Journal of Housing Research

ISSN: 1052-7001 (Print) 2691-1337 (Online) Journal homepage: https://www.tandfonline.com/loi/rjrh20

The Impact of Hurricane Ivan on Expected Flood Losses, Perceived Flood Risk, and Property Values

Ash Morgan

JOURNAL OF HOUSING RESEARCH VOLUME 16 ISSUE 1

J
H
R

The Impact of Hurricane Ivan on Expected Flood Losses, Perceived Flood Risk, and Property Values

Ash Morgan

Abstract

The catastrophic affects of Hurricane Ivan on the Florida Panhandle real estate market raised growing concerns over the number of households located within the floodplain areas of coastal communities. Results from a hedonic property price model indicate that subsidized insurance premiums create a market imbalance by reducing expected flood losses and perceived risks associated with living in floodplain areas. Results also reveal that Ivan created an adjustment in the real estate market, increasing expected flood losses by 75 percent and raising flood risk perceptions. Finally, results indicate that further changes or a restructuring of the system may be necessary to curb households' appetite for coastal living and offset the apparent imbalance in the real estate market.

On September 16, 2004, Hurricane Ivan roared ashore along the Florida-Alabama coastline with winds exceeding 140 mph, accompanied by torrential rain, a storm surge, and coastal flooding of 10 to 16 feet above normal tide levels. Ivan's path damaged or destroyed 75,000 homes and displaced 50,000 people in Florida's westernmost counties of Escambia and Santa Rosa. Over 90% of homeowners were left without electricity, which in many cases took weeks to restore. Access to and from the region was severely impacted due to the closure of the Pensacola Regional Airport and the Interstate 10 bridge collapse. The region was declared a federal disaster area and the Federal Emergency Management Agency (FEMA) airlifted in water, ice, and food to area residents.

Ivan was the fourth hurricane to hit Florida in 2004, with Charley, Frances, and Jeanne also making landfall that year. However, Ivan caused more flooding problems than all the others combined. The National Flood Insurance Program (NFIP) to Florida paid out $869 million for 9,800 claims after Ivan, compared to $280 million for the three other hurricanes combined.[1] One year after Ivan, more than 138,000 residents in the Florida Panhandle region applied to FEMA's Individuals and Household Program (IHP), which provides federal or state assistance to help pay for lodging, minimal home repairs, and other hurricane-related needs. A total of $162.2 million was approved under FEMA's IHP. Of this amount, Santa Rosa County residents received over $50 million, via 34,000 individual applications, accounting for the largest percentage (79.2%) of applications per household in the sixteen-county Panhandle region.[2]

In Santa Rosa County, real estate and flood insurance markets have been severely impacted due to the location and exposure of real estate to the recent storm activity.

Santa Rosa County lies on the Gulf of Mexico, in the western portion of Florida's Panhandle, with a significant portion of the county's area bordering the coastline. The county has experienced significant population growth[3] over the last decade as families and retirees are attracted by the pleasant climate, recreational amenities, and low cost of living. More recently, workers in the second-tier service-sector industries have also moved into the area due to the employment opportunities created by the rising population. Increasing population levels combined with the general attraction for coastal living means more households are located in floodplain areas. This has implications for sales of flood insurance policies in Santa Rosa County. The latest reports from the RAND Corporation (2005)[4] rank Santa Rosa County 53rd in the U.S.[5] in terms of flood insurance market penetration for single family homes.[6] In 2005, 9,059 Santa Rosa households had flood insurance policies, representing a market penetration rate of 20.1%.

The NFIP was authorized by Congress through the National Flood Insurance Act of 1968, as a voluntary program, providing a quid pro quo approach to floodplain management. Until this point, flood victims had to rely on government disaster assistance to recoup any losses from flooding events. Congress passed the NFIP in response to the increases in federal disaster assistance, but also due to the apparent lack of private insurance coverage availability.

However, early on in the program, even with subsidized insurance rates, participation rates for the voluntary program were very low. This led to Congress passing the National Disaster Protection Act of 1973, requiring federally regulated financial institutions to require flood insurance coverage as a condition for granting a loan to those wishing to finance properties located in the Special Flood Hazard Area (SFHA) of a community participating in the NFIP. The mandatory purchase system has since been further augmented through the National Flood Insurance Reform Act (NFIR) of 1994. The major focus of the NFIR was to address existing concerns that borrowers could acquire flood insurance coverage when obtaining a mortgage but then let the coverage expire. Unless borrowers failed to keep up with their monthly mortgage payments, financial institutions did not review the policies and so, very few punitive measures were enforced due to lack of compliance. As a result, under the NFIR, policies documented that insurance coverage must continue throughout the life of the loan.

