Modifying the National Flood Insurance Program to Reduce Flood Losses: Risk-Based Premiums and Affordability

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1 Executive Summary

After the turbulent 2005 Atlantic hurricane season and Hurricane Ike in Texas in 2008, the National Flood Insurance Program's (NFIP) debt lies at $17.8 billion, calling into question the NFIP's lack of fiscal sustainability in the wake of large-scale disasters. The U.S. debt crisis calls further for a re-evaluation of all government programs running a deficit. This study is thus motivated by Congress' call for more information on the fiscal sustainability of the NFIP, as it is currently structured.

With recent legislative proposals related to the NFIP and frequent short-term reauthorizations, there has been much discussion about revising current premiums to more accurately reflect flood risk. The Senate Committee on Banking and Urban Affairs Bill (S. 1940) and the House Bill (H.R. 1309) both propose to reauthorize the NFIP through 2016 and require that premiums reflect true flood risk as confirmed by actuaries. **However, there has been a lack of focus on the effects on affordability of these new proposed premiums. In this paper, we examine these effects and explore ways to make this shift more affordable and implementable.**

In our study, we assess the impact of the implementation of these legislative proposals. Our study seeks to build on the 2012 study, *A Methodological Approach for Pricing Flood Insurance and Evaluating Loss Reduction Measures: Application to Texas*, conducted by the Wharton Risk Center, Swiss Re and CoreLogic utilizing state of the art catastrophe models. Our analysis is based on data from this study and focuses on the impact on affordability of a change to risk-based premiums for households in Galveston County, Texas. What makes Galveston County a particularly appropriate county for this study on affordability is the fact that a large percentage of its population (33%) is located in a Federal Emergency Management Agency (FEMA) floodplain. Galveston County was ranked first out of 18 Texas coastal counties for the percentage of designated "high-risk" populations located in a FEMA floodplain, with 37% of the total population over age 65 living in a floodplain and almost half (43%) of the total population in poverty located in a floodplain.[1]

Using data from the above-mentioned study on current premiums and comparing them to the risk-based premiums calculated using sophisticated catastrophe models, which are common in the insurance industry, we found that out of the 14 Zip

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[1] "Coastal County Snapshots - NOAA Coastal Services Center." NOAA Coastal Services Center. Web. 8 Feb. 2012.

Codes eligible for this comparison, the annual premiums in 4 Zip Codes decreased while the annual premiums in 10 Zip Codes increased as the result of a risk-based policy. The maximum percentage increase for a zip code was 159.06% (from \$549 to \$1,442).

A major concern facing policy-makers regarding affordability is the question of *who* will pay for this increase in insurance premiums. Having calculated the total expected premium increase in Galveston County, we looked into the possibility of allowing for insurance vouchers for those households who may not be able to afford the premium increases. In order to address these issues of affordability, especially for those who would experience steeper increases in premiums, we propose that the government provide insurance vouchers to citizens to bear the cost of the premium increases. Under a select few definitions of affordability, we explored different scenarios under which those with annual household income below certain thresholds (e.g. under 50% of area median income, under 150% of the poverty line) would receive the vouchers in order to afford the increases in flood insurance premiums they have to pay to be protected.

In addition to analyzing the effects that a move to risk-based premiums would have on the affordability of insurance in Galveston County, it is important to look at other challenges in the implementation of updated risk-based premiums. One of the points of interest that emerged when comparing the Senate Banking Committee's and House of Representative's bills is that they differ in the rate at which they permit insurance premiums to increase per year in order to reach their "actuarially-indicated levels that reflect the true risk of flooding."[2] Currently, NFIP premiums may not increase by more than 10% a year. The Senate bill would allow premiums to increase by 15% a year while the House bill would allow premiums to increase by 20% a year. Using our data for Galveston County, we found that for the most aggressive strategy of the proposed strategies (the 20% phase-in policy), it would take six years until all Zip Codes are at risk-based levels (as measured by the mean). On the other hand, for the slower phase-in policy of 10%, it would take 10 years until all Zip Codes are at risk-based levels. These results strongly indicate the importance of an aggressive phase-in strategy.

We propose that premiums should be adjusted for risk *immediately* alongside the implementation of insurance vouchers. The immediate implementation of risk-based premiums would offer a number of benefits for the NFIP. Firstly, the immediate implementation would discourage development in high-risk areas. In addition,

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[2]"Senate Committee Passes Federal Flood Insurance Reform Legislation." Insurance Journal. 8 Sept. 2011. Web. 20 May 2012.

it would improve the financial sustainability of the program by increasing funding with the higher premiums. Finally, immediate implementation of risk-based premiums would further encourage households to adopt mitigation measures.

It is also important to look at ways to reduce exposure to flood risk. In this respect, we chose to explore the use of mitigation measures and the ways in which efforts towards mitigation should be incorporated into a move towards risk-based premiums. One of the primary drivers for a move towards accurate and updated risk-based premiums is that homeowners will better recognize their real exposure to risk. This recognition should thereby incentivize homeowners to adopt mitigation measures more readily. There are, however, a number of decision biases and economic constraints that explain why homeowners may choose not to invest in expensive flood mitigation.

Continuing to look at affordability in relation to mitigation investments, we also suggest offering assisted financing for mitigation efforts. While this is particularly important for those who may be unable to afford the high up-front investment costs, even those who may be able to afford the costs may choose not to invest in these measures, especially if they feel that they would not realize the benefits of their investment in the short-term. As such, we propose that FEMA or financial institutions offer mitigation loans to households in order to encourage investment in mitigation measures. The loans, to be paid back over the long-term, would make investment in mitigation more affordable and would spread the high investment costs over time. For low-income households, mitigation loan payment assistance could be provided. If the mitigation measures are effective, we expect households to experience a reduction in their risk-based premiums due to the reduced flood exposure. These savings in premiums could go towards the re-payment of loans. While this scheme should incentivize households to adopt mitigation, challenges remain regarding the awareness of the actual measures a homeowner can undertake to mitigate flood risk. Hence, it is imperative that these mitigation loans be coupled with information sharing on the forms of mitigation available to households. Moreover, we must weigh the costs of implementing certain mitigation measures against their benefits. Once again, information sharing of which mitigation measures homeowners should employ and which may be ineffective becomes a key part of the process.

While the Senate and House bills have suggested a shift towards risk-based premiums that more accurately reflect flood risk, it is crucial to examine this shift's impact on affordability for homeowners. As we will show in this paper, the Senate and House Bills need to be reconciled with appropriate policy supports to ensure

the sustainability of the National Flood Insurance Program and to minimize negative effects on affordability while reducing flood exposure and losses. We suggest an immediate implementation of the updated risk-based premiums, so that insurance payments would help improve program funding and thereby its sustainability. At the same time, we recommend that the government provide insurance vouchers to households that meet certain income thresholds to reduce the financial burden of premium increases on these homeowners. Lastly, we propose mitigation loans as a way to incentivize homeowners to employ mitigation measures and reduce flood exposure.

