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Abstract

This paper provides a detailed analysis of the operation of the National Flood Insurance Program (NFIP) in Florida, which accounts for 40 percent of the NFIP portfolio. We study the demand for flood insurance with a database of more than 7.5 million NFIP policies-in-force (the largest ever studied) for the years 2000–2005, as well as all NFIP claims filed in Florida. We answer four questions: What are the characteristics of the buyers of flood insurance? What types of contracts (deductibles and coverage levels) are purchased? Where and when are claims paid? How are prices determined and how much does NFIP insurance cost?

Keywords: flood insurance market; public–private collaboration; National Flood Insurance Program (NFIP); contract choice; Florida, decisionmaking under uncertainty.

***JEL Classification*:** D78, D81, G22, Q54

1. Introduction

The economic costs of natural disasters have risen dramatically over the past several decades. In the 1950s, natural disasters caused $53.6 billion in damages worldwide and by the 1990s, damages had risen to $778.3 billion (Munich Re, 2008). In 2008 alone, natural catastrophes inflicted $200 billion in direct economic damages worldwide, the third most costly year ever.

This growth in damages from natural disasters has made the question of how to manage catastrophe risk more salient, attracting the attention of policymakers and scholars alike. Improving management will require developing adequate and sustainable financial protection for potential victims of future disasters. Insurance has typically played a key role in providing financial protection against catastrophes. And insured losses have been growing along with total damages: of the 25 most costly insured losses over the period 1970–2008, 14 occurred since 2001, 12 of which were in the United States (Kunreuther and Michel-Kerjan, 2009).

Among natural hazards, floods are of particular concern since, during the 20th century in the United States, they accounted for the most lives lost and the most property damage of all natural disasters (Perry, 2000). In the United States, standard multiperil homeowners insurance policies, which are normally required as a condition for a mortgage, cover damage from fire, wind, hail, lightning, and winter storms, among other common noncatastrophe perils. Coverage for flood damage resulting from rising water is explicitly excluded in homeowners insurance policies, but coverage for these losses has been available through the federally managed National Flood Insurance Program (NFIP) since 1968.

Federal law requires property owners in 100-year floodplains—referred to as Special Flood Hazard Areas (SFHAs)—with a mortgage from a federally backed or regulated lender to purchase flood insurance; yet the effectiveness of this requirement in practice has been questioned as take-up rates have been found to be quite low in many places across the country

(e.g. Tobin and Calfee).[1] Lack of nationwide data on the number of properties in floodplains, however, hinders a complete assessment of NFIP market penetration. Two recent studies attempt to fill the gap. The first finds that, in a sample of coastal areas, 49 percent of eligible properties participated in the NFIP (Kriesel and Landry, 2004). The second, a 2006 RAND report, estimates that about 49 percent of properties in SFHAs purchased NFIP flood insurance, and only 1 percent of properties outside SFHAs purchased insurance, even though one-third of NFIP policies are outside SFHAs (Dixon et al., 2006). The RAND estimates represent a national average that masks high regional variation; take-up rates are much lower in some parts of the country, such as the Midwest.

Despite these concerns about take-up rates, very little research has empirically examined homeowners' demand for flood insurance. Browne and Hoyt (2000) provide the first empirical analysis. In spite of its important contribution to the field, the state-level aggregation of the data limits the interpretation of the results for decisionmaking at an individual level. In this paper, we extend the empirical work on the market for flood insurance by providing a detailed analysis of the demand for NFIP insurance in Florida. We draw on a unique database of all NFIP flood insurance policies issued in the state over six consecutive years (2000–2005); this amounts to more than 7.5 million policies. We focus our analysis on Florida because it has—at around 40 percent—by far the largest share of policies of the entire NFIP. We use the data to answer four specific questions about flood insurance demand in Florida: (1) What are the characteristics of the buyers of flood insurance? (2) What type of contracts (deductibles and coverage levels) are purchased? (3) Where and when are claims paid? (4) How are prices determined and how much does NFIP insurance cost?

[1] Low take-up rates were also found after Hurricane Katrina. In the Louisiana parishes affected by Katrina, the percentage of homeowners with flood insurance ranged from 57.7 percent in St. Bernard's to 7.3 percent in Tangipahoa. Only 40 percent of the residents in Orleans Parish had flood insurance (Hartwig and Wilkinson, 2005). These low percentages are particularly striking because the NFIP requires that homes located in SFHAs purchase insurance as a condition for federally backed mortgages.

We find that most NFIP policies in Florida are for single-family, residential properties. Just as the program overall is concentrated in only a few states, policies in Florida are highly concentrated in a few counties. The majority of policies are located within 100-year floodplains, but a sizable percentage of property owners nevertheless insure outside of these areas. The NFIP places a limit on the amount of coverage property owners can purchase, but in Florida, about 75 percent of homeowners insure below this limit. Most homeowners insure both their home and its contents, but about 13 percent do not insure their contents at all. These state-level averages, however, mask county-level variation.

On contract choices, we find that in 2005, 97 percent of customers chose a deductible lower than the maximum available, and almost 80 percent of policyholders choose the lowest possible deductible (i.e., $500). Our results on deductible choices are consistent with the literature on other insurance markets, albeit much more pronounced than previous work and based here on the largest sample ever studied. We also find, interestingly, though, that deductible choice varies with flood zone, with more homeowners in the riskiest areas—where the mandatory purchase requirement applies—choosing a higher deductible. Not many individuals appear to insure only catastrophes, as those at the limit of coverage are more likely to choose the lowest possible deductible. As anticipated, we also find that people have reacted to the 2004 floods in Florida by choosing a lower deductible and higher limit than they previously did.

In an analysis of the determinants of claims payments, we find that claims are higher in 100-year floodplains and lower when a property is elevated, has more than one floor, or has a basement. In addition, claims are lower in communities that have undertaken flood mitigation activities. Finally, we find that the average premium per policy and per $1,000 of coverage in Florida is among the lowest in the nation, which is somewhat counterintuitive given the storm surge exposure in this state. NFIP premiums are set for each flood zone nationally and do not vary by state or locality, so variations in price reflect variations among those purchasing policies. Furthermore, a recent U.S. Government Accountability Office (GAO) report noted that the NFIP

rate-setting process uses out-of-date data (GAO, 2008a). This might be even more pronounced in Florida given the fast urban development that has occurred there over the past 30 years.

The next section of the paper provides an overview of aspects of the NFIP program that are relevant to the analysis we conduct in this study. Section 2 also provides a cross-state comparison of several metrics of the NFIP to put our analysis of Florida in a national context. Section 3 systematically addresses each of the four questions above. Finally, section 4 concludes and offers some policy recommendations for improving the NFIP.

2. History and Function of the National Flood Insurance Program: Past and Present

2.1. Creation and operation of the NFIP

The NFIP grew out of a widespread belief among private insurance companies that flood peril was not insurable. It was argued in the United States that floods could not be insured by the private sector because: (1) only particular areas are subject to the risk, and as such, adverse selection would be a problem; (2) the premiums necessary would be so high that no one would be willing to pay them; and (3) collected premiums would not be sufficient to cover catastrophic events (Overman, 1957; Gerdes, 1963; Anderson, 1974). This concern culminated in the passage of the NFIP in 1968 following major floods that demonstrated the lack of coverage in many hazardous areas. It was thought that a government program could potentially be successful because it might pool risks more broadly, have funds to jumpstart the program, subsidize existing homeowners while charging actuarial rates to new construction, and tie insurance to land-use changes that might lower risks (Grossman, 1958). The program would also have the capacity to spread losses over time thanks to the potential for the program to borrow money from the federal government to compensate for a punctual deficit, something private insurers cannot do.

The NFIP was originally designed as a voluntary partnership between the federal government and communities: local governments enacted floodplain management regulations; in exchange, property owners in participating communities were eligible for federal flood

insurance.[2] To set premiums and support local governments, the NFIP creates Flood Insurance Rate Maps (FIRMs) of participating communities, which designate flood risks through different flood zones. To encourage further mitigation, the NFIP runs the Community Rating System (CRS), a voluntary program that rewards communities that undertake mitigating activities with lower premiums. The CRS has 10 classes, ranging from 1 for communities that have undertaken the most significant collective mitigation measures to protect against flood, to 10 for those that have done nothing. Communities can improve their class ranking by adopting a range of policies that reduce flood losses, improve awareness of flood risk, and/or facilitate accurate insurance ratings (more information on the CRS is available on FEMA's website).

The majority of NFIP policies are written through the Write-Your-Own (WYO) Program, which allows participating property or casualty insurance companies to write and service NFIP's standard flood insurance policy in their own names. The insurance companies bear no risk and are compensated for writing policies and settling claims, whereas the federal government benefits from the private industry's marketing channels and the presence of many insurers in participating communities. Nearly all of the flood policies issued today are written by companies that write flood insurance through the WYO program (99 percent in Florida over the period 2000–2005).