Today, the NFIP makes federally backed insurance money available to residents living in communities that agree to adopt flood mitigation measures that guide development in its floodplains. Yet, this in itself raises concerns over the provision of a federally subsidized flood insurance program in high-risk areas. In Florida alone, 80% of the 17 million residents live or conduct business near its coastline. As a result, 41% of all policies nationwide are written in Florida, which represents 1,908,898 flood insurance policies covering in excess of $313 billion in property as of July 2005.[7] In total, Florida has nearly $2 trillion in insured coastal exposure. Flooding concerns for area residents and businesses are also highlighted by the fact that 95% of Florida's communities participate in the NFIP.

Seven of the ten most expensive hurricanes in U.S. history occurred in a 14-month period between August 2004 and October 2005, all of which impacted the Florida coastline. The increased storm activity over this period re-ignites a concern over the number of households located in high-risk floodplain areas across the coastal communities of Florida.

One prominent argument against the NFIP is that it encourages demand for high-risk coastal living via subsidized insurance premiums. Subsidized insurance rates reduce expected losses (as revealed by the capitalized value of insurance premiums and non-insurable costs) associated with a flooding event. This in turn can reduce homeowners' risk perceptions. Economic theory suggests that, in efficient housing markets, properties located in a floodplain areas will sell at a discount as rational homeowners prefer properties located away from high-risk coastal areas; raising prices relative to comparable properties located in the floodplain. Controlling for housing characteristics and location differentials, any property price differentials should reflect perceived environmental risks, such as flooding. Further, if homeowners are risk neutral, the expected losses from flooding will be equal to the price discount.

However, the availability of a federally subsidized insurance program can distort the real estate market in high-risk coastal communities by lowering the cost of flood insurance, propping up demand and driving property price increases in high-risk areas. As a result, real estate markets may reveal property price premiums for properties located in high-risk flood areas as certain extraneous benefits (for example, the aesthetic benefits of living in waterfront communities) may exceed the artificially low perceived risks associated with flooding.

Many opponents of the NFIP believe that the recent storm activity and associated insured losses[8] call for restructuring of the NFIP—principally to increase the subsidized insurance premiums to more accurately reflect the true cost associated with living in floodplain areas.

This research develops an extensive dataset of 20,882 residential home sales in Santa Rosa County from January, 2000 through February 2006, and uses a hedonic property pricing model to provide a two-stage analysis. First, the effects of flood risk on property prices prior to Hurricane Ivan are estimated. The empirical findings suggest that prior to Ivan, the values of residential properties in designated floodplain areas were, on average, higher than comparable structures located outside the floodplain. This finding lends support to the argument that subsidized insurance premiums distort the real estate market, driving demand for, and raising prices of properties located in high-risk areas. As a result, other extraneous benefits outweigh the perceived risk associated with living in the floodplain area. Second, the change in post-Ivan floodplain property prices and insurance premiums are estimated to reveal the change in perceived flood risk and expected flood losses after the flooding event. Results reveal that the severity of Hurricane Ivan created a market adjustment, increasing expected flood losses by 75% and raising flood risk perceptions, as revealed by a 15% reduction in sales prices for an average property located in high-risk flood areas. Finally, following the post-Ivan adjustment in the real estate market, high-risk properties still command a price premium, indicating that further increases in the subsidized insurance premiums may be necessary to curb households' appetite for coastal living and offset the apparent imbalance in the Santa Rosa real estate market.

The paper proceeds as follows. There is a review of the relevant hedonic literature, a discussion of the dataset, and the hedonic property price modeling methodology. The results are then presented, together with a discussion of the principle findings. The paper closes with concluding remarks.

Literature Review

There have been a number of studies testing the relationship between flood risk and house values, with varying results. Some studies find that properties located in floodplain areas are valued between 4% and 12% below properties outside (MacDonald, Murdoch, Taube, and Huth, 1987; Shilling, Sirmans, and Benjamin, 1989; Spreyer and Ragas, 1991; Harrison, Harrison, Smersh, and Schwartz, 2001; and Bin and Polasky, 2003). For example, Shilling et al. use both semi-log and linear hedonic price models on 114 single-family homes in Baton Rouge, Louisiana, from December 1982 to February 1984. Using a dummy variable to account for location within a floodplain, they find the floodplain coefficient to be negative and significant at the 10% level. Spreyer and Ragas consider properties in two parishes of New Orleans that suffered significant floods in 1978, 1980, and 1983. Controlling for house and lot characteristics, they include flood location as an independent variable, and find this variable to be significant, revealing a discount for homes within the floodplain area. Harrison et al. use a database of property transactions in Alachua County, Florida, and find a price discount for homes located inside the floodplain, and also reveal that this price differential has increased since the implementation of the NFIR (1994).