2   Background

2.1   Overview of the National Flood Insurance Program

The National Flood Insurance Act of 1968 created the National Flood Insurance Program (NFIP), which was designed as a voluntary partnership between the federal government and local communities. The program had a three-prong plan: 1) To identify areas most at risk of flooding; 2) To minimize the economic impact of flooding events; and 3) To provide flood insurance to individuals and businesses.[3] The program was, however, not set up to deal alone with truly extreme events, and this is a critical point to bear in mind when analyzing the program's effectiveness. The NFIP provides insurance up to a maximum limit for residential property damage, now set at $250,000 for building coverage and $100,000 on contents' coverage. The program was structured to subsidize the cost of flood insurance on existing homes, in order to maintain property values, while charging actuarially fair rates on new construction.[4]

In 2007, about 1.2 million, or almost one of four, residential flood insurance policies under the NFIP continued to be sold at subsidized rates that did not fully reflect the actual risk of flood damage. The subsidized rates averaged 35 to 40 percent of what full-risk rates would be on the same properties and represented a large financial burden on the NFIP.[5] As of May 2012, the NFIP's debt is at $17.8 billion, and under current legislation, the NFIP may borrow an additional $3 billion from the Treasury. The Congressional Budget Office expects that this

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[3]King, Rawle O. "National Flood Insurance Program: Background, Challenges, and Financial Status." 4 Mar 2011.

[4]Erwann Michel-Kerjan (2010). "Catastrophe Economics: The National Flood Insurance Program." Journal of Economic Perspectives.

[5]"Options for Addressing the Financial Impact of Subsidized Premium Rates on the National Flood Insurance Program." United States Government Accountability Office. November 2008.

borrowing authority will be exhausted in 2014.[6]

2.2 March 2011 NFIP Congressional Research Service Report Summary

In Rawle King's March 2011 Congressional Research Service Report, "National Flood Insurance Program: Background, Challenges, and Financial Status,"[7] he cites several lessons from Hurricane Katrina and the 2008 Midwest floods, which could help inform Congress on the reform of the NFIP. First, program participation has not yet reached the level that was originally envisioned by Congress, as homeowners do not truly recognize their flood risk. The altering of rivers and streams by the construction of levees and other flood control structures has actually increased risk of floods throughout the affected floodplains, and there is thus a need to improve the NFIP's floodplain management standards. Moreover, actuarial policy rates do not always accurately reflect the flood risk in a given location because of inaccurate or outdated flood hazard maps. Levees provide a false sense of security, even though homeowners face significant uninsured losses if the levee is overtopped and they do not have flood insurance. Lastly, there is a moral hazard issue due to the availability of federally-subsidized flood insurance in high-risk areas, which encourages homeowners to locate in flood-prone areas and lowers their incentives to avoid flood risk because they expect compensation for flood-related losses from the federal government.

Given all these issues, King's report suggests several options to respond to these challenges. The government could reform and modernize the NFIP, which may include a gradual phase-in of actuarial rates, strengthening of floodplain management regulations and enforcement of mandatory insurance purchases, ongoing review of flood insurance program maps, and incentives for private sector participation. Another proposal is for multi-year flood insurance contracts that include mitigation loans tied to the property's mortgage. The government could also shift flood insurance back into the private sector, enabling private insurers to cover more flood risk. Two other proposals are for community group flood insurance policies and interstate compacts for flood control and management.

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[6]"Flood Insurance Reform and Modernization Act of 2011." Congressional Budget Office Cost Estimate (2011): Web. 27 Jan. 2011.

[7]King, Rawle O. "National Flood Insurance Program: Background, Challenges, and Financial Status." 4 Mar 2011.

3 Our Study

3.1 Thesis

With recent legislative proposals related to the National Flood Insurance Program (NFIP) and the upcoming expiration of the program, there has been much discussion about updating flood insurance premiums to more accurately reflect flood risk. **However, there has been a lack of focus on the effects on affordability of these new premiums. In this paper, we examine these effects and explore ways to make this shift more affordable and implementable.** In our study, we use Galveston County in Texas to assess the impact of actual implementation of the updated risk-based premiums and our proposal for flood insurance vouchers.

3.2 Motivation for Study

In the aftermath of the 2005 and 2008 hurricane season, Congress realized that the U.S. government's level of debt was unacceptable and that, within weeks, the government would not be able to pay off its debt owed to creditors. Congress met for many weeks to decide whether or not to raise the U.S.'s debt ceiling, allowing the U.S. to borrow more money to pay off outstanding debt. Fierce debate from many politicians made finding a solution to the problem suitable to the majority a difficult task. The pending default of the U.S., the potential demotion from a AAA credit rating, and the possible economic effects pushed the U.S. budget to the forefront of the minds of a large portion of the citizenry. Congress ultimately decided to re-evaluate all government programs which were running a deficit. This study is thus motivated by Congress' call for more information on the fiscal sustainability of the NFIP, as it is currently structured, and we will see in the following section that the upcoming expiration of the program and recent legislative proposals make this a timely and relevant study for Congress.

Figure 1.
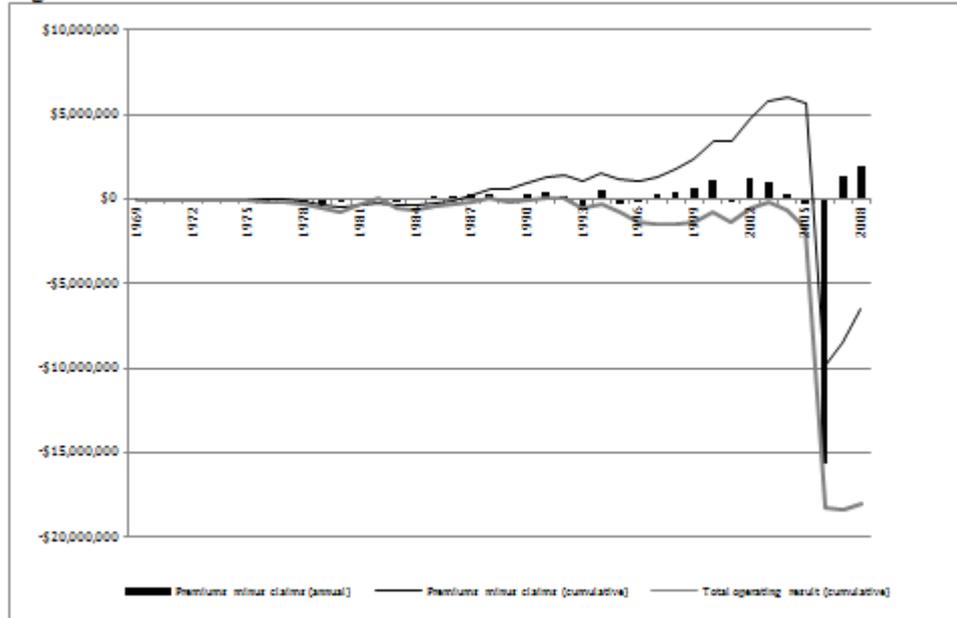
Financial Operation of the NFIP – 1969-2008 (in $1,000)
Sources: Michel-Kerjan (2010). "Catastrophe Economics". Journal of Economic Perspectives.

Figure 1 reveals that the NFIP lost a substantial amount of money in 2005, due in large part to Hurricane Katrina. Prior to 2005, the financial balance of the NFIP had been quite stable and in fact, performed quite well in the years leading up to 2005. Thus, the central question is whether the poor performance in 2005 and the resulting debt are evidence of the NFIP's lack of fiscal sustainability. We note here that it is not the purpose of the NFIP to generate revenue for the government; its goal is to provide fiscal stability to citizens in the face of flood risks while not losing money over the long-term.