Despite this potentially synergistic effort between the NFIP and private companies, take-up rates for flood insurance have historically been low. One reason is that private insurance agents do not seem to market NFIP policies (Anderson, 1974); in addition, individuals are not interested in voluntarily purchasing flood insurance because of behavioral biases in evaluating low-probability risks and/or a lack of information (Anderson, 1974; Kunreuther, 1979; Power and Shows, 1979). Tropical Storm Agnes in 1972 demonstrated to Congress that very few people were participating in the NFIP, leading to the passage of the Flood Disaster Protection Act in 1973 (Anderson, 1974). This act limited federal disaster assistance for nonparticipating

[2] For more on the history and functioning of the NFIP, see Pasterick (1998).

communities and also created a mandatory purchase requirement: federally backed or regulated lenders must require the purchase of flood insurance by anyone taking out a mortgage on property acquired or developed in an SFHA. Although this led to a large relative increase in policies-in-force, the 1993 floods in the Midwest revealed that the mandatory purchase requirement was not being widely enforced, and sanctions on lenders were tightened in 1994.[3]

It is difficult to determine how well these regulations are working in practice because of a lack of nationwide data on the number of properties in 100-year floodplains (Kriesel and Landry, 2004; Dixon et al., 2006). Despite this limitation, one can look at the absolute evolution of flood insurance coverage over time. The combination of FEMA's attempts to raise awareness regarding the risk of floods and a series of major flooding episodes that occurred in 1992–1993 significantly contributed to increasing the number of flood policies issued by the NFIP.[4] A more significant increase started in 2004 and accelerated in the aftermath of Hurricane Katrina and major floods in Louisiana. In December 2007, 5.65 million policies were in place—almost 700,000 more than in 2005. Over the same period, the total value of property insured under the NFIP grew rapidly. Total exposure was nearly $214 billion nationwide in 1990 and $568 billion in 2000. In December 2007, it reached $1.14 trillion and it continues to grow. Not surprisingly, premiums collected for flood coverage have significantly increased as well, from $670 million in 1990, to $2.85 billion at the end of December 2007.

2.2. Cross-state comparisons

The NFIP does not play the same role in every state. Table 1 provides an overview of the coverage and premiums in the top 10 states (ranked by the number of flood policies-in-force) at

[3] The National Flood Insurance Reform Act of 1994 created financial penalties for lenders that did not comply with the mandatory purchase requirement, stated that liability is not altered by sale or transfer of the loan, and mandated that lenders purchase insurance on behalf of the borrower if the borrower fails to do so.

[4] Three significant flood events in 1992 (a Texas flood, Hurricane Andrew, and a Nor'Easter) generated more than $500 million in insured losses; a March storm and the floods in the Midwest in 1993 also generated $500 million in payments by the NFIP. The Texas floods in October 1994, the Louisiana floods in May 1995, and Hurricane Opal in 1995 cost the NFIP a total of more than $1.2 billion.

the end of December 2007 using data from FEMA. Note that these are average figures that mask important differences within a state depending on location, exposure to risk, value of the house, and demographics of the homeowner. We will discuss these variables in more detail for the state of Florida in the next section of the paper.

The NFIP market is highly concentrated. Two states—Florida and Texas—represent more than 50 percent of the entire number of NFIP policies-in-force. Around 70 percent of policies are located in just five states—Florida, Texas, Louisiana, California, and New Jersey.[5] The distribution among the top states remains nearly the same when the dollar value of the coverage-in-place is used instead of the number of policies as the measure of the quantity of insurance. The top five states account for more than $800 billion of flood coverage, or 71 percent of the national total. When looking at take-up rates (policies divided by Census population estimates from 2000), Florida has one of the highest take-up rates, whereas Texas has a rate that is much lower than that of Louisiana, despite having more policies. Average premiums per policy vary from a low $411 in Florida to a high $757 in New York.[6] Finally, the average quantity of insurance coverage per policy varies somewhat by state from the national average of $202,000. In December 2007, it ranged from $186,000 in Louisiana to $233,000 in California.

[5] All states have at least some NFIP policies-in-force. The states with the lowest number of policies-in-force, with less than 5,000 are: Alaska, District of Columbia, Montana, North Dakota, South Dakota, Utah, Vermont, and Wyoming. Total coverage in these states ranges from $226,397,000 in D.C. to $980,648,600 in Utah. The premium per policy ranges from $374 in D.C. to $896 in Utah, with most in the $600s.

[6] As discussed in section 3 in more detail, prices for NFIP insurance are set nationally and vary only by flood zone and characteristics of the house. They do not vary by state or locality, so the numbers reported here reflect the variety in flood risk by state, variation in the composition of who buys insurance, and of course, how much coverage is bought per policy—a function of the value of homes.

TABLE 1. NFIP SUMMARY STATISTICS WITH A FOCUS ON THE TOP 10 STATES

	Number of flood policies in place	Insurance penetration (policies divided by 2000 population in 100s)	Quantity of insurance in place ($U.S.)	Total annual premiums ($U.S.)	Average premium per policy ($U.S.)	Average premium per $1,000 of coverage ($U.S.)	Average quantity of insurance per policy ($U.S.)
Nation	5,554,041	1.97%	1,120,767,708,600	2,810,863,345	506	2.51	201,793
Florida	2,189,759	13.70%	454,409,776,100	901,071,362	411	1.98	207,516
% nationwide	39.43%		40.54%	32.06%			
Texas	666,920	3.20%	145,170,577,200	279,895,243	420	1.93	217,673
% nationwide	12.01%		12.95%	9.96%			
Louisiana	502,085	11.23%	93,608,829,200	286,015,533	570	3.06	186,440
% nationwide	9.04%		8.35%	10.18%			
California	266,171	0.79%	62,041,065,600	168,952,788	635	2.72	233,087
% nationwide	4.79%		5.54%	6.01%			
New Jersey	223,650	2.66%	45,945,494,500	159,123,884	711	3.46	205,435
% nationwide	4.03%		4.10%	5.66%			
TOP 5 STATES	**3,848,585**	**4.60%**	**801,175,742,600**	**1,795,058,810**	**466**	**2.24**	**208,174**
% nationwide	**69.29%**		**71.48%**	**63.86%**			
South Carolina	197,334	4.92%	43,090,182,300	101,117,712	512	2.35	218,362
% nationwide	3.55%		3.84%	3.60%			
New York	144,253	0.76%	31,598,332,600	109,182,682	757	3.46	219,048
% nationwide	2.60%		2.82%	3.88%			
North Carolina	133,955	1.66%	28,618,309,100	74,043,712	553	2.59	213,641
% nationwide	2.41%		2.55%	2.63%			
Virginia	105,860	1.50%	23,137,990,700	57,149,668	540	2.47	218,572
% nationwide	1.91%		2.06%	2.03%			
Georgia	88,429	1.08%	19,465,735,700	49,644,456	561	2.55	220,128
% nationwide	1.59%		1.74%	1.77%			
TOP 10 STATES	**4,518,416**	**3.48%**	**947,086,293,000**	**2,186,197,040**	**484**	**2.31**	**209,606**
% nationwide	**81.35%**		**84.50%**	**77.78%**			

Sources: Authors' calculation from FEMA data as of December 31, 2007.

3. Analysis of the Flood Insurance Market in the State of Florida

With more than 40 percent of the policies-in-force in the United States, Florida offers a natural setting to better understand the functioning of the NFIP and the characteristics of homeowners who choose to buy flood coverage. Moreover, the state is highly exposed to hurricane risks and has the greatest concentration of exposed value in high-risk areas; Florida is thus of particular interest to many policymakers. In this section, we answer four questions regarding flood insurance in Florida: (1) What are the characteristics of the buyers of flood insurance? (2) What type of contracts (coverage levels and deductibles) are purchased? (3) Where and when are claims paid? (4) How are prices determined and how much does NFIP insurance cost?

To answer these questions, we compiled data from several sources. The first is a data set of more than 7.5 million flood insurance policies provided to us by the NFIP.[7] It includes all of the policies-in-force in Florida for six consecutive years (2000–2005) ranging from more than 1.21 million policies in 2000 to more than 1.37 million in 2005. The data set excludes identifying information regarding the homeowner, preventing us from doing a household-level analysis, but it does provide the policyholder's zip code, city, and county. The data set contains a variety of variables relating to the policy, such as the coverage level, premium, and deductible, as well as the flood zone, the CRS class, and the type of policy (e.g., single-family or commercial).

We also received a dataset from the NFIP containing all claims filed in Florida through August 31, 2006, excluding identifying information. It includes information on the claim, such as the date of the loss, the catastrophe with which it is associated, the amount of damage, and how much was paid. It also contains information for a subset of the policies on the house and contents associated with the claim, such as structural features of the house and the value of the house and contents.

[7] We thank FEMA for sharing this data set and the claims data set for the purpose of our research project, and we are indebted to Tim Scoville and Ed Pasterick for the many discussions we had together on the practical operation of the program over the past several years.

Finally, from the 2000 U.S. Census, we compiled county-level demographic information, such as median income and median value of owner-occupied housing. Although these figures have certainly evolved since 2000, they are the most recently available Census data. We used such measures to better understand the factors driving the decision to purchase insurance.