Other studies find no significant negative effects on home prices from locating in designated floodplain areas. For example, Muckleston (1983) rejects the hypothesis that mean assessed values of single-family residential homes in designated floodplain areas appreciate at lower rates than comparable homes outside the floodplain, finding that the values of homes within the regulated floodplain actually grew faster than those outside. Schaefer (1990) considers residential property values in New York, Ontario and finds mixed, inconclusive results of differences in home values within and outside floodplain areas depending on the specific model used.

The ambiguity in results reveals the counterbalancing nature of living in designated floodplain areas—there are positive effects, such as the aesthetic benefits of living in waterfront properties or the convenience for water-based recreation, but also negative effects, such as increased flood risk.

Another set of research compares the price reduction from properties located in a floodplain with the capitalized value of flood insurance premiums. A common finding in this research (MacDonald, Murdoch, Taube and Huth, 1990; Spreyer and Ragas, 1991; and Bin and Polasky, 2003) is that the capitalized value of flood insurance premiums exceeds the sales price reduction, revealing that that there are some uninsurable costs associated with flood risk, such as disruption to normal life and loss of sentimental items. For example, Bin and Polasky use data from over 8,000 single-family residential homes sales (between 1992 and 2002) in Pitt County, North Carolina, and study the impact of Hurricane Floyd on residential property prices. They find that the value of a house located in the floodplain is, on average, 5.8% lower than a comparable structure located outside the floodplain. They also find that the discount for floodplain location increases after the hurricane and this exceeds the capitalized value of insurance premiums.

However, as pre-event conditions should already be capitalized in both expected flood risk and expected insurance premiums, a more revealing comparison is to measure the post-hurricane changes in perceived risk and expected flood losses to examine the post-storm correction in the housing market.

This paper augments previous studies by considering the real estate market imbalance created by subsidized insurance rates and by examining both the change in flood risk perceptions and expected flood losses in the aftermath of Hurricane Ivan. The research also avoids selection bias commonly found in other research by using a unique dataset of over 20,000 property sales observations across the county. Due to the difficulty in developing data sets on home sales with their associated structural and locational attributes, many hedonic studies use small data sets and analyze specific neighborhoods. However, the small sample size can introduce selection bias into the model and significantly reduce confidence in interpreting the findings. For example, in small sample sizes, the sale of one or two low- or high-priced units can significantly influence the average price in the sample.

Data

Santa Rosa County is located in the western portion of Florida's Panhandle. The total area of the county is 1,017 square miles with a population of 138,276.[9] Pensacola Bay and East Bay border the southern and southwestern portion of the county, with the Blackwater and Coldwater rivers flowing through the county. At the southernmost portion of the county is the peninsula of Gulf Breeze, bordered by East Bay to the north, Pensacola Bay to the west, and Santa Rosa Sound to the south. Exhibit 1 is a map of the county, which indicates the Census tracts that make up the Gulf Breeze peninsula, and outlines the designated floodplain areas as the shaded area.[10]

Data on 20,882 residential home sales from January 2000 through December 2006 were gathered. Exhibit 2 presents a description of the variables used in the analysis while Exhibit 3 provides the descriptive statistics for the data.

The average sales price over the six-year period is $188,963, ranging from $15,000 to over $2.5 million. The average home across the sample is 1,896 square feet, and is 12 years old with three bedrooms and two bathrooms.

Due to the unique aesthetic and recreational attributes associated with living on the Gulf Breeze peninsula, a disproportionately large number of residential home sales occur in this area. For example, over 48% of all residential home sales in the six-year study period occurred in the Gulf Breeze area; 36% of the property sales in the sample occur after Hurricane Ivan hit the region. Therefore, to control for locational differences across the sample, using Geographical Information Systems (GIS) software, the data on home sales are disaggregated by census tract.

Also using GIS software, the location of each residential home sale is identified and evaluated with floodplain mapping data to generate a dummy variable for all home sales that are within the designated floodplain area. Approximately 10% of all homes in the dataset are within the floodplain area.

