The Florida Catastrophic Storm Risk Management Center

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The Capitalization of Stricter Building Codes in Jacksonville, Florida, House Prices

THE FLORIDA STATE UNIVERSITY
COLLEGE OF BUSINESS
The Florida Catastrophic Storm Risk Management Center

THE CAPITALIZATION OF STRICTER BUILDING CODES IN JACKSONVILLE, FLORIDA HOUSE PRICES

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OUTLINE OF RESEARCH PROJECT

- Introduction
- Storm Mitigation and Building Requirements
- Mitigation and Building Performance
- Data and Methodology
    - The Empirical Model
    - The Data
        - *Location Relative to Risk*
        - *General Neighborhood Location*
        - *Specific Demographic Variables*
        - *Characteristics of the Data*
        - *Data Characteristics of the Wind Contours*
        - *Data Characteristics of the Neighborhoods*
- Empirical Results
    - What the Model Says About the Aggregate Data
    - What the Model Says About the Windborne Debris Region
    - What the Model Says About the 110 MPH Wind Zone
    - What the Model Says About the 100 MPH Wind Zone
    - *What the Model Says About the Jacksonville Neighborhoods*
        - *What the Model Says About the Beaches Neighborhood*
        - *What the Model Says About the Southside Neighborhood*
        - *What the Model Says About the Arlington Neighborhood*
        - *What the Model Says About the Northside Neighborhood*
        - *What the Model Says About the Westside Neighborhood*
    - Understanding the Building Code Premiums

Summary

I. Introduction

In 2002, the state of Florida found itself adjusting to a major change in the real estate construction industry: the Florida Building Code. The Florida Building Code, which became effective on March 1, 2002, set stricter requirements for home construction and was designed to eliminate the existing patchwork of building regulations within the state. Some of the major changes deal with new requirements for high-wind damage. The new code, through stricter requirements for siding and shingles, is designed to ensure that buildings in high-intensity hurricane areas can better withstand the impact of wind-borne debris. Depending on the location, builders in coastal counties are required to build homes to withstand winds of 110 to 150 miles per hour.

When hurricanes make landfall, they weaken due to the loss of energy from their warm water source and due to friction resulting from the land mass terrain. As such, the highest wind speeds from a particular storm occur on or near the coast. The Windborne Debris Region (WBDR) in Florida is defined as areas where the basic wind speed is 120 miles per hour or areas within one mile of the coast that experience winds of 110 or greater miles per hour.

Under the new code, homeowners have three options for meeting the increased wind standards: (1) impact-resistant doors and windows that use laminated glass similar to that found in car windshields; (2) window shutters including plywood in some areas; or (3) a reinforced roof that won't become detached should wind enter the home.

In general, evidence shows that homes built under the new Florida Building Code are better at withstanding a major disaster. A 2005 study by University of Florida engineer Kurt Gurley shows that newer homes withstood the four hurricanes of 2004 better than older homes. This is attributed largely to the stronger building code. Examining the damage caused by hurricanes Charley, Frances, Jeanne, and Ivan, Gurley concludes that homes built under the Florida Building Code sustained less damage than homes built between 1994 and 2001. A couple of key findings were that the new requirements for shingles and reinforced garage doors proved effective in withstanding higher winds. The study reinforces the notion that quality codes are critical in minimizing hurricane damage.

However, in 2002, a group of engineers, academic experts, and state and local building officials at the Andrew 10th Anniversary Symposium indicated a general feeling that the Florida Building Code did not go far enough to protect coastal residents beyond the Miami-Fort Lauderdale corridor (Scherzagier, 2002). While acknowledging that the devastation of Hurricane Andrew was still somewhat fresh in the minds of South Floridians, the participants felt that many residents and local officials in other parts of the state have failed to recognize the potential risk posed by a major hurricane. The 2002 building code, modeled after the Miami-Dade code, assigns wind zone designations to each part of the state based on standards created by the American Society of Civil Engineers. A major criticism of the new building code was that it failed to make building codes uniform throughout the state since the building code did not extend to the panhandle area of Florida. As a result of the Panhandle Exemption, the 140 miles per hour wind standard applied only to a narrow band of coastline in this part of Florida.

The establishment of the 2002 Florida Building Code created concerns about increased construction costs. Some builders and officials estimated that construction costs could increase by as much as 10 percent and that wind compliance alone could add as much as $3,500 to $12,000 to a 2,000 square-foot house (Kimel, 2002). A Department of Community Affairs study estimated that the materials and processes required under the new code could increase the cost of a new home between 0.5 percent and 10 percent (Sams, 2002).

Recent studies by Dumm, Sirmans, and Smersh (2008) and (2009) examine the capitalization of the stricter 1994 South Florida Building Code in Miami, Florida house prices. Their study also examines whether consumers' opinion of value changed with the "reality check" of the seven hurricanes occurring in 2004-2005. The study examines home sales for Dade and Broward Counties over the 2000 through 2007 time period. A hedonic pricing model is used to capture the differential effect on house prices of the stricter 1994 South Florida Building Code, which was a result of the extensive damage caused by Hurricane Andrew in 1992. Dividing properties into three geographical zones based on risk exposure, the authors find that the stricter building code has a positive effect on selling price. The greatest effect is seen in the coastal zone, which has the greatest exposure. Selling prices for homes built under the new code were about 10.4 percent higher than prices for comparable homes built under the older, less-strict code. The premium for safety decreases as hurricane risk exposure decreases. For interior zones, there was less capitalization of the stricter building code into house prices. The post-catastrophe (reality check) variables show that, following the minimal impact of the 2004 hurricanes on the Miami area, the premium for structural integrity disappears. However, after the 2005 hurricanes, which were more devastating to the Miami area, the building code premium returns.

This study follows up the Dumm, Sirmans, and Smersh (2008) study by examining the capitalization of the 2002 Florida Building Code in house prices for the Jacksonville, Florida housing market. This study examines consumer buying behavior in a market that has seen a more recent strengthening in building code (2002 versus the 1994 South Florida Building Code) followed by heightened hurricane activity in 2004 and 2005. As such, this study addresses the value to consumers of safety as signaled by the institution of a stronger building code in a setting where this change is more recent. Also, although the Jacksonville area has experienced some hurricanes and other severe storms, it has historically enjoyed a lower risk exposure to storm disaster. In fact, Hurricane Dora (1964) is the only hurricane to make landfall in Jacksonville since 1851. The data used in the Dumm, Sirmans, and Smersh 2008 paper came from Miami-Dade county where the entire county is in the windborne debris region. On the other hand, the windborne debris region of the Jacksonville data comprise about 6 percent of the sample. Using the Jacksonville data will allow the examination of the stricter building code to consumers whose risk exposure expectations may be different/lower than consumers in south Florida.

So, while it may be presumed that houses built after the implementation of the stronger building code in Florida could be presumed to be “safer”, only the Dumm, Sirmans, and Smersh (2008) study has measured the extent to which the stricter building codes are valued by consumers. This study complements the previous study by measuring the capitalization of the stricter building codes into house prices for an additional geographical area. These results for an area with less risk exposure will test the generalization of the results from the previous study. This study also examines whether homebuyers attached greater value to the stricter building codes after the “reality check” of the series of storms in 2004 and 2005. In addition, relative to the most recent statute requirements, this study identifies those houses that are in or out of the wind borne debris region and measures price differences for houses across the two regions.

II. Storm Mitigation and Building Requirements

A building code is a set of rules designed to provide general public safety relative to buildings and other structures. This is accomplished through a set of rules that specify minimum construction standards. Codes may apply to the general construction of the building or to specific components such as size of rooms or door openings. Traditionally, code requirements have been both prescriptive, which sets the rules on how construction is to be done and performance-based, which sets the required level of performance but not how it is achieved. In addition, code requirements tend to be reactive to ensure that current problems are not repeated.[1]

Regulations on building and construction can be traced back to early recorded history. Hammurabi, the sixth Babylonian king, enacted the ancient law code, The Code of Hammurabi, around 1790 B.C. The Code provided various laws, one being that "If a Builder builds a house for someone, and does not construct it properly, and the house which he built falls in and kills the owner (or the owner's son), then that builder (or builder's son) shall be put to death".[2] An early form of building code is also provided in the Bible in Deuteronomy 22:8 as stated in The Law of Moses: "When thou buildest a new house, then thou shalt make a battlement (railing) for thy roof, that thou bring not blood upon thine house, if any man fall from thence."

In colonial America, George Washington and Thomas Jefferson, for public health and safety reasons, advocated that building regulations be used to establish minimum standards. As the country grew, building code regulations in the early 1900s were established by local enforcement authorities in conjunction with participants of the building industry. The first formal building code organizations appeared in the early 1900s, with the first being the Building Officials and Code Administrators (BOCA) International, Inc. formed in 1915. The second organization, the International Conference of Building Officials (ICBO) was formed in 1922 and represented building code officials from the western U.S. A third organization, the Standard Building Code Congress International (SBCCI), was formed in 1941 to represent building code officials in the southern U.S. Finally, the nonprofit organization, the International Code Council (ICC), was established in 1944 for the purpose of developing a single set of comprehensive national construction codes. A major advantage of the ICC is that is provides a forum for discussion of regulatory issues.[3]

Florida began mandating statewide building codes during the construction boom of the 1970s. These codes provided "state minimum building code" guidelines for municipalities and counties. In the 1990s,

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[1] See Wikipedia.org/wiki/Building_code.

[2] See Wikipedia.org/wiki/Code_of_Hummurabi.

[3] See http://growth-management.alachuacounty.us/building/buildcode.php

prompted by natural disasters and an increasingly complex system of regulations, a comprehensive review of the state building code system was undertaken. This was followed by the 1998 Florida Legislature creating a single state building code, the Florida Building Code, which was to be enforced by all local governments (some felt that Florida went from 470 local codes to one code with 470 interpretations). Once this single code system became effective on March 1, 2002, it superseded all previous local codes. The Florida Building Code was modeled after national model building codes and provides construction-related regulations for both public and private buildings, except for those specifically exempted. Local governments may amend the requirements but only to be more stringent.

Recognizing that the Florida Building Code improves a structure's ability to withstand hurricanes, the 2007 Florida Legislature revised Florida statutes to require additional hurricane mitigation measures under certain conditions for residential structures built prior to the adoption of the Florida Building Code (Draft Report, Florida State University Catastrophic Storm Risk Management Center, 2009). The statute addresses windstorm loss mitigation and institutes requirements for roofs and opening protection. The rule defines the conditions under which a structure must be upgraded and provides specific mechanisms for the upgrading process. The statute also requires the creation of a uniform scale to grade the ability of a home to withstand the wind load from a sustained severe tropical storm or hurricane. This rating must be disclosed to the buyer when the home is sold. Under the new statute, several aspects of roof construction are required to be addressed when a roof is replaced. These include gable end bracing, water barriers, strengthened roof decking, and strengthened opening protections. Also, for houses located in the wind borne debris region with an insured value of at least $300,000, improvements must be made to roof-wall connections. Finally, for higher-priced homes in the wind borne debris zone, activity must include opening protection meeting the standards of the Florida Building Code.

