 will be discussed first. Models 1 regresses house price against square footage (LnSQFT), number of bedrooms (LnBED), median income (LnMEDINC), violent crime rate (LnCRIME), and air quality (LnAIRQ). Model 2 includes FEMA X (FEMA_X) in the regression as a single dummy variable. Model 3 builds on Models 1 and 2 and adds in distance from the beach (DIST).

In models 1-6, the most significant coefficient associated with housing price is square footage (LnSQFT) which has a positive coefficient significant at the one percent level. The coefficient of the final regression is pretty robust and shows that with every one percent of additional square footage, the price of a home goes up by 0.9% to 1.02%.

The coefficient for median income (LnMEDINC) is positive and statistically significant at the ten percent level for models 1 and 2 and significant at the five percent level in the later models. The coefficient can be interpreted as an elasticity. For every one percent increase of median income the price of a home goes up by 0.40% to 0.422%.

The coefficients for bedrooms (LnBED), violent crime (LnCRIME) and air quality (LnAIRQ) all did not end up being statistically significant in the model. This could be for multiple reasons but likely has to do with the fact that most homes in the sample had three bedrooms so factors like size and location had a much larger pull on price. As stated in the data section, Miami-Dade County has an overall high level of air quality compared to the United States and is not an area where air quality is a concern which is probably why small variations in air quality held little effect. Violent crime rate was not significant which was surprising but may be explained by the small sample size and overall high crime rate in the area.

In Model 2, when FEMA X (low flood risk) was added to the model with distance, the coefficient for FEMA X was negative but not statistically significant. This was not the expected result to see as literature previously has shown homes in a flood zone lower the value of a property (Dei-Tutu, Hansen and Benson 2013).

Model 3 adds distance from the beach (DIST). This variable's coefficient was also statistically significant with a negative marginal associated with distance. This connects to the idea that it is desirable to live near an area with access to the beach and can add to the value of a home. In Model 3, the coefficient for distance was -0.0185 at the one percent level of significance. Distance from the beach is given in miles and not log-transformed like the dependent variable; price, so the coefficient cannot just be interpreted at face value. Instead, the coefficient must be multiplied by 100. This yields the result -1.85. It can be interpreted is as every mile further the from the beach a house is, its value decreases by 1.85%.

Due to the availability of different levels of risk, in Model 4 FEMA AE (FEMA_AE) is added to Model 4. This is to differentiate the differences in risks. FEMA AH, the medium risk level, was omitted. This allows for the coefficient of FEMA X rating to represent the price difference between safe and medium risk homes and the coefficient of FEMA AE to represent the price difference between high and medium risk homes. Both FEMA AE and FEMA X ratings were not statistically significant in this model.

Model 5 extends on Model 3 and interacts FEMA X (safe) rated homes with distance from the beach to test whether and how much the marginal effect of each variable on its price is influenced by the other. This is represented in the table as a FEMA_X*DIST. This is modeled after much of the literature that looks at risk as a binary variable. This allowed for a marginal analysis of FEMA when FEMA X is equal to 1 or equal to zero (whether the home is flood safe or poses a flood risk), to vary with distances from the beach. The coefficient given with FEMA_X*DIST on Table 4 is not an adequate analysis of the interaction because it does not capture the variations within the margins. Variations of the marginal effect of FEMA X with distance is illustrated in Figure 3 where total distance from the beach is plotted for distance ranging from 0 to 50 miles with 5 mile intervals. As Figure 3 shows, FEMA X homes have a negative and statistically significant marginal effect between a distance of 0 and under 20 miles. Between about 20 and just under 45 miles of distance from the beach, the marginal effect of a FEMA X rated home is not statistically significant. After 45 miles or above, FEMA X rated homes had a positive marginal effect on price. The marginal effect at 45 miles or higher is 0.316 and significant at the 10 percent level, this value must be exponentiated to be interpreted. This can be interpreted as a 14% increase of price or higher when a home is FEMA X rated and over 45 miles from the beach. This means there is a price penalty for safe homes until the distance to the beach increases to over 45 miles and at that point there is a sizeable increase in price.