Methodology

This research uses a hedonic property price modeling technique to evaluate the effects of flood risk on residential property values. Hedonic property price models are based on

Exhibit 1. Santa Rosa County Floodplain Map

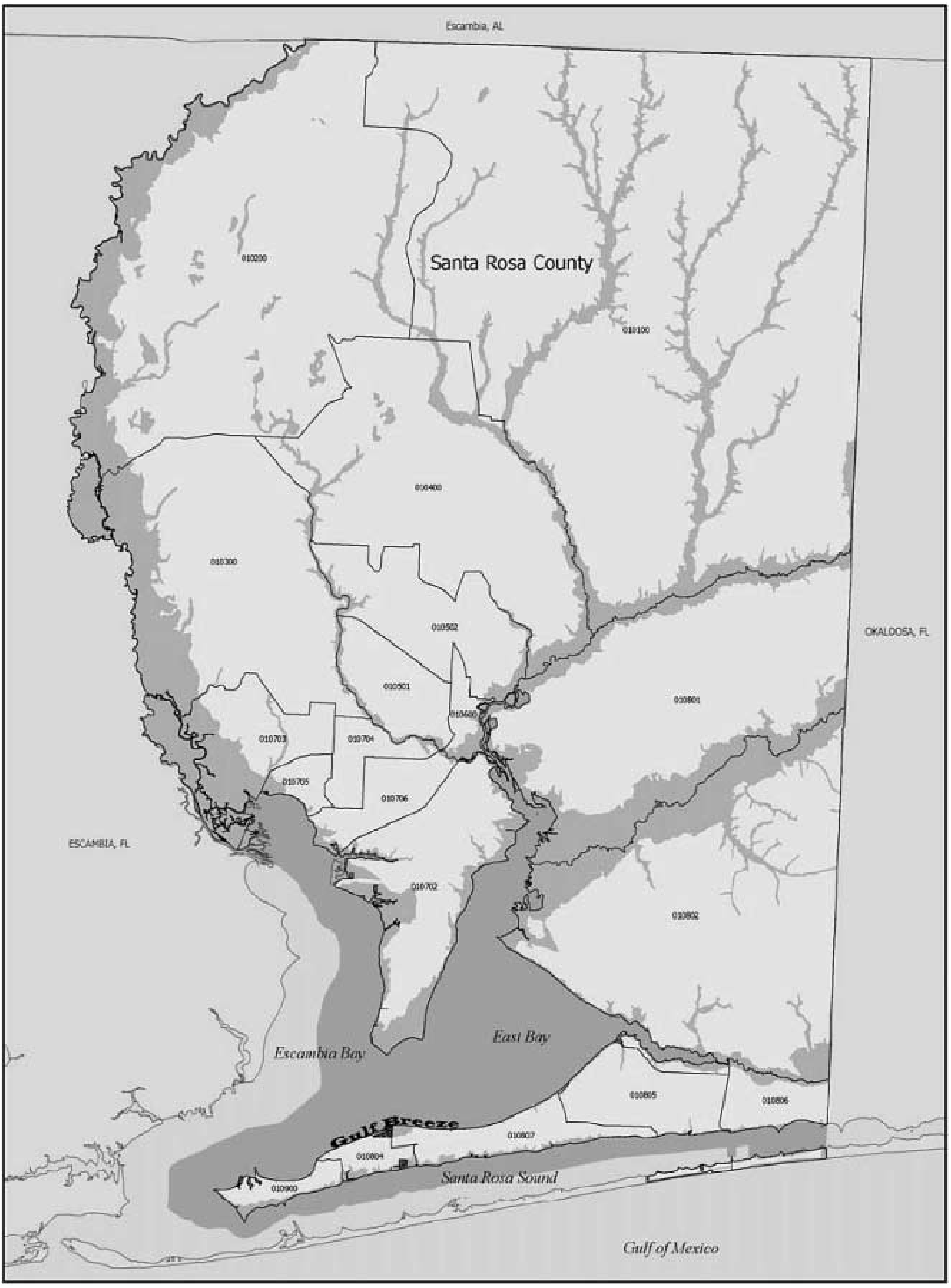

Exhibit 2. Definition of Variables

Variable	Description
Sales Price	Property sales price adjusted to 2006 dollars
TR_010900	Dummy variable (1 if house is in Tract_010900, 0 otherwise)
TR_010804	Dummy variable (1 if house is in Tract_010804, 0 otherwise)
TR_010805	Dummy variable (1 if house is in Tract_010805, 0 otherwise)
TR_010806	Dummy variable (1 if house is in Tract_010806, 0 otherwise)
TR_010807	Dummy variable (1 if house is in Tract_010807, 0 otherwise)
TR_010801	Dummy variable (1 if house is in Tract_010801, 0 otherwise)
TR_010802	Dummy variable (1 if house is in Tract_010802, 0 otherwise)
TR_010702	Dummy variable (1 if house is in Tract_010702, 0 otherwise)
TR_010703	Dummy variable (1 if house is in Tract_010703, 0 otherwise)
TR_010704	Dummy variable (1 if house is in Tract_010704, 0 otherwise)
TR_010706	Dummy variable (1 if house is in Tract_010706, 0 otherwise)
New	Dummy variable (1 if house is a new home, 0 otherwise)
Age	Year house was built subtracted from 2006
Sq. foot	Total square footage of structure
Bedrooms	Number of bedrooms
Bathrooms	Number of bathrooms
Flood	Dummy variable (1 if property is in floodplain, 0 otherwise)
Ivan	Dummy variable (1 if sale occurred after Ivan, 0 otherwise)
2001	Dummy variable (1 if property sold in 2001, 0 otherwise)
2002	Dummy variable (1 if property sold in 2002, 0 otherwise)
2003	Dummy variable (1 if property sold in 2003, 0 otherwise)
2004	Dummy variable (1 if property sold in 2004, 0 otherwise)
2005	Dummy variable (1 if property sold in 2005, 0 otherwise)
2006	Dummy variable (1 if property sold in 2006, 0 otherwise)

the theory of household behavior. The theory suggests households value a good because they value the characteristic of the good rather than the good itself. In hedonic property price valuations, the price of a residential home is a function of a number of housing characteristics (size of home, number of bathrooms, age of home, and so on) and neighborhood attributes (proximity to water, location in floodplain areas, and so on). In hedonic property price theory, the relationship between housing price and housing characteristics can be expressed by the hedonic price function:

$$P = f(\boldsymbol{X},F), \tag{1}$$