From a purely statistical point of view, Hurricane Katrina was a low-probability, high-consequence event. Events such as these very rarely happen, but when they do, the consequences are severe. If the NFIP's unknown yearly return distribution is zero, than the NFIP's expected losses are equal to its expected profits and the program is fiscally stable (although borrowing will be necessary to cover losses at some points). Alternatively, we can propose the following question: given the performance of the NFIP since its inception, is the mean loss in any given year 0? In this example, we are observing events occurring from an unknown and potentially changing distribution and trying to make inferences about certain parameters, most importantly the mean. As an example, if the true distribution of the loss is normal with mean zero, the Law of Large Numbers tells us the average yearly profit of the NFIP (which is currently negative), will converge to zero as time

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goes on. Given that we have a limited number of data points on the NFIP's net profit per year, it is difficult to determine whether or not the mean loss is different from zero with very high confidence, and we cannot conclude with certainty that there exists a property whose premiums do not reflect risk. However, there are two important observations:

1. As we can see from Figure 1, the variance of the yearly loss is increasing over time, due to the increasing number of policies-in-force and high correlation between large subsets of those policies.

2. Random checks of flood maps and corresponding risk-based premiums by experts suggest current premiums underestimate true risk and should be, on average, revised upward.

From the first observation, we derive that the NFIP will need to be able to borrow more money from the Treasury in order to cover losses. From the second observation, we note those losses will likely exceed gains and thus, if premiums are not changed to better reflect risk, the NFIP will likely lose money over time. The Senate and House have both proposed to phase in new risk-based premiums to increase the NFIP's revenue to a level necessary to meet losses over the time horizon. In the following section, we will give further background on recent legislative proposals.

3.3 Recent Legislative Proposals: Senate Banking Committee Bill and House Bill (H.R. 1309)

The NFIP will expire on May 31, 2012, and the Senate and House have created legislative proposals in response to the upcoming expiration. The Senate Committee on Banking and Urban Affairs Bill (S. 1940) and the House Bill (H.R. 1309) both reauthorize the NFIP through 2016 and require that premiums reflect true flood risk as confirmed by actuaries.

The Obama Administration's proposal, passed July 12, 2011, by the House of Representatives under H.R. 1309, reported that "1.2 million, or 20%, of all NFIP properties are charged premiums below the actuarial value of the insured liability," while NFIP premium collections, including subsidized and unsubsidized policies, cover about 70% of the actuarial value of the insured liability. Under this House bill, the NFIP would collect about $700 million in additional premium revenue in the next five years and about $4.2 billion in the next decade. The proposal includes the following changes:

1. Increase premiums in the next five years for a subset of "subsidized properties" (non-residential or non-primary residences, residences sold to new owners and severe repetitive loss properties)

2. Redefine severe repetitive loss properties as residences with at least four paid claims greater than $5,000 or with two paid claims that cumulatively exceed the market value of the house

3. Increase premiums one year after enactment for policyholders of the "subsidized properties" by no more than 20% per year until the amount collected covers the full expected cost of the insurance

4. New policies that fit the "subsidized properties" one year after enactment would immediately pay the full cost actuarial premium.[8]

The Senate Banking Committee passed its version of the bill on September 8, 2011. This proposal would forgive the NFIP's nearly $18 billion debt, and unlike the House bill, would only allow for premiums to be increased by 15 percent per year to reach their actuarially indicated levels that reflect the true risk of flooding.[9]

An important point to note is that while both bills deal with phasing in updated risk-based premiums, they do not tackle the issue of affordability, which is what we will examine later in this paper, with a comparison of the affordability effects of each of these bills.

3.4   Focus of Our Study: Texas

Our study seeks to build on the study *A Methodological Approach for Pricing Flood Insurance and Evaluating Loss Reduction Measures: Application to Texas*, conducted by the Wharton Risk Center, Swiss Re and CoreLogic. Swiss Re is one of the leading global reinsurers, and CoreLogic is a large data analytics provider to businesses and government. This study assesses the risks and associated costs and benefits of a selected number of loss reduction measures (mitigation measures) and also compares different pricing methods with those used by the NFIP.[10] The

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[8]Brockway, Jaime L. "Obama supports fewer NFIP premium subsidies, cutting $4.2 billion." Insurance & Financial Advisor. Web. 1 Feb. 2012.

[9]"Senate Committee Passes Federal Flood Insurance Reform Legislation." Insurance Journal - Property Casualty Insurance News. Web. 9 May 2012.

[10]Czajkowski, Jeffrey, Howard Kunreuther, and Erwann Michel-Kerjan. "A Methodological Approach for Pricing Flood Insurance and Evaluating Loss Reduction Measures: Application to Texas." Center for Risk Management and Decision Processes, The Wharton School, University of Pennsylvania (2011).

study focuses on Travis County and Galveston County in Texas, and our study specifically uses data on Galveston County's existing premiums and updated risk-based premiums from this Texas study.

3.5 Why Texas?

There are a number of factors that make Texas an ideal focus of study for this report. In terms of flood risk, Texas is frequently affected by hurricanes and other tropical cyclones; there is exposure to both storm surge and riverine flooding. Texas also has the second largest number of NFIP policies-in-force after Florida, at 12% of total policies-in-force. Additionally, there are several socioeconomic factors that make Texas an important state to study. In terms of population, Texas is the second most populous state in the U.S. with over 24 million residents, and is one of the fastest growing states in the nation, averaging 21% population growth per decade since 1960. Finally, Texas has the second largest state GDP in the U.S. at over $1.2 trillion.

3.6 Galveston County: Background and Flood Risk

In the following study, we present a detailed analysis of the impact on Galveston County of switching from its current insurance premiums to updated risk-based premiums, and the implications on the affordability of flood insurance for Galveston's residents.

Galveston County is located on the southeastern coast of Texas and is comprised of the mainland, Galveston Bay and Galveston Island[11] (see Figures 2 and 3). Galveston County currently has a population of 287,918[12] (ranking as the 16th most populated county in the state, of 254 counties) with a median household income of $58,324 according to the 2010 Census. As seen in Figure 4, Galveston County's income distribution is skewed to the left, with 13% of the population in poverty.[13] Poverty and a skewed income distribution are both key issues for the county. In addition, the unemployment rate is higher than the Texas average (at 9.8% vs. 8.7%).[14]

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[11]Diana J. Kleiner. "GALVESTON COUNTY." Handbook of Texas Online.

[12]Hoque, Nazrul. "Estimates of the Total Populations of Counties and Places in Texas for July 1, 2009 and January 1, 2010." (2010): Texas State Data Center. Web. 8 Feb. 2012.

[13]"Small Area Income and Poverty Estimates." U.S. Census Bureau. Web. 8 Feb. 2012.