Model 6 is an extension of model 4 by using the other risk ratings and interacting them each with distance (FEMA_AE*DIST). The interest is to differentiate the marginal effect of different levels of risk on price according to price by a property's distance from the beach. Similar to Model 5 (FEMA_X*DIST) and (FEMA_AE*DIST) the coefficient of the variables do not fully capture the marginal effects. Instead, Figure 4 and Figure 5 will be used to discuss the marginal effects of each FEMA rating at varying distances from the beach.

Figure 4 shows the marginal effects of FEMA X conditional on their respective distances from the beach. Similar to Model 5, the marginal effect is plotted for distance of 0 to 50 miles, with 5-mile intervals. As the graph shows, the marginal effects of FEMA X rated homes increases with distance, a trend similar to that shown in Figure 3, but with larger confidence intervals, the marginal effects are no longer statistically significant at any level of distance.

Figure 5 analogously shows the marginal effect of FEMA AE at various distances from the beach. Figure 5 shows that the marginal effect of FEMA AE has the opposite trend as that in Figure 4: it falls with distance. Further, a distance of 15 miles or less, the marginal effect is positive, which is the opposite of what is seen in the literature. Typically homes that have high flood risk bring the value of a home down and have a negative coefficient (Dei-Tutu, 2002; Harrison et al, 2001; & Gibson et al 2017). As the distance grows the marginal effect becomes negative but is never statistically significant.

Table 4: Regressions

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
LnSQFT	1.024***	1.002***	0.900***	0.952***	0.978***	0.972***
	(0.163)	(0.164)	(0.144)	(0.148)	(0.143)	(0.146)
LnBED	-0.61	-0.0378	-0.0142	-0.087	-0.109	-0.108
	(0.261)	(0.261)	(0.228)	(0.233)	(0.224)	(0.227)
LnCRIME	0.165	0.233	0.0504	0.000111	0.0873	0.111
	(0.26)	(0.267)	(0.235)	(0.237)	(0.228)	(0.231)
LnMEDINC	0.420*	0.447*	0.422**	0.375*	0.402**	0.434**
	(0.235)	(0.236)	(0.205)	(0.207)	(0.199)	(0.202)
LnAIRQ	-0.0823	-0.144	0.135	0.0819	0.0244	-0.128
	(0.195)	(0.203)	(0.185)	(0.188)	(0.185)	(0197)
FEMA_AE				0.149		0.519**
				(0.11)		(0.258)
FEMA_X		-0.0964	-0.103	-0.0289	-0.456***	-0.177
		(-0.0862)	(0.0751)	(0.0923)	(0.161)	(0.211)
DIST			-0.0185***	-0.0169***	-0.0269****	-0.0155**
			(0.00364)	(0.00379)	(0.00489)	(0.00746)
FEMA_AE*DIST						-0.0199*
						(0.0112)
FEMA_X*DIST					0.0172**	0.00714
					(0.00695)	(0.00854)
Constant	0.582	0.469	1.413	1.931	1.65	1.567
	(3.015)	(3.012)	(2.63)	(2.643)	(2.549)	(2.55)
Obs	85	85	85	85	85	85
R-Squared	0.657	0.662	0.747	0.753	0.766	0.778

