Come Rain or Shine:
Evidence on Flood Insurance Purchases in Florida[1]

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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 policy-level database of more than 7.5 million NFIP coverage purchasers in Florida, and a database of all NFIP claims, from 2000 to 2005. We answer four questions: What are the characteristics of flood insurance buyers? What type of contracts (deductibles and coverage levels) are purchased? Where and when are claims paid? How are prices determined and how much does NFIP insurance actually cost?

1. Introduction

The economic costs of natural disasters have risen dramatically over the past several decades. In the 1950s, damages from natural disasters worldwide were $53.6 billion, and by the 1990s, they had risen to $778.3 billion (Munich Re, 2008). The year 2008 alone inflicted $200 billion in direct economic damages from natural catastrophes 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 and has attracted the attention of policymakers and scholars alike. Such radical changes in the rhythm and scale of disasters highlight the necessity of 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 uninsured losses have been growing along with total damages. Looking at insured losses only, of the 25 most costly insured losses over the period 1970–2008, 14 occurred since 2001, 13 of which were in the United States (Swiss Re, 2008a, b). We have now entered a new era of catastrophes.

Within the spectrum of natural hazards, floods are of particular concern because, 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 are normally required as a condition for a mortgage. These policies 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. For example, after a 1998 flood in northern Vermont, the Federal Emergency Management Agency (FEMA) found that 84 percent of residents in SFHAs did not have insurance, even though 45 percent of these uninsured residents were required to purchase this coverage (Tobin and Calfee, 2005). Hurricane Katrina in 2005 again revealed lower-than-expected take-up rates

for flood insurance.[3] Lack of nationwide data on the number of properties in floodplains, however, makes a complete assessment of NFIP market penetration difficult. 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). 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.

Quite surprisingly, though, 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 level of aggregation of the data in this study (state level for most of the variables) 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 the state of 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 chose to focus our analysis on the state of Florida because it has become a world-peak zone for disaster financing and also 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) do they purchase? (3) Where and when are claims paid? (4) How are prices determined and how much does NFIP insurance cost?

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

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[3] 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.

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. However, these findings vary across counties.

On contract choices, we find that 98 percent of customers chose a deductible lower than the maximum available, and almost 80 percent of policyholders chose the lowest possible deductible (i.e., $500) in 2005. 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, 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 then they previously did.

An analysis of the determinants of claims payments finds that claims are higher in 100-year floodplains and lower when a property is elevated, has more than one floor, or has a basement. The analysis also confirms that 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 exposure to flood surge in this state. This is because NFIP premiums are set for each flood zone nationally and do not vary by state or locality. 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 of the National Flood Insurance Program and Cross-State Comparisons

Creation 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) flood losses can be catastrophic, that is, enough premiums could not be collected 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.

Flood Risk Designations

To set premiums and support local governments, the NFIP maps participating communities, designating flood risks through different flood *zones*. These maps are called Flood Insurance Rate Maps (FIRMs). A building that was in place pre-FIRM—before the mapping of flood risk was completed in that area—is given subsidized rates.[4] New constructions built after the risk mapping has been made public are charged actuarial rates. The expectation was that, as the housing stock turned over, fewer policies would be subsidized. However, around a quarter of properties are still subsidized today (CBO, 2007) and, 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). It appears that the housing stock of structures that are eligible for subsidies is turning over more slowly than predicted, partly because of new construction and renovation techniques that have

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[4] The subsidy applies only to the first $35,000 of coverage on the building and $10,000 on contents, although the mean and median claims in 2004 were below these limits (CBO, 2007).

extended the life of buildings (Pasterick, 1998; Wetmore et al., 2006).[5] Of particular relevance to Florida, the Congressional Budget Office found that many subsidized properties in coastal areas (23 percent of their sample) were second homes, vacation homes, or rentals (CBO, 2007).[6]

The analysis in this paper is based on the risk estimates (in the form of designated flood zones) from FEMA FIRMs. 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 FIRMs are out of date, and thus the maps can severely underestimate the true risk (GAO, 2008a)[7]. FEMA has begun a map modernization program to correct this problem.

Operation of the NFIP

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. [8] To encourage further mitigation, the NFIP runs the Community Rating System (CRS), which is a voluntary program that rewards communities that undertake mitigating activities with lower premiums. The majority of NFIP policies are written through the Write-Your-Own (WYO) Program. The WYO program allows participating property/casualty insurance companies to write and service NFIP's standard flood insurance policy in their own names. The premium charged by the private insurer is the same as that charged by the federal government through the direct program. The insurance companies bear no risk and are compensated for writing policies and settling claims, and the federal government benefits from the private industry's marketing channels and the presence of many insurers in participating

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[5] Subsidized properties only become required to pay actuarial rates when they are damaged at half the property value or are improved, creating an increase in value of 50 percent (CBO, 2007).

[6] For more on the effects of eliminating NFIP subsidies, see PricewaterhouseCoopers (1999).

[7] This was also found by Temple University researchers who undertook a detailed analysis of the Pennypack Creek Watershed in Pennsylvania and found that their assessment designated more 100-year floodplains than the existing FIRM (Center for Sustainable Communities, 2006).

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

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; this led to the passage of the Flood Disaster Protection Act of 1973 (Anderson, 1974; FEMA, 2002). This act limited the federal disaster assistance for nonparticipating 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 a 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. 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.

As discussed in the introduction, however, it is difficult to determine how well these regulations are working 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 important 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.[9] 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 were in place in 2005.

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[9] 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 cost the NFIP a total of more than $1.2 billion.

Over the same period, the total value of property insured under the NFIP grew rapidly. Since 2000, the total exposure (sum of the limits on all policies) has almost doubled; it was nearly $214 billion in 1990 and $568 billion nationwide 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.

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 the end of December 2007 using data provided by FEMA. We briefly discuss each item in the table. 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 in the next section of the paper when we analyze the Florida market.

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.[10] 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 figure. 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. With a high take-up rate and total number of policies, Florida represents about one-third of the total $2.81 billion in premiums collected by the NFIP nationwide. As discussed in section 4 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

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[10] 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.

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. 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.