[14]"Map: LA." Databases, Tables & Calculators by Subject. Web. 8 Feb. 2012.
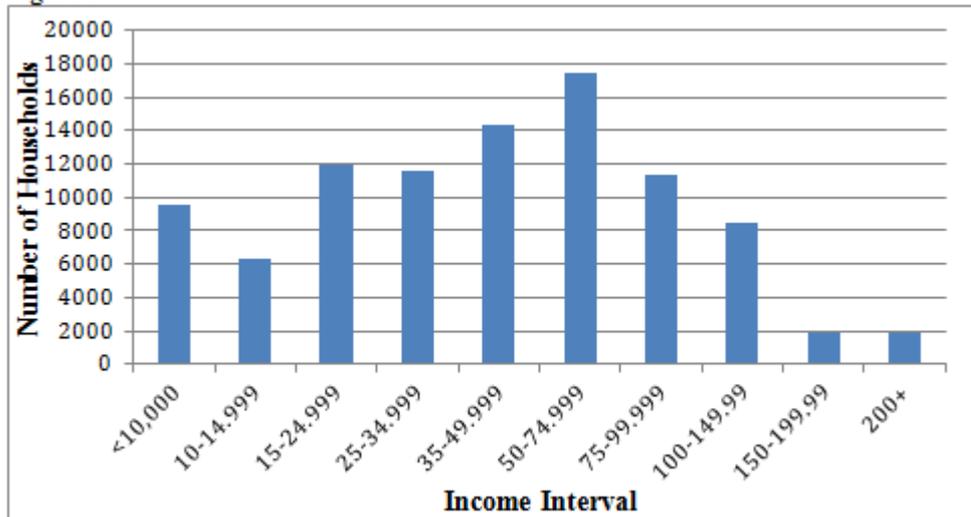
Figure 3

Map of Galveston County
http://en.wikipedia.org/wiki/File:Galveston_count
y_map.jpg

Figure 2

Map of Texas Highlighting Galveston County
http://en.wikipedia.org/wiki/File:Map_of_Texas_highlighting_Galvesto
n_County.svg

Figure 4

Galveston County is further appropriate for the analysis because the county is exposed to both types of flood risk: flash floods from excess rain as well as flooding from hurricanes moving large bodies of water. Galveston is the Texas county most frequently hit by hurricanes and tropical storms, most recently being directly hit by Hurricane Ike in 2008.[15] The damage from Hurricane Ike was severe, with about 17,000 homes seriously damaged. Of these homes, 5,200 of the families affected did not have flood insurance. Joe Higgs of Gulf Coast Interfaith (a group that helped hurricane victims in Galveston) said that most of the home-

[15]Czajkowski, Jeffrey, Howard Kunreuther, and Erwann Michel-Kerjan. "A Methodological Approach for Pricing Flood Insurance and Evaluating Loss Reduction Measures: Application to Texas." Center for Risk Management and Decision Processes, The Wharton School, University of Pennsylvania (2011).

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owners affected were poor or elderly. This is supported by the fact that significant percentages of Galveston's poor and elderly populations reside in flood plains, as discussed later in this section.[16]

Galveston County has also been hit by hurricanes that caused major damage in 1900, 1915, 1961 and 1983[17] , with the hurricane in 1900 the most severe one the county has experienced. Galveston Island was hit by this Category 4 hurricane on September 8, 1900. The hurricane killed approximately 8,000 people, and is considered the deadliest storm in U.S. history. Engineers built a sea wall to protect Galveston Island in 1902, which reduced the effect of later storms, and even raised the entire city, but the city remained vulnerable.

The county contains 17 Zip Codes with varying levels of flood risk depending on house location, elevation and type. Given the large size of Galveston, there are many households in each income bracket as reported by the U.S. Census Bureau. In terms of exposure of the NFIP, Galveston is ranked second, with nearly $14 billion in NFIP-insured exposure. The total number of NFIP policies in place was 64,694 in 2008.[18]

What makes Galveston County a particularly appropriate county for this study on affordability is that a large percentage (33%) of its population is located in a FEMA floodplain (see Figure 5); the National Oceanic and Atmospheric Association (NOAA) ranked Galveston County second out of 18 Texas coastal counties for the percentage of the population located in a FEMA floodplain. Moreover, Galveston County was ranked first out of the 18 Texas coastal counties in the same study for the percentage of designated "high-risk" populations located in a FEMA floodplain, with 37% of the total population over 65 living in a floodplain and almost half (43%) of the total population in poverty located in a floodplain.[19]

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[16]McKinley Jr., James C. "As Galveston Recovers From Hurricane Ike, Some Residents Feel Left Behind - NYTimes.com." The New York Times. 20 Sept. 2009. Web. 9 May 2012.

[17]Diana J. Kleiner, "GALVESTON COUNTY," Handbook of Texas Online.

[18]Czajkowski, Jeffrey , Howard Kunreuther, and Erwann Michel-Kerjan. "A Methodological Approach for Pricing Flood Insurance and Evaluating Loss Reduction Measures: Application to Texas." Center for Risk Management and Decision Processes, The Wharton School, University of Pennsylvania (2011).

[19]Coastal County Snapshots - NOAA Coastal Services Center." NOAA Coastal Services Center. Web. 8 Feb. 2012.

Figure 5
Galveston County Floodplain

"Coastal County Snapshots - NOAA Coastal Services Center." NOAA Coastal Services Center. Web. 8 Feb. 2012. <http://www.csc.noaa.gov/snapshots/#flood&48167>.

4   Analysis

4.1   Determining Risk-Based Premium Calculations

Building off "A Methodological Approach for Pricing Flood Insurance and Evaluating Loss Reduction Measures: Application to Texas,"[20] we use the results of this study on the cost of insuring a large sub-sample of houses in each zip code to determine how flood insurance premiums would change given a shift from current premiums to the risk-based premiums calculated using sophisticated catastrophe models common in the insurance industry. We calculate changes in flood insurance premiums for 14 of the 17 Zip Codes that comprise Galveston. Three Zip Codes are left out of the study: 77511, 77546 and 77581, because there was insufficient data on houses in these Zip Codes to run a catastrophe model with requisite statistical significance and because most of the houses for which data is available is from one subpopulation of the zip code which is not representative of the zip code as a whole.

Before we proceed, it is important to understand how Swiss Re's catastrophe models work. A rudimentary, simplified sketch is as follows: CoreLogic collects data on each building in Galveston County. Collected data for each building may include height above sea level, horizontal distances to each nearby body of water, strength of building foundation, and many other variables on which the amount of damage caused by a flood and the likelihood of a flood are dependent. Swiss Re then runs a stochastic simulation in which floods of different type and magnitude

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[20]Czajkowski, Jeffrey, Howard Kunreuther, and Erwann Michel-Kerjan. "A Methodological Approach for Pricing Flood Insurance and Evaluating Loss Reduction Measures: Application to Texas." Center for Risk Management and Decision Processes, The Wharton School, University of Pennsylvania (2011).

occur over time. After running the stochastic simulation many times, the result is a probability distribution with respect to the cost of damages to each house. Finally, the average annual loss (AAL), the expected cost of damage done to each building over a year's period of time, is computed. Averaging the AAL for each building in a given zip code yields the mean risk-adjusted premium for that zip code. We should note both the current NFIP premiums and risk-adjusted premiums do not include loading costs (that is, costs of administration, marketing, operating). Furthermore, the simulations used to calculate the AAL are performed under the true probability measure, not the risk-neutral measure, and thus are not adjusted for the risk preferences of the insurer. Thus, the risk-adjusted premiums below do not compensate insurers for bearing the risk of losses and thus are lower bounds on premiums that insurers would actually charge. The difference between the AAL and the price charged by an insurance company would depend heavily on the variance of flood damages, particularly the fatness of the right tail of the distribution for which they may need to purchase reinsurance to protect themselves against a catastrophic loss.

Assumptions:

1. We assume the number of households within a certain income bracket have incomes uniformly distributed across the bracket. For example, if there are 10,000 houses in the \$25,000 to \$35,000 income bracket and the mean premium increase is \$1000, this then assumes there are 1,000 households with incomes between \$25,000 and \$26,000 who would fall below \$25,000 as a result of the premium increase. Note this assumption is necessary because we do not have household-level income data.