where, $\boldsymbol{X}$ represents a vector of continuous characteristics (bedrooms, bathrooms, size) assumed to influence the house price, P, while F represents the flood risk variable. Here it is assumed the housing market is in equilibrium[11] and so, prices are at the market clearing level. Each individual chooses a house and location by maximizing the utility function:

Exhibit 3. Descriptive Statistics

Variable	Mean	Std. Dev.	Min.	Max.
Mean Sales Price	$188,963.47	$119,314.86	$15,261.00	$2,480,885.00
TR_010900	0.040	0.196	0.000	1.000
TR_010804	0.091	0.289	0.000	1.000
TR_010805	0.220	0.414	0.000	1.000
TR_010806	0.119	0.323	0.000	1.000
TR_010807	0.164	0.370	0.000	1.000
TR_010801	0.031	0.174	0.000	1.000
TR_010802	0.040	0.195	0.000	1.000
TR_010702	0.065	0.247	0.000	1.000
TR_010703	0.085	0.279	0.000	1.000
TR_010704	0.052	0.223	0.000	1.000
TR_010706	0.071	0.258	0.000	1.000
New	0.292	0.455	0.000	1.000
Age	12.473	12.268	0.000	96.000
Sq. foot	1,896.090	607.573	800.000	6,800.000
Bedrooms	3.261	0.582	1.000	5.000
Bathrooms	2.137	0.496	1.000	5.000
Flood	0.102	0.302	0.000	1.000
Ivan	0.358	0.479	0.000	1.000
2001	0.114	0.318	0.000	1.000
2002	0.129	0.336	0.000	1.000
2003	0.156	0.363	0.000	1.000
2004	0.199	0.399	0.000	1.000
2005	0.189	0.391	0.000	1.000
2006	0.117	0.321	0.000	1.000

Note: n = 20,882.

$$U(Z,\mathbf{X},F), \tag{2}$$

where, Z is a composite good, representing a bundle of all other goods, subject to a budget constraint given by:

$$Y - P - Z = 0, \tag{3}$$

where, Y is the individual's income and the price of Z is normalized to \$1. Taking the partial derivative of Equation 1 with each housing characteristic variable yields the corresponding implicit price of the housing characteristic. So, estimating the partial derivative of Equation (1) with respect to the flood risk variable yields the first-order necessary condition:

$$\frac{\partial U/\partial F}{\partial U/\partial Z} = \frac{\partial P}{\partial F}. \tag{4}$$

Equation 4 reveals the individual's marginal willingness to pay for reduced flood risk. The natural log of price is used as the dependent variable, giving the hedonic property price function its common semilog form:

$$\ln P = \alpha + \sum_i \beta_i X_i + \gamma F + \varepsilon, \tag{5}$$

where X_i is the housing characteristic variable of the i^{th} housing attribute, F is a dummy variable that is set equal to one if the property sale is within the designated floodplain area, and zero otherwise, and ε is a random error term. White's alternative method (White, 1980) of the variance-covariance matrix is used to derive estimates of the standard error corrected for potential heteroscedasticity. The marginal effects are also presented along with estimation results with all marginal effects evaluated at the observed sample means.