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	Average premium per $1,000 of coverage	Average quantity of insurance per policy
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, this state is highly exposed to hurricane risks and has the greatest concentration of exposed value in high-risk areas; this state 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) How much coverage of flood insurance do they purchase? (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 dataset of more than 7.5 million flood insurance policies provided to us by the NFIP.[11] It includes all of the policies-in-force in Florida for six consecutive years (2000–2005): more than 1.21 million policies in 2000, 1.24 million in 2001, 1.26 million in 2002 and 2003, 1.29 million in 2004, and 1.37 million in 2005. The dataset excludes identifying information of the homeowner, preventing us from doing a household-level analysis, but it does have the zip code, city, and county in which the policyholder is located. The dataset contains a variety of variables relating to the policy, such as the coverage level, premium, and deductible. The dataset also has the flood zone, the CRS number, and the type of policy (e.g., single-family or commercial).

From the NFIP, we also received a claims dataset that contains 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.

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

Finally, we also drew on data from the 2000 U.S. Census. This gave us 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 recent available Census data. We used such measures to better understand the factors driving the decision to purchase insurance.

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

Occupancy type

The majority of flood policies in Florida (more than 80 percent) are for single-family, residential properties (Table 2). The remaining policies are either for multiple-family homes or other residential coverage (e.g., mobile homes). Only about four percent of policies-in-force are nonresidential (e.g., commercial). For that reason, the majority of our analyses in the rest of the paper will focus on single-family, residential properties. The number of such policies in Florida has increased from around 985,000 in the year 2000 to more than 1.15 million single-family, residential policies-in-force in 2005.

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

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

Market penetration by county

The number of single-family, residential policies-in-force per household (using an estimate of number of households from the 2000 Census) provides a measure of market penetration. Unfortunately, data are not available on the number of structures located in floodplains for each county, so a rough estimate of the take-up rate must be done using total population from the 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, those counties with the highest take-up rates are located on the coast.

FIGURE 1. TOP FIVE FLORIDIAN COUNTIES IN TERMS OF MARKET PENETRATION IN 2005
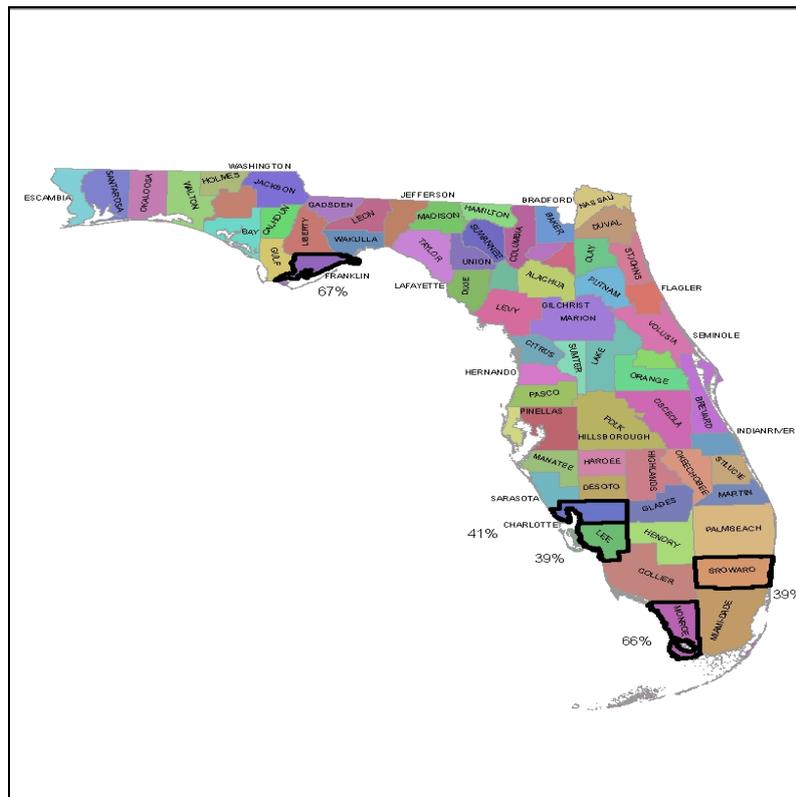
One can also examine the rankings of counties using the total exposure for the NFIP rather than the number of policies-in-force. The counties with the greatest total amount of exposure (building and contents coverage minus building and contents deductibles) for single-family policies in 2005 were: Broward ($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 risk zone. Ideally, we would like to be able to look at take-up rate (the number of flood policies purchased divided by the total number of houses) by flood zone. Unfortunately, no comprehensive, statewide dataset of the number of households in each flood zone by county is available. From our data, however, we do have the number of policies-in-force in each flood zone (Table 3).

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

FLOOD ZONE*	PERCENTAGE IN 2005	PERCENTAGE IN 2004	PERCENTAGE IN 2003	PERCENTAGE IN 2002	PERCENTAGE IN 2001	PERCENTAGE IN 2000
X	17.90	15.15	14.89	15.31	15.62	15.39
A-A99	17.36	18.74	19.64	20.30	20.89	21.71
AE	32.22	32.80	32.30	31.77	31.56	31.78
AHB	22.17	22.99	18.34	20.13	20.07	19.77
AO, AOB, AH	2.26	2.55	6.81	4.3	3.52	2.64
V-VE	.94	1.04	1.09	1.12	1.16	1.23
B, C, D	7.15	6.73	6.93	7.05	7.17	7.44

See text for explanation of flood zone categories. A full definition of each NFIP zone is available at: http://www.fema.gov/plan/prevent/fhm/fq_gen13.shtm

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 they are coastal floodplains that are associated with a risk of storm surge. Quite surprisingly to us, given that Florida is highly exposed to hurricane risk, 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,

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 designates minimal flood risk. About 18 percent of all residential, single-family policies-in-force were in zone X in 2005, up from 15.4 percent in 2000. The mandatory purchase requirement does not apply in zones B, C, D, or X, but if a property owner's community is participating in the NFIP they may still purchase insurance at rates lower than those for the 100-year floodplain.

Market penetration by Community Rating Systems (CRS) class

We also examined how policies broke down across CRS levels. The deduction in premiums that a community can receive by participating in the CRS and undertaking mitigating activities can range from 0 to 45 percent of the full actuarial rate (as defined by FEMA), depending on the level of actions taken. Table 4 shows how policies-in-force break down by CRS class. In 2005, about a quarter of residential policies-in-force were in communities with no CRS discount. The remaining three-quarters of policies benefitted from some type of price discount ranging from 5 to 25 percent. Virtually no policies got a discount higher than 25 percent.