There are major concerns with the new statute relative to both the roofing requirements and the new rating system. For the roofing requirements, anticipated problems include (1) a lack of knowledge of the requirements, (2) a concern for consistent enforcement across jurisdictions, (3) anticipation of inspection delays, and (4) a concern that the 15% threshold for required mitigation is too low. Because the mitigation requirement is completely removed if the total cost exceeds 15% of the cost of roof replacement, the concern is that the structural mitigation will never be performed.

The portion of the new statute requiring a home grading scale is designed to create a uniform measurement of a property's ability to withstand the wind load from a sustained hurricane or severe storm. Any buyer of a home in the wind-borne debris region must be informed of this rating. The two primary issues with these inspections are (1) the potential for unethical behavior by increasing the number of items to be inspected before a sale and (2) the inspections are visual, yet the inspector must verify wall to foundation connections.

III. Mitigation and Building Performance

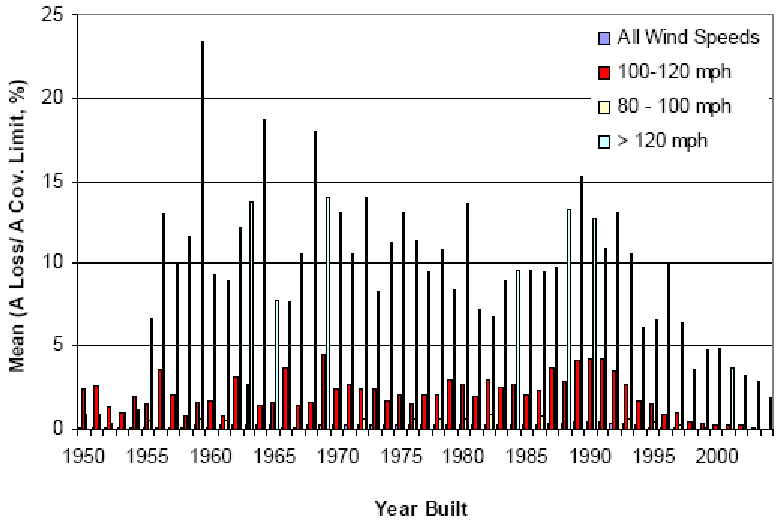
For the stakeholders in an insurance marketplace with catastrophe exposure, mitigation provides the hope for a future of lower losses and price volatility. As such, mitigation affects every participant in the insurance marketplace and the importance of effective mitigation cannot be understated. Following the losses from the 2004 and 2005 hurricanes seasons, mitigation was recognized as important for the long-term viability of the Florida property insurance market. This is clearly evidenced in the following recommendation from the 2006 Task Force on Long-term Solutions for Florida's Hurricane Insurance Market:

> "It is imperative that any program focus strongly on ensuring that homes in Florida are wind resistant through mitigation, which is defined as a construction activity that fortifies or hardens the envelope of residential structures by using a variety of techniques. **Strong, enforced building codes are the foundation for a sustainable market for Floridians**." (2006 Hurricane Task Force)

As noted above, the Florida Building Code contains information regarding mitigation and in fact, the building code can be considered a package of mitigation features that has changed through time in recognition of the structural engineering benefits provided by various building techniques and additional add-on types of mitigation features (e.g. storm shutters) for various parts of the Florida market. The roof section of the house is one of the primary areas of focus of the Florida Building Code. The structural integrity of the roof is critical for the house to withstand hurricane force winds as the roof holds the rest of the structure together and it also protects personal property inside the house from wind and water damage. As such, the Florida Building Code specifies construction details like nailing patterns and length of nails that are to be used. Assuming that the builder builds to the code, the consumers then have information on the added value that particular home provides both in terms of safety and economic value. Economic value can be direct via mitigation credits (reductions) to the homeowner premium as well as important indirect benefits to the homeowner if the structure remains intact (e.g., avoids or reduces loss of valuable personal items, costs of living elsewhere while the home is being repaired or rebuilt).

The following figure shows the average ratio of insured losses to coverage amount by year of construction and wind speed. This is an important measure of building performance as it captures the amount of insured losses paid out in relation to the coverage provided under coverage A (building) of the homeowners policy. As such, this ratio provides pricing information to the insurer based on building and loss profile characteristics (i.e., wind speed). The results provided in Figure 1 show interesting patterns through time and are, in part, a reflection of the building standards and code in place in locales where and when homes are constructed. Of interest for this study is the clear improvement in performance for the newer homes (i.e., built under the newer building code). These results are included in the most recent study completed by Applied Research Associates (ARA) for the Office of Insurance Regulation in 2008. The ARA study shows that the newer homes perform better across all wind speeds, but the strongest performance (lower ratio) are for windspeeds that would be classified as major hurricanes (i.e., category 3 or higher).

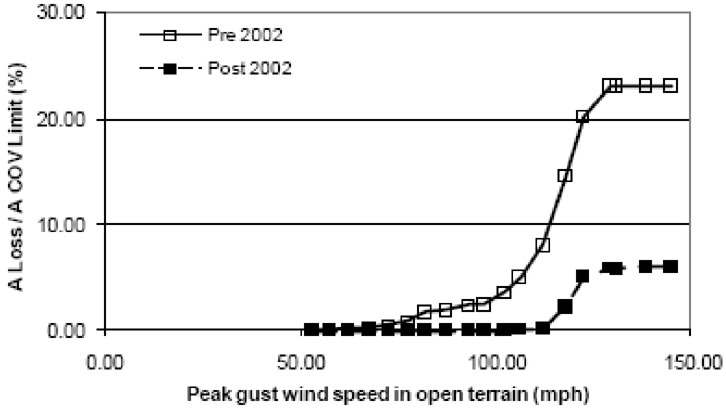
Figure 1
Estimated Losses by Construction Year



Source: Applied Research Associates
http://www.floir.com/pdf/ARALossMitigationStudy.pdf

Figure 2 shows the performance difference even more directly by examining loss costs for homes built before or after the FBC 2002. The results are produced via a modeling process that, in this case, assumes open terrain at the building location (i.e., full impact of wind). For the lower peak gust wind speeds, there is little or no difference in the performance advantages of a pre or post-FBC code home. However, as peak gust wind speeds start to increase, the performance of the post-2002 FBC code homes becomes clear.

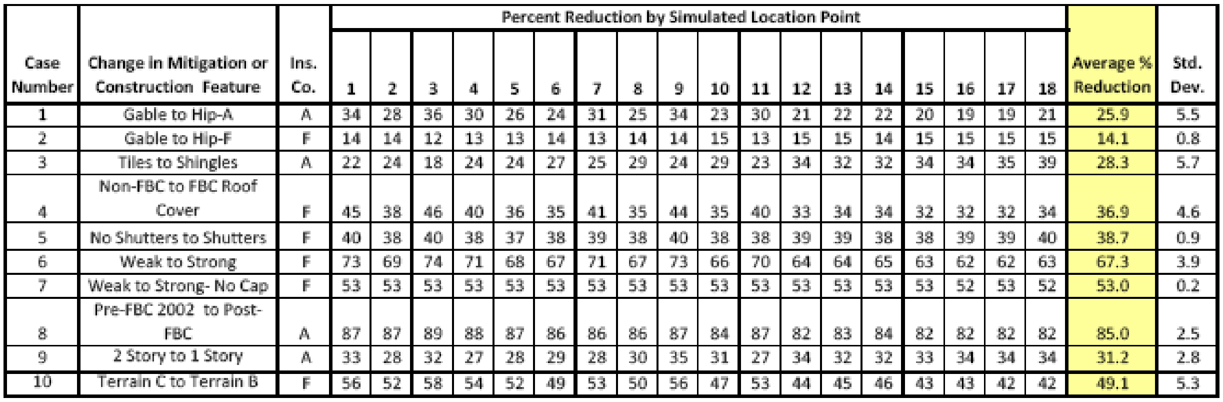
Figure 2
Pre versus Post Building Code Comparison



Source: Applied Research Associates
http://www.floir.com/pdf/ARALossMitigationStudy.pdf

The results contained in Figure 3 provides further support for recognizing that mitigation package contained in a post FBC 2002 home performs better than one reflect by home built prior to 2002. Case number 8 (pre versus post 2002 building code) is evaluated at 18 simulated location points. Of the ten mitigation feature comparisons, the pre versus post Florida Building Code category showed the largest reduction.

Figure 3
Modeled Results: Examples of Mitigation Impact



Case Number	Change in Mitigation or Construction Feature	Ins. Co.	Percent Reduction by Simulated Location Point																		Average % Reduction	Std. Dev.
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		
1	Gable to Hip-A	A	34	28	36	30	26	24	31	25	34	23	30	21	22	22	20	19	19	21	25.9	5.5
2	Gable to Hip-F	F	14	14	12	13	13	14	13	14	14	15	13	15	15	14	15	15	15	15	14.1	0.8
3	Tiles to Shingles	A	22	24	18	24	24	27	25	29	24	29	23	34	32	32	34	34	35	39	28.3	5.7
4	Non-FBC to FBC Roof Cover	F	45	38	46	40	36	35	41	35	44	35	40	33	34	34	32	32	32	34	36.9	4.6
5	No Shutters to Shutters	F	40	38	40	38	37	38	39	38	40	38	38	39	39	38	38	39	39	40	38.7	0.9
6	Weak to Strong	F	73	69	74	71	68	67	71	67	73	66	70	64	64	65	63	62	62	63	67.3	3.9
7	Weak to Strong- No Cap	F	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	52	53	52	53.0	0.2
8	Pre-FBC 2002 to Post-FBC	A	87	87	89	88	87	86	86	86	87	84	87	82	83	84	82	82	82	82	85.0	2.5
9	2 Story to 1 Story	A	33	28	32	27	28	29	28	30	35	31	27	34	32	32	33	34	34	34	31.2	2.8
10	Terrain C to Terrain B	F	56	52	58	54	52	49	53	50	56	47	53	44	45	46	43	43	42	42	49.1	5.3

Source: Applied Research Associates (2008)
http://www.floir.com/pdf/ARALossMitigationStudy.pdf

The primary questions of interest in this study are similar to those addressed in the Dumm, Sirmans, and Smersh (2008) study, i.e,:

- Are consumers willing to pay a premium for safety (as measured by stricter building codes) when purchasing homes in areas exposed to catastrophic storm loss?
- Do consumers factor in locational risk (e.g., coastal versus inland) in their pricing decisions?
- Are consumer preferences for safety impacted by broader hurricane activity when a local region has not experienced significant hurricane losses?