Results

The regression results testing for the effects of flood risk on residential property values are presented in Exhibit 4. The results show that all the structural variables have the expected signs and are significant at the 99% level. As expected, square footage, and the number of bedrooms and bathrooms positively influence home values while, on average, the age of a property diminishes its value. For example, results indicate that an additional bedroom and bathroom increase house values by $9,935 and $17,093 respectively.

The coefficient on the flood variable (*FLOOD*) has a positive sign and is statistically significant at the 99% confidence level, indicating that houses located in the designated floodplain area sell at a premium. The estimated marginal effects reveal that for an average property in the sample, location within the floodplain area raises property values by an estimated $49,311. To think of this another way, the coefficient on *FLOOD* indicates that a $200,000 house located in the floodplain can attribute approximately $55,000 of its value to its floodplain location. One interpretation for the finding that properties sell for a premium in high-risk flood areas is that subsidized insurance premiums create a market imbalance by reducing expected flood losses and the perceived risks associated with living in floodplain areas. This stimulates demand for high-risk coastal living beyond that which would occur in a market free of intervention. As a result, the extraneous benefits of living in coastal areas outweigh the artificially low perceived risks, supporting demand and creating price premiums for properties in high-risk areas. This reveals the significant perceived benefit of coastal living on the value of a property in the Santa Rosa real estate market, and that such benefits overwhelm the perceived risk of flooding.

The coefficients on the census tract dummies control for variation across the different floodplain areas of Santa Rosa County. The excluded census tract is TR_010705 (see Exhibit 1), so the coefficients are interpreted relative to that tract. As expected, properties located on the Gulf Breeze peninsula have a higher value, all else being equal. Properties located in TR_010900 have the highest values, controlling for other characteristics.

The year dummies control for the general house appreciation over the sample time period. The excluded year is the Year 2000, so coefficients on the year dummies reveal

Exhibit 4. Hedonic Price Regression

Variable	Coeff.	Std. Error	*p*-value	Marginal Effect
Constant	10.399	0.019	<0.001	
TR_010900	0.535	0.011	<0.001	$95,768.58
TR_010804	0.329	0.008	<0.001	$58,844.46
TR_010805	0.213	0.006	<0.001	$38,123.42
TR_010806	0.216	0.007	<0.001	$38,696.22
TR_010807	0.277	0.006	<0.001	$49,579.42
TR_010801	−0.024	0.011	0.036	−$4,313.90
TR_010802	0.162	0.010	<0.001	$29,035.59
TR_010702	0.054	0.008	<0.001	$9,660.63
TR_010703	0.092	0.007	<0.001	$16,480.53
TR_010704	−0.003	0.009	0.755	−$508.36
TR_010706	−0.010	0.008	0.217	−$1,784.63
New	−0.125	0.005	<0.001	−$22,444.81
Age	−0.009	0.000	<0.001	−$1,521.50
Age^2	0.000	0.000	<0.001	
Sq. foot	0.884	0.012	<0.001	$158.24
Sq. foot^2	−0.082	0.003	<0.001	
Bedrooms	0.056	0.004	<0.001	$9,934.50
Bathrooms	0.100	0.005	<0.001	$17,092.71
Flood	0.275	0.007	<0.001	$49,310.92
Ivan	0.095	0.005	<0.001	$17,069.44
2001	0.004	0.007	0.588	$721.37
2002	0.033	0.007	<0.001	$5,797.81
2003	0.067	0.007	<0.001	$12,071.76
2004	0.141	0.007	<0.001	$25,208.57
2005	0.243	0.011	<0.001	$43,563.23
2006	0.272	0.011	<0.001	$48,637.88

a significant property price appreciation over the following five-year period. For example, homes sold in 2006 sell at a 27% premium relative to those sold in 2000, all else being equal.