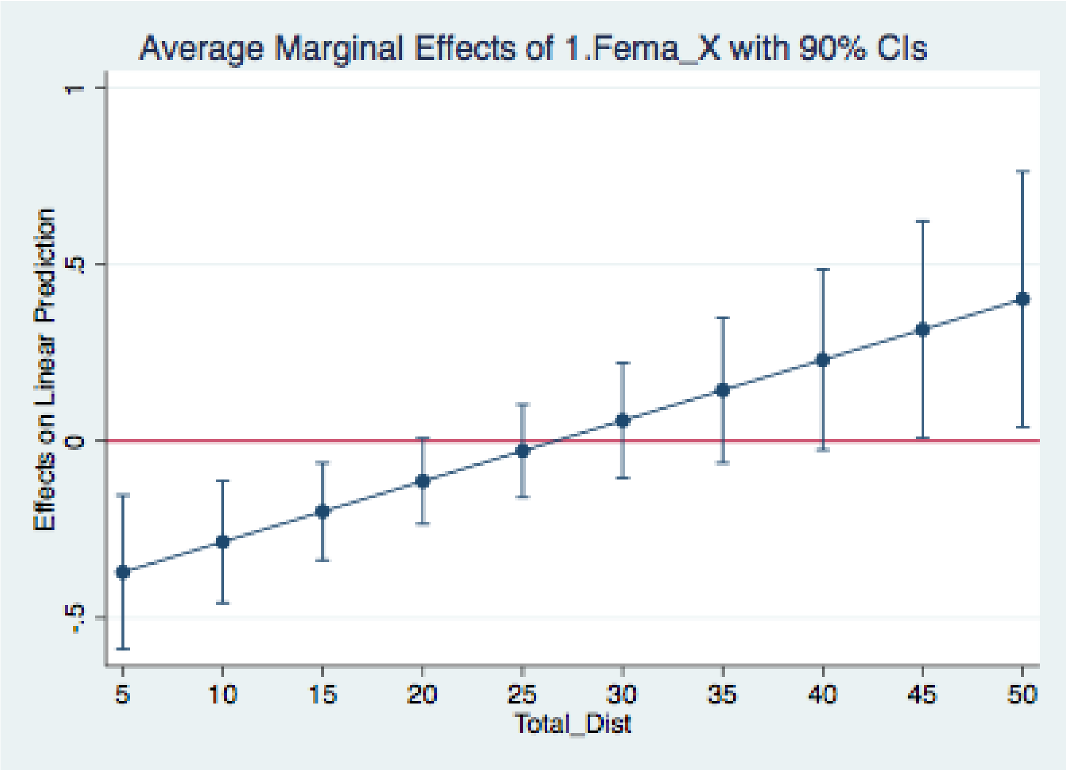

Figure 3: Marginal Effects of FEMA_X*DIST with 90% Cis Model 6

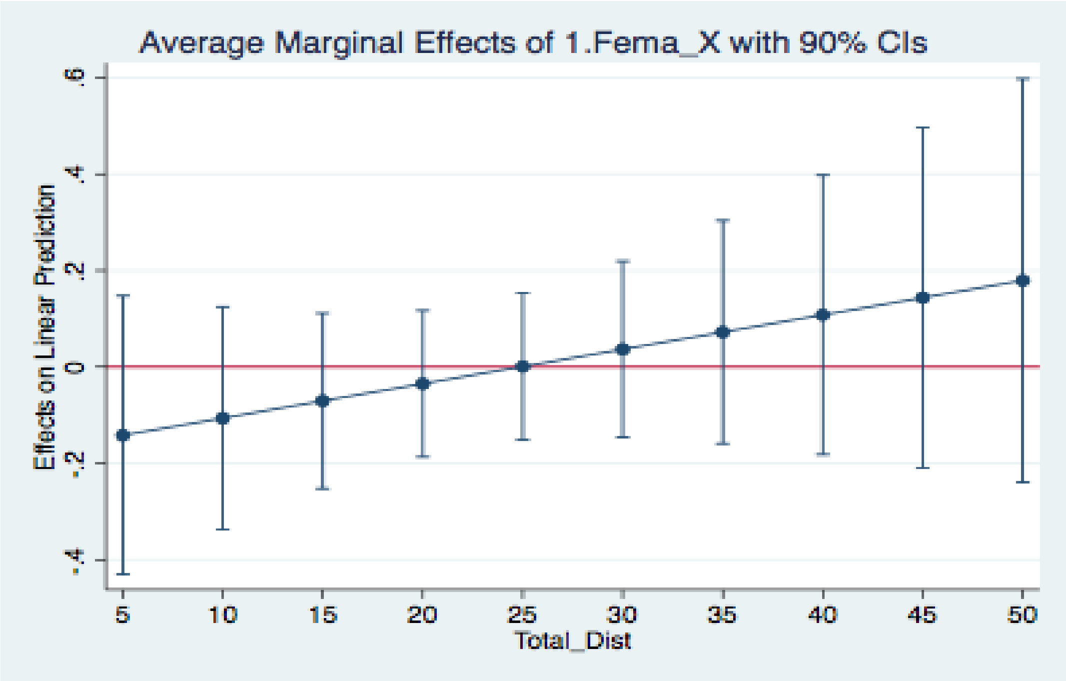

Figure 4: Marginal Effects of FEMA_X*DIST with 90% CIs Model 7

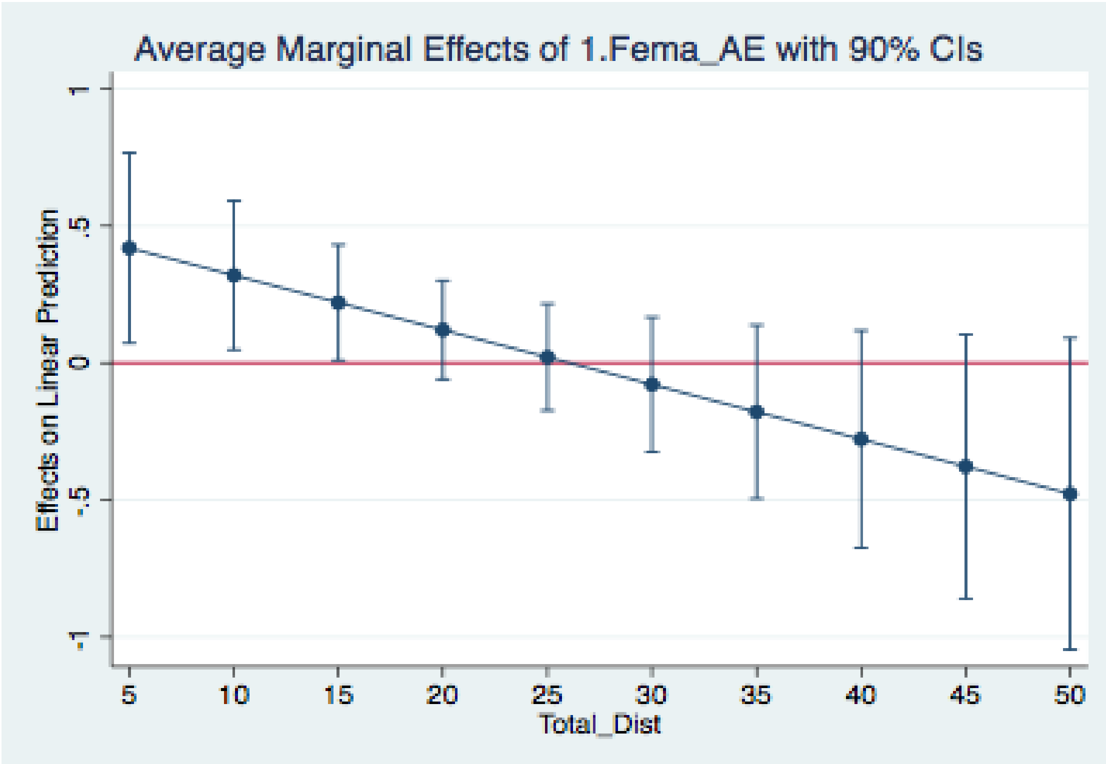

Figure 5: Marginal Effects of FEMA_AE*DIST with 90% CIs Model 7

VI. Conclusion

This study estimated the effect on FEMA rated flood risk in Miami-Dade County on a property's value using a hedonic price approach. This study used natural logs in estimating the hedonic function. The results of this estimation show that when a home is marked as FEMA X (safe) the value of the home is actually lower than an otherwise similar home in a FEMA-unsafe zone until the distance from the beach is above forty-five miles when FEMA X (safe) flood risks rating becomes an asset. At this point, a FEMA X rating increases the value of a home by 14%. Before a forty-five-mile distance from the beach, a FEMA X rated home can bring down the value of a property, especially if it is near the beach, possibly because the proximity to the beach brings along with it some flood risk not captured in the FEMA X rating. The homes that are both far away from the beach (more than 45 miles) and flood safe are more valuable than homes that are also far away (more than 45 miles) from the beach and are not flood safe. Only at 45 miles distance from the beach does a FEAMA X safety rating provide a property price premium.

When both FEMA X and FEMA AE homes interact together in the same regression FEMA AE (high-risk homes) have a statistically significant and positive relationship with price at a distance from the beach of 15 miles or less. This means that in this regression flood risk in areas that are close to the beach are actually adding additional value