While the engineering benefits of improved performance of owning a home built under the newer building code are clear and easily understood, the questions above relate to whether and to what degree consumers are willing to pay for improved structural performance.

Although the focus of this paper is on a market exposed to catastrophic storm risk, it is important to recognize that the potential impact of mitigation applies to markets with other catastrophic exposures (e.g. flood, earthquake). While studies (e.g., Dumm, Sirmans, and Smersh, 2008; Simmons and Sutter, 2006) have found evidence indicating that consumers are willing to pay a premium for safety, the results from the existing literature are mixed. The questions addressed in this paper as well as Dumm, Sirmans, and Smersh (2008) provide important insights into consumer purchasing behavior regardless of the type of catastrophic exposure. As Meyer (2008) suggested, “the consumer’s sense of risk oscillates between these two extremes driven by the most recent activity”. To better understand consumer behavior in the presence of catastrophic risk that varies by time and location is an important contribution of this paper.

IV. Data and Methodology

This study examines directly the effect of a change in building codes on house prices. It also examines whether consumers' perceptions of building codes are changed after major catastrophic events. The empirical models are estimated using owner-occupied, single-family homes in the Jacksonville, Florida area.

A. The Empirical Model

Real estate research has typically used hedonic regression analysis to measure the marginal effects of housing characteristics on house prices. A review of over 125 empirical studies using hedonic pricing models for real estate by Sirmans, Macpherson and Zietz (2005) shows examination of a large number of variables. However, only the recently completed study by Dumm, Sirmans and Smersh (2008) has examined the effect of building code changes on house prices.

The typical form of the hedonic pricing model is:

$$\ln(sp) = \alpha_0 + \beta_i X_{ij} + \varepsilon_i$$

where selling price (sp) is expressed in logged form, α_0 is a constant term, β_i is the regression coefficient for the ith housing characteristic, X_{ij} is a vector of housing characteristics (e.g. structural and locational) for property j, and ε_i is the residual error term.

To examine the effect of the change in building code, the hedonic model is expanded to include a variable to account for the building code under which a given house is built. The results should show the extent to which consumers value safety and disaster mitigation (Simmons and Sutter (2007) for example). If consumers value safety and if a stricter building code is perceived to reflect this, the results should show houses built under the stricter building code selling for higher prices relative to houses built under the less strict code, everything else held constant.

The model also includes variables to measure whether the 2004 and 2005 hurricanes were a "reality check" and whether they raised safety concerns and building code awareness for home buyers. These variables measure, for houses that sold immediately after these catastrophic events, whether there were differences in selling prices based on different building codes. To the extent that these recent disasters created greater public awareness of severe storm danger and an increased the desire for safety, houses with stricter building codes would be expected to sell for a price premium relative to houses with the less-strict code.

With the additional variables, the hedonic model is now:

$$\ln(\mathrm{sp}) = \alpha_0 + \beta_i X_{ij} + \beta\, Bldgcode_j + BldgcodePostH1_j + BldgcodePostH2_j + BldgcodePostH3_j + \varepsilon_i$$

where $Bldgcode_j$ is the building code for property j. *Bldgcode* is a binary variable that takes the value of one if the house was built after the 2002 stricter building code change and zero if the house was built before the code change. This variable will test whether there is a price differential for properties sold under the older code and the newer, stricter building code. To the degree that consumers value disaster mitigation and to the extent that a stricter building code is considered by consumers to reflect this, the expected coefficient on $Bldgcode_j$ would be positive.

$BldgcodePostH1_j$, $BldgcodePostH2_j$, and $BldgcodePostH3_j$ are interactive variables between building code and the periods after the major hurricanes of 2004 and 2005 for property j. The four hurricanes of 2004 occurred in August and September 2004 and the three hurricanes that impacted Florida in 2005 occurred in July through October. $BldgcodePostH1_j$ represents properties built under the new code that sold October 2004 through June 2005. This is the time between the last hurricane of 2004 and the first hurricane of 2005.[4] $BldgcodePostH2_j$ represents houses built under the new code that sold November 2005 through May 2006. This is the time between the last hurricane of 2005 and the start of the 2006 hurricane season. $BldgcodePostH3_j$ represents houses built under the new code that sold after the end of the 2006 hurricane season (December 2006 through 2007).[5] These variables will test whether the "reality checks" of the 2004 and 2005 hurricanes increased consumers' awareness of building codes in the form of higher prices for homes built under the stricter code. To the extent that a recent disaster creates a greater desire for safety and if stricter building codes are felt to reflect this, the coefficients on the interaction variables would be expected to be positive.

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[4] The time period between hurricane periods is in whole months.

[5] Given the forecast for heightened hurricane activity during the 2006 hurricane season (frequency and storm strength) and the corresponding impact on consumer expectations, the third post period extends across a time period where hurricane expectations/forecasts (high) did not align with actual experience in Florida (no hurricanes).

B. The Data

Jacksonville is the largest city in the U.S. and the state of Florida and is the county seat of Duval County. As a result of a 1968 consolidation of city and county governments and an expansion of the city limits to include almost the entire county, Jacksonville has been the largest city in land area in the contiguous United States. Jacksonville is located in the First Coast region of northeast Florida and is centered on the St. Johns River. The city was originally founded in 1791 and known as Cowford, so named for a narrow point in the river where cattle crossed. The city was renamed in 1822 in honor of Andrew Jackson, the first military governor of the Florida Territory.

This study uses transaction data in the Duval County, Florida housing market. With regard to boundaries, Duval County is nearly the same as the city of Jacksonville, but also includes the smaller communities of Atlantic Beach, Neptune Beach, and Jacksonville Beach. The data come from the Duval County Property Appraiser's Office, and include sales price and date, square footage, year built, and lot size.

A GIS property parcel database is also available, and this data allows for a variety of different location variables to be created. These include distance from the CBD and distance from the coast, as well as different sets of dummy variables for location. Risk variables include location within the different wind contours. Basic location variables include dummy variables for the commonly recognized areas in Duval County (Northside, Westside, Arlington, Southside, and Beaches).

The study analyzes single-family homes in the Duval County, Florida housing market. With regard to boundaries, Duval County is nearly the same as the city of Jacksonville, but also includes the smaller communities of Atlantic Beach, Neptune Beach, and Jacksonville Beach.

The data come from the Duval County Property Appraiser's Office, and include sales transactions from 2000 through 2008. Those data variables are:

sale_month:	month of sale, 1 through 12
sale_day:	day of sale, 1 through 31
sale_year:	year of sale, 2000 through 2008

Basic summary statistics are as follows:

Year	**MeanSale Price**	**MedianSale Price**	**Numberof Sales**
2000	$128,189	$107,200	13,148
2001	$134,246	$115,900	13,948
2002	$147,960	$128,000	15,310
2003	$162,963	$140,000	17,075
2004	$180,485	$154,900	18,832
2005	$211,145	$179,900	21,662
2006	$226,076	$183,500	12,820
2007	$221,370	$184,000	9,064
2008	$216,205	$183,500	7,391

As can be seen, while the single-family housing market in Jacksonville clearly peaked in 2006, it is interesting to note that prices have not fallen significantly. Sales volume however, has dropped to roughly one-third of what it was in 2005.

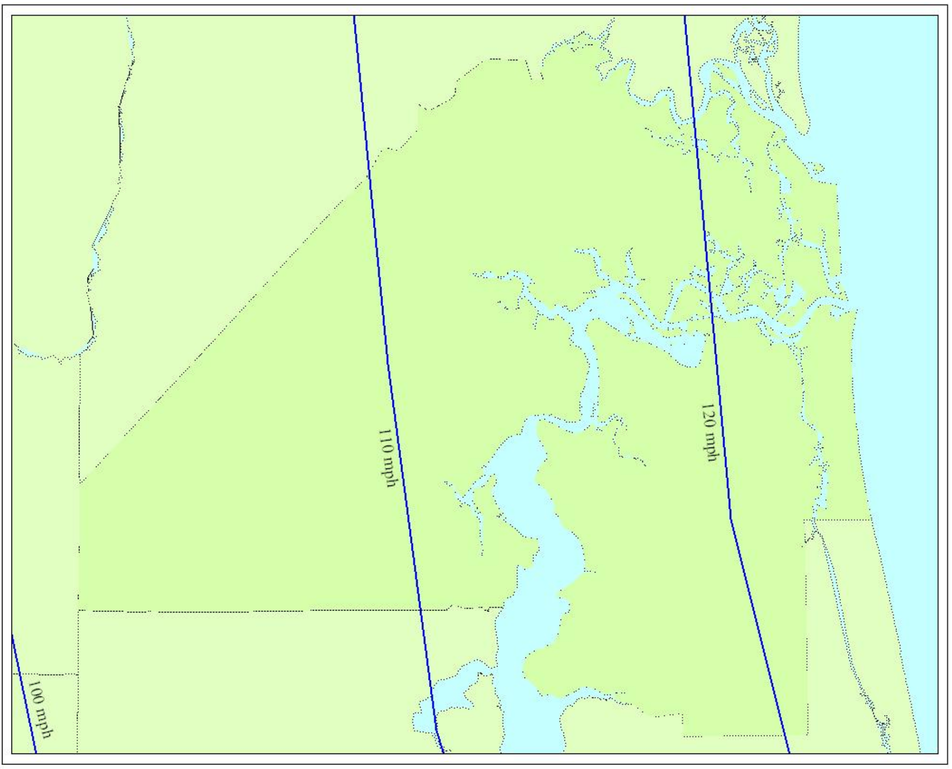
The Duval County Property Appraiser's Office also has a building database which includes information such as house size, the year the house was built, and the size of the lot. Those data variables are:

Square footage (heated_area): heated (living) area
year_built: the year the house was built
acres: lot size in acres

The Duval County Property Appraiser's Office also has a GIS property parcel database, which is projected in the State Plane coordinate system (US feet) NAD83, Zone 3601 (Florida East). A Geographic Information System (GIS) is used to convert to longitude / latitude coordinates, and then calculate various location variables.