Exhibit 5 presents the regression results with an added post-Ivan interaction term that tests for the impact of Hurricane Ivan on residential property prices. The post-Ivan interaction term is negative and statistically significant at the 99% level. The pre-Ivan estimated premium for properties located in the floodplain area is $57,412. After Hurricane Ivan, the premium falls by an estimated $27,940, representing a 15% reduction in post-Ivan floodplain property values. This finding suggests that the catastrophic damage caused by Hurricane Ivan re-affirmed homeowners' flood risk perceptions, causing a decline in home sales prices for properties within the floodplain, and the increased perceived flood risk mitigates some of the extraneous benefits of living adjacent to the water; a result that supports the findings of Bin and Polasky (2004).

Exhibit 5. Hedonic Price Regression with Hurricane Ivan-Interaction Term

Variable	Coeff.	Std. Error	*p*-value	Marginal Effect
Constant	10.391	0.019	<0.001	
TR_010900	0.534	0.011	<0.001	$95,564.52
TR_010804	0.330	0.008	<0.001	$59,087.90
TR_010805	0.211	0.006	<0.001	$37,892.51
TR_010806	0.216	0.007	<0.001	$38,918.18
TR_010807	0.277	0.006	<0.001	$49,586.58
TR_010801	−0.021	0.012	0.072	−$3,703.51
TR_010802	0.163	0.010	<0.001	$29,282.61
TR_010702	0.056	0.009	<0.001	$10,120.66
TR_010703	0.091	0.008	<0.001	$16,550.34
TR_010704	−0.000	0.009	0.919	−$143.20
TR_010706	−0.010	0.008	0.231	−$1,646.80
New	−0.125	0.005	<0.001	−$21,945.40
Age	−0.008	0.000	<0.001	−$1,517.92
Age^2	0.000	0.000	<0.001	
Sq. foot	0.887	0.013	<0.001	$158.69
Sq. foot^2	−0.827	0.003	<0.001	
Bedrooms	0.055	0.004	<0.001	$9,841.42
Bathrooms	0.094	0.005	<0.001	$16,840.32
Flood	0.321	0.008	<0.001	$57,412.46
*Flood*Ivan*	−0.156	0.013	<0.001	−$27,940.10
2001	0.005	0.007	0.510	$914.69
2002	0.033	0.007	<0.001	$6,005.45
2003	0.068	0.007	<0.001	$12,302.67
2004	0.170	0.007	<0.001	$25,575.52
2005	0.353	0.007	<0.001	$42,970.74
2006	0.380	0.008	<0.001	$57,412.46

The damage caused by Hurricane Ivan on residential properties also had a significant effect on flood insurance premiums. Flood insurance premiums depend on a number of location and housing characteristic variables, such as the estimated base flood elevation, existence of a basement, and value of housing contents to be insured. Following the method employed by Bin and Polasky (2004), insurance premiums for building and contents are estimated using post-Flood Insurance Rate Maps (FIRM) for single-family homes (assessed at the mean home sales price) using NFIP insurance rates.[12] The capitalized values of flood insurance premiums are calculated as the present value of the annual insurance payments in perpetuity at a 3%, 4%, and 5% discount rate.[13] Unlike previous research, this research estimates the capitalized values of flood insurance premiums both before and after the flooding event to estimate the change in the expected cost of insurance due to flooding as a result of Hurricane Ivan. Exhibit 6 reveals an increase in the expected losses associated with flooding (including all non-insurable risks)

Exhibit 6. Expected Flood Losses

	Present Value of Insurance Premiums by Discount Rate		
	3%	4%	5%
Expected Flood Losses (Pre-Ivan)	$15,400	$11,550	$9,240
Expected Flood Losses (Post-Ivan)	$26,900	$20,175	$16,140
Change in Expected Flood Losses	$11,500	$8,625	$6,900

following the flooding event. For example, at a 3% discount rate, the capitalized value of flood insurance premiums rise by $11,500—a 75% increase.

While the increase in expected flood losses and perceived flood risks reveal a post-Ivan market adjustment, reducing prices for high-risk properties, continued floodplain property price premiums suggest that further increases in subsidized flood insurance premiums are required to offset the imbalance in the Santa Rosa real estate market and reduce demand for living in high-risk coastal communities.

Conclusion

A federally subsidized insurance program can distort real estate markets by artificially lowering expected flood losses. In turn, this can reduce the perceived flood risks for homeowners with properties located in high-risk flood areas. The recent spate of storm activity and the severity of the insured losses have focused attention on the role of the NFIP in encouraging households to locate in these high-risk areas and leads a call for a restructuring of the system.

