

**Managing Catastrophes through Insurance:  
Challenges and Opportunities for Reducing Future Risks**

**Howard Kunreuther**  
*The Wharton School*  
*University of Pennsylvania*  
[Kunreuther@wharton.upenn.edu](mailto:Kunreuther@wharton.upenn.edu)

**Erwann Michel-Kerjan**  
*The Wharton School*  
*University of Pennsylvania*  
[ErwannMK@wharton.upenn.edu](mailto:ErwannMK@wharton.upenn.edu)

November 2009

Working Paper # 2009-11-30

---

Risk Management and Decision Processes Center  
The Wharton School, University of Pennsylvania  
3730 Walnut Street, Jon Huntsman Hall, Suite 500  
Philadelphia, PA, 19104  
USA  
Phone: 215-898-4589  
Fax: 215-573-2130  
<http://opim.wharton.upenn.edu/risk/>

---

## CITATION AND REPRODUCTION

This document appears as Working Paper of the Wharton Risk Management and Decision Processes Center, The Wharton School of the University of Pennsylvania. Comments are welcome and may be directed to the authors.

This paper may be cited as: Howard Kunreuther and Erwann Michel-Kerjan, “**Managing Catastrophes through Insurance: Challenges and Opportunities for Reducing Future Risks**” Risk Management and Decision Processes Center, The Wharton School of the University of Pennsylvania, November 2009.

The views expressed in this paper are those of the author and publication does not imply their endorsement by the Wharton Risk Center and the University of Pennsylvania. This paper may be reproduced for personal and classroom use. Any other reproduction is not permitted without written permission of the authors.

### THE WHARTON RISK MANAGEMENT AND DECISION PROCESSES CENTER

Established in 1984, the Wharton Risk Management and Decision Processes Center develops and promotes effective corporate and public policies for low-probability events with potentially catastrophic consequences through the integration of risk assessment, and risk perception with risk management strategies. Natural disasters, technological hazards, and national and international security issues (e.g., terrorism risk insurance markets, protection of critical infrastructure, global security) are among the extreme events that are the focus of the Center’s research.

The Risk Center’s neutrality allows it to undertake large-scale projects in conjunction with other researchers and organizations in the public and private sectors. Building on the disciplines of economics, decision sciences, finance, insurance, marketing and psychology, the Center supports and undertakes field and experimental studies of risk and uncertainty to better understand how individuals and organizations make choices under conditions of risk and uncertainty. Risk Center research also investigates the effectiveness of strategies such as risk communication, information sharing, incentive systems, insurance, regulation and public-private collaborations at a national and international scale. From these findings, the Wharton Risk Center’s research team – over 50 faculty, fellows and doctoral students – is able to design new approaches to enable individuals and organizations to make better decisions regarding risk under various regulatory and market conditions.

The Center is also concerned with training leading decision makers. It actively engages multiple viewpoints, including top-level representatives from industry, government, international organizations, interest groups and academics through its research and policy publications, and through sponsored seminars, roundtables and forums.

More information is available at <http://opim.wharton.upenn.edu/risk>.

# Managing Catastrophic Risks through Insurance: Challenges and Opportunities for Reducing Future Risks

Howard C. Kunreuther and Erwann O. Michel-Kerjan\*

[Kunreuther@wharton.upenn.edu](mailto:Kunreuther@wharton.upenn.edu) and [ErwannMK@wharton.upenn.edu](mailto:ErwannMK@wharton.upenn.edu)

*Center for Risk Management and Decision Processes*

*The Wharton School*

November 2009

## Key Points

**A New Era of Catastrophes.** A series of large-scale catastrophes have occurred in the United States during the first decade of the 21<sup>st</sup> century that has overshadowed previous years. Fourteen of the twenty-five most costly insured catastrophes in the world since 1970 occurred during the past eight years, thirteen in the U.S. With respect to natural disasters our country has entered a new era of catastrophes and the coming years are likely to be even more devastating. Property values at risk in hazard-prone areas have increased significantly due to population growth and increased value at risk. For example, the population of Florida has increased from 2.8 million in 1950 to a projected 19.3 million in 2010 – almost a sevenfold increase. Some believe that global warming might lead to much more intense hurricanes hitting the coast over a shorter period of time.