Figure 4

Duval County Wind Zones



B.1. Location Relative to Risk

The primary risk to homeowners from a hurricane is due to wind. Wind contours are shown in the map above.[6] The wind-borne debris region (WBDR) is identified as a designated area where the basic wind speed is 120 mph or greater – for much of Duval County, this is approximately 6.8 miles from the coastline. Roughly 18% of the housing stock is located within that zone, and are identified as:

Windborne Debris Region:	Binary variable with a value of one if the house is located within the Windborne Debris Region (east of the 120 mph contour), and zero otherwise;

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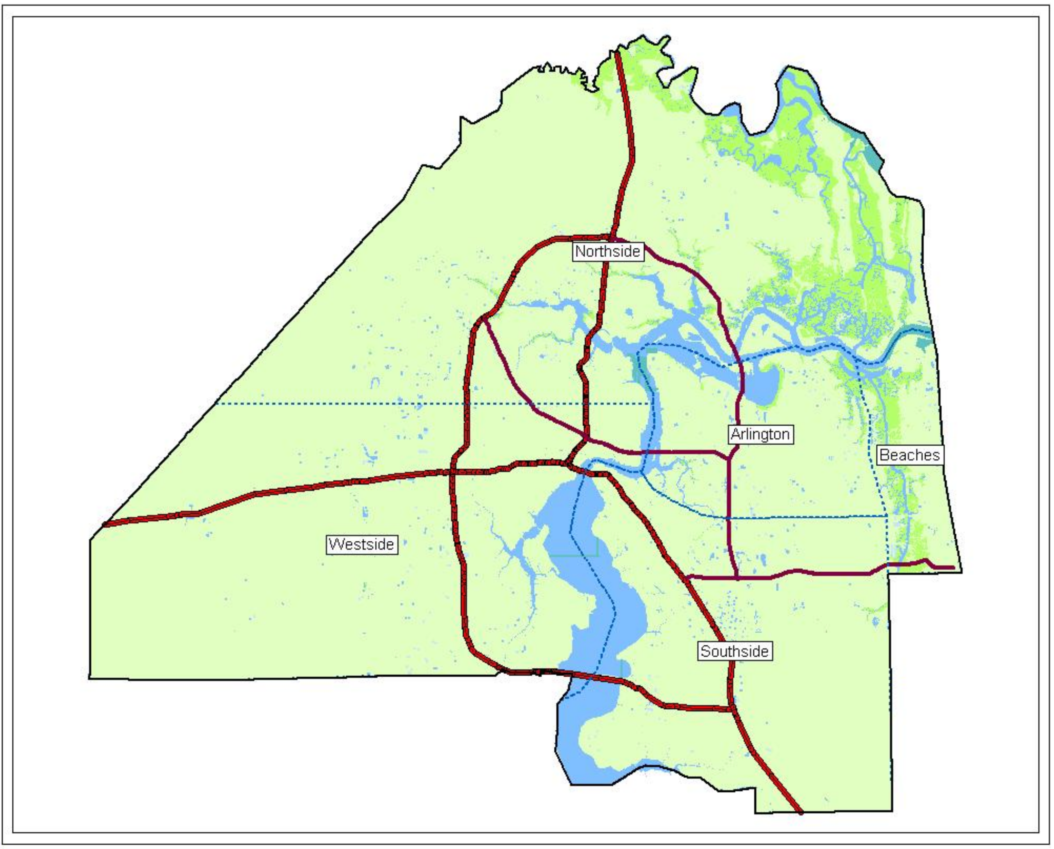
[6] This map is the State of Florida Wind-Borne Debris Region map. It is a contour map of maximum wind speeds in miles per hour (mph) at 33 feet (10m) above the ground. It is produced by the Florida Department of Community Affairs (DCA) which oversees the Florida Building Code. FEMA maps are concerned with flood zones, and thus are primarily contour maps of elevation. The Wind-Borne Debris Region map is a better measure of hurricane risk because it concerns wind speed from a

110 MPH Zone: Binary variable with a value of one if the house is within the 110 mph wind zone, zero otherwise;

100 MPH Zone: Binary variable with a value of one if the house is located within the 100 mph wind zone, zero otherwise.

Figure 5

Jacksonville Neighborhoods



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hurricane. While there is also flood risk in a hurricane, it is mostly from storm surge along the coastline, and not in the inland low-lying areas that are measured in FEMA maps.

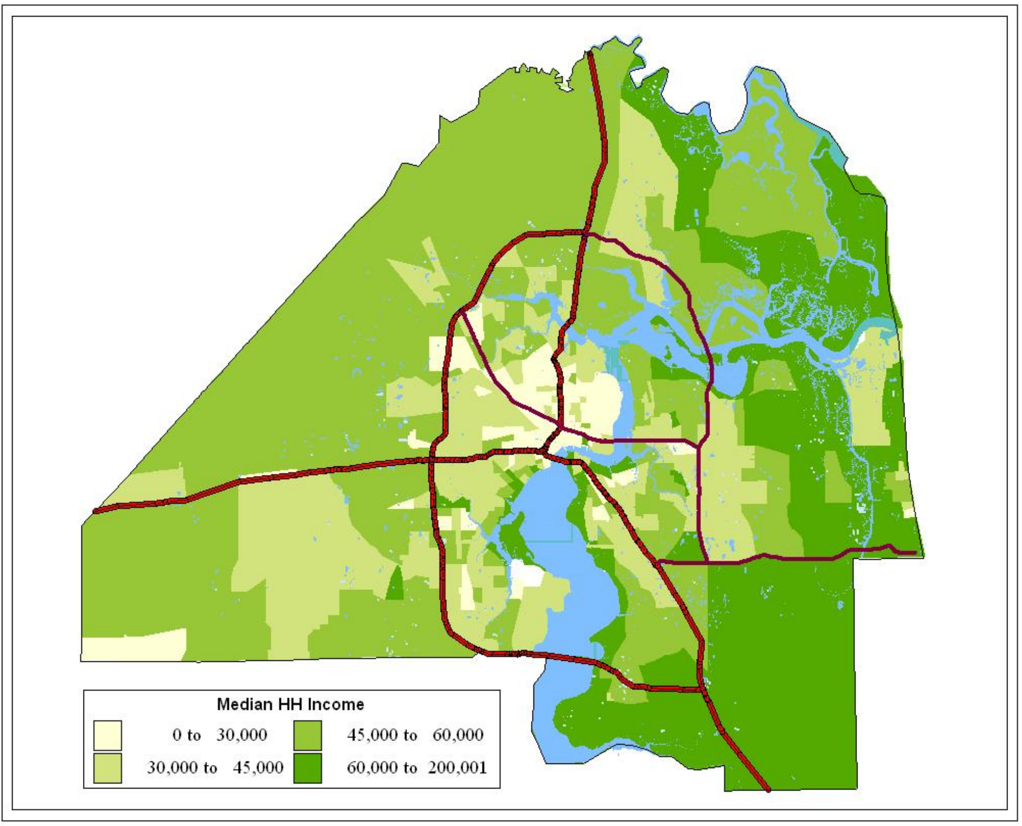
B.2. General Neighborhood Location

Jacksonville has five very general neighborhoods with demographic similarities that are commonly referred to. These are shown in Figure 5. These are "Northside," "Westside," "Arlington," "Beaches," and "Southside." Five dummy variables are created in GIS as follows:

Northside: value of 1 if located in this area and 0 otherwise;
Arlington: value of 1 if located in this area and 0 otherwise;
Westside: value of 1 if located in this area and 0 otherwise;
Southside: value of 1 if located in this area and 0 otherwise;
Beaches: value of 1 if located in this area and 0 otherwise.

Figure 6

Census Block Income: Duval County



B.3. Specific Demographic Variables

Data is available from the 2000 census of Population and Housing regarding household size and median household income. This was taken at the census block group level – there are 422 block groups within Duval County.

The map In Figure 6 shows the spatial distribution of household income. Variables were created for each house based on the block group in which it is located. These are:

Household_Size:	household size which varies from 1.24 to 3.85 persons per household
Median_Income:	household income which varies from $4,648 to $200,001.

The final data set contains 61,513 home sales and includes those houses that were built between 1970 and 2008 and sold between 2003 and 2008. Houses built before 1970 are excluded from the sample for two reasons. First, Fronstin and Holtmann (1994) have shown that, during Hurricane Andrew, homes built after 1970 had significantly increased damage than homes built in the 1960s and before. This is attributed a relaxation of building codes in Florida beginning in the 1970s, resulting in lower quality construction, faulty design, and flimsy materials. Second, a consolidation referendum was held in Jacksonville in 1967 whereas in October 1968, the governments of Jacksonville and Duval County merged to create the Consolidated City of Jacksonville. Fire, police, health and welfare, recreation, public works, and housing and urban development were all combined. At this point, building code requirements would have become consistent across all areas of the city/county. Thus, to provide more consistent results, those houses that were built before 1970 are excluded from the sample.

B.4. Characteristics of the Data

This section contains descriptive statistics of the variables included in the estimation model. Table 1, which defines the variables included in the regression model, is shown in the Appendix along with Table 2, which provides summary statistics for the variables in the regression model. For the aggregate data (61,513 observations), houses that sold between 2003 and 2008 had an average selling price of $216,852 with a minimum price of $10,000 and a maximum of $9,148,000. The average square footage was 2,461 and the average lot size was 0.29 acres. The average age was 9.30 years (remember that no house is more than 38 years old). About 43 percent of the houses sold were built under the new building code. The average household size was 2.7 persons and the average household income was $58,409. The proportion of homes sold each year increases constantly through 2005, after which it steadily declines through 2008. The number of homes sold each season is relatively constant with more homes sold in the spring and summer than in the fall and winter. About 6 percent of the homes in the data sample are located in the Windborne Debris Region. In contrast, 70 percent of homes is located in the 110 MPH Zone and 24 percent of homes are located in the area with the lowest risk exposure, the 100 MPH Zone.

The *Posth* variables show the proportion of houses that were sold after each of the 2004, 2005, and 2006 hurricane seasons. The statistics show that homes sales dropped after the 2005 hurricane season. This decrease in home sales after the 2005 hurricane season is consistent throughout the zones. Also, the proportion sold of new code homes relative to total sales decreased after the 2005 hurricane season compared to the previous year. This is also consistent across wind zones. For example, *Posth1* indicates that 20 percent of the houses in the sample (Panel A) were sold after the 2004 hurricane season. *Posth1_c02* shows that 48 percent of these houses were built under the new code. After the 2005 hurricane season, however, sales accounted for only about 12 percent of the total sample. Of this 12 percent, about 36 percent were built under the new code.

The five neighborhood variables show the proportion of houses sold within each neighborhood. As seen, slightly more than 6 percent of home sales in the sample occurred in the *Beaches* area. This is the smallest proportion for any neighborhood. The largest percentage of houses were sold in the *Southside* area (31 percent). For the individual zones, practically all the houses sold in the Windborne Debris Region were contained in the *Beaches* neighborhood (98 percent). Very small percentages came from the *Arlington* and *Northside* areas. Homes in the 110 MPH Zone were more dispersed. Most came from the *Arlington*, *Southside*, and *Northside* areas. For the 100 MPH Zone, most of the houses were in the *Westside* neighborhood (96.50 percent), with the remainder coming from *Northside*.