This research examines the Santa Rosa housing market to estimate the effect of flood risk on the sales prices of residential properties located in high-risk flood areas. Results suggest that prior to the storm, high-risk properties actually sell for a premium, indicating that subsidized insurance premiums create a market imbalance by reducing expected flood losses and the perceived risks associated with living in floodplain areas. As a result, the aesthetic benefits of living close to the water, or the convenience for water-based recreation opportunities, outweigh the risks associated with living in the floodplain area, stimulating demand for coastal living and driving up residential prices therein.

The findings reveal that the severity of Hurricane Ivan created a market adjustment, increasing expected flood losses by 75% and raising flood risk perceptions, as revealed by a 15% reduction in sales prices for an average property located in high-risk flood areas.

While Hurricane Ivan increases both flood risk perceptions and expected flood losses, high-risk properties still command a price premium, indicating that further increases in the subsidized insurance premiums may be necessary to curb households' appetite for coastal living and offset the apparent imbalance in the Santa Rosa real estate market.

The author notes that while attempting to create a larger dataset than traditional property price hedonic studies, the findings are still limited to one area, therefore results cannot easily be extrapolated to other areas; however, as the sample area is somewhat representative of the Gulf Coast region, results can perhaps be extrapolated to other areas impacted by the recent hurricane activity.

Endnotes

[1] FEMA-Hurricane Ivan Recovery in The Panhandle Adds Up To $1.4 Billion. http://www.fema.gov/news/newsrelease.fema?id=18831.

[2] FEMA-Hurricane Recovery Passes $5.6 Billion Mark. http://www.fema.gov/news/newsrelease.fema?id=18305.

[3] Approximately 70% between 1990 and 2004, U.S. Census.

[4] http://www.iii.org/media/facts/statsbyissue/flood.

[5] Santa Rosa County ranked 53rd from over 3,000 U.S. counties studied.

[6] Market penetration is calculated as number of state policies/total number of single family residences*100.

[7] Florida Division of Emergency Management: http://www.floridadisaster.org/flood_insurance.htm.

[8] Insured losses for Hurricane Ivan are estimated at $7.4 billion (Source: Insurance Information Institute).

[9] 2004 Census.

[10] Floodplains are defined as areas that would flood in a 100-year flood event.

[11] The sample was screened to remove outliers or non-arms length transactions. For each observation, a price per square foot measure was calculated and all transactions under $25 per square foot were deleted from the sample.

[12] Rates are calculated based on properties with no basement, located in flood zone type A, with an estimated base flood elevation greater than three feet, with assumed content values ($15,000, $30,000, and $50,000) increasing with house-price range. Assumed deductibles are $500, and all premiums include the increased cost of compliance (ICC) fee and the federal policy fee of $6 and $80 respectively.

[13] While there is little consensus in the economic literature regarding what constitutes an appropriate discount rate, 3% is widely used in practice. Policy analysts generally agree that economic analyses should present sensitivity analysis of alternative discount rates. To comply, this paper presents results at the 3%, 4%, and 5% levels.

References

Bin, O. and S. Polasky. Effects of Flood Hazards on Property Values: Evidence Before and After Hurricane Floyd. *Land Economics*, 2004, 80, 490–500.

Harrison, D., G. Smersh, and A. Schwartz. Environmental Determinants of Housing Prices: The Impact of Flood Zone Status. *Journal of Real Estate Research*, 2001, 21, 2–20.

MacDonald, D., J. Murdoch, P. Taube, and W. Huth. Flood Hazard Pricing and Insurance Premium Differentials: Evidence from the Housing Market. *Journal of Risk and Insurance*, 1990, 57, 654–63.

Muckleston, K.W. The Impact of Floodplain Regulations on Residential Land Values in Oregon. *Water Resources Bulletin*, 1983, 19:1, 1–7.

Schaefer, K.A. The Effect of Floodplain Designation/Regulation on Residential Property Values: A Case Study in New York, Ontario. *Canadian Water Resources Journal*, 1990, 15, 319–32.

Shilling, J.D., C.F. Sirmans, and J.D. Benjamin. Flood Insurance, Wealth Redistribution, and Urban Property Values. *Journal of Urban Economics*, 1989, 26, 43–53.

Spreyer, J.F. and W.R. Ragas. Housing Prices and Flood Risk: An Examination Using Spline Regression. *Journal of Real Estate Finance and Economics*, 1991, 4, 395–407.

White, H. A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity. *Econometrica*, 1980, 48, 817–38.

Ash Morgan, University of West Florida, Pensacola, FL 32514 or amorgan@uwf.edu.