2. We assume the distribution of income for those with flood insurance is identical to the distribution of income for all citizens in Galveston County (there is no selection bias with regard to income when focusing on households with flood insurance policies).

3. We assume every household will experience the mean increase in premium for a given zip code. This assumption is necessary because we do not know the current premiums and risk-based premiums on a household level, only on a zip code level. Thus the implicit assumption is also made that the sampling of houses used by the aforementioned study is representative of those currently covered by flood insurance policies.

4. We assume the distribution of incomes in 1999 is the same as it is now and we can convert from 1999 dollars to 2011 dollars simply by looking at the

increase in the median income. This assumption is necessary because we do not have more recent income data at the zip code level.

Thus, the following analysis is an example of analyses that could be done to examine how changes to the NFIP would affect homeowners, rather than a near-perfect calculation of affordability rates in Galveston County.

The table below, broken down by zip code, shows the current mean NFIP premium paid by the average household, the mean risk-adjusted premium (as projected by Swiss Re's catastrophe models), and the dollar (percentage) change between the two figures. The main takeaways from this table are as follows:

1. "Flood risk" differs drastically by zip code. As the table shows, zip code 77517 needs to pay only $165.68 on average to insure against losses whereas zip code 77554 needs to pay $2,399.57 on average to insurance against future losses. Comparing the two numbers, we can rationalize flood risk as approximately fourteen times as great (on average) in the later zip code as compared with the former.

2. Changes in flood risk have not occurred uniformly across the county. Taking the mean current NFIP premium as a proxy for the flood risk as determined by the outdated flood maps, and the risk-adjusted premium as a proxy for the current flood risk, we see the percentage change in risk is not constant across the Zip Codes. Some Zip Codes, such as 77517, are actually paying much more than is warranted given the current risk of flooding, whereas other Zip Codes are paying significantly less than is warranted given the current risk of flooding. Under this framework, the expected value of future losses has actually decreased in zip code 77517 since the creation of the old maps.

Table 1: Rate Changes by Zip Code

Zip Code	Current Premium NFIP	Risk-Adjusted Premium	$ Change	% Change
77510	$ 296.29	$ 270.68	$ (25.61)	-8.6%
77517	$ 290.54	$ 165.68	$ (124.86)	-42.97%
77518	$ 297.42	$ 301.08	$ 3.66	1.23%
77539	$ 396.83	$ 606.47	$ 209.64	52.83%
77550	$ 881.14	$ 804.05	$ (77.08)	-8.75%
77551	$ 866.54	$ 1,161.07	$ 294.53	33.99%
77554	$ 1,786.43	$ 2,399.57	$ 613.14	34.32%
77563	$ 701.16	$ 983.58	$ 282.42	40.28%
77565	$ 549.06	$ 1,422.41	$ 873.35	159.06%
77568	$ 322.04	$ 599.44	$ 277.40	86.14%
77573	$ 307.06	$ 534.08	$ 227.02	73.93%
77590	$ 292.03	$ 728.48	$ 436.45	149.45%
77591	$ 277.79	$ 325.77	$ 47.98	17.27%
77650	$ 1,411.04	$ 987.29	$ (423.74)	-30.03%

4.2 Affordability

The analysis is performed as follows: for each zip code, we calculate the mean increase (or decrease) in premium a household would experience when moving from the current premium to the risk-based premium given by the aforementioned study. Then, we define affordability as a percentage above the official poverty line and calculate the expected number of households that would fall below that income level from the income loss resulting from the premium increase. The results are shown in Table 2. Note we show our analysis for two different defined affordability levels: the poverty line and 150% of the poverty line.

The table below documents the affordability analysis for each zip code. The first two columns show "current affordability" (that is, the percentage of households which are above the poverty line and 150% of the poverty line in a given zip code). The middle two columns indicate affordability after the premium increase (or decrease). As stated above, each household's yearly income in each zip code is decreased by the difference between the current NFIP premium (which we assume they are currently paying) and the risk-adjusted NFIP premium (which we assume they will be paying). The percentage of households who fall under the defined affordability lines after the requisite income adjustment are thus displayed. Finally,

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in the right two columns, the percentage changes in affordability due to the premium increases are shown. We note that Zip Codes 77517 and 77650 experience a decrease in the number of households who are now under the poverty line (for both Zip Codes) and a decrease in the number of households who are now under 150% of the poverty line due to significant premium decreases, as seen in Table 1 above.

Table 2: Affordability Statistics By Zip Code

Zip Code	Number of Households	Current Affordability		Affordability After Premium Increase/Decrease		% Change in Affordability	
		100% PL	150% PL	100% PL	150% PL	100% PL	150% PL
77510	4596	19.8%	31.4%	19.7%	31.3%	0.0%	0.0%
77517	1920	18.2%	32.0%	18.0%	31.8%	-0.2%	-0.3%
77518	2427	33.5%	52.3%	33.6%	52.3%	0.0%	0.0%
77539	11452	25.9%	42.1%	26.3%	42.5%	0.3%	0.4%
77550	5450	47.5%	65.4%	47.5%	65.4%	0.0%	0.0%
77551	3952	35.0%	50.1%	36.0%	50.8%	1.0%	0.7%
77554	6820	22.3%	35.8%	22.8%	36.3%	0.4%	0.4%
77563	3680	31.9%	49.1%	32.4%	49.6%	0.4%	0.6%
77565	**2215**	**17.0%**	**28.2%**	**18.1%**	**29.5%**	**1.1%**	**1.2%**
77568	3610	30.8%	49.7%	31.5%	50.6%	0.8%	0.9%
77573	21380	9.6%	18.2%	9.8%	18.4%	0.1%	0.1%
77590	8538	31.5%	47.4%	32.9%	48.5%	1.4%	1.1%
77591	2061	35.2%	50.9%	35.4%	51.0%	0.2%	0.1%
77650	1644	32.2%	47.8%	31.6%	47.3%	-0.5%	-0.5%

To provide additional insight behind the calculations in the table above, we will illustrate changes for a sample zip code. Take, for instance, zip code 77565. From the table above, we notice from the left two columns that 17.0% of households in this zip code currently have yearly incomes less than the federal poverty line. Likewise, 28.2% of households in this zip code currently have yearly incomes less than 150% of the federal poverty line. The middle two columns document affordability after the premium increase. From the table documenting rate changes, we see households in this zip code on average need to be paying an extra $873 in flood insurance each year. Thus, after $873 is subtracted from each household's annual income in zip code 77565, 18.1% of households are now below the poverty line and

29.5% are below 150% of the poverty line. With an eye on the right two columns of the table, we see this represents a 1.1% increase in the number of households below the poverty line and a 1.2% increase in the number of households below 150% of the poverty line.

Thus, if we define affordability as having an annual income above the poverty line, 1.1% of households in this zip code were originally able to afford flood insurance and now can no longer do so after the premium increase. Additionally, another 11.9% of the population was never able to afford flood insurance in the first place and continues to not be able to do so. The remainder of the population can still afford flood insurance after the premium increase.