B.4.a. Data Characteristics of the Wind Coutours

The Windborne Debris Region contains homes sold during the 2003-2008 period that are located within 120 MPH wind contour or within the 110 MPH zone and 1 mile of the coast. These are properties that would have the greatest exposure to extreme hurricane risk. These houses had an average selling price of $325,256, 2,349 square feet, and a lot size of 0.21 acres. These houses were, on average, 15.43 years old. About 10percent of these houses were built under the new building code. The average household size was 2.46 people and the average household income was $60,472. The proportion of homes sold each year increases constantly through 2005 after which it declines through 2008. The seasonal variables show that, proportionately, more homes are sold in the spring and summer than the fall and winter. Of the total sample, 3,692 sales came from the Windborne Debris Region.

A large proportion of the sample was located in the 110 MPH Zone (42,771 out of 61,513 home sales). Although these homes would have less risk exposure than homes in the Windborne Debris Region, they could still be subjected to extreme conditions. As seen, the average selling price for homes in this area ($228,855) was much less than the average price in the Windborne Debris Region. These houses had an average of 2,537 square feet and had average lot sizes of 0.29 acres. The average age for houses sold in this area was 9.34 years. A much larger percentage of the houses sold in the 110 MPH Zone (41 percent) relative to the Windborne Zone were built under the new building code. The average household size was 2.66 persons and the average household income was $62,526. The proportion of homes sold each year increases until 2005, then declines. On a proportionate basis, more homes are sold in the spring and summer than in the fall and winter.

The 100 MPH Zone contains properties that are located on the leeward side of the wind contour. The risk exposure for these houses would be expected to be somewhat less than for properties located in the other two zones. The average house price is lowest for this zone ($156,145). The houses were slightly smaller (2,273 square feet), but had comparable lot sizes (0.30 acres) relative to the other zones. These houses were, on average, 7.69 years old, newer than homes sold in either of the other two zones. Of the 15,050 homes sold in this zone, 56 percent were built under the new building code. The average household size was 2.78 persons and the average household income was $46,203.

B.4.b. Data Characteristics of the Neighborhoods

Descriptive statistics for the neighborhoods are also contained in Table 2. The highest average price is observed in the *Beaches* area while *Westside* has the lowest average price. Homes, on average, are the oldest in *Beaches* and newest in *Northside*. Homes in *Southside* had the greatest average square feet while the average lot size and average household size are very comparable across all neighborhoods. Across the 2003-2008, home sales peak in 2005 for *Northside*, *Westside*, and *Southside*. However, for *Beaches* and *Arlington* home sales peak in 2004. Except for *Northside* and *Southside*, home sales decline continuously from 2005 through 2008. For most neighborhoods, spring and summer were the best seasons for home sales.

The proportion of homes sold under the new building code varies greatly. Also, the proportion of homes sold under the new building code is correlated with the average age of the homes in the area. For example, only about 11 percent of homes sold in the *Beaches* area were built under the new code (average age 15 years) compared to 80 percent of the homes sold in *Northside* (average age four years). As with the wind zone data, the number of houses sold after the 2005 hurricane season decreases dramatically compared to sales the previous year for all neighborhoods. And, the data show that, for all neighborhoods, the proportion sold of new code homes decreased relative to total sales after the 2005 hurricane season. For example, in the *Westide* area, 22 percent of houses in the total sample sold in the period after the 2004 hurricane season (*posth1*). Of this 22 percent, about 61 percent (compare *posth1_c02*) were houses built under the new code. After the 2005 hurricane season, however, only about 11 percent of the total sample (*posth2*) sold in *Westside*. Of this 11 percent, about 44 percent were houses built under the new code.

V. Empirical Results

The regression model is first estimated for the aggregate data and for each of the three wind zones. The model is then estimated for the five general "neighborhood" locations. The statistics for all the regressions show that the model is a good fit for the data and has high explanatory power. The results are discussed in this section.

A. What the Model Says About the Three Wind Zones

A.1. What the Model Says About the Aggregate Data

The regression model is first applied to the aggregate data (all results are given in Tables 3A and 3B in the Appendix). The housing characteristics have the expected effect on sales price. Square footage and lot size both have a positive effect on selling price. The age variable has a negative effect on selling price.[7] Average household size has a negative effect on selling price while household income has a positive effect. The zone variables show that house prices decrease as location moves inland from the coast. The variables Y2004 through Y2008 represent the year in which the house is sold. With Y2003 as the omitted variable, the results show that house prices increased steadily over the period 2003 through 2006 with prices in 2006 being 42 percent higher than prices in 2003 (2006 house prices in Jacksonville were about 70 higher than prices in 2000, the start of the housing boom). For 2007 and 2008, the data show that house prices decline from the 2006 peak such that, by 2008, house prices were 26 percent

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[7] To account for the multicollinearity between age and the building code variable, a two-step method is used. First, age is regressed on the other variables in the hedonic model. Then the regression residuals between age and predicted age are included in the hedonic model. Tests show that this eliminates the correlation problem between age and building code.

higher than prices in 2003 (2008 prices were 55% higher than prices in 2000). The seasonal variables show that comparable houses sold for higher prices in the summer and fall relative to the winter and spring.

The variables of primary interest are those measuring the effect of building code. The variable measuring price differences between the stricter and less-strict building codes shows that, for the aggregate data, houses sold over the 2003-2008 period that were built under the stricter building code actually sold for about 7 percent less, on average, than houses built under the older, less-strict code.

The post-catastrophe ("reality check") variables provide some interesting insight into buyer behavior. Following the 2004 hurricanes, the pricing gap between houses built under the old and new codes became narrower, with houses built under the stricter code still selling for less on average. However, this negative pricing disappears after the 2005 hurricanes and houses built under the new code have a price premium of about 7.50 percent. This result is not surprising given the combined effect of two years of hurricane losses and the "close call" in 2004 in the form of Hurricane Charlie. Moving out of 2006 and into 2007 and 2008, the building code premium disappears and once again becomes negative (about 5.70 percent).

A.2. What the Model Says About the Windborne Debris Region

When the regression model is applied to houses in the windborne debris region, the housing characteristics variables show that square footage has a positive effect on selling price while lot size is not significant. The age variable is negative. Household size has a negative effect on price while household income has a positive effect. The year variables show that house prices in this zone peaked in 2006, having increased by 45 percent since 2003 (81 percent since 2000). The Y2008 result shows that prices had dropped dramatically by 2008, with prices being at 29 percent the 2003 level. The seasonal variables show that houses sold for higher prices in the summer and fall relative to the winter and spring.

The building code variable shows that consumers in the windborne debris region, those homebuyers with the greatest risk exposure, were differentiating between homes built under the new code versus the old code and were willing to pay a premium of about 4.60 percent for the stricter code. This means that houses built under the new code sold for almost five percent more than comparable houses built under the older code.

The “reality check” variables for the windborne debris region show that, immediately after the hurricanes of 2004 and the 2005 hurricanes, the premium paid for houses built under the new code did not change. The premium remains constant through 2008.

A.3. What the Model Says About the 110 MPH Wind Zone

Applying the regression model to the110 MPH Zone, the intermediate zone, produces the expected results for the housing characteristics variables. Again, they are all positive and significant. The age variable is negative. Household size has a negative effect on price and household income has a positive effect. The year variables show that house prices in this zone increased about 41 percent from 2003 to 2006 (68 percent over the 2000-2006 period). The seasonal variables show that houses sold for higher prices in the summer and fall relative to the winter and spring.

The building code results for the 110 MPH Zone show a negative premium of about 7.50 percent for homes built under the new code. Thus, for this zone, the stricter building code was not valued by consumers and houses built under the new code actually sold for less, on average. The post-catastrophe building code variables show that the negative premium decreased from 7.50 percent to 5.35 percent after the 2004 hurricanes. However, after the more devastating 2005 hurricane season, houses in this area built under the new code sold for a premium of almost 5.60 percent. After the relatively calm 2006 hurricane season, the building code premium once again becomes a negative 7.50 percent over the period 2007-2008.

A.4. What the Model Says About the100 MPH Wind Zone

For the most inland zone, the 100 MPH Zone, the housing characteristics again behave as expected with significant, positive coefficients. The one exception is the lot size variable which is not significant. The age variable is negative. Household size has a negative effect on selling price and household income has a positive effect. The year variables show that, from 2003 to 2006, house prices increased by 42 percent (68 percent for 2000 to 2006). The seasonal variables show that prices are highest in the summer and fall.

The building code results show that homes built under the new, stricter building code sold for less, on average, than houses built under the old code. The premium is a negative 4.93 percent. The post-catastrophe variables show that, after the 2004 hurricanes, the negative premium remained constant at a negative 4.93 percent. However, after the 2005 hurricanes, a substantial positive premium of 14 percent is observed for houses built under the new code. After the relatively calm 2006 hurricane season, the building code premium was still positive but had decreased from 14 percent to 2.32 percent.

B. What the Model Says About the Jacksonville Neighborhoods

B.1. What the Model Says about the Aggregate Data

The main information contained in this regression model is that the building code variable shows a negative premium of just over 3 percent. The signs and impact of the 2004 and 2005 hurricane seasons are consistent with the description provided in A.1. above. Additionally, prices in the four neighborhoods shown are lower than prices in the holdout neighborhood, Beaches.

B.2. What the Model Says About the Beaches Neighborhood

When the regression model is applied to houses in the Beaches neighborhood, the housing characteristics variables behave as expected with positive, significant coefficients. The age variable is negative. Household size has a negative effect on price while household income has a positive effect. The year variables show that house prices in this zone peaked in 2006, having increased by 44 percent since 2003. The Y2008 result shows that prices had dropped dramatically by 2008, with prices being at 29 percent the 2003 level. The seasonal variables show that houses sold for higher prices in the summer and fall relative to the winter and spring.

The building code variable shows that consumers in the Beaches neighborhood, those homebuyers with some of the greatest risk exposure, were differentiating between homes built under the new code versus the old code and were willing to pay a premium of about 3.65 percent for the stricter code. This means that houses built under the new code sold for almost five percent more than comparable houses built under the older code.

The “reality check” variables for the Beaches neighborhood show that, immediately after the hurricanes of 2004 and the 2005 hurricanes, the premium paid for houses built under the new code did not change. The premium remains constant through 2008.

B.3. What the Model Says About the Southside Neighborhood

When the regression model is applied to houses in the Southside neighborhood, the housing characteristics variables behave as expected with positive, significant coefficients. The age variable is negative. Household size has a negative effect on price while household income has a positive effect. The year variables show that house prices in this zone peaked in 2006, having increased by 39 percent since 2003. The Y2008 result shows that prices had dropped dramatically by 2008, with prices being at

26 percent the 2003 level. The seasonal variables show that houses sold for higher prices in the summer and fall relative to the winter and spring.