**Who Should Pay for Future Losses?** A key question that needs to be addressed is: *Who should pay for the cost of future disasters?* In some states, there is increasing tension between insurers and state regulators: insurers would like to charge risk-and-cost of capital-based premiums while state regulators or policymakers require that premiums be set artificially low to encourage economic development in their state and to address affordability issues for those currently residing in hazard-prone areas.

**Impact of Current Insurance Programs.** In many states due to regulatory restriction, private insurers cannot provide pricing signals to residents in hazard-prone areas as to the risks they face and this may cause them to have a false sense of security. There may be short-term rewards to elected officials if mega disasters do not occur in their term of office. In the long run, however, a policy of artificially low rates discourages individuals from adopting cost-effective risk reduction measures and hence increasing our exposure to large-scale disasters. When these catastrophes occur, disaster assistance is often provided to those who suffer losses and who are not adequately protected. Even with this relief many of these victims will not fully recover from the disaster.

**The Need for Leadership and Innovative Programs.** Given divergent agendas between insurers and states insurance regulators, the prices insurers are permitted to charge in some states may lead them to significantly reduce their coverage and in some cases refuse to write new coverage in hazard-prone areas or even consider or take steps to leave the state completely as illustrated by State Farm's stated intention to leave Florida by 2011. The insurance industry has an opportunity to take a leadership role in proposing new approaches for **significantly reducing exposure** to future natural disasters while at the same time providing funds to aid victims in their recovery process and assure an adequate return to shareholders. By adhering to a set of guiding principles and working closely with other interested parties in the private and public sectors there is an opportunity to reduce property exposure so as to reduce future losses by billions of dollars from what it would otherwise be.

---

\* The authors thank Donald Griffin and Lynn Knauf of Property Casualty Insurers Association of America (PCIAA) for many fruitful discussions and for comments on a previous version of this paper. Financial support from the Wharton Risk Management and Decision Processes Center's Managing Extreme Events Project is gratefully acknowledged.

## Findings

**Guiding Principles** Two guiding principles should guide the development of insurance programs for providing protection against catastrophic risks:

***Principle 1 – Premiums Reflecting Risk:** Insurance premiums should be based on risk to provide signals to individuals as to the hazards they face and to encourage them to engage in cost-effective mitigation measures to reduce their vulnerability to catastrophes.*

***Principle 2 – Dealing with Equity and Affordability Issues:** Any special treatment given to residents currently residing in hazard-prone areas (e.g. low income homeowners) should come from general public funding and not through insurance premium subsidies.*

**Risk Reduction Measures Significantly Decrease Catastrophic Losses:** Well-enforced building codes significantly reduce damage from hurricanes. Based on a sample of over 5,600 homeowners affected by Hurricane Charley in Florida in 2004, residences built under the wind-resistant standards enforced in 1996 had a claim frequency that was 60 percent lower than those that were built pre-1996. Claims for pre-1996 damaged homes resulted in an average of \$24 per square foot compared to \$14 per square foot for those constructed between 1996 and 2004. If all homes in Florida were assumed to meet the current building codes, our analyses show that the percentage reduction in damage from hurricanes with a return period of 100 years was 61 percent. In other coastal states like New York, Texas and South Carolina, mitigation has also the potential to provide significant cost savings. For a 100-year hurricane, mitigation would reduce the potential losses by 44 percent in South Carolina, 39 percent in New York, and 34 percent for Texas.

**Capacity of Private Insurance in Covering Catastrophic Losses:** Suppose now that insurance premiums are allowed to reflect risk, all homes have adopted existing building codes and private reinsurance is available. In that case, we show under a series of assumptions that private insurers should be able to cover most or all of the losses from severe hurricanes in Florida, New York, South Carolina and Texas by exposing only a limited portion of their surplus to these regions. The percentage of insurers' surplus necessary to provide full coverage against losses associated with a 100-year hurricane ranges between 1 and 5.4 percent in the four states; for a 250-year hurricane, it ranges from 1.7 in South Carolina to 12.5 percent in Florida.