4.3 Proposal: Flood Insurance Vouchers

An important follow-up question related to affordability and relevant for policy makers is – who pays? We first propose the government will bear the full cost in the form of providing vouchers to citizens to cover the premium increases. Note that these vouchers have to be used to pay for flood insurance and cannot be used for other purposes. We then show the same calculations under various public policies, such as not giving vouchers to households whose income is above a certain level. The results are shown for a level of $200,000, $150,000 and $100,000. As we decrease the income level, the share of the premium increase paid by the government drops as the share paid by high-income citizens rises. Note it is likely not all citizens will actually use the vouchers when purchasing insurance so the expected amount paid by the government is an upper-bound, as it assumes all citizens will redeem vouchers.

In Table 3 below, we generate a variety of scenarios to illustrate the relative, monetary share of the increased flood risk borne by the government and individuals. These scenarios are laid out below:

Scenario A: Households with total income above $200,000 do not receive vouchers

Scenario B: Households with total income above $150,000 do not receive vouchers

Scenario C: Households with total income above $100,000 do not receive vouchers

Scenario D: Only households below 150% PL receive vouchers

Scenario E: Only households below 100% PL receive vouchers

Table 3: Major Stakeholders – Spending Required

Scenario	Amount Paid by Government (Thousand U.S.D)	Amount Paid by Individuals (Thousand U.S.D)	Number of Households Receiving Vouchers
A - below $200,000 net income	12,000	400	38,500
B - below $150,000 net income	11,700	700	37,600
C - below $100,000 net income	10,400	2,000	33,500
D - below 150% PL	4,400	8,000	13,700
E - below 100% PL	2,700	9,700	8,600

The rightmost column of the table, the number of households receiving vouchers, is estimated as follows: we first calculate the number of households that qualify for a voucher (as indicated by the given scenario) for each zip code. Second, we calculate the percentage of houses in the given zip code which have flood insurance (out of the total number of houses in that zip code). Finally, we multiply the percentage of houses with flood insurance by the number of households which qualify for a voucher to arrive at the number of households which will receive a voucher.

4.4 Additional Scenarios: Altering our definition of affordability

Our analysis thus far has used two different definitions of affordability: a household is eligible for the voucher scheme if they are below 100% of the poverty line, and a household is eligible for the voucher scheme if they are below 150% of the poverty line. We have defined affordability based on income relative to the poverty line as this definition seems to be common among literature dealing with affordability.[21]

Additional scenarios for the provision of vouchers to households could be created based on the common "income limits" used by the U.S. Department of Housing and Urban Development (HUD). Income limits are established by the HUD to help determine whether households are eligible for certain programs provided by the HUD (e.g. HUD-subsidized housing).[22]

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[21]Kunreuther, Howard C., and Erwann O. Michel-Kerjan. At War With the Weather. Cambridge, MA: The MIT Press, 2011.

[22]"HUD HANDBOOK 4350.3: OCCUPANCY REQUIREMENTS OF SUBSIDIZED MULTI-FAMILY HOU.S.ING PROGRAMS." Department of Housing and Urban Development, 2003.

HUD establishes and publishes income limits for each county or Metropolitan Statistical Area (MSA) in the country. The income limits are based on the median income of the geographic area for which the limit is established, or the "area median income."[23] HUD uses the following limits to define very-low income households, low-income households and moderate-income households:

1. Very-low income: persons at or below 30% of the Area Median Income (AMI)

2. Low-income: persons at or below 50% of the AMI

3. Moderate income: persons at or below 80% of the AMI[24]

Using these definitions, certain programs may only be available to low-income and very-low income housing vs. all three income limit groups.

In our study, we create three additional scenarios for our affordability vouchers:

1. Provide vouchers only to those households categorized as very-low income

2. Provide vouchers to those households categorized as very-low income and low-income

3. Provide vouchers to those households categorized as very-low income, low-income and moderate income

The analysis was performed as above in the case of the 100% and 150% of the poverty line definitions of affordability. For each zip code, we used the mean increase (or decrease) in premium a household would experience when moving from the current premium to the risk based premium given by the study conducted by the Wharton Risk Center. Then, we define affordability as a percentage of the Area Median Income (referring to Galveston County's median income) and calculate the expected number of households that would fall below that income level from the income loss resulting from the premium increase. The results are shown in Table 4 below. Note we show our analysis for the three different defined affordability levels: 30% of AMI, 50% of AMI and 80% of AMI. Households below 30% of the area median income had annual income of $17,495.10 or less, households below 50% of the area median income had annual income of $29,159.50 or less, and households below 80% of the area median income had annual income $46,653.60 or less.

[23] "CHAPTER 3. ELIGIBILITY FOR ASSISTANCE AND OCCUPANCY 4350.3 REV-1." HUD Occupancy Handbook. Department of Housing and Urban Development. Web. 9 May 2012.

[24] "Finding affordable housing, affordable apartments and rental homes." Apartments for rent — Affordable Housing — Section 8. Web. 9 May 2012.

Table 4: Affordability Statistics By Zip Code (AMI Standard)

Zip Code	% of households within each income limit below before premium increase			% of households within each income limit below after premium increase			% Falling Below Affordability Line		
	30% AMI	50% AMI	80% AMI	30% AMI	50% AMI	80% AMI	30% AMI	50% AMI	80% AMI
77510	14.5%	26.0%	45.2%	14.4%	26.0%	45.2%	0.0%	0.0%	-0.1%
77517	13.0%	25.3%	41.7%	12.8%	25.1%	41.5%	-0.2%	-0.3%	-0.2%
77518	25.5%	43.5%	66.3%	25.5%	43.5%	66.3%	0.0%	0.0%	0.0%
77539	19.2%	34.5%	56.3%	19.5%	34.8%	56.6%	0.3%	0.4%	0.3%
77550	38.4%	57.3%	76.9%	38.4%	57.3%	76.9%	0.0%	0.0%	0.0%
77551	25.2%	43.7%	65.2%	26.3%	44.4%	65.8%	1.0%	0.7%	0.7%
77554	16.1%	29.6%	45.7%	16.6%	30.0%	46.0%	0.4%	0.4%	0.3%
77563	25.6%	40.8%	61.9%	26.1%	41.4%	62.3%	0.4%	0.6%	0.4%
77565	12.3%	23.0%	38.8%	13.3%	24.2%	39.8%	1.1%	1.2%	1.1%
77568	22.7%	40.8%	63.7%	23.4%	41.7%	64.2%	0.8%	0.9%	0.6%
77573	6.4%	14.1%	28.8%	6.5%	14.3%	29.0%	0.1%	0.1%	0.1%
77590	22.2%	40.4%	61.1%	23.6%	41.5%	62.0%	1.4%	1.1%	0.9%
77591	26.1%	44.0%	64.4%	26.2%	44.2%	64.5%	0.2%	0.1%	0.1%
77650	24.9%	40.6%	59.2%	24.9%	40.6%	59.2%	0.0%	0.0%	0.0%

As in our analysis above, we developed three distinct scenarios for which households would receive affordability vouchers and which would not. The monetary share of the increased flood risk borne by governments and individuals in each scenario is expressed in Table 5 below:

Table 5: Major Stakeholders – Spending Required (AMI Standard)

Scenario	Amount Paid by Government (Thousand U.S.D)	Amount Paid by Individuals (Thousand U.S.D)	Number of Households Receiving Vouchers
30% AMI	2,000	10,400	6,200
50% AMI	3,600	8,800	11,400
80% AMI	5,800	6,600	18,600

4.5   Phasing In Updated Risk-Based Premiums

Having analyzed the impacts a move to risk-based premiums would have on the affordability of insurance in Galveston County, it is important to look at certain

other challenges in the implementation of updated risk based premiums. One of the points of interest that emerged when comparing the Senate Banking Committee's and House of Representative's bills is the fact that they differ in the rate at which they permit insurance premiums to increase per year in order to reach their "actuarially-indicate levels that reflect the true risk of flooding".[25] Currently, the premiums cannot be increased by more than 10% a year. The Senate bill would allow premiums to increase by 15% a year, while the House bill would allow premiums to increase at 20% a year.