The building code variable shows that consumers in the Southside neighborhood were differentiating between homes built under the new code versus the old code and were willing to pay a premium of about 2.40 percent for the stricter code. This means that houses built under the new code sold for about two and a half percent more than comparable houses built under the older code.

The post-catastrophe variables show that, after the 2004 hurricanes, the premium remained constant at 2.40 percent. However, after the much more devastating 2005 hurricanes, a substantial positive premium of 9.45 percent is observed for houses built under the new code. After the relatively calm 2006 hurricane season, the building code premium turned into a negative 5.84 percent.

B.4. What the Model Says About the Arlington Neighborhood

When the regression model is applied to houses in the Arlington neighborhood, the housing characteristics variables behave as expected with positive, significant coefficients. The age variable is negative. Both household size and household income have a positive effect. The year variables show that house prices in this zone peaked in 2006, having increased by 42 percent since 2003. The Y2008 result shows that prices had dropped dramatically by 2008, with prices being at 26 percent the 2003 level. The seasonal variables show that houses sold for higher prices in the summer and fall relative to the winter and spring.

The building code variable shows a negative premium for the stricter building code of 4.10 percent. This means that houses built under the new code sold for about four percent less than comparable houses built under the older, less strict code.

The post-catastrophe variables show that, after the 2004 hurricanes, the negative premium shrinks to 0.0063 percent. However, after the much more devastating 2005 hurricanes, a substantial positive premium of 9.26 percent is observed for houses built under the new code. After the relatively calm 2006 hurricane season, the building code premium remains positive but shrinks to 1.19 percent.

B.5. What the Model Says About the Northside Neighborhood

When the regression model is applied to houses in the Northside neighborhood, the housing characteristics variables behave as expected with positive, significant coefficients. The age variable is negative. Household size has a negative effect on selling price while household income has a positive effect. The year variables show that house prices in this zone peaked in 2006, having increased by 46 percent since 2003. The Y2008 result shows that prices had dropped dramatically by 2008, with prices being at 27 percent the 2003 level. The seasonal variables show that houses sold for higher prices in the summer and fall relative to the winter and spring.

The building code variable is not statistically significant, showing no significant difference in selling prices for homes built under the different building codes. However, the post-catastrophe variables show that, after the 2004 hurricanes, a positive premium of about 3.50 percent appears for homes built under the stricter building code. After the losses from the 2005 hurricanes, an even more substantive positive premium of 16.29 percent is observed for houses built under the new code. After the relatively calm 2006 hurricane season, the building code premium disappears.

B.6. What the Model Says About the Westside Neighborhood

When the regression model is applied to houses in the Westside neighborhood, the housing characteristics variables show that square footage has a positive effect on selling price while lot size has no significant effect. The age variable is negative. Household size has a negative effect on selling price while household income has a positive effect. The year variables show that house prices in this zone peaked in 2006, having increased by 43 percent since 2003. The Y2008 result shows that prices had dropped dramatically by 2008, with prices being at 29 percent the 2003 level. The seasonal variables show that houses sold for higher prices in the summer and fall relative to the winter and spring.

The building code variable is negative, indicating that houses built under the stricter building code sold for about 5.06 percent less than homes built under the older, less strict code. The post-catastrophe variables show that, after the 2004 hurricanes, there was not a change in the negative premium for the stricter code. However, after the much more devastating 2005 hurricanes, a positive premium of almost 15 percent appears for the stricter code. After the relatively calm 2006 hurricane season, the building code premium drops dramatically to 1.36 percent, although it remains positive.

C. Understanding the Building Code Premiums

The negative premiums for some of the building code results would seem to be counterintuitive as the worst one might expect is consumer indifference between building codes. However, the negative results actually are consistent with the moral hazard problem of hurricanes and insurance discussed by Fronstin and Holtmann (1994). They discuss consumer behavior in regard to consumers' preferences for product characteristics over more solid construction due to the ease of substituting insurance for hurricane disaster mitigation efforts. Under these circumstances, a negative premium for a stricter building code is not surprising.

The ease with which insurance might replace disaster mitigation is affected by the availability and affordability of insurance. Homeowners saw their premiums increase after the 2004 hurricane losses. Although mitigation features may have been previously recognized as important in reducing loss, the losses from 2004 and 2005 provided substantial loss data. This data has been useful in more accurately and adequately reflecting through premium reduction the impact of mitigation. As in Dumm, Sirmans, and Smersh (22008), we would argue that, in 2004, differences in insurance premiums between old-code homes and new-code homes did not adequately reflect the mitigation benefits of the new-code home. Consumers were purchasing homes in a market where prices and other costs of home ownership (e.g. property taxes) were increasing. Without sufficient differences in insurance premiums between old-code and new-code homes, it would appear that, in some cases, consumers found greater value in old-code homes.

In contrast to the negative building code premiums, the time period following the 2005 hurricane season shows a change in consumer attitudes toward building codes. A positive premium for the stricter building code is observed in the aggregate data and for every zone.

Despite predictions of a highly active and destructive 2006 hurricane season, no hurricanes made landfall in Florida. The same was true for 2007 and 2008. The third “reality check” variable captures a time period where forecasts of continued heightened hurricane activity proved to be inaccurate. It also reflects the passage of time from the significant losses of 2005. The premium for the stricter building code is positive in the windborne debris region (with the most risk exposure) and in the 100 MPH Zone (with the least risk exposure) indicating that consumers continued to value the stricter building code. However, the building code premium is negative in the 110 MPH Zone for this time period. One possible explanation could be the “test of time” syndrome. A homebuyer may not see the benefit of paying as great a premium for a newer-code home (which may have fewer amenities) relative to an older home that has stood the test of several severe natural disasters. Also, two inactive hurricane seasons following forecast of heightened hurricane activity are likely to desensitize consumer concerns about building safety. Finally, the financial impact of escalating property prices, taxes, and insurance costs following the

2005 hurricane season are likely to have led some consumers to a purchase decision where costs constraints overrode, in part, concerns for safety. [8]

VI. Summary

Due to its location, Florida is susceptible to significant hurricane and severe storm exposure. With the Atlantic Ocean on one side and the Gulf of Mexico on the other, it is not a matter of if but a matter of when catastrophe strikes. Over the last twenty years, considering Hurricane Andrew in 1992 and the seven hurricanes in 2004 and 2005, catastrophic losses from storms have totaled $52 billion (Florida Office of Insurance Regulation, 2006).

These losses have led to debates concerning the safety of Florida's housing stock and its ability to withstand natural disasters. Research has shown that homes built under tougher building code standards are more resistant to hurricanes. However, more stringent building code regulations increase building costs. A major issue is whether consumers appreciate this additional safety and whether they are willing to pay for the increased cost associated with more stringent building codes. Tornado research has shown that consumers do recognize and value safety and disaster mitigation. Although the importance of stronger building codes may seem intuitive, the value that consumers attach to these mitigation efforts is less clear. This study has addressed this issue.

In 2002 the state of Florida instituted a major change in the real estate construction industry: the Florida Building Code. The Florida Building Code became effective on March 1, 2002 and set stricter requirements for home construction. It was designed to eliminate the existing patchwork of building regulations within the state. Some of the major changes deal with new requirements for high-wind damage through stricter requirements for siding and shingles. The major goal is to ensure that buildings in high-intensity hurricane areas can better withstand the impact of wind-borne debris. Depending on the location, builders in coastal counties are required to build homes to withstand winds of 110 to 150 miles per hour. Thus, while houses built after the implementation of the stronger building codes in South Florida could be presumed to be "safer", only the previous Dumm, Sirmans, and Smersh study (2008) has measured the extent to which the stricter building codes are capitalized by consumers in their home buying decisions.

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[8] "At a time when many Florida property owners were experiencing significant increases in property taxes given the real estate boom, losses from the 2004 and 2005 hurricane seasons added to that burden in the form of substantial increases in property insurance premiums and the fears regarding future hurricanes" (Heilscher, 2006).

This study has followed up the Dumm, Sirmans, and Smersh (2008) study by examining the capitalization of the 2002 Florida Building Code in house prices for the Jacksonville, Florida housing market. The study has examined consumer buying behavior in a market that has seen a more recent strengthening in building code (2002 versus the 1994 South Florida Building Code) followed by heightened hurricane activity in 2004 and 2005. As such, this study has addressed the value to consumers of safety as signaled by the institution of a stronger building code in a setting where this change is more recent. Also, as discussed, although the Jacksonville area has experienced some hurricanes and other severe storms, it has historically enjoyed a lower risk exposure to storm disaster. Hurricane Dora (1964) is the only hurricane to make landfall in Jacksonville since 1851. Using the Jacksonville data has allowed the examination of the stricter building code to consumers whose risk exposure expectations may be different/lower than consumers in south Florida.

A hedonic pricing model was used to estimate the differential effect on house prices of the stricter 2002 Florida Building Code. The model also tested whether the stricter building code became more valuable to homebuyers after the disaster "reality checks" of 2004 and 2005. Results were presented for the aggregate data and for zones with different risk exposure. The results show that houses in the Windborne Debris Region that were built under the new, stricter building code sold for about 4.50 percent more, on average, than houses built under the older, less strict code. Thus, for the area with the greatest risk exposure, consumers were recognizing the value of the stricter building code and were willing to pay a premium for the additional safety.

For the "reality check" variables in the Windborne Debris Region, the results were interesting. These variables showed that, after the devastating storms of 2004 and 2005, the premium paid for the stronger building code did not change.

The interior wind zones showed a different result for the building code premium than the Windborne Debris Region. These zones showed a negative premium for building code. Thus, for these zones, the stricter building code was not valued by consumers and houses built under the newer code actually sold for less, on average. The post-catastrophe variables for the 110 MPH Zone show that, after the 2004 hurricanes, the building code premium became less negative and, after the 2005 hurricanes, became positive. After the relatively quiet 2006 hurricane season, the premium once again turns negative. The results for the 100 MPH Zone showed that, after the 2004 hurricanes, the negative premium did not change. However, after the 2005 hurricanes, the building code premium turned positive. After the 2006 hurricane season, the building code premium shrinks but remains positive. Thus the impact of these storms on consumer behavior was substantial for these zones.