3.1. What are the characteristics of the buyers of flood insurance in Florida?

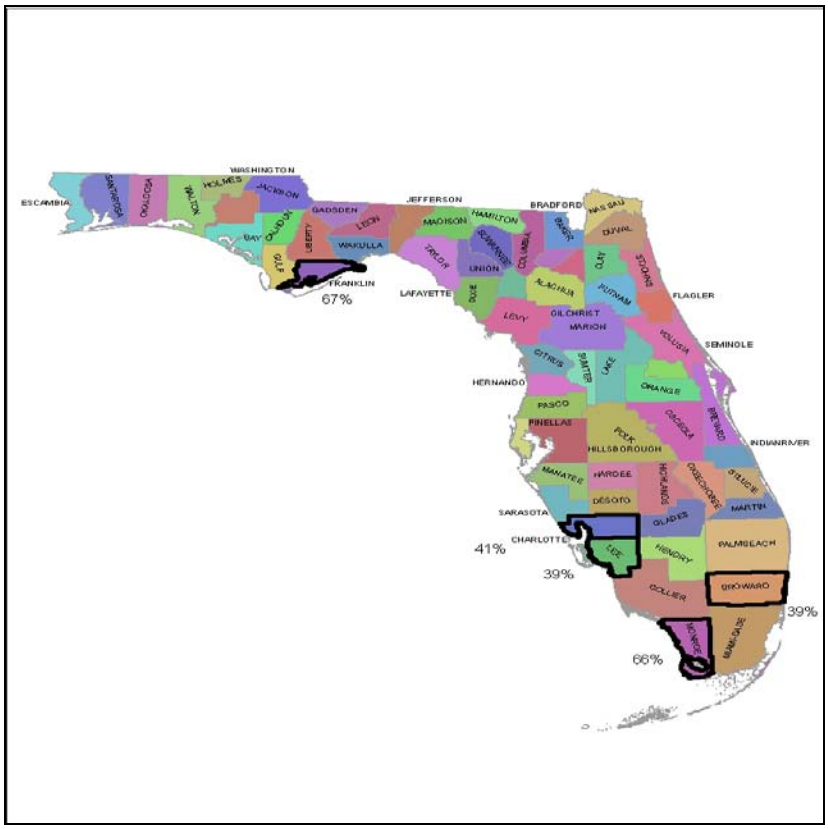
Occupancy Type -- More than 80 percent of the flood policies in Florida are for single-family, residential properties (Table 2); therefore, the majority of our analyses will focus on them. The number of such policies in Florida has increased from around 985,000 in 2000 to more than 1.15 million policies-in-force in 2005.

TABLE 2. PERCENTAGE OF POLICIES-IN-FORCE IN FLORIDA BY OCCUPANCY TYPE, 2000–2005

OCCUPANCY TYPE	PERCENTAGE IN 2000	PERCENTAGE IN 2001	PERCENTAGE IN 2002	PERCENTAGE IN 2003	PERCENTAGE IN 2004	PERCENTAGE IN 2005
Single-family	81.27	82.01	82.51	82.82	83.09	83.50
2- to 4-family	4.94	4.81	4.69	4.66	4.58	4.45
Other residential	9.69	9.01	8.56	8.27	8.03	7.82
Nonresidential	4.11	4.18	4.24	4.26	4.29	4.22

Market Penetration by County -- The number of single-family, residential policies-in-force per household provides a measure of market penetration. Unfortunately, data are not available on the number of houses located in floodplains for each county, so we estimate take-up rates for the entire county using total population counts from the 2000 Census. The Florida counties with the highest percentage of single-family, residential policies-in-force in 2005 were Franklin (67 percent), Monroe (66 percent), Charlotte (41 percent), Lee (39 percent), and Broward (39 percent) Counties (see Figure 1). The counties with the lowest percentage of policies were Gadsden (0.005 percent), Liberty (0.005 percent), Jackson (0.006 percent), Madison (0.01 percent), and Washington (0.01 percent). Not surprisingly, given the hurricane risk in Florida, coastal counties had the highest take-up rates.

FIGURE 1. TOP FIVE FLORIDIAN COUNTIES IN TERMS OF MARKET PENETRATION IN 2005



One can also examine the rankings of counties on total exposure for the NFIP rather than the number of policies-in-force. The counties with the greatest total amount of exposure (building plus contents coverage minus building and contents deductibles) for single-family policies in 2005 were Broward ($58 billion), Miami–Dade ($40.9 billion), Palm Beach ($21.3 billion), Lee ($17.1 billion), and Pinellas ($13.3 billion). The counties with the most policies-in-force were the same counties with the greatest amount of total coverage. They were not, however, the counties with the highest market penetration. The five counties with the lowest amounts of total exposure were Madison ($8.85 million), Jefferson ($6.78 million), Hamilton ($6.05 million), Union ($4.04 million) and Liberty ($1.69 million).

Market Penetration by Flood Zone -- The number of policies-in-force also varies by FEMA mapped flood zone.[8] We would ideally like to be able to examine take-up rates by flood zone; unfortunately, there is not a comprehensive database of the number of households in each flood zone by county available. Our data, however, do indicate the number of policies-in-force in each flood zone (see Table 3)[9].

TABLE 3. PERCENTAGE OF SINGLE-FAMILY RESIDENTIAL POLICES-IN-FORCE IN FLORIDA BY FLOOD ZONE

FLOOD ZONE*	PERCENTAGE IN 2000	PERCENTAGE IN 2001	PERCENTAGE IN 2002	PERCENTAGE IN 2003	PERCENTAGE IN 2004	PERCENTAGE IN 2005
X	15.39	15.62	15.31	14.89	15.15	17.90
A-A99	21.71	20.89	20.30	19.64	18.74	17.36
AE	31.78	31.56	31.77	32.30	32.80	32.22
AHB	19.77	20.07	20.13	18.34	22.99	22.17
AO, AOB, AH	2.64	3.52	4.3	6.81	2.55	2.26
V-VE	1.23	1.16	1.12	1.09	1.04	0.94
B, C, D	7.44	7.17	7.05	6.93	6.73	7.15

**See text for explanation of flood zone categories.*

The A zones (shaded in Table 3) are FEMA-designated 100-year floodplains where the mandatory purchase requirement applies. The subcategories within the A designations (A-A99; AE; AHB; and AO, AOB, and AH) refer to whether a detailed hydraulic analysis has been done and, if so, the particular nature of the flooding. Not surprisingly, about 75 percent of all single-family policies in Florida are located in these 100-year floodplains. V zones are also in the 100-year floodplain and the mandatory purchase requirement applies, but these are coastal floodplains that are associated with a risk of storm surge. Quite surprisingly to us, very few policies were in the V zones. This could be because they cover a very small geographic area.

Zone B designates moderate flood risk and Zone C designates minimal flood risk. Both areas are outside of the 100-year floodplain. Zone D consists of areas with possible flood risks,

[8] There is some question about the accuracy of these maps, however. Flood risks are not stationary. Development that reduces impervious surface area can increase flooding, as can the engineering of rivers (e.g., Criss and Shock, 2001) and possibly climate change. A recent GAO study reveals that many maps are out of date, such that some maps may severely underestimate the true risk (GAO, 2008a)[8]. FEMA has begun a map modernization program to correct this problem.

[9] Being in a floodplain not only increases the insurance cost, but can lower property value (MacDonald, Murdoch, and White, 1987; MacDonald, White, Taube, and Huth, 1990; Bin, Kruse and Landry, 2008).

but no analysis has been completed on these areas. These three zones represent only a small percentage of policies in Florida. Flood Zone X is composed of those areas determined to be outside of the 100-year and 500-year floodplains, and thus at minimal flood risk. Still, about 18 percent of all residential, single-family policies-in-force were in Zone X in 2005 (up from 15.4 percent in 2000) even though mandatory purchase requirement does not apply (nor does it apply in Zones B, C, or D).

Market Penetration by CRS Class -- We also examined policies by CRS class. As discussed earlier, classes range from 10 to 1 (with 10 indicating no mitigation and 1 indicating the maximum amount of mitigation). The deduction in premiums that a community can receive by participating in the CRS and undertaking mitigating activities—such as improved stormwater management, land-use regulations, or outreach campaigns—ranges from 0 to 45 percent of the full FEMA-defined actuarial rate, depending on the level of actions taken. In 2005, about a quarter of residential policies-in-force were in communities with no CRS discount (class 10) (see Table 4). The remaining three-quarters of policies benefitted from some type of price discount, ranging from 5 to 25 percent (class 9 to 5). Virtually no policies received a discount higher than 25 percent.[10]

TABLE 4. PERCENTAGE OF RESIDENTIAL POLICIES-IN-FORCE IN FLORIDA BY CRS CLASS

CRS DISCOUNT	Percentage in 2000	Percentage in 2001	Percentage in 2002	Percentage in 2003	Percentage in 2004	Percentage in 2005
0% (class 10)	22.20	23.08	23.03	22.97	23.15	26.36
5% (class 9)	17.50	13.84	10.01	7.67	6.83	5.09
10% (class 8)	35.81	33.10	31.62	28.15	27.57	25.24
15% (class 7)	23.90	25.64	17.41	19.68	20.52	21.68
20% (class 6)	0.09	3.79	17.21	18.30	8.64	8.22
25% (class 5)	0.5	0.55	0.72	3.23	13.29	13.41