**Encouraging Investment in Risk Reduction Measures:** Many existing homes have not adopted cost-effective risk reduction measures, making the nation highly vulnerable to catastrophes. We examine why homeowners do not invest voluntarily in mitigation measures, and why insurers and some elected officials do not encourage them to do so. We propose strategies to replace the status quo, which require that premiums reflect risk (Principle 1).

**Measuring Affordability of Coverage:** Although issues of affordability of insurance have been widely discussed by the media, little empirical analysis has been done on this issue. Using data from the American Housing Survey on eight cities in states exposed to hurricane risks (Florida, New York, South Carolina and Texas) between 16 percent (Dallas) and 31 percent (Tampa) of owner-occupied homes are owned by households that cannot afford insurance using 200 percent of the federal poverty line as the threshold level. At 125 percent of the federal poverty line, the percentage varies from nearly 7 percent in Dallas to 17 percent in Tampa. Among low-income households judged unable to afford insurance, a large fraction of homes without mortgages are nevertheless insured. For those who cannot afford coverage we recommend an insurance voucher program modeled after existing programs such the Food Stamp Program and Low Income Home Energy Assistance Program.

## Proposals

**Developing Long-Term Insurance Contracts:** To encourage the adoption of cost-effective mitigation measures on new and existing homes we propose developing long term contracts---long-term insurance (LTI) and long-term mitigation loans. LTI would provide stability to homeowners many of whom have seen their premiums significantly increased after catastrophes and some of whom have had their policies canceled. LTI would also reduce marketing costs to insurers and provide extended time diversification. Long-term mitigation loans would spread the costs of risk-reduction measures to the homeowner over a number of years. For such a program to be feasible insurers would have to be allowed to charge insurance premiums that reflect risk. The annual cost of the mitigation loan if the measure were cost-effective would then be less than the reduction in insurance premiums reflecting the reduced claims costs. This would be a win-win situation for insurers, homeowners, banks that have a more secure investment and taxpayers due to lower future disaster relief expenditures.

**Protecting Against Catastrophic Losses:** Suppose insurers are permitted to charge premiums that reflect risk. Private carriers are likely to seriously consider marketing long-term policies if they know they can protect themselves against the possibility of a catastrophic loss that will seriously reduce their surplus. Insurers can address this issue by diversifying their portfolio so that they reduce the likelihood of highly correlated losses from a catastrophic disaster, purchasing reinsurance and alternative transfer instruments (e.g. insurance linked securities, catastrophe bonds) and/or buying some protection from federal/state reinsurance programs.

**Congress Could Encourage the Housing Government-Sponsored Enterprises (GSEs) to Guarantee these Mortgages:** This would be done automatically for mortgages financing residential transfers, since the improvement would be rolled into the loan amount. To encourage this, we recommend that the GSEs increase their ceiling loan amounts modestly to allow for these improvement loans. As for other homeowners, if the Housing GSEs (Fannie Mae, Freddie Mac or Ginnie Mae) do not voluntarily provide such guarantees, Congress could mandate that they do.

**Require a Seal of Approval of Hurricane/Earthquake Mitigation Compliance:** The seal of approval must be provided at the time that the home is sold after inspection by certified contractors. The seal indicates that the property meets safety criteria specified in building codes. For *new properties*, the contractor must provide the buyer with this seal of approval. For *existing properties*, the buyer should pay for the inspection. If the house does not satisfy the criteria, then the owner can be provided with a long-term home improvement loan tied to the mortgage to undertake the necessary mitigation measures. For *homes not subject to a sale*, the homeowners could still voluntarily seek a seal of approval and should be incentivized to do so by discounts on their insurance premiums.

**Commercial Opportunities: Development of a Market for Mitigation Loans Tied to Mortgages:** Banks and insurers should partner to provide homeowners with home improvement loans for mitigation that will be tied to the seal of approval. A seal of approval becomes a condition for insurance coverage and hence a mortgage on properties that are transferred. Risk-based insurance premiums are lowered to reflect the expected benefits of mitigation and should more than cover the annual cost of the home improvement loan.