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

CRS DISCOUNT	Percentage in 2005	Percentage in 2004	Percentage in 2003	Percentage in 2002	Percentage in 2001	Percentage in 2000
0%	26.36	23.15	22.97	23.03	23.08	22.20
5%	5.09	6.83	7.67	10.01	13.84	17.50
10%	25.24	27.57	28.15	31.62	33.10	35.81
15%	21.68	20.52	19.68	17.41	25.64	23.90
20%	8.22	8.64	18.30	17.21	3.79	.09
25%	13.41	13.29	3.23	.72	.55	.5
More than 25%[12]	0	0	0	0	0	0

Table 4 also shows how these percentages varied between 2000 and 2005. Over this time period, an increasing percentage of policies were receiving no discount, but also, an increasing percentage was receiving a 20 or 25 percent discount. For instance, between 2000 and 2002, less than 1 percent of the policies were located in communities that received a 25 percent discount on

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[12] Only a few policies in the dataset are in CRS classes that provide a discount higher than 25 percent. The dataset includes 1 such policy (with a 50 percent discount) in 2004, 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, and 2001.

their 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 for other catastrophe risks, people tend to drop their coverage after a certain period if they have not suffered a loss; this has been described as the "natural disaster syndrome" (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, there were roughly 985,000 single-family, residential policies-in-force. By 2005, only about 38 percent of the policies purchased in 2000 were still in force. This result should be viewed with caution, however, since we are unable to determine whether a policy dropped from our database because a homeowner moved elsewhere or because a homeowner dropped her policy while staying in the same house.

Figure 2. Tenure of Policies-in-Force in 2000
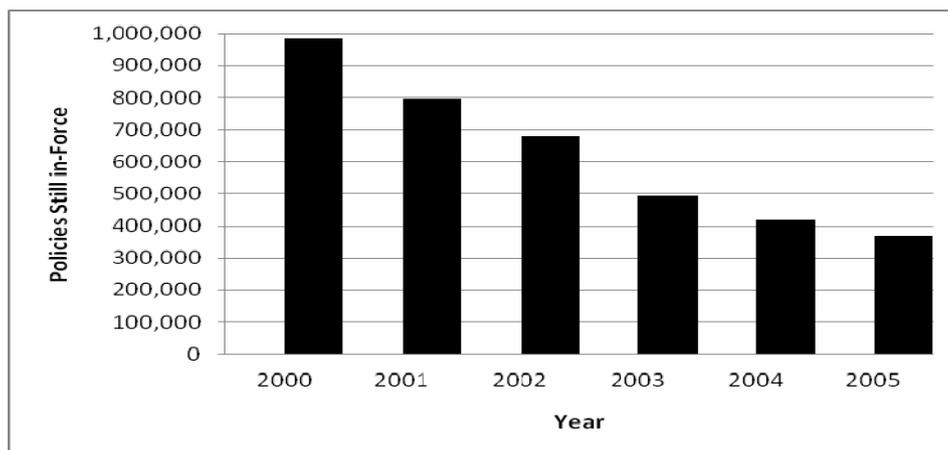
In conclusion, a more granular analysis of flood insurance in place in the state reveals important differences among counties. Like the country overall, the NFIP market in Florida is highly concentrated, with just a few counties responsible for the majority of policies and coverage. Most of these policies are for single-family homes and, naturally, most of the

coverage-in-force is located along the coasts and in SFHAs. That said, almost 20 percent of homeowners are buying insurance outside of the mandatory purchase areas. Retention appears to be a problem in Florida, but we do not know for sure whether a policy is terminated because the homeowner relocates or whether s/he decides to stop buying flood insurance.

3.2: What type of contracts (deductibles, coverage levels) do policyholders purchase?

We now focus more specifically on the design of the flood insurance contract Floridians purchase. We first explore the coverage levels that homeowners in Florida choose and then examine deductible choices. Finally, we look at how these choices changed in 2005, following the active hurricane season and flood surge that affected Florida in 2004; that year, Florida was hit with four hurricanes—Charley, Frances, Ivan, and Jeanne—as well as 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 a maximum coverage limit (a policy has, in fact, two maximum limits—one for the structure and one for the contents; in 1968 it was $17,500 and $5,000, respectively and has been modified several times since). This maximum for single-family, residential policies has remained unchanged since 1994 though at $250,000 for the structure and $100,000 for contents.[13] 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 this maximum, we indexed this limit to 2008 prices (total maximum limit of $350,000 in 2008). Figure 3 depicts this 2008-index total policy limit over the period 1968–2008 using the official U.S. inflation rate for each year. 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 where it was in 1978, despite significant inflation over this period and despite real estate prices that increased in many areas at a much higher rate than inflation. Over the years, some have argued that the $250,000 coverage limit is too low. This concern was raised again following Hurricane Katrina. With our data, we

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[13] Commercial (nonresidential) buildings are eligible for up to $500,000 in building coverage and up to $500,000 on personal property. 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 content coverage, and 100,000 had content coverage only.

were able to gauge whether that $250,000 threshold really constitutes a limitation on the demand side for homeowners in Florida.