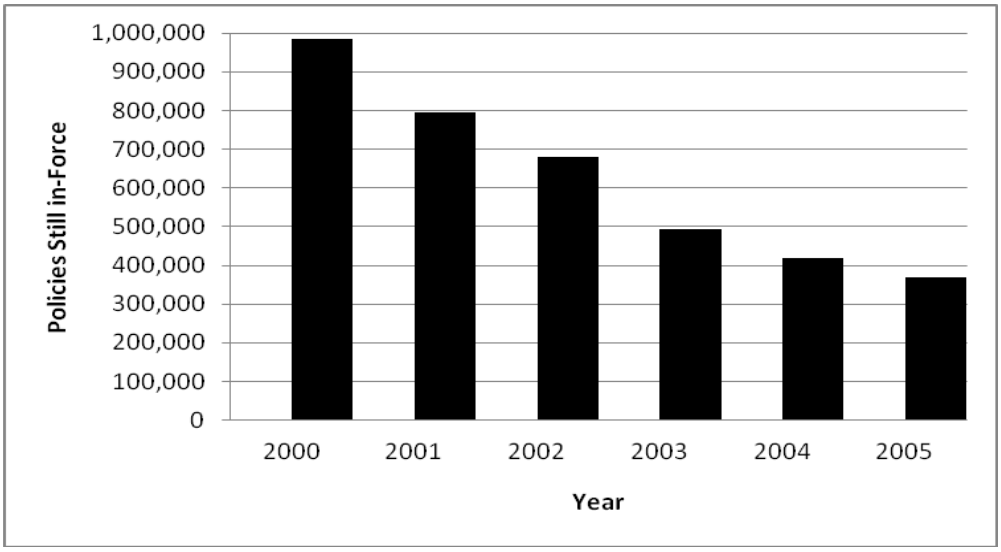
Between 2000 and 2005, an increasing percentage of policies were receiving no discount, and an increasing percentage were receiving a 20 or 25 percent discount. For instance, between

[10] Only a few policies in the data set are in CRS classes that provide a discount higher than 25 percent. The data set includes 1 such policy in 2004 (with a 50 percent discount), 1 in 2002 (with a 30 percent discount), 35 policies in 2000 (with a 75 percent discount), and no policies with a discount greater than 25% in 2005, 2003, or 2001.

2000 and 2002, fewer than 1 percent of the policies were located in communities that received a 25 percent discount on premiums. That proportion significantly increased in the following two years, with more than 13 percent of the policies having such a discount in 2005.

Tenure of Flood Policies -- How long homeowners keep their policies and whether low retention rates can explain the lower-than-desired take-up rates in many flood-prone areas in the United States is an open question (GAO, 2006). As with other catastrophe risks, homeowners may drop their coverage after a certain period if they have not suffered a loss (Kunreuther, 1978). From our sample, we can track the unique identifying policy number for all of the policies-in-force in the year 2000 and see how many of these were still in place in subsequent years (Figure 2). In 2000, roughly 985,000 single-family, residential policies were in force; by 2005, only about 38 percent of these policies were still in force. We cannot determine, however, whether a policy dropped from our database because a homeowner moved elsewhere or died, or because a homeowner dropped their policy while staying in the same house.

FIGURE 2. TENURE OF POLICIES-IN-FORCE IN 2000



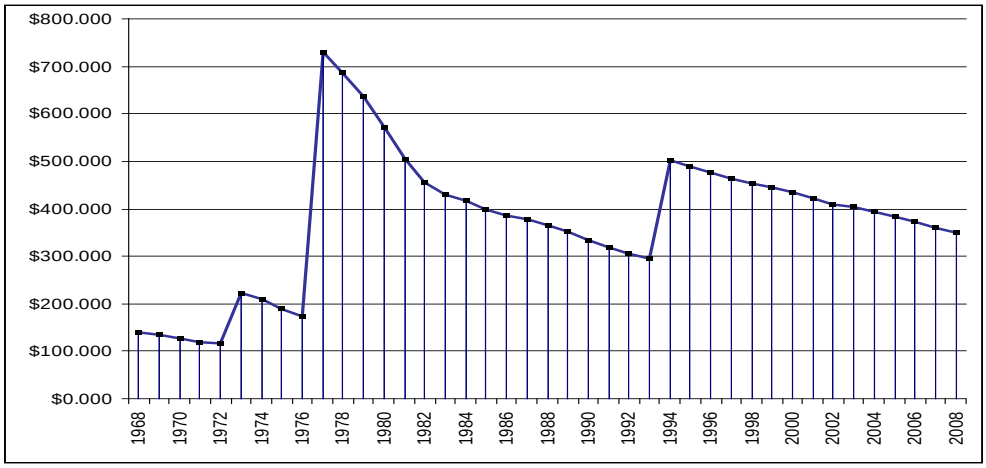
3.2. What type of contracts do policyholders purchase?

We turn now to the design of the flood insurance contracts Floridians purchase. We first explore the coverage levels that homeowners in Florida choose and then examine deductible choices. Finally, we look at changes in these choices in 2005 following the 2004 hurricane season, in which Florida was hit with four hurricanes—Charley, Frances, Ivan, and Jeanne—and tropical storm Bonnie.

Coverage Levels -- The amount of insurance that homeowners can purchase from the NFIP has evolved over time. The NFIP has always had two maximum coverage limits, one for the structure and one for the contents. In 1968, these limits were $17,500 and $5,000, respectively, for residential property; since then, they have been modified several times but have remained unchanged since 1994 at $250,000 for the structure and $100,000 for contents.[11] Homeowners affected by the mandatory purchase requirement also must meet a minimum coverage level: the principal remaining on the outstanding mortgage (unless this amount is above the maximum coverage limit). To compare the evolution of the real value of the coverage limit, we indexed the current total limit for building and contents coverage of $350,000 to 2008 prices over the period 1968–2008, using the official U.S. inflation rate for each year (Figure 3). In real prices, the maximum limit on a flood policy in 2008 was about the same as it was 20 years before and much lower than it was in 1978, despite significant inflation over this period and real estate prices that increased in many areas at a much higher rate than inflation. Over the years, some have argued that the $350,000 coverage limit is too low; this concern was raised again following Hurricane Katrina.

[11] Commercial (nonresidential) buildings are eligible for up to $500,000 in building coverage and $500,000 in contents coverage. According to FEMA, as of June 2007, nearly 2 million of the 5.4 million policies-in-force had building coverage only, 3.4 million had both building and contents coverage, and 100,000 had contents coverage only.

FIGURE 3. FLOOD TOTAL COVERAGE LIMITS BY YEAR INDEXED TO 2008 DOLLARS



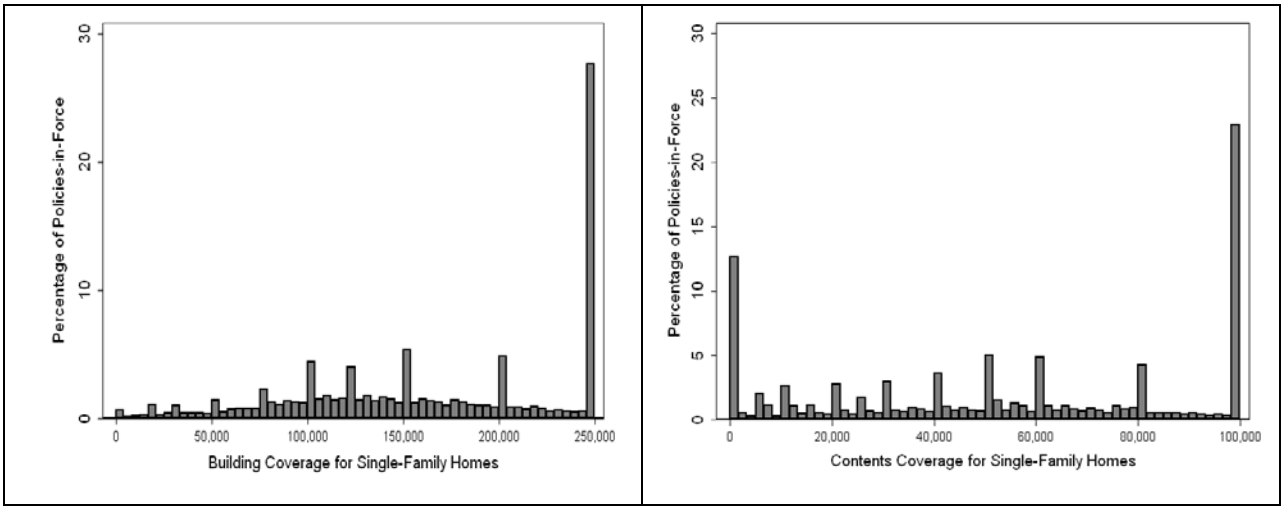
We were able to examine whether the $350,000 threshold is really a constraint on the demand side for homeowners. For policies-in-force in Florida in 2005, the limit is not binding for the majority of homeowners. More specifically, we find that about 73 percent of single-family homes had building coverage below the $250,000 limit in 2005.[12] Given that the median value of owner-occupied housing units in Florida reported in the 2000 Census was only $105,000, this result should not be surprising. Although the multimillion-dollar houses on the beach receive a great deal of media attention, most residences in Florida are valued at less than the NFIP building coverage limit for residential properties.[13] Further, flood damages may not always completely destroy a structure, so not insuring the full value of the home may be quite rational (discussed further below).

Figure 4 depict the percentage of the 1.14 million single-family flood policies in 2005 that selected a given limit for building and contents coverage. Although almost three-quarters of homeowners did not purchase building insurance at the coverage limit, about 27 percent did

[12] Note that we are considering the amount of coverage purchased, not coverage as a percentage of home value.
[13] Moreover, in many areas in Florida, property prices are probably heavily determined by the price of the land more than the cost of the house itself.

(Figure 4, left). Presumably many of these policyholders would welcome the option of choosing a higher limit.[14] Moreover, the number and proportion of policyholders who have purchased the $250,000 limit has been growing steadily. In 2000, only around 10 percent of single-family policyholders were at the coverage maximum. This percentage rose in 2003 to 17 percent and to 27 percent in 2005. In part, this reflects the growth of Florida's population and the increased value of real estate.