to the price of a home. This possibly occurs because high flood risk ratings are given to homes very close to the beach, such that the amenity value of beach access dominates the risk rating. This implies that differentiating by risk as low or high, each relative to medium risk, essentially do not yield a significant impact of flood risk on property price.

This study found that measuring flood risk at three different levels does not yield significant results and that only binary risk measures have an effect on price. This indicates that high risk has an effect on price when interacted with distance, but FEMA AH (medium risk) does not have any effect on price. As mentioned above, this could explain why the results of the terms interacted in the same regression have yielded such different results than are typically seen in similar studies.

VII. Discussion and Limitations

There are many possible reasons why these results may occur. As established, proximity to the beach is a valuable asset a home can have (Conroy and Milosch). The desire to live near the beach may be much stronger than the desire to be flood safe for most buyers. This would mean that until the distance from the beach is so far that it is unlikely to be considered any sort of asset, the FEMA X rating, has a negative effect on the price of a home.

Another possible explanation is that FEMA ratings are simply objective ratings. People may not trust the FEMA rating of their property or not take them seriously. Although homeowners with certain ratings are required to buy flood insurance, people looking for homes in Miami-Dade County may already feel inclined to buy flood insurance regardless of the FEMA rating of their home. Real estate markets in this area may not even consider flood ratings in pricing the homes because if the home is in a specific zone, the buyer is required to buy insurance and that would be a separate price from the home itself.

Florida politicians have strongly encouraged all Florida residents who live in an eligible community to purchase NFIP insurance (Moline, 2019). The senate has proposed a bill to sharpen a personal warning to Florida residents who do not have flood insurance to warn them of the potentially dire consequences of not purchasing insurance (Moline, 2019). If more people with low risk and low value properties enter the insurance market, then the costs of high value and high risk properties in the flood insurance market will be subsidized. This also helps keep the values of premiums low on high risk properties. If the majority of people buy flood insurance in Miami-Dade County the mandated flood insurance premium may be less relevant.

The Florida insurance market has some interesting qualities that could explain these results as well. Although residents with government mortgages in flood zones are required to purchase insurance, there is little follow up that is done to make sure that owners continue to purchase insurance (Howard, 2019). This means that people who are not concerned about risk can easily get out of paying for their insurance. This could make it so having to purchase flood insurance is not really considered a penalty that they have to account for in the long term.

Another interesting quality is that NFIP will only cover up to $250,000 in damage from flooding (miamidade.gov). Small private insurance markets have taken advantage of this and set up insurance for the niche group that wants more coverage than $250,000 (Howard, 2019). The only problem is that few people are willing to pay even more for insurance.