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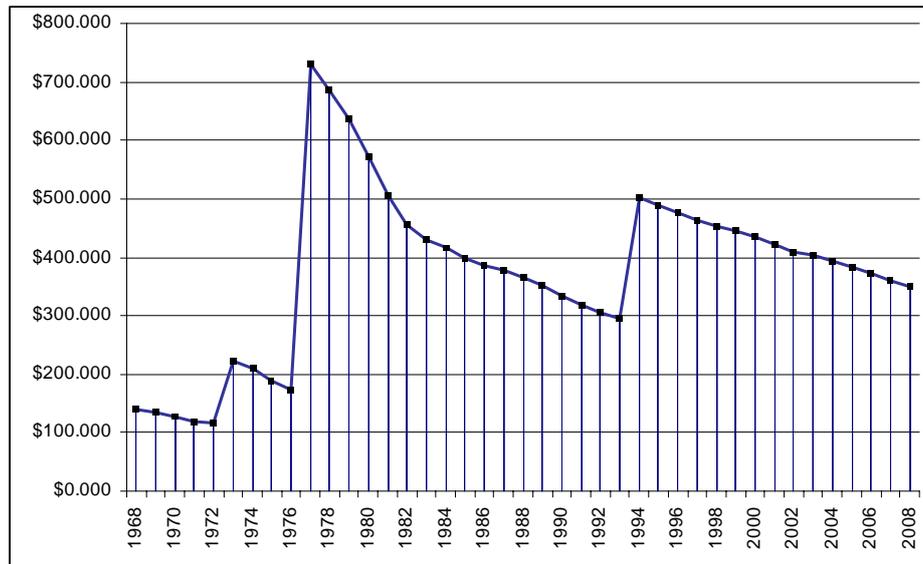

Source: Authors' calculation

After considering all policies-in-force in Florida in 2005, we conclude that this 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.[14] 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 much media attention has been paid to the multimillion dollar houses on the beach, the majority of residences in Florida are valued at less than the NFIP building coverage limit for residential properties.[15] Further, flood damages may not always completely destroy a structure, so not insuring the full value of the home may be quite rational (see Figure 5).

Figure 4 depicts the percentage of the 1.14 million flood policies in 2005 that selected a given limit for building and contents coverage.

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[14] Note that we are looking at the amount of coverage purchased here and not coverage as a percentage of home value.

[15] Moreover, in many areas in Florida, it is likely that housing price is heavily weighted by the price of the land more than the cost of the house itself.

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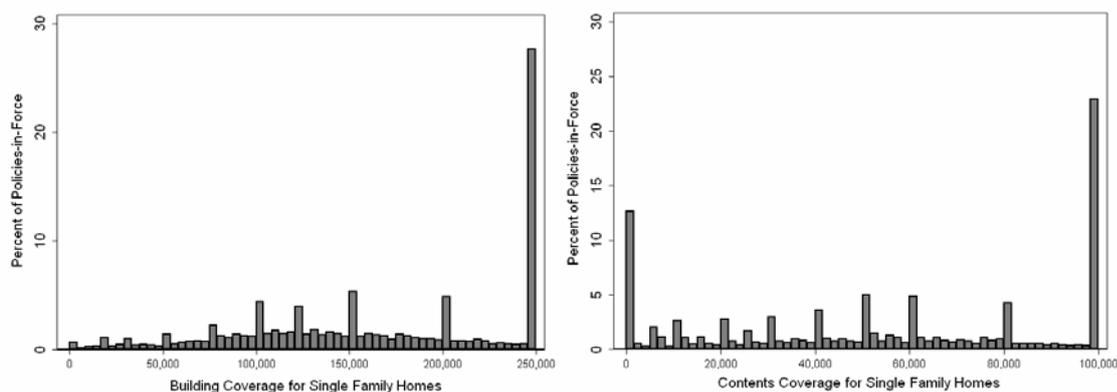
Although almost three-quarters of homeowners did not purchase insurance at the coverage limit, about 27 percent did (Figure 4, left). Presumably many of these policyholders would welcome the option of choosing a higher limit.[16] Moreover, the number and proportion of policyholders who have purchased the $250,000 limit has been growing steadily. In 2000, only around 10 percent of single-family policyholders were at the coverage maximum limit. This percentage rose in 2003 to 17 percent and to 27 percent in 2005. In part, this reflects the growth of Florida's population over this time period and the increased value of the real estate.

About 23 percent of single-family policies in Florida in 2005 were at the $100,000 limit for contents coverage—very close to the 27 percent number at the building coverage limit (Figure 4, right). Out of all the 1.14 million single-family policies-in-force in 2005, roughly 12.5 percent had zero contents coverage. The number with zero contents coverage had been declining slowly since 2000, however, whereas the number at the coverage limit rose substantially over this time, from 7.5 percent in 2000 to almost 23 percent in 2005.

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[16] Not surprisingly, several private insurers, including 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 deal with 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; Best's Review, 2006). RAND recently examined the market of 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.

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 policyholders at the limit, whereas in other counties, such as Walton, Nassau, Collier, and Martin Counties, half or more of the policyholders were at the limit. Over time, more counties are finding more policyholders at the coverage limit. In 2000, the counties with the highest percentages of policies at the limit had only about 25 percent at the limit (these were Indian River, Walton, and Martin Counties), whereas in 2005, the highest percentages were more than 50 percent. Given these results, there would certainly be a demand for a higher limit of flood insurance in these counties.

As expected, policyholders with higher levels of building coverage tend to have higher levels of contents coverage, as well. On average over the entire state, there is approximately a 70 percent chance that a policyholder will buy 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 insured losses policyholders can expect from a flood.[17] About three-quarters of the residential claims in Florida between 2000 and 2006 in our dataset had information on the assessed value of the house. Figure 5 shows for this subsample the amount of the claim paid divided by the value of the structure.[18] We see that most building claims payments were significantly less than the value of the property.[19] For just over 50 percent of the claims, the building claim was no more than 10 percent of the property value.

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

[18] 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.

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

Figure 5. Residential Claims in Florida between 2000 and 2006 Divided by Value of the Property
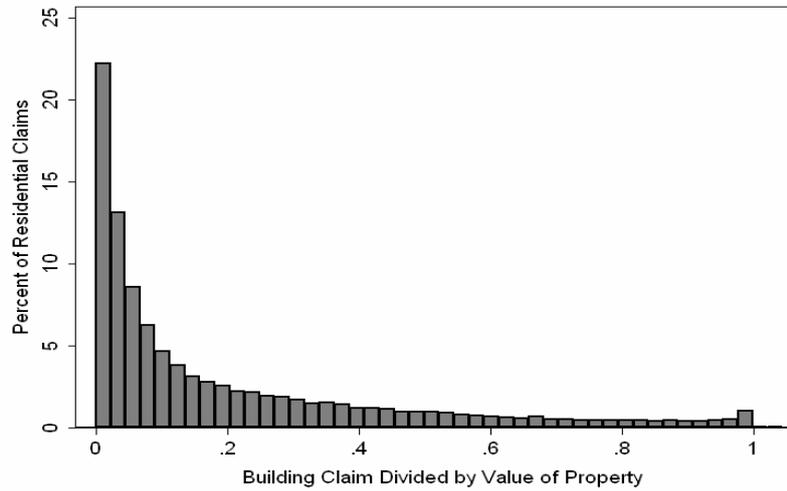
In our assessment of the ratio of claims paid to coverage purchased for residential claims in Florida between 2000 and 2006 (Figure 6), we find a similar story. For roughly half of the observations, the claim paid was 8 percent or less of the amount of coverage purchased. Taken together, Figures 5 and 6 indicate that choosing to insure up to a maximum that is below the value of the property is a rational choice for most homeowners.