FIGURE 4. BUILDING AND CONTENTS COVERAGE; SINGLE-FAMILY HOMES IN FLORIDA IN 2005



About 23 percent of single-family policies in Florida in 2005 were at the $100,000 limit for contents coverage (Figure 4, right). Out of all 1.14 million single-family policies-in-force in 2005, roughly 12.5 percent had zero contents coverage. The number with zero contents coverage has been declining slowly since 2000, however, whereas the number at the coverage limit rose substantially during this time, from 7.5 percent in 2000 to almost 23 percent in 2005.[15]

[14]Several private insurers, including American International Group (AIG) and Chubb, offer private insurance in excess of the NFIP policy limits. However, the same problems of insurability that the NFIP was set up to address affect private programs. To our knowledge, AIG and Chubb only offer coverage in a handful of states, none of which are Gulf Coast states (Silverman, 2005). RAND recently examined the market for private flood insurance, estimating that between 130,000 and 190,000 policies are entirely from private companies and perhaps 180,000–260,000 policies are just for coverage in excess of the NFIP cap (Dixon et al., 2007). Compared to the 5.7 million NFIP policies-in-force, this is quite a small number.

[15] These state averages mask considerable county-level variability in whether policyholders are up against the maximum coverage limit. In 2005, some counties, such as Liberty and Lafayette Counties, had virtually no

As expected, policyholders with higher levels of building coverage tend to have higher levels of contents coverage, as well. On average statewide, a policyholder has an approximately 70 percent chance of buying the maximum limit of contents coverage if she has bought the maximum limit of building coverage. Also as expected, the percentage of single-family, residential policyholders at the limit at the county level in 2000 is positively correlated with income measures from the 2000 Census, such as the median value of owner-occupied housing and median income. We calculated that the correlation coefficient is approximately 0.6 for both measures; this is statistically different from zero at better than the 1 percent level. Both the median value of owner-occupied housing and median income are significant predictors in county-level regressions with the percentage of policies at the coverage limit as the dependent variable (not reported; available from the authors).

Another important element to consider in making decisions about flood insurance coverage is the level of losses policyholders can expect from a flood.[16] About three-quarters of the residential claims in our data set between 2000 and 2006 included information on the assessed value of the house. For this subsample, Figure 5 shows the amount of the building claim paid divided by the value of the structure (left graph).[17] Most building claims payments were significantly less than the value of the property;[18] for just over 50 percent of the claims, the amount paid was no more than 10 percent of the property value.

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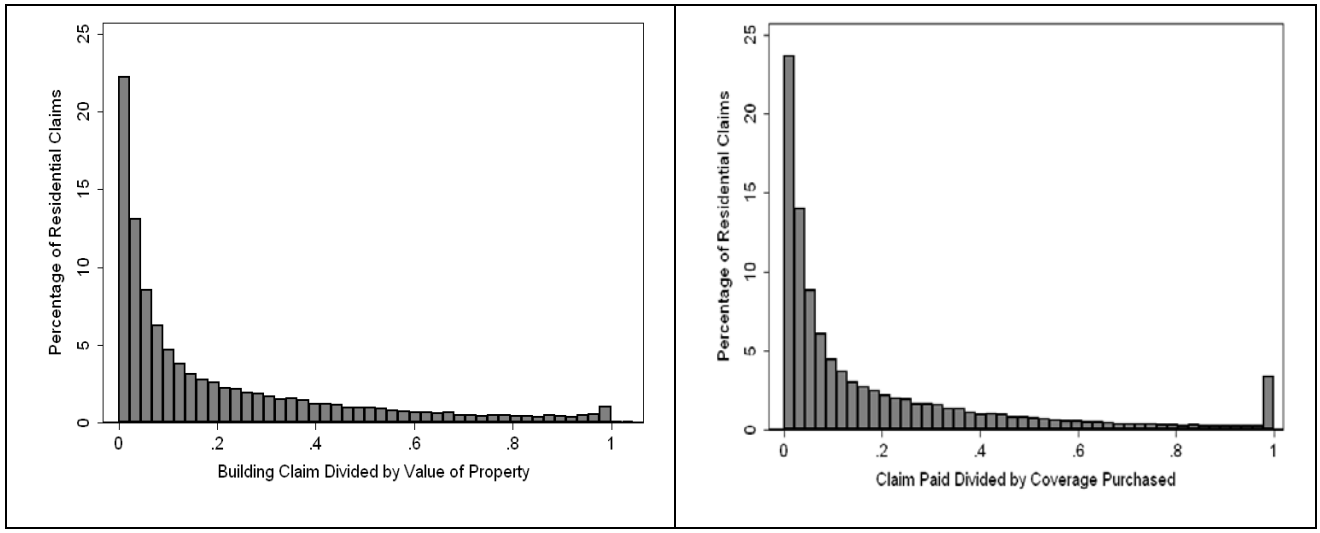
policyholders at the limit, whereas in others, such as Walton, Nassau, Collier, and Martin Counties, half or more of the policyholders were at the limit.

[16] We thank one of the referees for helpful suggestions on this point.

[17] Approximately 12 percent of the observations had a claim payment of zero and a few were greater than the value of the property. These are not included in Figure 5.

[18] Contents claims are not included in Figure 5 because the value of contents was not available.

FIGURE 5. RESIDENTIAL CLAIMS IN FLORIDA 2000–2006 OVER THE VALUE OF THE PROPERTY AND FLOOD COVERAGE PURCHASED



In examining the ratio of claims paid to coverage purchased for residential claims in Florida between 2000 and 2006 (Figure 5; right graph), we find a similar story. For roughly half of the observations, the claim paid was 8 percent or less of the amount of coverage purchased. Taken together, Figures 5 indicate that choosing to insure at an amount that is below the value of the property is a rational choice for most homeowners.

Deductible -- In addition to coverage levels, homeowners can choose their deductible. The NFIP offers a choice of six deductibles under which policyholders retain the full loss: $500, $1,000, $2,000, $3,000, $4,000, and $5,000. Choosing a higher deductible can lower the cost of insurance. For instance, someone who chooses a $5,000 deductible for both building and contents coverage would pay (all other things being equals) only 74% of the premium she would pay with $500 deductibles.

Studies on insurance choice for automobile insurance and homeowners policies have found that individuals prefer low-deductible policies, even when these are financially unappealing because of the higher prices charged to cover the cost of processing small claims

and to combat adverse selection (Eldred, 1980; Cutler and Zeckhauser, 2004; Sydnor, 2006). The samples in these studies were relatively modest, however. Here, we are able to consider deductible choices based on a much larger sample than has been studied before in the literature. We find that, of the more than 1 million flood insurance policies-in-force in 2005, 98.3 percent of customers chose a deductible lower than the maximum available. Further, almost 80 percent of policyholders chose the lowest possible building deductible, $500, and around 18 percent chose the second-lowest deductible available, $1000. Overall, these percentages were largely constant over the 2000–2005 period. For contents coverage, the deductible choices were similar, with about 83 percent of single-family policies having a deductible of $500 in 2005 and 15 percent choosing $1,000. This might be explained by the fact that out of all claims filed in Florida through August 31, 2006, nearly half of the claims paid were lower than the highest deductible of $5,000.

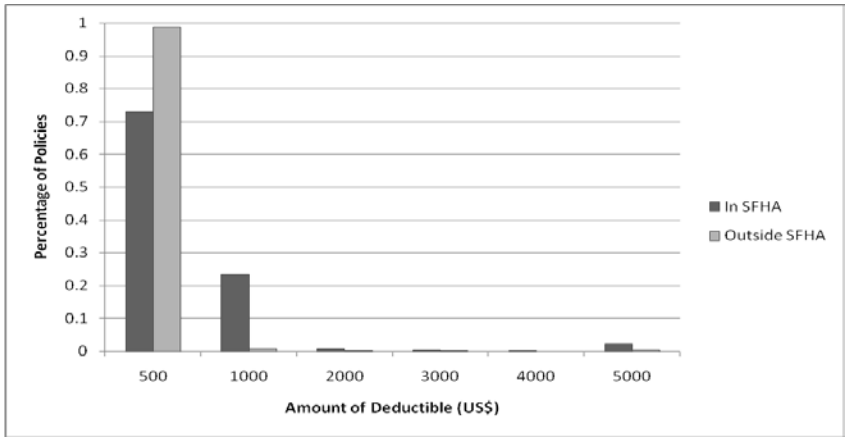
Interestingly, homeowners inside SFHAs (100-year floodplains) did not choose the lowest deductible as often as those outside SFHAs. They were also more likely to choose the highest deductible offered (see Figure 6). One explanation for this finding is that more policyholders inside SFHAs are forced to insure by their lender because of the mandatory purchase requirement and are thus simply trying to minimize costs by choosing a higher deductible. Another explanation is that some properties outside SFHAs probably qualify for the NFIP's Preferred Risk Policy, which only offers a $500 deductible.[19]

Still, overall, most homeowners prefer low deductibles, consistent with the findings of previous studies. Several factors might explain the choice of a low deductible, and unfortunately, without interviews of flood coverage purchasers, we cannot tease apart these competing explanations. First, consumers might want to cover as much potential damage as possible (risk aversion). They do not act rationally by evaluating expected losses, but rather assess risk in a binary way: "I suffer a loss or I don't; but if I do, I want to be sure my investment in insurance

[19] Thanks to Justin Gilmore for pointing out this possible explanation.

protection gets me as much as possible back." Second, some homeowners might not be aware that higher deductibles are offered. Third, for some customers who are forced to buy flood insurance by lenders, a low deductible means that the insurer will make payments to customers more often. Even though such payments may not be a valid indication of a company's reliability, they may at least increase confidence in the company's promise of protection against unlikely large losses. Fourth, some lenders enforce a $1,000 or 1 percent of the coverage maximum deductible on policies. Fifth, as suggested by Kunreuther (1978), some individuals may see insurance as an investment, rather than a risk-spreading tool, and want to collect something back from their policies. The lowest possible deductible will make them more likely to collect as much as possible.