This sets up an interesting dilemma for wealthy people with very valuable properties. If a property is already worth millions of dollars a payout of $250,000 may seem miniscule. The $250,000 pay out is less than half the value of the average price in this sample. Property buyers who are looking for homes in the area already, may not even bother to consider flood risk because the yearly average premium of $394 is practically nothing to them and the protection from disaster is a small fraction of the properties value. If this is the case, a very wealthy person looking for homes in Miami-Dade County may simply prefer to live on the beach even with the high flood risk because the penalty of having to buy insurance means almost nothing to them.

Another explanation is the general environment of Miami-Dade County itself. Miami-Dade County is 16% people over 65 (US Census, 2018). The elderly may be less likely to think of a property as a long term investment and care very little about potential damage from a future flood of a property. A retired person may be willing to pay more to be close to the beach and think very little about the flood risk of a property. This could also occur with very wealthy individuals who move to Florida for the no-income tax laws, who come from high tax states like New York, New Jersey, Massachusetts and California (Warren, 2019). The premium that these individuals pay on flood insurance would be a small fraction of what they paid in income taxes. Real estate agents in luxury areas like Miami Beach and Key Biscayne claim that the issue of flood risk rarely even comes up in discussion when selling properties (Warren, 2019). The general consensus in the luxury real estate market by the coast is that people are not buying properties for the long term (Warren, 2019).

The luxurious beaches in the wealthiest parts of Miami were largely bailed out by foreign investors after the 2008 foreclosure crisis (Farzad, 2018). Foreign investors are also not concerned about flood risk on their properties. Housing specialists in the area agree that these investors typically believe that they can time the market and sell before any catastrophic damages occur on their property (Farzad, 2018).

What all of the listed factors to explain this result have in common, is that people who have the money to live near the beach are still willing to pay to live near the beach. Figure 6 demonstrates how this fits with the results of this paper. Figure 6 shows a flood map of the Miami-Dade County coastline. As the map shows, all areas directly on the beach are coded in purple which means it has a flood risk. This paper only measured distance from a public beach. This means that a home directly on the water could have a similar distance from a public beach as a home that is not directly on the coast. Homes directly on the coast could have access to private beaches which is considered an asset to many buyers. Flood safe rated homes may be less desirable directly on the coast because their location is still slightly further from the beach, and beach access is incredibly valuable in Miami-Dade County. Therefore, the penalty of distance from the beach only starts reducing for flood-safe rated homes, once the beach is far enough away that it is no longer considered a coastal property.

There are some limitations to the methods of this study. The sample size was small and greatly focused on the city of Miami. The study only focuses on Miami-Dade County and cannot be generalized to any area outside of the county. Miami-Dade County is not an area that can be generalized to most regions in the United States due to its specific geography and significance as a major metropolitan area.

This study only looked at the asking price for a home instead of the final sales price. Zillow lists that the median asking price of homes in Miami-Dade County is about $100,000 higher than the median final sales price (Zillow, 2019). This is a limitation of this sample because the price that the homes in this sample were actually sold for could be different than the sales prices analyzed. If there is a large discrepancy between sale prices and final prices, this study would not be able to capture that.

This study used median income as a socioeconomic characteristic of a neighborhood. Due to the large amount of retirees and foreign investors, a measure of wealth may have been a more accurate way to see socioeconomic characteristics of a neighborhood. Even so, that information is difficult to access and may not reflect the knowledge of a typical property buyer unless they have extensive information on a neighborhood. This could be a considered a limitation of information.

The use of hedonic analysis and the limitations of hedonic analysis is described in detail in the theoretical and empirical framework section. Despite the limitations, this study offers significant evidence that there is a relationship between distance from the beach and the price of homes in Miami-Dade County and that flood risk does not change the value in coastal areas.