Figure 6. Residential Claims in Florida between 2000 and 2006 Divided by Purchased Coverage

Figure axes: Y-axis "Percent of Residential Claims" (0 to 25); X-axis "Claims Paid Divided by Coverage Purchased" (0 to 1)
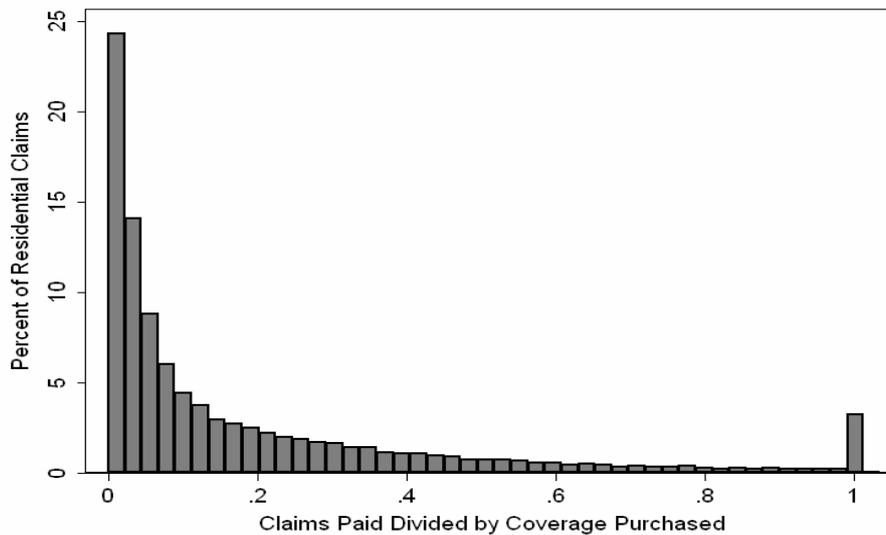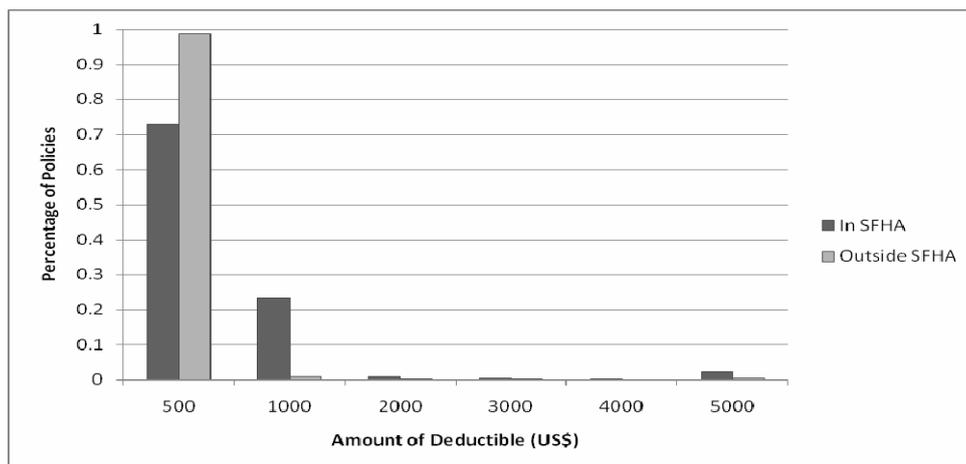
Deductible

The second element of the contract we analyze is the choice of the deductible. The NFIP offers policyholders a choice of six deductibles for building coverage under which policyholders retain the full loss: $500, $1,000, $2,000, $3,000, $4,000, and $5,000. NFIP premiums are calculated by multiplying the coverage limit chosen (minus the deductible) by the rate per $1 of coverage based on characteristics of the house, and then multiplying by a deductible factor. If a homeowner chooses the lowest deductible for both contents and building coverage, the deductible factor is 1. Choosing a $1,000 deductible for both gives a deductible factor of 0.96. Choosing a $5,000 deductible for both gives a deductible factor of 0.74. So choosing the highest deductible reduces costs by about 25 percent. Looking at all claims for Florida through August 31, 2006, a little more than half of the claims paid were greater than the highest deductible of $5,000.

Many studies on insurance choice 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. This preference has been found for automobile insurance and homeowners policies (Eldred, 1980; Cutler and Zeckhauser, 2004; Sydnor, 2006). The samples in these studies were relatively modest, however. Here, we are able to look at 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 one. We also find that 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 for the 6 other million policies we analyzed over the time period we studied (2000–2005).

An interesting difference becomes apparent if one examines the deductible choice by flood zone. Homeowners inside SFHAs (100-year floodplains) did not choose the lowest deductible as often as those outside SFHAs and were more likely to choose the highest deductible (see Figure 7). One explanation for this finding is that more policyholders inside SFHAs are being 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.

FIGURE 7. CHOICE OF DEDUCTIBLE BY FLOOD ZONE

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, in the absence of interviews of buyers of flood coverage, we are unable to tease apart these competing explanations. First, consumers might want to cover as much as possible whatever happens (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 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. Small claims might help make the payment of required insurance more tangible. Fourth, some individuals may see insurance as an investment, rather than a risk-spreading tool and want to collect something back from their policy. The lowest possible deductible will make them more likely to collect and guarantees that in the case of a loss they will collect back as much as possible (Kunreuther, 1978).