Using an illustrative example from our data on Galveston County, we can see that it would take a maximum of 10 years to reach the risk-based premium levels (at the 10% premium increase rate). While the gradual phasing in of increased premiums is important – it would seem almost incomprehensible from a politician's point of view for their constituents to experience a steep increase in premiums within the span of a year – it is also important to consider how practical a phase-in policy is and the potential downsides to having a phase-in policy rather than an immediate implementation of risk-based premiums.

The graph below shows the percentage of Zip Codes in Galveston County (of a total of 14 Zip Codes) that have reached risk-based levels over time. We see for the more aggressive strategy (20% phase in policy), it takes only 6 years until all Zip Codes are at risk-based levels (as measured by the mean). For a slower phase-in policy of 10%, it takes 10 years until all Zip Codes are at risk-based levels. These results strongly indicate the importance of an aggressive phase-in strategy. While a phase-in policy of 10% is understandable in order to protect those who may be unable to afford a steeper increase in their premiums, our proposal above of providing vouchers to households to assist with the affordability of these premium increases could actually allow for a more aggressive strategy to be put in place.

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[25] "Senate Committee Passes Federal Flood Insurance Reform Legislation." Insurance Journal. 8 Sept. 2011. Web. 20 May 2012.

Number of Years to Reach Risk-Based Levels
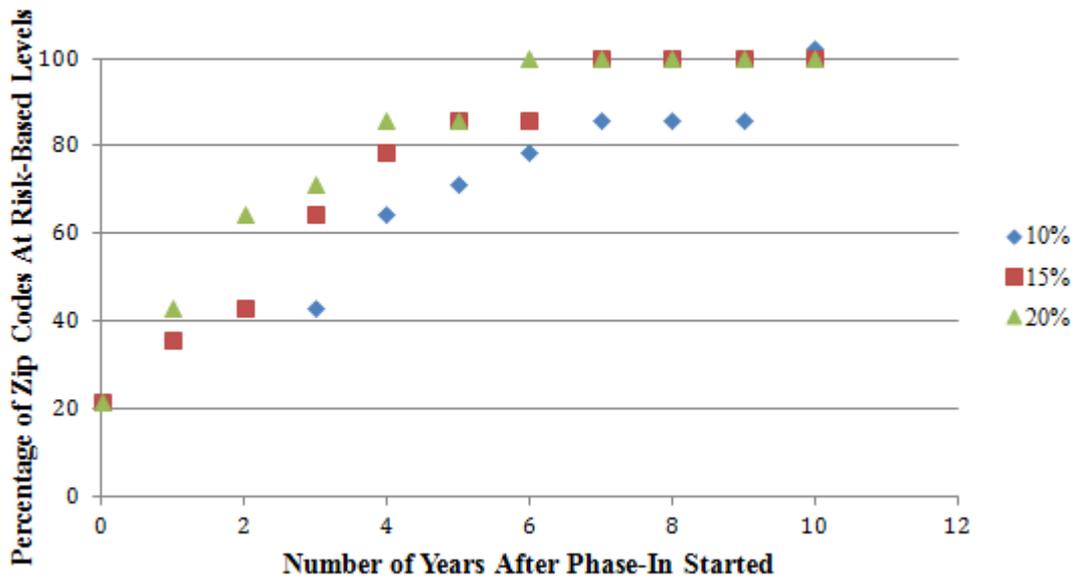
We propose that premiums should be adjusted for risk immediately, alongside the implementation of insurance vouchers. This proposal has the potential to make the NFIPreforms more politically feasible. We recommend that insurance vouchers support the immediate implementation of risk-based premiums since, as is seen in our data on Galveston, there are going to be households that cannot afford an immediate increase in premiums. These households would be supported by the insurance voucher scheme, resolving equity issues.

The immediate implementation of risk-based premiums would offer a number of benefits for the NFIP. Firstly, an immediate implementation of risk-based premiums would discourage development in high-risk areas. In the cases where risk-based premiums represent an increase on current premiums, these increased premiums would act as significant disincentives for families or individuals looking to move into these areas. Risk-based premiums would allow families and individuals to make more fully-informed decisions as the new premiums would reflect the real hazard in the area rather than a misleading subsidized rate. Even if those looking to move into the area choose not to take into consideration the actual flood risk involved, they are more likely to be deterred by an immediate increase in the premiums they would have to pay, solely from a financial viewpoint, rather than a gradual increase in premiums spread over a few years which they may not consider as severe.

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In addition, the immediate implementation of risk-based premiums would improve the financial sustainability of the program by increasing funding. As we saw in our analysis, there are households that can afford the new risk-based premiums. Hence, the NFIP would no longer have to subsidize these households. Financially, this is a much more sustainable option than the NFIP slowly phasing out premium subsidies to those who do not need the subsidization while still subsidizing premiums for those who cannot afford the increases.

Finally, immediate implementation of risk-based premiums would also further encourage households to adopt mitigation measures. As discussed in the section below, there are a number of biases that prevent homeowners from investing in mitigation. An important barrier to investment in mitigation measures is that people do not have an accurate understanding of their exposure to flood risk. If a household's premium were to increase significantly, an immediate increase in their premium would more likely help them understand that their home is located in a high-risk area. If their premiums increased over a period of six to 10 years, the impact of the premium increase would not be as strong. If a household were made aware of the actual risk they were facing, they would be more likely to employ mitigation measures in order to reduce their flood risk.

5 Mitigation

In our study so far, we have been working under the assumption that the physical exposure to flood risk stays the same for all households in Galveston. It is, however, important to look at ways in which one can reduce exposure to flood risk as well. In this respect, we have chosen to explore the importance of mitigation measures (i.e. risk reduction), and the ways in which efforts towards mitigation should be incorporated into any changes in insurance premiums that move towards updated risk-based premiums. In addition, one of the primary drivers for a move towards accurate and updated risk-based premiums is that homeowners will recognize their real exposure to risk. This recognition should incentivize homeowners to adopt mitigation measures more readily. There are, however, a number of decision biases and constraints that prevent homeowners from investing in flood mitigation.

5.1 Decision-Making Process For Purchasing Mitigation Measures

In looking to incorporate the adoption of mitigation measures into a more comprehensive strategy to create more affordable insurance premiums, it is important to first examine homeowners' decision-making process and associated biases in choos-

ing whether or not to purchase mitigation.

When making mitigation purchase decisions, individuals think about a wide range of considerations and goals. These can vary from financial considerations to emotion-related goals, such as reducing anxiety or avoiding regret. How people prioritize each goal varies by individual and context. For instance, people often buy flood insurance after suffering losses in a flood, but cancel their policies after several years without a flood.[26] After a flood, anxiety is high, and people seek to reduce and avoid it, but after some time with no flood, people feel more at peace and are less concerned with a flood occurring. Similarly, people will choose to invest in mitigation measures only after suffering losses in a flood or if flood risk has been made more salient to them (by flooding in neighboring towns, or other parts of the country). Experimental findings also reveal that "people focus on the unpleasantness of the outcome rather than on its probability when they have strong emotional feelings attached to the event."[27] Moreover, after suffering a loss, people may invest in mitigation as a form of consolation. However, they are unlikely to invest if their community has not been impacted by a flood in many years.