The post-catastrophe ("reality check") variables provide some interesting insight into consumer behavior. For the zone with the most risk exposure, the existing positive premium for building code did not change after either the "close call" of 2004 (Hurricane Charlie) or the 2005 hurricanes. For the two inland zones, the negative building code premium for the zone with the highest negative premium (110 MPH Zone) was reduced immediately following the 2004 hurricane season. The overall, impact of the 2004 hurricanes on Florida was significant and the effect of these losses on the consumers' behavior toward risk is observed. This behavior is affected even more after the 2005 hurricanes. However, it appears that consumer's memories are short since the building code premium disappears (and returns to a negative level) after the relatively quiet 2006 hurricane season.

The 100 MPH Zone also has a negative building code premium but it is only about two-thirds the negative premium for the 110 MPH Zone. After 2004 this negative premium remains constant. But, after 2005, the premium increases dramatically to a positive level, indicating a change in consumer attitudes toward risk exposure. And, even after the quiet 2006 season, the code premium remains positive although it shrinks considerably.

A possible explanation for some consumer behavior is that, even though the four 2004 hurricanes had a significant impact on Florida and resulted in a "close call", these hurricanes did not directly impact the Jacksonville area. Thus, although in some cases, consumers seemed to have a greater appreciation of the stricter building code, they were not willing to pay a positive premium for the additional safety. Consumer behavior reverses, however, after the 2005 hurricanes. The cumulative effect of the combined hurricane seasons seemed to have had a much greater impact on consumers. This is reflected in the positive building code premium.

However, after the relatively mild 2006 hurricane season, the building code premium decreases for one inland zone. For the 110 MPH Zone the premium reverts back to being negative. For the 100 MPH Zone the premium is still positive but is less than it was after the 2005 season. This may be the result of the "test of time" syndrome for consumers. A homebuyer may see no advantage of paying a premium for a newer-code home (which may have fewer amenities) relative to an older home that has stood the test of several severe natural disasters. In other words, consumers have a greater preference for additional amenities as opposed to disaster mitigation. In addition, factors such as the cost-effectiveness of substituting hazard insurance for hurricane disaster, consumers' preferences for product characteristics over solid construction, and the availability of social insurance (efficient evacuation, National Guard protection of property) may affect the value that consumers attach to the stricter building code.

The results for the primary variables of interest for the neighborhood zones also show differences in consumer willingness to pay a premium for safety. For the Beaches and Southside neighborhoods, the coefficient on the building code variable is positive and significant. For the Northside and Westside neighborhoods, there is a negative premium for homes built under the 2002 Florida building code. As observed for wind zone locations, there is a positive premium for homes sold after the 2005 hurricane season. The premium ranges from 3.65 percent for the Beaches neighborhood to just over 16 percent for the Northside neighborhood. For homes sales after the 2006 hurricane season, the Beaches, Arlington, and Westside neighborhoods continue to show a premium albeit small for Arlington (1.19 percent) and Westside (1.36 percent). For the Southside neighborhood, the premium turned negative for the post 2006 hurricane season period (5.84 percent).

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APPENDIX

TABLE 1. VARIABLE DEFINITIONS

Variable	Definition
Ln(sp)	Log of sale price ln(*sp)* = dependent variable
SqFt	The square footage of the house
Lot Size	Size of the lot in acres
Age	The age of the house in years
HhSize	Average household size by census block
HhIncome	Average household income by census block
Bldgcode	Binary variable with a value of one if the house was built under the stricter 2002 Florida Building Code, zero otherwise
BldgcodePostH1	Binary variable with a value of one if the house was built under the stricter 2002 Florida Code and was sold between October 2004 to June 2005 (after the last hurricane in 2004 and before the first hurricane of 2005), zero otherwise
BldgcodePostH2	Binary variable with a value of one if the house was built under the stricter 2002 Florida Code and was sold between November 2005 to May 2006 (after last hurricane of 2005 to beginning of next hurricane season), zero otherwise
BldgcodePostH3	Binary variable with a value of one if the house was built under the stricter 2002 Florida Code and was sold after December 2006 into 2007 (after the 2006 hurricane season), zero otherwise
WBR Zone	Binary variable with a value of one if the house is within Windborne Debris Region (120 mph wind contour), zero otherwise
110MPH Zone	Binary variable with a value of one if the house is within the 110 mph wind zone, zero otherwise
100 MPH Zone	Binary variable with a value of one if the house is located within the 100 mph wind zone, zero otherwise
Y2003 – Y2007	Time trend variables for the years 2003 through 2007
Fall	Binary variable if the house was sold during the fall season (September, October, and November), zero otherwise
Winter	Binary variable if the house was sold during the winter season (December, January, and February), zero otherwise
Spring	Binary variable if the house was sold during the spring season (March, April, and May), zero otherwise
Summer	Binary variable if the house was sold during the summer season (June, July, and August), zero otherwise
Beaches	Binary variable if the house is located within the Beaches section of Jacksonville, zero otherwise
Arlington	Binary variable if the house is located within the Arlington section of Jacksonville, zero otherwise
Northside	Binary variable if the house is located within the Northside section of Jacksonville, zero otherwise
Southside	Binary variable if the house is located within the Southside section of Jacksonville, zero otherwise
Westside	Binary variable if the house is located within the Westside section of Jacksonville, zero otherwise

Table 2
Descriptive Statistics
Aggregate and Wind Born Debris Region

	Panel A: Aggregate (N=61513)				**Panel B: Wind Born Debris Region (N=3692)**			
Variable	**Mean**	**Min**	**Max**	**StdDev**	**Mean**	**Min**	**Max**	**StdDev**
Price	216851.70	10000	9148000	159068.60	325255.80	20000	3800000	275981.30
Age	9.30	0	38	9.73	15.43	0	38	9.31
SqFT	2461.28	810	14004	849.12	2349.42	891	14004	1025.44
Lot Size	.29	.02	66.17	.54	.21	.03	4.44	.28
HhSize	2.67	1.24	3.85	.29	2.46	1.5	3.85	.29
HhIncome	58409.18	8750	170072	18566.39	60472.35	29583	92881	17922.82
Bldgcode	.429	0	1	.495	.103	0	1	.304
Posth1	.200	0	1	.400	.182	0	1	.386
Posth2	.116	0	1	.320	.117	0	1	.321
Posth3	.198	0	1	.398	.186	0	1	.389
Posth1_c02	.095	0	1	.294	.021	0	1	.144
Posth2_c02	.042	0	1	.201	.009	0	1	.096
Posth3_c02	.095	0	1	.293	.022	0	1	.147
Beaches	.065	0	1	.247	.983	0	1	.127
Arlington	.231	0	1	.421	.008	0	1	.087
Northside	.145	0	1	.352	.009	0	1	.094
Westside	.247	0	1	.432	.000	0	0	.000
Southside	.311	0	1	.463	.000	0	0	.000
Winter	.215	0	1	.411	.209	0	1	.406
Spring	.270	0	1	.444	.294	0	1	.455
Summer	.275	0	1	.446	.286	0	1	.452
Fall	.240	0	1	.427	.212	0	1	.408
Y2003	.201	0	1	.401	.220	0	1	.414
Y2004	.221	0	1	.415	.228	0	1	.419
Y2005	.258	0	1	.437	.227	0	1	.419
Y2006	.130	0	1	.336	.150	0	1	.357
Y2007	.096	0	1	.295	.097	0	1	.296
Y2008	.094	0	1	.292	.078	0	1	.269
WBR Zone	.060	0	1	.238				
110mph Zone	.695	0	1	.460				
100mph Zone	.245	0	1	.430				

Table 2 (Continued)
Descriptive Statistics
110 and 100 Mile Per Hour Wind Zones

	Panel C: 110 MPH Zone (N=42771)				**Panel D: 100 MPH Zone (N=15050)**			
Variable	**Mean**	**Min**	**Max**	**StdDev**	**Mean**	**Min**	**Max**	**StdDev**
Price	228855.40	10000	9148000	161929.70	156144.90	11200	1000000	56947.70
Age	9.34	0	38	9.54	7.69	0	38	9.76
SqFT	2537.04	810	12918	882.99	2273.41	840	10448	646.99
Lot Size	.29	.02	66.17	.56	.30	.03	19.21	.50
HhSize	2.66	1.24	3.59	.30	2.78	2.18	3.24	.20
HhIncome	62526	8750	170072	19462.47	46203.38	20481	74583	7447.33
Bldgcode	.409	0	1	.492	.565	0	1	.496
Posth1	.195	0	1	.396	.219	0	1	.413
Posth2	.117	0	1	.322	.111	0	1	.314
Posth3	.202	0	1	.402	.189	0	1	.391
Posth1_c02	.086	0	1	.281	.139	0	1	.346
Posth2_c02	.042	0	1	.201	.051	0	1	.220
Posth3_c02	.097	0	1	.296	.107	0	1	.309
Beaches	.009	0	1	.095	.000	0	0	.000
Arlington	.331	0	1	.471	.000	0	0	.000
Northside	.195	0	1	.396	.035	0	1	.185
Westside	.016	0	1	.127	.965	0	1	.185
Southside	.448	0	1	.497	.000	0	0	.000
Winter	.217	0	1	.412	.210	0	1	.407
Spring	.267	0	1	.442	.275	0	1	.446
Summer	.275	0	1	.447	.271	0	1	.445
Fall	.241	0	1	.428	.244	0	1	.429
Y2003	.204	0	1	.403	.188	0	1	.390
Y2004	.217	0	1	.412	.232	0	1	.422
Y2005	.255	0	1	.436	.273	0	1	.446
Y2006	.129	0	1	.336	.126	0	1	.332
Y2007	.097	0	1	.296	.094	0	1	.291
Y2008	.098	0	1	.297	.087	0	1	.282

Table 2 (Continued)
Descriptive Statistics
Beaches and Arlington Neighborhoods

	Panel E: Beaches (N=4024)				Panel F: Arlington (N=14203)			
Variable	**Mean**	**Min**	**Max**	**StdDev**	**Mean**	**Min**	**Max**	**StdDev**
Price	349791.90	20000	3800000	297422.40	201358.30	10000	2300000	99087.14
Age	14.99	0	38	9.32	11.02	0	38	8.90
SqFT	2498.83	891	14004	1178.03	2349.88	840	10794	731.20
Lot Size	.21	.03	3.26	.17	.25	.03	8.98	.22
HhSize	2.50	1.5	3.85	.31	2.80	1.75	3.19	.29
HhIncome	61244.17	29583	92881	17357.03	57958.85	24286	85503	10814.91
Bldgcode	.112	0	1	.315	.254	0	1	.435
Posth1	.181	0	1	.385	.191	0	1	.393
Posth2	.117	0	1	.321	.112	0	1	.316
Posth3	.183	0	1	.387	.181	0	1	.385
Posth1_c02	.023	0	1	.150	.053	0	1	.225
Posth2_c02	.011	0	1	.103	.020	0	1	.140
Posth3_c02	.023	0	1	.150	.050	0	1	.219
Zwbd	.902	0	1	.297	.002	0	1	.044
Z110mph	.098	0	1	.297	.998	0	1	.044
Z100mph	.000	0	0	.000	.000	0	0	.000
Winter	.210	0	1	.408	.211	0	1	.408
Spring	.292	0	1	.455	.282	0	1	.450
Summer	.286	0	1	.452	.282	0	1	.450
Fall	.211	0	1	.408	.225	0	1	.417
Y2003	.220	0	1	.414	.219	0	1	.413
Y2004	.231	0	1	.421	.233	0	1	.423
Y2005	.227	0	1	.419	.228	0	1	.420
Y2006	.150	0	1	.357	.149	0	1	.356
Y2007	.096	0	1	.295	.098	0	1	.298
Y2008	.077	0	1	.267	.073	0	1	.261