We tested the hypothesis that people with the highest limit would tend to also have a higher deductible on their policies.[20] This would be consistent with some individuals choosing to insure against catastrophic losses but not small losses. The analysis reveals, however, that this is *not* the case. To the contrary, we find that people who bought the highest limit on their coverage were more likely to take the lowest possible deductible: 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. Table 5 presents the number of policyholders choosing a given deductible stratified by the amount of building coverage purchased in 2005 (results for previous years are very similar). 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	Total 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
Number of Policies	58,099	153,036	270,668	209,988	138,796	313,257	1,143,844

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[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.

For contents coverage (full results not provided here), the deductible choices were similar, with about 83 percent of single-family policies having a deductible of $500 and 15 percent having a deductible of $1,000. Again, these percentages were fairly consistent from 2000 to 2005 and the number and proportion choosing the $500 deductible increased with higher amounts of contents coverage.

Impact of Catastrophes on Consumers' Choices

In 2004, Florida was hit by four hurricanes and one tropical storm. This was the first time in recorded history that Florida had been hit that way in one season. These events caused billions of dollars in damages, the evacuation of over 9 million people, and many fatalities. We were interested in whether this exceptional year led homeowners to alter their flood insurance purchase decisions. We predicted that insurance take-up rates would increase after these storms and that perhaps coverage levels would rise, as well.

The NFIP does not react to any specific local episode by increasing its rates; rather, it sets its rates at a national level, as discussed in the next section. As a result, the premiums of NFIP flood policies remained virtually the same in Florida before and after this series of storms. Any changes are thus due to a reaction to these events and not to a change in the price formula of insurance; changes hence mainly translated into a different limit and/or deductible selected by the policyholders. Policies-in-force increased in the state of Florida every year between 2000 and 2004, but not by more than a couple of percentage points. Between 2004 and 2005, however, the number of policies-in-force jumped 6 percent. This is suggestive evidence that storms encourage more property owners to purchase flood insurance.

It also appears that after the storms, more individuals chose the lowest possible deductible on coverage to their home—$500. 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. Looking only at Santa Rosa and Escambia Counties, however, where damage from the 2004 storms was severe, the percentage with the lowest deductible jumped dramatically 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. In both counties, the proportion of policyholders

choosing the lowest deductible increased much more between 2004 and 2005 than between any two years from 2000 to 2004.

Finally, after the storms, it seems that single-family, residential policyholders purchased a higher limit on their coverage. 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. 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 was growing 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 living in devastated areas and who had coverage wished they had purchased the largest possible coverage before being flooded (regret); the floods were a vivid experience, not only for those affected but also their neighbors and families, and people, therefore, revised their belief after the storms to think flooding was more likely; or the decision to buy more insurance also became more appealing because it was viewed as a sound financial investment.

3.3: Where and when are claims paid?

In this section, we investigate the particular events driving claims, how claims vary across counties, and the determinants of the magnitude of claims paid. Figure 8 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.

FIGURE 8. NFIP CLAIMS PAID IN FLORIDA BY YEAR
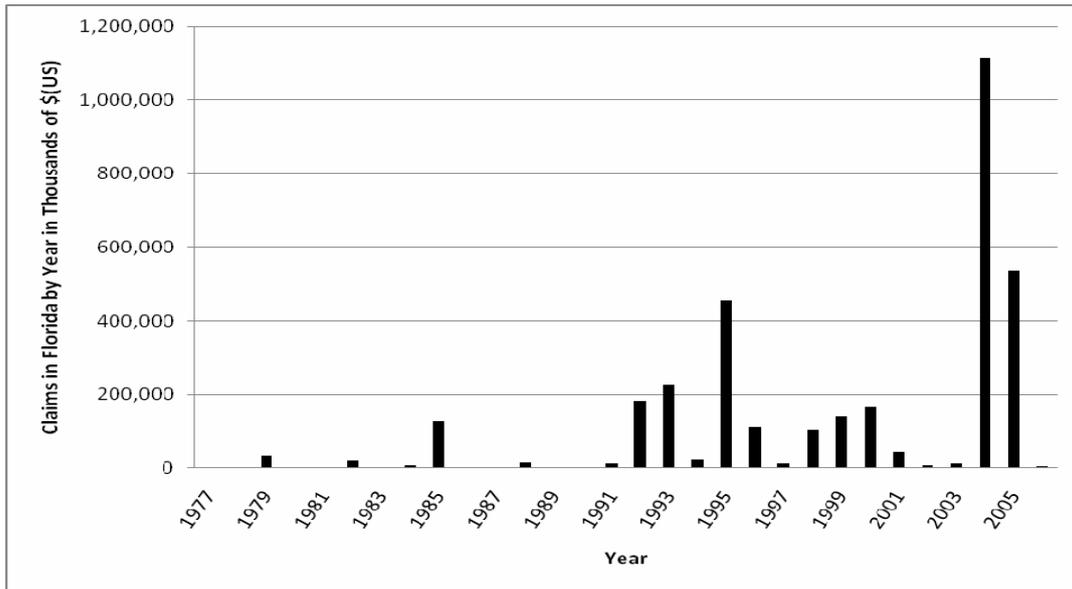
As discussed above, the NFIP does not cover wind damage (this coverage is provided by private insurers through homeowners policies or through state insurance pools), but major hurricanes in coastal states typically induce significant flood losses resulting from storm surge pushing water inland, or from flooding induced by 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 for covered households in Florida were associated with Hurricane Wilma and just under a quarter were associated with Hurricane Katrina. Another 13 percent of claims were due to Hurricane Dennis—a total of 88 percent of the claims for that year.

Mean claim payments in Florida between 2000 and 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 higher levels of damage than inland flooding from heavy rain. This is consistent with the higher NFIP premiums charged in V zones. Coverage levels, however, are not much different across the zones, although we are unable to control for all factors that influence coverage levels to make an accurate determination.

We also considered more closely the counties that generated the highest amount of flood insurance claims from 2000 to 2005. Rather than looking at the total value of these 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, 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).[21] Santa Rosa and Escambia counties, located in the far northwest of Florida (see Figure 1), both suffered severe losses from the 2004 hurricane season. Flood claims for Santa Rosa were about $350 million, or about 30 percent of the total flood coverage in the county; Escambia claims were $260 million, or 25 percent of its entire coverage. This certainly came as a surprise because only about 35 percent (Santa Rosa) and 40 percent (Escambia) of flood policies are located in a 100-year flood area in these two counties. This raises the question of what does determine the magnitude of NFIP claims.