FIGURE 6. CHOICE OF DEDUCTIBLE BY FLOOD ZONE



We tested the hypothesis that people with the highest limit would tend to also have a higher deductible on their policies.[20] (Higher deductibles lower the cost per dollar of coverage as discussed in section 3.2) This would be consistent with some individuals choosing to insure against catastrophic losses but not small losses. To the contrary, the analysis reveals that people who bought the coverage limit were more likely to choose the lowest possible deductible: in

[20] Results previously published show that policyholders would choose a lower deductible but also a lower limit on the policy, focusing mainly on noncatastrophic loss. For instance, in his survey of insurance buyers, Eldred (1980) found that 68 percent of the automobile policies and 69 percent of the homeowners policies that had the lowest deductible also had liability limits of $25,000 or less, even though insurance professionals and consumer publications agreed that a $100,000 personal liability limit was necessary to afford reasonable protection.

2005, nearly 81 percent of policyholders with the maximum $250,000 limit also had the lowest possible deductible, versus nearly 73 percent for policies with a limit lower than $100,000 for building coverage (see Table 5; results were similar for previous years). The number and proportion choosing the $500 deductible for contents coverage also increased with higher amounts of coverage. This suggests that individuals are trying to receive the maximum payout from their insurance or cover both small losses and catastrophic ones.

TABLE 5. PERCENTAGE OF POLICYHOLDERS CHOOSING THE GIVEN DEDUCTIBLE FOR VARYING AMOUNTS OF BUILDING COVERAGE IN 2005

Building Coverage Deductible	0 – $50,000	$50,000 – $100,000	$100,000– $150,000	$150,000– $200,000	$200,000– $250,000	$250,000	Policies
$500	72.5%	72.8%	79.9%	80.9%	82.1%	81.2%	909,077
$1,000	25.6%	24.3%	17.9%	16.5%	15.1%	14.8%	202,714
$5,000	1.2%	1.9%	1.4%	1.5%	1.6%	2.4%	20,417
Policies	58,099	153,036	270,668	209,988	138,796	313,257	1,143,844

Impact of Catastrophes on Consumers' Choices -- In 2004, the four hurricanes and one tropical storm that hit Florida caused billions of dollars in damages, the evacuation of more than 9 million people, and many fatalities. We were interested in whether this exceptional year led homeowners to alter their flood insurance purchase decisions. Browne and Hoyt (2000) found that recent floods led to higher insurance take-up rates and greater levels of coverage. Consistent with their findings, we predicted that insurance take-up rates would increase after these storms and that perhaps coverage levels would rise as well. The NFIP sets its rates nationally, not in response to local episodes. As a result, the premiums of NFIP flood policies remained virtually the same in Florida before and after this series of storms. Any changes we observe are thus due to homeowners' reactions to these events and not to a change in the insurance price formula.

Policies-in-force increased in Florida every year between 2000 and 2004, but not by more than a couple of percentage points each year. Between 2004 and 2005, however, the number of policies-in-force jumped 6 percent. This suggests that the storms encouraged more property owners to purchase flood insurance. In addition, after the storms, more individuals

appear to have chosen the lowest possible building deductible. Considering only single-family, residential policies, for those homeowners with coverage less than or equal to $50,000, the percentage in the state overall choosing the lowest deductible grew by up to a few percentage points consistently each year between 2000 and 2005. Considering only Santa Rosa and Escambia Counties, however, where damage from the 2004 storms was severe, the proportion of policyholders choosing the lowest deductible increased much more between 2004 and 2005 than between any other two years from 2000 to 2004. The percentage with the lowest deductible jumped between 2004 and 2005 by close to 14 percent in Santa Rosa and roughly 7 percent in Escambia. This same phenomenon was observed among those with the highest possible coverage of $250,000.

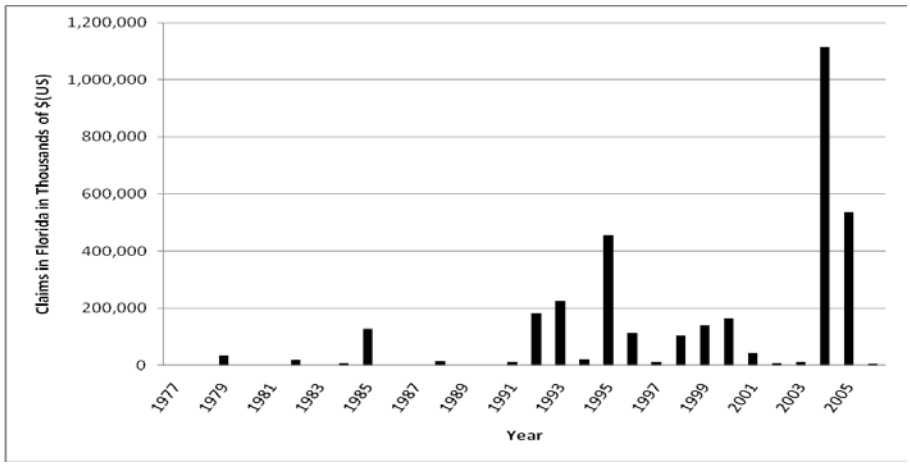
Further, single-family, residential policyholders appear to have purchased a higher limit on their coverage after the storms. The percentage of policyholders in the state with coverage less than or equal to $150,000 dropped every year between 2000 and 2004, but never by more than 5 percent per year. Between 2004 and 2005, though, the number fell by 9 percent. At the same time, the percentage choosing the highest possible building coverage of $250,000 grew each year. Between 2000 and 2004, the growth was never more than 3 percent per year. Between 2004 and 2005, it was double that amount at about 6 percent. Mean building coverage in 2004 was $152,290 for single-family, residential homes and was $164,835 in 2005.

Several factors might explain these changes. People who lived in devastated areas and had minimal coverage might have wished, post-storm, that they had purchased the highest possible coverage before being flooded (this is the role of regret; see Braun and Muermann, 2004). It could also be that the floods were a vivid experience, not only for those affected but also their neighbors and families, and after the storms, therefore, people revised their beliefs, deciding that flooding was more likely and thus insurance more worthwhile. The 2004 floods could have also led more people to think the decision to buy more insurance was a sound financial investment.

3.3. Where and when are claims paid?

In this section, we investigate how claims vary across counties and the determinants of the magnitude of claims paid. Figure 7 provides an overview of the total amount of claims paid by year in Florida from 1978 to 2005 for all types of policies—commercial and residential. All claims are in constant year 2000 dollars. The high level of claims from the unusual 2004 season is readily apparent.[21]

FIGURE 7. NFIP CLAIMS PAID IN FLORIDA BY YEAR



The NFIP does not cover wind damage from hurricanes (this coverage is provided by private insurers through homeowners policies or through state insurance pools), but major hurricanes in coastal states typically also induce significant flood losses from storm surge pushing water inland or torrential rains as hurricanes move inland. For these reasons, hurricanes are responsible for the majority of NFIP claims in Florida. For example, in 2004, 15 percent of NFIP claims in Florida were attributable to Hurricane Charlie, 17 percent to Hurricane Frances, 36 percent to Hurricane Ivan, and 18 percent to Hurricane Jeanne—a total of 86 percent of flood claims. In 2005, more than 50 percent of all claims payments were associated with Hurricane Wilma, just under a quarter with Hurricane Katrina, and 13 percent with Hurricane Dennis—a total of 88 percent of the claims for that year. Mean claim payments in Florida between 2000 and

[21] For comparison, in Florida in 2004, $661 million was collected in premiums, and in 2005, $729 million was collected.

2005 were about $3,000 higher for V flood zones—floodplains associated with wave action—than for A flood zones. This suggests that storm surge or other coastal flooding associated with wave action inflicts greater damage than inland flooding from heavy rain. This is consistent with the higher NFIP premiums charged in V zones. Coverage levels do not differ much across the zones, but we cannot control for all factors that influence coverage levels to make an accurate determination.

We also examined which counties generated the highest amount of flood insurance claims between 2000 and 2005. Rather than considering the total value of reimbursements (a county with many more policies will receive more payments, all else being equal), we examined the average insurance claim per policy in each county. For certain counties, this figure is quite high indeed: $44,017 for Santa Rosa County, $34,954 for Escambia,[22] and $10,259 for Monroe County. The other eight counties in the top 10 are as follows: Wakulla ($8,868), Okaloosa ($7,366), Franklin ($5,481), Baker ($3,499), Gilchrist ($3,083), De Soto ($3,035), and Walton ($2,640). This raises the question of what determines the magnitude of NFIP claims.