Table 2 (Continued)
Descriptive Statistics
Northside, Westside, and Southside Neighborhoods

	Panel G: Northside (N=8909)				Panel H: Westside (N=15221)				Southside: (N=19156)			
Variable	**Mean**	**Min**	**Max**	**StdDev**	**Mean**	**Min**	**Max**	**StdDev**	**Mean**	**Min**	**Max**	**StdDev**
Price	189194.50	10000	9148000	141526.10	159055.80	10000	3582000	86159.17	259199.30	17000	4545000	177450.80
Age	3.86	0	38	8.19	8.17	0	38	1.08	10.26	0	38	9.52
SqFT	2602.34	850	8580	765.15	2247.39	810	10448	663.96	2640.34	864	12918	957.99
Lot Size	.39	.02	66.17	1.14	.29	.03	19.21	.44	.28	.02	10.07	.34
HhSize	2.70	2	3.39	.17	2.77	1.24	3.59	.22	2.54	1.73	3.52	.30
HhIncome	49316.12	12939	73333	11408.25	45943.65	8750	126373	8923.68	72281.40	18796	170072	21839.22
Bldgcode	.800	0	1	.400	.546	0	1	.498	.359	0	1	.480
Posth1	.215	0	1	.411	.216	0	1	.412	.191	0	1	.393
Posth2	.113	0	1	.317	.112	0	1	.316	.122	0	1	.327
Posth3	.223	0	1	.416	.193	0	1	.394	.206	0	1	.404
Posth1_c02	.177	0	1	.382	.132	0	1	.338	.075	0	1	.263
Posth2_c02	.080	0	1	.272	.049	0	1	.216	.042	0	1	.201
Posth3_c02	.187	0	1	.390	.107	0	1	.309	.091	0	1	.287
WBR Zone	.004	0	1	.061	.000	0	0	.000	.000	0	0	.000
110mph Zone	.936	0	1	.244	.046	0	1	.210	1.000	1	1	.000
100mph Zone	.060	0	1	.237	.954	0	1	.210	.000	0	0	.000
Winter	.221	0	1	.415	.211	0	1	.408	.220	0	1	.414
Spring	.263	0	1	.440	.277	0	1	.448	.254	0	1	.436
Summer	.249	0	1	.433	.270	0	1	.444	.282	0	1	.450
Fall	.267	0	1	.443	.242	0	1	.428	.244	0	1	.429
Y2003	.194	0	1	.396	.186	0	1	.389	.200	0	1	.400
Y2004	.193	0	1	.395	.228	0	1	.420	.218	0	1	.413
Y2005	.301	0	1	.459	.271	0	1	.445	.256	0	1	.436
Y2006	.094	0	1	.292	.129	0	1	.335	.128	0	1	.334
Y2007	.087	0	1	.281	.097	0	1	.295	.098	0	1	.298
Y2008	.131	0	1	.338	.088	0	1	.284	.100	0	1	.300

Table 3A
Regression Model Output: Aggregate and Wind Zones
Dependent Variable = ln(sp)

	Aggregate	**WBD**	**110MPH**	**100MPH**
Constant	**11.358910**	**12.129820**	**10.977820**	**10.893160**
	.0124113	(056808)	(.012571)	(.042144)
Age_Resid	**-0.007227**	**-.001355**	**-.008199**	**-.006761**
	.0001969	(.000602)	(.000214)	(.000538)
SqFT	**0.000383**	**.000402**	**.000386**	**.000348**
	.000002	(.000005)	(.000002)	(.000005)
Lot Size	**0.040062**	**.021243**	**.047754**	**.020905**
	.040062	(.017683)	(.002349)	(.005882)
HhSize	**-0.142944**	**-.529006**	**-.109598**	**-.135178**
	.0042634	(.018101)	(.004364)	(.016672)
HhIncome	**0.000006**	**.000007**	**.000005**	**.000007**
	.000001	(.000000)	(.000000)	(.000000)
Bldgcode	**-0.071418**	**.045742**	**-.074888**	**-.049259**
	.003379	(.021806)	(.003714)	(.008059)
BldgcodePosth1	**0.014489**	-.042894	**.021354**	.014688
	.005016	(.037713)	(.005731)	(.010434)
BldgcodePosth2	**0.146340**	.022755	**.130588**	**.190015**
	.006770	(.052220)	(.007503)	(.014880)
BldgcodePosth3	0.014500^{+}	-.047507	-.009670	**.072479**
	.006228	(.038577)	(.006971)	(.015401)
110MPH	**-0.318979**			
	.0051074			
100 MPH	**-0.437247**			
	.005737			
Spring	-0.008593^{+}	.013457	-.002363^{+}	**-.035171**
	.003410	(.012949)	(.003763)	(.008111)
Summer	**0.039745**	**.044327**	**.040641**	**.032766**
	.003428	(.013055)	(.003771)	(.008228)
Fall	**0.069805**	**.048227**	**.064706**	**.087444**
	.003510	(.013972)	(.003860)	(.008339)
Y2004	**0.119978**	**.168615**	**.123910**	**.097654**
	.003651	(.013510)	(.004031)	(.008763)
Y2005	**0.286082**	**.361535**	**.288644**	**.265507**
	.003780	(.013749)	(.004157)	(.009434)
Y2006	**0.416914**	**.453972**	**.413445**	**.420096**
	.004393	(.015383)	(.004814)	(.010970)
Y2007	**0.392617**	**.441839**	**.386580**	**.398715**
	.005198	(.017880)	(.005680)	(.013349)
Y2008	**0.265330**	**.286280**	**.263582**	**.278501**
	.005834	(.019297)	(.006335)	(.015497)
N	61513	3692	42771	15050
R2	.68	.80	.70	.41

Coefficient (Standard Error); Bold text- Significant at the 1% level; +- Significant at the 5% level; ++- Significant at the 10% level

Table 3B
Regression Model Output: Aggregate and Neighborhoods
Dependent Variable = ln(sp)

	Aggregate	**Beaches**	**Arlington**	**Northside**	**Westside**	**Southside**
Constant	**11.402320**	**12.002910**	**10.555390**	**1.997420**	**11.110710**	**11.1759**
	(.012614)	(.052290)	(.018148)	(.068085)	(.037848)	(.013798)
Age_Resid	**-.006891**	**-.002184**	**-.008546**	**-.007300**	**-.006050**	**-.0079571**
	.000194	(.000606)	(.000276)	(000882)	(.000525)	(000239)
SqFT	**.000380**	**.000409**	**.000381**	**.000342**	**.000371**	**.000378**
	.000002	(.000005)	(.000003)	(.000006)	(.000005)	(.000002)
Lot Size	**.050462**	**.096862**	**.124662**	**.055968**	.011092	**.081789**
	.002234	(.031864)	(.008638)	(.003533)	(.006868)	(.004650)
HhSize	**-.135558**	**-.481251**	**.076974**	**-.164880**	**-.256822**	**-.106892**
	(.004650)	(.016714)	(.007881)	(.024156)	(.014038)	(.005388)
HhIncome	**.000005**	**.000007**	**.000003**	**.000006**	**.000009**	**.000003**
	(.000000)	(.000000)	(.000000)	(.000000)	(.000000)	(.000000)
Bldgcode	**-.032430**	.036477^{++}	**-.040583**	.000929	**-.050647**	**.023672**
	(.003448)	(.020550)	(.005795)	(.012995)	(.008260)	(.004435)
BldgcodePosth1	**.013265**	-.058498^{++}	**.034325**	.034679^{+}	.014771	-.001791
	(.004942)	(.035190)	(.009585)	(.013588)	(.010971)	(.006720)
BldgcodePosth2	**.144551**	.005087	**.133239**	**.162862**	**.200194**	**.070964**
	(.006671)	(.047520)	(.013930)	(.018226)	(.015542)	(.008403)
BldgcodePosth3	.014269^{+}	-.023563	**.052458**	.019499	**.064302**	**-.082143**
	(.006244)	(.036718)	(.010994)	(.025785)	(.015751)	(.007782)
Arlington	**-.299088**					
	(.005343)					
Northside	**-.466795**					
	(.005964)					
Westside	**-.466692**					
	(.005603)					
Southside	**-.303317**					
	(.005075)					
Spring	**-.007224**	.012785	-.003819	-.011679	**-.024867**	.001848
	(.003360)	(.012599)	(.005071)	(.011517)	(.008330)	(.004225)
Summer	**.040358**	**.042882**	**.029999**	**.064979**	**.035695**	**.03942**
	(.003377)	(.012710)	(.005099)	(.011857)	(.008471)	(.004162)
Fall	**.071080**	**.048606**	**.052707**	**.125597**	**.091053**	**.044165**
	(.003458)	(.013587)	(.005361)	(.011569)	(.008606)	(.004265)
Y2004	**.117442**	**.163078**	**.119957**	**.126496**	**.104162**	**.112497**
	(.003597)	(.013124)	(.005285)	(.013022)	(.009064)	(.004487)
Y2005	**.288103**	**.358699**	**.290878**	**.304569**	**.271258**	**.279304**
	(.003745)	(.013439)	(.005570)	(.013742)	(.009719)	(.004555)
Y2006	**.418292**	**.443114**	**.420117**	**.455173**	**.434110**	**.392391**
	(.004328)	(.015007)	(.006148)	(.017872)	(.011220)	(.005283)
Y2007	**.393246**	**.431908**	**.381352**	**.414459**	**.410719**	**.369590**
	(.005122)	(.017529)	(.007217)	(.025220)	(.013540)	(.006156)
Y2008	**.268818**	**.287523**	**.264462**	**.274342**	**.291937**	**.26136**
	(.005749)	(.018956)	(.008503)	(.026955)	(.015767)	(.006695)
N	61513	4024	14203	8909	15221	19156
R^2	.69	.81	.73	.46	.44	.82

Coefficient (Standard Error); Bold text- Significant at the 1% level; +- Significant at the 5% level; ++- Significant at the 10% level