Determinants of Claims Payments

The current debate about the future of the NFIP is mainly focused on how to make the program more sustainable over the long term so that taxpayers are not held financially responsible for those living in high-risk areas. To shed light on this debate and make concrete recommendations as to how the operation of the program can be improved (see section 4), we sought to better measure the determinants of claims payments.

We used the data on single-family NFIP claims between 2000 and 2005 to uncover the key drivers of the magnitude of claims payments in Florida. We looked at 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. This analysis is somewhat limited by the data available, but we were able to examine 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 as the impact of riskier locations—whether the home is located in a 100-year floodplain.

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[21] Miami–Dade was ranked 23rd with an average of $929 in claims per policy over this period of time; Palm Beach was 59th with $148.

Finally, we 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. Information on current CRS class for each community in Florida is on the FEMA website and this was merged into our claims data. CRS classes range from 1 to 9 (communities *not* participating are in class 10); each class carries with it a 5 percent discount in premiums with class 1 receiving the maximum reduction (i.e., a 45 percent discount) and class 9 receiving only a 5 percent discount. 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. Unfortunately, data were missing for one or more variables for some of the observations. After cleaning the data,[22] more than 40,000 observations remained of claims payments that could be used for the analysis (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	7.01	1.63	5[23]	10
More than 1 floor	0.273	0.446	0	1
Building elevated	0.218	0.413	0	1
Basement	0.075	0.264	0	1
SFHA	0.856	0.351	0	1

Simple ordinary least squares regressions were run on these data. Fixed effects for year, 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. Results are presented in Table 7, with robust Huber–White standard errors in parentheses.

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[22] 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.

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

Column I shows the results with the natural log of claims over property value as the dependent variable, and column II gives the results of the natural log of claims over coverage as the dependent variable.[24]

TABLE 7. REGRESSION RESULTS

	Expected sign	I ln(Claims/property value)	II ln(Claims/coverage)
Variable		Coefficient	Coefficient
CRS class	+	0.1614*** (0.0097)	0.1426*** (0.0067)
More than 1 floor	–	-0.5676*** (0.0227)	-0.5498*** (0.0185)
Building elevated	–	-0.5434*** (0.0234)	-0.6837*** (0.0219)
Basement	+/–	-0.0784** (0.0356)	-0.0222 (0.0340)
SFHA	+	0.1985*** (0.0293)	0.1832*** (0.0219)
FE: Year, catastrophe number, county		Y	Y
R-squared		0.1567	0.1828
N		42,573	42,573

Robust 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 ***.

Results are as predicted. The most striking result is the highly significant coefficient on the CRS class variable. As a community adopts mitigating measures, it moves up in the CRS ranking and achieves a lower CRS class (so, a higher CRS class number implies *less* mitigation). Our results suggest that claims as a percentage of value or coverage increase by around 15 percent for a one-level increase in CRS class. More intuitively, mitigation pays: as communities adopt mitigating activities, claims decrease. This result is important because we have not been able to find such local evidence of CRS effectiveness in the literature.

Other coefficients are also 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)—by just under 20 percent, whether as a percentage of value or of coverage. Claims are also lower for buildings with basements, potentially because in many cases, basements alone flood, leading homeowners to file small claims (there are limitations on what the NFIP will cover in basements). When a building is

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[24] We appreciate insightful suggestions on this regression by an anonymous referee.

elevated, claims as a percentage of home value fall by almost 55 percent and claims as a percentage of coverage fall by just under 70 percent; thus, this is, by far, the most important driver of claim reduction and shows, again, that proper risk reduction measures can save a lot.

In our dataset, each claim includes a number indicating the catastrophe that caused the loss. Fixed effects for these events were included in the regression. Although not reported individually above, Hurricanes Ivan, Frances, and Charley all were associated with highly significant increases in claims in both specifications, as were tropical storms Allison and Gabrielle. The only catastrophe that led to statistically significant lower claims was October flooding in 2001. This would suggest that hurricane-related water damage in Florida has been more severe than non-hurricane flooding.

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

The NFIP's goals with regard to setting prices differ from those of a private insurance company because the NFIP does not have to seek profit, nor must its prices reflect the cost of capital. Beyond financial soundness, the NFIP also aims to support floodplain management and encourage widespread adoption of flood insurance with its pricing strategy (Hayes et al., 2007). As discussed above, certain properties are offered subsidized rates, whereas others are charged the *full-risk* premium. Because a little less than 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 *historic average loss year* (Hayes et al., 2007).

It is important to understand that, in the history of the program, losses resulting from Hurricane Katrina have been truly exceptional.[25] FEMA has decided currently to give 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). The NFIP has borrowing authority from the U.S. Department of the Treasury, and at the end of 2007, it had borrowed $17

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[25]Between 1968 and July 2005, the program's revenue was $23.6 billion and its total insurance 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 cumulative result was a deficit of about $3 billion (Wharton Risk Center, 2008). In contrast, the 2005 hurricanes led to NFIP liabilities of around $23 billion.

billion, largely as a result of the 2004 and 2005 hurricane seasons. Current revenue is unlikely to be sufficient to cover its operating expenses and claims as well as interest and principal payments to the Treasury (GAO 2008a). Some determination will have to be made regarding how the NFIP will repay these costs or whether the federal government will assume the costs of catastrophe years.

"Actuarial" premiums set by FEMA are based first on the determination of 10 flood risk zones. Rates are then set for each flood zone for the nation as a whole; rates for similar flood zones are the same everywhere in the country. The formula the NFIP uses to calculate the actuarial rates is described in the yearly rate reviews. The minimum rate is \$0.16 per \$100 of building coverage. Taken from the 2008 *Actuarial Rate Review* (Hayes and Spafford, 2008), the NFIP formula for calculating rates is:

$$Rate = \left[\sum PELV * DELV\right] * \frac{LADJ * DED * UNIS}{EXLOSS}$$

PELV gives the probability of water reaching a certain height, relative to the base flood elevation. This is calculated for many different potential heights based on engineering and hydrological analyses. Elevations are rounded to the nearest foot. Events rarer than the 350- to 500-year event are not considered because FEMA notes that it is difficult to estimate extremely rare events. DELV gives the ratio of flood damage to the value of the property. FEMA assesses this ratio from tables that relate depth of water to damage. The tables are checked by FEMA against actual claim data. LADJ is a loss adjustment factor given as a percentage of losses. It is currently 4.12 percent and covers the cost of payment loss adjuster fees and special claim investigations. DED is the deductible offset. UNIS is a factor to adjust the DELV values for the fact that most people underinsure. Finally, EXLOSS is a loading factor for insurance agent commissions and other expenses; in non-V zones, it is 10 percent and in V zones it is 20 percent. To set rates for subsidized properties, the total amount of actuarial premiums the NFIP expects to collect is subtracted from the historical average loss year to determine a target amount of revenue that subsidized properties must generate.