This result is significant to the social and scientific background of this issue. If the flood predictions that scientists have made about Miami are correct, it is a bad investment for buyers to purchase properties at such a high risk. The fact that the value of the homes on the coast has not reduced enough to be comparable with homes in flood-safe areas, means that this could cause numerous issues for homeowners in the future.

This study offers a starting point for further research on flood risk and property value in Miami-Dade County. From the results of this paper, it may be interesting to conduct a study similar to Michael et al (2001) and conduct a survey directed at property owners and prospective buyers to gauge the typical awareness of flood risk. Research could also look at the marginal utility functions of wealth in the area to gauge why access to the beach has such a high pull in value for luxury property buyers. Another direction the research can take is evaluating the cost of losses due to predicted flood risk. Another study could compare the discount rate of houses with flood risks due to the average premiums on houses like Harrison et al (2002) and Dei-Tutu (2001). There are current predictions that within the next 30 years roughly 64,000 houses in Miami will be flooded (UOCS, 20180). If that prediction is accurate, it is increasingly important to continue to research the relationship with flood risk and property value in this area in order to try and mitigate costs of damages.

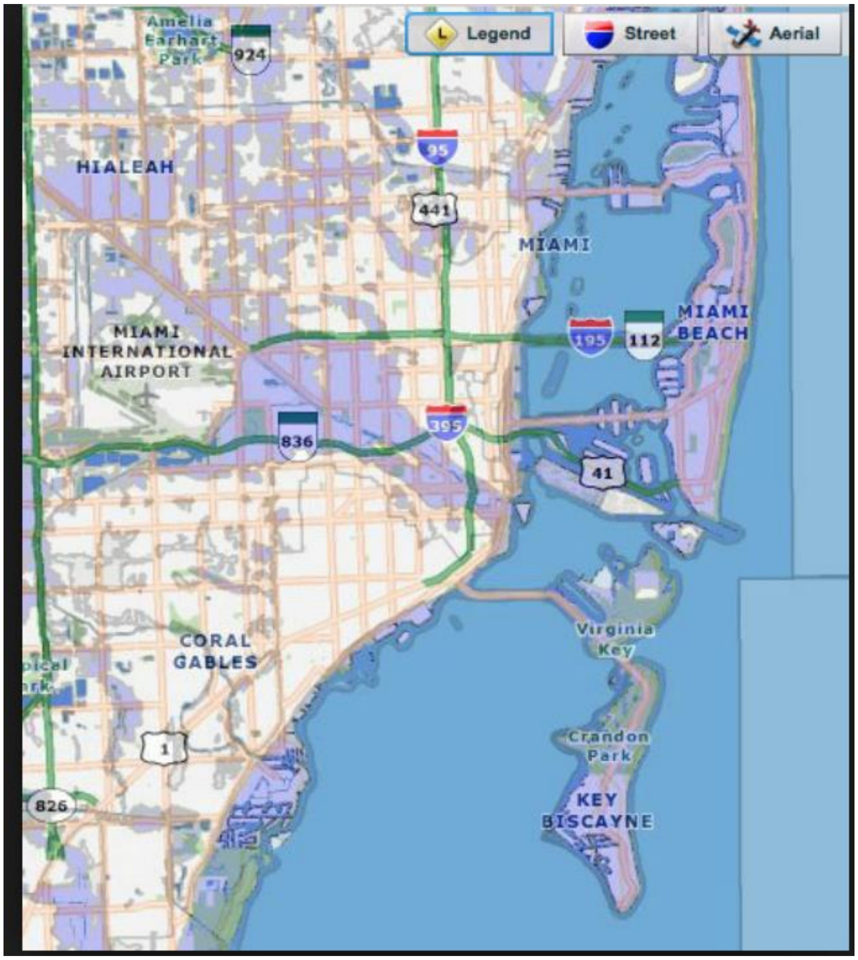

Figure 6: Coastline Flood Map (Source arcgis.com)

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