Determinants of Claims Payments -- Much of the current debate about the future of the NFIP is focused on how to improve the program's long-term financial sustainability so that taxpayers are not responsible for those living in high-risk areas. To shed light on this debate and make concrete recommendations for improving the program's operation (see section 4), we used the data on single-family NFIP claims between 2000 and 2006 to uncover the key drivers of claims payments in Florida. In this analysis, we consider two dependent variables: the magnitude of a claim divided by the amount of coverage purchased and the magnitude of a claim divided by the recorded property value.[23] Our individual variables are somewhat limited by the data available,

[22] Flood claims for Santa Rosa were about $350 million (about 30 percent of the total flood coverage in the county); Escambia claims were $260 million (25 percent of its entire coverage). This was surprising because only about 35 percent (Santa Rosa) and 40 percent (Escambia) of policies are in a 100-year floodplain in these two counties.
[23] As stated earlier, the value of the home was only available for about 75 percent of claims.

but we were able to examine several relevant factors. We consider the influence of the structural characteristics of a house that could reduce damages, such as having more stories, having a basement, and being elevated, as well whether the home is located in a 100-year floodplain. We also assessed the impact of community flood mitigation measures by including a variable for the CRS class of the community in which the property was located. As discussed earlier, CRS classes range from 1 to 9 (communities *not* participating are in class 10); each decrease in class means more mitigation and carries with it a 5 percent point discount in premiums: properties in class 1 community receive the maximum (45 percent) discount; those in class 9 receive only a 5 percent discount.

Unfortunately, data were missing for one or more variables for some of the observations, reducing the sample size somewhat. Still, after cleaning the data,[24] more than 42,000 observations remained. Summary information on the variables is presented in Table 6.

TABLE 6. SUMMARY OF DETERMINANTS OF CLAIMS DATA

Variable	Mean	Std. Dev.	Min	Max
Claims/property value	0.218	0.268	~0	1
Claims/coverage	0.196	0.256	~0	1
CRS class[25]	7.01	1.63	5	10
More than one floor (dummy variable; 1 if more than one floor)	0.273	0.446	0	1
Building elevated (dummy variable; 1 if building elevated)	0.218	0.413	0	1
Basement (dummy variable; 1 if has basement)	0.075	0.264	0	1
SFHA (dummy variable; 1 if in SFHA)	0.856	0.351	0	1

Since our dependent values are proportions between 0 and 1 (with a significant fraction at the value 1) and our independent variables are likely to be nonlinearly related to these proportions, we use a generalized linear model with a logit link function and the binomial family estimated by quasi-maximum likelihood (Papke and Wooldridge 1996). Fixed effects for year,

[24] For many claims, the payment was recorded as zero. These claims could have been closed without payment or the information was missing; they were not included in the regressions. Also, 25 observations had claims larger than coverage levels; these were dropped. Finally, just under 2 percent of claims had claim amounts entered that were larger than the value of the property. For these, the value of claims over coverage was set equal to one.

[25] Although in theory communities could have a lower CRS class, it appears over this time period that no community in Florida has achieved a CRS rating better than 5.

county, and catastrophe number (unique identifying numbers given to named catastrophes, such as hurricanes) were included. Although this should control for many potential influences on claims, the results should be interpreted with a degree of caution because of potential omitted variable bias. The CRS class was also entered as a fixed effect to allow each different CRS level (1–9) to have a unique effect on the dependent variables.

Results are presented in Tables 7 and 8 for claims as a proportion of property value and as a portion of coverage, respectively.[26] In both tables, column I presents the coefficient estimates, and column II presents marginal effects. Given the logit transformation, the coefficients might be somewhat difficult to interpret; the marginal effect is easier to interpret as it gives the effect of a one-unit change in our independent variables on our dependent variable. Standard errors, given in parentheses, are clustered by census tract.

TABLE 7. REGRESSION RESULTS: CLAIMS OVER PROPERTY VALUE

		I	II
Variable	**Expected sign**	**Coefficient**	**Marginal effect**
More than one floor	–	-0.58971*** (.04844)	-0.08494*** (0.00659)
Building elevated	–	-0.54634*** (.08933)	-0.07761*** (.01076)
Basement	+/–	-0.11008*** (.04639)	-0.01673** (.00682)
SFHA	+	0.22031*** (.04437)	0.03283*** (.00635)
CRS Class 5	-	-0.66192** (.32973)	-0.09473** (.04307)
CRS Class 6	-	-0.28855 (.33519)	-0.04166 (.04443)
CRS Class 7	-	-0.29307 (.32404)	-0.04439 (.04749)
CRS Class 8	-	-0.23878 (.32536)	-0.03566 (.04634)
CRS Class 9	-	-0.30457 (.35444)	-0.04343 (.04574)
Fixed effects: Year, catastrophe number, county		Y	
McFadden R-squared		.16294	
Log pseudolikelihood		-16,049	
N		42,232	

[26] We appreciate insightful suggestions on this regression by anonymous referees.

TABLE 8. REGRESSION RESULTS: CLAIMS OVER COVERAGE

		I	II
Variable	**Expected sign**	**Coefficient**	**Marginal effect**
More than 1 floor	–	-0.61364*** (.05479)	-0.07779*** (.00662)
Building elevated	–	-0.65486*** (.09684)	-0.08042*** (.00941)
Basement	+/–	-0.09847** (.05001)	-0.01330** (.00650)
SFHA	+	0.18581*** (.05098)	0.02469*** (.00652)
CRS Class 5	-	-0.55027 (.34643)	-0.07064* (.04100)
CRS Class 6	-	-0.29388 (.35719)	-0.03739 (.04136)
CRS Class 7	-	-0.31095 (.34568)	-0.04164 (.04458)
CRS Class 8	-	-0.33409 (.34521)	-0.04327 (.04161)
CRS Class 9	-	-0.38030 (.37063)	-0.04662 (.03960)
Fixed effects: Year, catastrophe number, county		Y	
McFadden R-squared		0.18990	
Log pseudolikelihood		-14,730	
N		42,232	

*Note for Tables 7 and 8: Clustered standard errors are given in parentheses. Coefficients significant at the 10 percent level are marked with *, those significant at the 5 percent level are marked with **, and those significant at the 1 percent level are designated by ***.*

All signs are as predicted. Homes with more floors have lower claims, probably because damage does not affect the entire structure. Claims are much higher in the riskiest areas—100-year floodplains (or SFHAs)—and are lower for buildings with basements, potentially because in many cases, basements alone flood, leading homeowners to file small claims (the NFIP's coverage in basements is limited). When a building is elevated, claims fall, demonstrating that risk reduction measures can indeed reduce damages. The analysis also shows that participation in the CRS program can lower claim amounts. The only significant coefficient is on Class 5. This coefficient is also the largest in magnitude in both regressions, suggesting that the most significant reductions in claims come in communities that aggressively engage in mitigation, although the magnitude is comparable to the coefficients on variables for structural characteristics of the house. If CRS is included in both regressions as a variable and not as fixed

effects, it is significant at the 1 percent level, with a marginal effect of 0.0187 for the claims over property value regression and 0.0078 for the claims over coverage regression. Note that these are positive, because in this specification, increasing CRS by one unit signifies *less* mitigation.

Although not reported individually in Tables 7 and 8, Hurricanes Frances, Ivan, Katrina, and Wilma from the 2004 and 2005 hurricane seasons were all positive, statistically significant predictors of claims in both regressions. Other positive and significant catastrophes were Tropical Storms Gordon (2000) (only significant for claims over property value as the dependent variable), Allison (2001), and Gabrielle (2001) as well as flooding in October of 2000. Tropical Storm Isadore (2002) and Hurricane Dennis (2005) were significant and negative predictors of claims in both regressions, likely because neither tracked directly over the state. Hurricane Jeanne (2004) was negative and significant with claims over coverage as the dependent variable.

3.4. How are prices determined and how much does NFIP insurance cost in Florida?

The NFIP's price-setting goals differ from those of a private insurance company because the NFIP does not have to seek a profit, nor must its prices reflect the cost of capital. Further, certain properties are offered subsidized rates, whereas others are charged the full-risk premium.[27] Because just under a quarter of all policies are subsidized, the entire program cannot be actuarially sound. The goal of the NFIP regarding its pricing is thus not fiscal solvency, but the collection of enough premiums to cover the operating expenses and losses associated with the

[27] A building that was in place before the mapping of flood risk was completed in that area is given subsidized rates. New properties constructed after the risk mapping has been made public are charged actuarial rates. The expectation was that fewer policies would be subsidized over time. However, around a quarter of properties are still subsidized today because the housing stock is turning over more slowly than predicted, partly as a result of new construction and renovation techniques that have extended the life of buildings (Pasterick, 1998; Wetmore et al., 2006; Congressional Budget Office [CBO], 2007). Although it constitutes a declining percentage of all NFIP policies, the number of properties receiving subsidized premium rates has grown since 1985; by 2007, it was at its highest point in almost 30 years (GAO, 2008b). Of particular relevance to Florida, the CBO found that many subsidized properties in coastal areas (23 percent of their sample of 10,000 properties) were second homes, vacation homes, or rentals (CBO, 2007).

historic average loss year, as well as to support floodplain management and encourage widespread adoption of flood insurance (Hayes et al., 2007).

"Actuarial" premiums set by FEMA are based first on the determination of the flood risk zones.[28] Rates are then set for each flood zone, with the same rates for similar flood zones nationwide. The formula the NFIP uses to calculate the actuarial rates is described in the yearly rate reviews. Rates also vary by certain characteristics of the house, such as its height above base flood elevation. NFIP rates are revised each May. By law, any yearly increase in premiums cannot exceed 10 percent overall. This pricing strategy clearly leads to important cross-subsidizations in the program. GAO (2008a) notes that rates do not reflect local topographical conditions and finds that, based on historical claim and premium data, NFIP rates are not always reflections of the risk. Without a detailed analysis of expected losses in various locations, however, it is impossible to say if and how much the prices of NFIP policies may deviate from true risk-based rates.