Rates also vary by certain characteristics of the house, such as its height above base flood elevation. NFIP rates are revised once a year in May. By law, any yearly increase in premiums

cannot exceed 10 percent overall. Katrina aside, prices are not changed much in response to individual events. For instance, the 2004 Actuarial Rate Review recommended no change in premiums for V zones—those associated with wave action—and only a 1.4 percent total increase in premiums across other zones. After Hurricane Katrina, the contingency loading associated with SFHAs was increased from 5 percent to 10 percent for A zones and from 10 percent to 20 percent for V zones (Hayes et al., 2007).

This pricing strategy clearly leads to important cross-subsidizations in the program. Rates are not risk-based at the local level, so prices will be "too high" in some areas and "too low" in others. The GAO notes this problem that rates do not reflect local topographical conditions and finds that a look at historical claim and premium data suggests that NFIP rates are not always reflections of the risk (GAO 2008a). 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. The GAO has further criticized some aspects of the NFIP pricing strategy. Some of the data used are outdated, such as estimates of flood probabilities that are from the 1980s, and some data are inaccurate, such as damage estimates that do not reflect the full amount of NFIP claim experience (GAO 2008a).

The 2008 Rate Review gives the average premium for different flood zones. The actuarial rates (nonsubsidized properties) are shown in Table 8. It is clear from the table that, although the V zones along the coast represent a very small percentage of business, the risks of flood damage in these areas, and thus the rates for these zones, are much higher.

TABLE 8: NFIP ACTUARIAL AVERAGE PREMIUMS

Zone	Percentage of business	Average annual premium as of May 2008 (US$)
AE,A,AO,AH,AOB,AHB	39.6%	429.92
POST-81 V,VE	0.9%	2,270.27
B,C,X	37.3%	394.34

Source: Hayes and Spafford (2008).

Since rates are set by zone for the entire country, variations in the average premium across geographic 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). When looking at the average premium paid per $1000 of coverage in

Florida in 2005, the cost ranges 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 are 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 insurance purchase decision by the homeowners.

In looking at the change in the average premium per $1,000 of coverage between 2000 and 2005, we find that not only did this not increase, but 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. As we analyze above, these two counties suffered the most from water pushed by the 2004 hurricanes. Further, these two counties also 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 (i.e., 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—rather than decreased—over this time period.

Although this decline in average cost per $1,000 might seem counterintuitive, there are 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 you live in a 100-year floodplain, a flood close to you is a vivid reminder of your possible exposure), and these were 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, there was a relative decline in the proportion of policies in the most expensive V zones. For Escambia, the percentage of policies in V zones dropped from 6.2 percent in 2000 to 3.1 percent in 2005. In Santa Rosa, the percentage of policies in V zones 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 limit levels between 2000 and 2005. The pricing formula described above is not linear in dollars of coverage because the probability of suffering the first $X of loss is higher than the probability of suffering $2X of loss. 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.

The NFIP's pricing strategy of basing rates on a historical average loss year does not leave room for anticipation of changes in future conditions. With scientists recently proclaiming that, as a result of climate change, "stationarity is dead" regarding water management (Milly et al., 2008), it may be time for the NFIP to consider how to design pricing strategies that are more forward-looking and more local. 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.

4. Conclusion and Possible Improvements to the NFIP

This paper has provided an overview of both the functioning of the NFIP at a national level and a close look at policies and claims in the state of Florida, which has the largest share of NFIP policies and coverage-in-force. We hope that these results will 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 more and more people locating in high-risk areas. The NFIP has also seen a significant change in the scope of its operation 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 and the functioning of the NFIP. Other findings, however, revealed some common misconceptions about the NFIP. The extreme concentration of the NFIP market in a few states is somewhat surprising because one may expect flood risk to be spread more broadly across the country. It 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. Since this is the area of highest hurricane risk, the main flooding threat in the state, this makes sense. With the high concentration of the NFIP portfolio along the Gulf coast, the NFIP has become somewhat of a hurricane insurance program, although it does not cover wind damage.

The massive debt the NFIP now faces from the Hurricane Katrina claims, coupled with the pricing strategy discussed here, makes it evident 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 every year 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, it would certainly be important for the GAO to analyze whether this routine 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 which are taking part in the NFIP's 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, more effort could be put into encouraging communities to join this program and to accelerate through the levels. One might

also consider household-level premium reductions for property owners who flood-proof their homes or businesses.

Our analysis also provides evidence that people drop coverage pretty quickly. A true breakthrough would be for FEMA to start offering multiyear flood insurance contracts rather than the current one-year contracts. Indeed, since NFIP is managed at a federal level, nothing precludes FEMA from issuing 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 mitigation more attractive over time. For instance, if long-term flood insurance policies are in place (rates could be reviewed every 5 or 10 years), FEMA could offer 20-year risk reduction loans to its policyholders to incentivize them to reduce their exposure to flood. If policyholders can benefit from an annual rebate on their flood insurance that is more than what they spend every year to reimburse their flood mitigation loan, this would be a win–win situation for everyone[26].

Finally, in discussions over reforms to the NFIP, the issue of coverage limits is often raised. Although some homeowners in Florida might desire higher coverage for their relatively expensive homes, the current limit is not binding for the majority of homeowners. It has become more binding over time, however, suggesting possible demand for an increased limit. 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. In complement to offering more coverage, the NFIP could also better connect homeowners with private insurers offering higher levels of flood coverage.

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[26] For more on the possibility of long-term insurance contracts, see: Jaffee et al., 2008; Kunreuther and Michel-Kerjan, 2009.

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