Decisions to protect against natural hazards, in the form of both purchasing insurance and investing in mitigation, are also based in part on what other people are doing or think is appropriate according to social and cognitive norms. One example of this behavior comes from a pretest interview of an earthquake questionnaire, whereby a homeowner indicated that he would buy earthquake insurance after hearing that his neighbor had purchased it, even though his beliefs about the risk he was facing and the actual cost of the coverage did not change.[28] As when buying new products, people are influenced by what others are doing in deciding whether or not to buy insurance.

Myopia is also a key bias, whereby people tend to focus on short-term horizons. As a result of myopia, people fail to consider the future occurrence of a catastrophe and assume it will not happen to them. Conventional wisdom holds that major catastrophes are low-probability events, which further compounds the problem since people are even less likely to believe those catastrophes will occur and thus choose not to protect against them by buying insurance or investing in mitigation.

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[26]Kunreuther, H., Meyer, R., Michel-Kerjan, E. (in press). "Overcoming Decision Biases to Reduce Losses from Natural Catastrophes," in E. Shafir (ed.), Behavioral Foundations of Policy, Princeton University Press.

[27]Kunreuther, H., Meyer, R., Michel-Kerjan, E. (in press). "Overcoming Decision Biases to Reduce Losses from Natural Catastrophes," in E. Shafir (ed.), Behavioral Foundations of Policy, Princeton University Press.

[28]Ibid

People will focus only on the potential benefits of protecting their homes over the next several years due to myopia, but will find it difficult to justify a high, upfront investment for loss reduction measures, even though they will be effective for 20 to 30 years.

Furthermore, many households are reluctant to invest in mitigation measures due to a tendency to discount future benefits more heavily, especially if they know they are already insured against losses from floods. A survey of 1,131 individuals conducted by the Department of Environment, Food and Agriculture (DEFRA) in the UK showed that many households and small businesses in areas of significant flood risk recognize the benefits of property-level measures, including the potential long-term financial savings, greater feelings of safety and reductions in the disruption caused by floods. However, the survey also showed that "many people are deterred from taking action because they feel [the measures] are expensive or not their responsibility."[29]

In addition to these decision biases, budget constraints exist ("I live from payday to payday"), especially in regions such as Galveston County. The above sections of our study focused on the challenges of affordability of insurance. Mitigation measures are often seen as a secondary or additional step for protection after having purchased insurance. For households that are unable to afford flood insurance at the increased risk-based premium rates, a key question arises as to how they could be expected to adopt flood mitigation measures that require significant up-front investments as well.

5.2 Encouraging Investment in Mitigation: Mitigation Loans

Continuing to look at affordability in relation to mitigation investments, we find that it is crucial to offer assisted financing for mitigation efforts. While this is especially important for those who may be unable to afford the high up-front costs, even those who are able to afford the costs may choose not to invest in these measures.

As such, we propose that FEMA or financial institutions offer long-term mitigation loans to encourage investment in mitigation measures. These loans, to be paid back over the long-term, would make investment into mitigation more affordable and would spread the high investment costs over time. For low-income households, mitigation loan payment assistance could be provided. In addition,

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[29] "Developing the evidence base for flood resistance and resilience: Summary Report." Department of Environment, Food and Rural Affairs. Environment Agency. Web. 9 May 2012

if the mitigation measures are effective, we expect households to experience a reduction in their risk-based premiums. The savings from a household's reduced premiums could be used towards repayments of the mitigation loan. This once again highlights the importance of premiums accurately reflecting the flood risk, as risk-based premiums will be updated to reflect the new, reduced risk after the household's investment in mitigation.

While this scheme should incentivize households to adopt mitigation, challenges remain regarding the awareness of the actual measures a homeowner may undertake to mitigate flood risk. The survey mentioned above, conducted by DEFRA in the UK of households and small businesses in areas of significant flood risk, showed that the flood resistance or resilience measure of which most people were aware was the sandbag, despite the fact that most flood management experts consider sandbags to be a largely ineffective preventative technique. In addition, less than one in four of the 1,131 surveyed were able to recall any resistance measures (measures to prevent entry of water into a building fabric) other than sandbags and only one in ten could think of an example of a resilience (measures to limit the impact of flood water within a building) measure.[30]

Hence, it is imperative that these mitigation loans be coupled with information sharing on the forms of mitigation available to households. It is important to weigh the costs of implementing certain mitigation measures versus the benefits in terms of reduced risks to households. In certain cases, such as the elevation of an existing house, the costs involved may outweigh the benefits gained from a reduced exposure to risk. Information sharing of which mitigation measures homeowners should take on and which may be ineffective becomes a key part of the process.

We note that our focus for this mitigation proposal, however, is on the creation of new structures rather than an assessment of existing homes.

6 Conclusion

With the U.S. debt ceiling issues from the summer of 2011, the significant flood losses from recent hurricanes and the uncertain future of the National Flood Insurance Program, it is a crucial time to review the program and propose structural changes. While the House and Senate have suggested a shift towards risk-based premiums that more accurately reflect flood risk, it is also important to examine this shift's impact on affordability for homeowners. As we have shown in this pa-

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[30] "Developing the evidence base for flood resistance and resilience: Summary Report." Department of Environment, Food and Rural Affairs. Environment Agency. Web. 9 May 2012.

per, these new risk-based premiums have important implications for homeowners, but moving to risk-based premiums can be effective with appropriately designed supports to achieve policy goals. We suggest an immediate implementation of the updated risk-based premiums, instead of the phase-in proposed by the legislative bills, so that insurance payments would help improve program funding and thereby its sustainability. At the same time, we recommend that the government provide insurance vouchers to reduce the financial burden of premium increases on homeowners. Lastly, we propose mitigation loans as a way to incentivize homeowners to employ mitigation measures and reduce flood exposure.

We recognize, however, that further study is needed before the implementation of the above recommendations. Our focus on Galveston County in this paper represents a small subset of the potential impact of the implementation of the updated risk-based premiums. Moreover, our proposal for mitigation loans will more likely affect new construction than existing homes. In general, it will be important for the government to conduct a cost-benefit analysis of updating floodplain maps to determine new risk-based premiums and study more in-depth the costs and benefits of providing insurance vouchers and mitigation loans.

Furthermore, aside from the various scenarios we have conducted to examine the impact of insurance vouchers to improve affordability, there are additional ones that would be interesting to explore for further research. Two ideas are as follows:

1. Analysis of second homes: In this scenario, the government would not provide insurance vouchers to homes that have been identified as second homes or vacation homes.

2. Analysis of repetitive losses: In this case, the government would not provide insurance vouchers to homes that have suffered repetitive losses.

While there are further research points to consider, this paper begins to examine the affordability effects of the implementation of the updated risk-based premiums for flood insurance according to recent legislative proposals. The Senate and House bills need to be reconciled with appropriate policy supports to ensure the sustainability of the National Flood Insurance Program and to minimize negative effects on affordability while reducing flood exposure and losses.

7   Acknowledgements