Between 1968 and July 2005, the program's revenue was $23.6 billion and its total expenses were $24.3 billion ($16.5 billion in claims payments and $7.4 billion paid to private insurers that participate as financial intermediaries in the WYO program but do not bear any risk). In addition, the program spent $2.2 billion on administrative expenses. Taken altogether, after 37 years of operation, the NFIP had a deficit of about $3 billion. The NFIP had not had a truly catastrophic year until 2005. The NFIP has borrowing authority from the U.S. Department of the Treasury and, at the end of 2007, it had borrowed $17 billion, largely as a result of the 2004 and 2005 hurricane seasons. Currently, FEMA gives a 1 percent weight to the 2005 claims when determining the historic average loss year, while seeking advice on an appropriate weighting going forward (Hayes et al., 2007). Current revenue is unlikely to be sufficient to

[28]As of May 2008, NFIP the average actuarial premium (nonsubsidized properties) in A zones (which represented 39.6% of the total) was $430, for zone B,C, X (about 37.3%) it was $394, and it was $2,270 for V zones along the coasts (Hayes and Spafford, 2008).

cover NFIP operating expenses and claims as well as interest and principal payments to the Treasury (GAO 2008a). Congress will need to determine if and how the NFIP will repay these costs or whether the federal government will assume the costs of catastrophe years.

The NFIP's pricing strategy of basing rates on a historical average loss year does not allow for anticipation of changes in future conditions (e.g. new habitat characteristics or changes in weather patterns). With the long delay in updating maps (as of April 2008, close to two-thirds of the maps were more than 10 years old; GAO (2008a)), even without climate change, risk designations are often outdated because of changes in development that in some places have dramatically altered the risk. This leads to rates that do not reflect risk, potentially sending misleading signals to property owners.

Coming back to our analysis of Florida, because rates are set by zone for the entire country, variations in the average premium across geographic areas reflect differences in the percentage of homes located in different flood zones, the structure of the home (basement, elevation, etc.), or the nature of the policy (selected deductible and limit). The average premium paid per $1,000 of coverage in Florida in 2005 ranged from $1.30 in Flagler County to $7.50 in Dixie County, with a mean of $2.79 and a median of $2.50. Interestingly, the counties in which the cost of insurance was the most expensive were not necessarily those with the highest proportion of policies in SFHAs: more than 50 percent of policies in Palm Beach, Broward, and Santa Rosa Counties were in these high-risk zones, but these are among the counties with the lowest average cost of flood insurance. Variations in average cost must therefore be due to differences in the types of homes insured and the coverage and deductible chosen by homeowners.

We find that the average premium per $1,000 of coverage did not increase between 2000 and 2005; in fact, it significantly decreased in *all but two* of the 67 counties in Florida. Surprisingly, the decline in cost is even more severe when one considers Santa Rosa and

Escambia counties. These two counties, which suffered the most damage from the 2004 hurricanes, saw a significant increase in the proportion of flood policies located in high-risk areas (data not reported here). Nevertheless, the average cost of flood insurance in Santa Rosa decreased from $2.27 per $1,000 of flood coverage in 2000 to $1.60 in 2005 (a 29 percent decrease); in Escambia County, the cost decreased from $2.85 per $1,000 of flood coverage in 2000 to $1.91 in 2005 (a 33 percent decrease). We know from the NFIP rate reviews that premiums for many of the zones increased somewhat—rather than decreased—over this time period. So what is driving the drop in average costs?

There might be several explanations. First, more single-family homeowners outside of floodplains in these two counties purchased policies between 2000 and 2005 (possibly because, regardless of whether one lives in a 100-year floodplain, a flood nearby is a vivid reminder of one's possible exposure), and these are the lowest-cost policies. In Escambia, the percentage of policies outside of 100-year floodplains grew from 36 percent in 2000 to 60.2 percent in 2005. In Santa Rosa, the percentage grew from 46.8 percent to 65.2 percent. As a result, the average cost per $1,000 of coverage throughout each of these counties decreased. Second, the relative proportion of policies in the most expensive V zones declined. For Escambia, the percentage of policies in V zones dropped from 6.2 percent in 2000 to 3.1 percent in 2005; and in Santa Rosa, the percentage fell from 4.3 percent in 2000 to 2.7 percent in 2005. This also has driven down the average cost in each county. Finally—and this had a stronger effect on lowering the average insurance cost—homeowners in these counties significantly increased their coverage levels between 2000 and 2005, which also had a decreasing impact on the average cost per $1,000 of coverage (since the marginal cost is decreasing). In Escambia, the mean building coverage for single-family, residential policies increased from $130,822 in 2000 to $171,233 in 2005—a large 31 percent increase. In Santa Rosa, it increased from $137,967 to $186,496—an increase of 35 percent. Therefore, although individuals are more protected and might be paying more in

absolute terms, the average cost per $1,000 of coverage decreased significantly after the 2004 floods in these two counties.

4. Conclusion and Possible Improvements to the NFIP

This paper provides both an overview of the functioning of the NFIP nationally and a close look at flood insurance purchases and claims in Florida, which has the largest share of NFIP policies and coverage-in-force of any state in the Union. These results should contribute to a better microeconomic understanding of the market for flood insurance in the United States. This is an important issue because flood losses have been accelerating over the past 15 years, largely due to an increased concentration of homes in high-risk areas. The NFIP has also seen a significant change in its operation's scope over these past 15 years. From 1992 to 2007, it has grown from 2.5 million policies to more than 5.5 million, from $800 million in premiums collected from policyholders to $2.6 billion, and from covering $237 billion in value at risk to more than $1 trillion—increases of 120, 225, and 320 percent, respectively.

Some of our findings are in accordance with well-documented expectations on homeowners' decisionmaking regarding insurance purchasing (e.g. choice of very low deductibles) and the functioning of the NFIP. Other findings, however, revealed some common misconceptions. For instance, the current coverage limit is not binding for the majority of homeowners, even though the number of those buying this limit has significantly increased recently. The response to the 2004 hurricane season also suggests that homeowners may desire more coverage and that this demand will become more pronounced if Florida has another devastating hurricane season in the coming years. Excess coverage is available through the private market, however, and to the extent that NFIP rates are not risk-based, there may be equity concerns in continuing to offer coverage to the wealthiest residents at lower than risk-based

rates. Instead of, or in addition to, offering more coverage, the NFIP could better connect homeowners with private insurers offering higher levels of flood coverage.

The extreme concentration of the NFIP market in a few states is also somewhat surprising because one may expect flood risk to be spread more broadly across the country. This may be one more indication of the trend toward increased capital and people in coastal areas. The NFIP is also concentrated within Florida such that the highest concentration of coverage and policies-in-force is on the coasts. With the high concentration of the national NFIP portfolio along the Gulf Coast, the NFIP has become more of a hurricane insurance program than a program for inland flood losses, although it does not cover wind damage.

The massive debt the NFIP now faces from the 2005 hurricane claims, coupled with the program's pricing strategy, shows that the NFIP is not designed to be self-sufficient financially in the aftermath of truly catastrophic losses. This issue requires serious consideration as the NFIP comes up for renewal in the autumn of 2009. To limit taxpayer liability for damages incurred by those living in the riskiest areas, several changes could be implemented. First, prices could be modified to reflect the most recent information about exposure, which would probably lead to increases in insurance premiums collected by the program. Second, FEMA could partner with the private sector or draw on the financial markets to access additional capital to address truly catastrophic flooding; this could be done, for example, through the issuance of pre- or postevent bonds. Finally, because more than a third of every dollar paid by an NFIP policyholder goes to the administrative costs of private insurers that do not bear any risk, GAO should analyze whether the level of this payment is still justified 40 years after the program's inception.

Another important way to make the NFIP more effective would be to focus more heavily on risk reduction. Our analysis of claims in Florida clearly indicates that mitigation works. Claims are much lower both for elevated homes and, perhaps more importantly from a policy perspective, for communities that take part in the CRS. The reductions in premiums seem to be

roughly warranted as communities that adopt mitigating measures do have lower claims, all else being equal. To further lower losses, communities could be more strongly encouraged to join this program and to achieve a lower CRS class. One might also consider household-level premium reductions for property owners who flood-proof their homes or businesses.

By following a one-million policy sample over time we provide some evidence that people drop coverage quickly, which has major policy implications since many of those are likely to request federal relief in the aftermath of a major flood. A more radical change in NFIP operation to address this problem would be for FEMA to move away from traditional one-year flood insurance contracts and to instead offer multiyear flood insurance contracts. This would ensure more people maintain coverage over time. FEMA could issue 5-, 10-, or even 20-year flood policies tied to the property (rather than to the individual) that would go hand-in-hand with the mortgage; this could also make investment in flood mitigation more attractive over time. For instance, if 10-year flood insurance policies are in place (with rates reviewed periodically), banks or the federal government could offer 10-year loans to NFIP policyholders for mitigation activities. If policyholders can benefit from an annual rebate on their flood insurance that is greater than the annual loan payment, this would be a win–win situation for everyone.[29]

[29] For more on the possibility of long-term insurance contracts, see: Jaffee et al., 2008; Kunreuther and Michel-Kerjan, 2010.

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