## Proposals *cont'd.*

**Property Tax Credits from Local, State and Federal Government:** Local, state and federal government should provide property tax credits to individuals and commercial enterprises to encourage mitigation. Property taxes should not be increased to reflect the improvement in the quality of the house, as this discourages individuals from investing in mitigation measures. Rather, a tax credit could be given so homeowners will want to adopt these measures. Some cities (e.g. Berkeley, CA) have followed this principle re earthquake mitigation.

**Addressing the Affordability of Insurance:** Congress should mandate that the Government Accountability Office (GAO) undertake a study on the relationship between income and purchase of insurance to better measure the affordability issue. Using subsidized premiums as a means of providing low cost insurance coverage is not a good way to subsidize low income residents because this is not a sustainable solution over time. Insurance prices should reflect the underlying risk to provide a clear signal to individuals and businesses of the dangers they face. We propose that those deemed to deserve special treatment should receive insurance vouchers instead of subsidized premiums. These vouchers must be used to buy homeowners' coverage similar to the requirement that food stamps be used to buy groceries.

## Table of Contents

<b>Key Points</b> .....	<b>i</b>
<b>Findings</b> .....	<b>ii</b>
<b>Proposals</b> .....	<b>iii</b>
<b>1. Introduction: More Frequent and Devastating Catastrophes</b> .....	<b>3</b>
<b>1.1 Challenges for Insurers</b> .....	<b>5</b>
<b>1.2 Challenges for Political Leaders</b> .....	<b>8</b>
<b>2. Guiding Principles for Making Better Use of the Insurance Infrastructure</b> .....	<b>10</b>
<b>2.1 Designing Insurance Programs Using the Two Guiding Principles</b> .....	<b>11</b>
<b>2.2 Who Should Subsidize Insurance?</b> .....	<b>12</b>
<b>2.3 Can Private Insurers Cover Catastrophic Losses if Principle 1 Applies?</b> .....	<b>13</b>
<b>3. Reducing Loss Exposure through Mitigation Measures</b> .....	<b>16</b>
<b>3.1 Reduction in Losses from Catastrophic Hurricanes through Statewide Risk Reduction Measures in Place</b> .....	<b>16</b>
<b>3.2 Why Property Owners Do Not Invest in Cost-Effective Mitigation Measures</b> .....	<b>21</b>
<b>3.3 Why Insurers Do Not Encourage the Adoption of Risk Reduction Measures</b> .....	<b>22</b>
<b>3.4 Why Local Governments Do Not Encourage the Adoption of Risk Reduction Measures</b> ....	<b>23</b>
<b>3.5 Encouraging Mitigation Measures through Public-Private Sector Initiatives</b> .....	<b>23</b>
<b>4. A New Concept: The Development of Long-Term Contracts</b> .....	<b>27</b>
<b>4.1 Need for Long-Term Insurance</b> .....	<b>27</b>
<b>4.2 Why Does a Market for Long-Term Insurance Not Exist Today?</b> .....	<b>28</b>
<b>4.3 Developing an LTI Policy</b> .....	<b>29</b>
<b>4.4 Protecting Against Catastrophic Losses</b> .....	<b>29</b>
<b>5. A Natural Pilot for Long-Term Insurance: Flood Insurance through the NFIP</b> .....	<b>31</b>
<b>6. Open Questions and Conclusions</b> .....	<b>33</b>
<b>References</b> .....	<b>35</b>
<b>Appendix A: Existing Voucher System Programs</b> .....	<b>37</b>
<b>Appendix B:</b>	
<b>B1. Assumptions and Methodology for the Competitive Market Analysis</b> .....	<b>38</b>
<b>B2. Reinsurance Assumptions and Calculations</b> .....	<b>40</b>
<b>About the Authors</b> .....	<b>42</b>

**[ THIS PAGE BLANK ]**

“Our nation is facing large-scale risks at an accelerating rhythm, and we are more vulnerable to catastrophic losses due to the increasing concentration of population and activities in high-risk coastal regions of the country. The question is not whether catastrophes will occur, but when and how frequently they will strike, and the extent of damage they will cause. Now is the time to develop and implement economically sound policies and strategies for managing the risk and consequences of future disasters. Absence of leadership in this area will inevitably lead to unnecessary loss of lives and economic destruction in the devastated regions.”

**Kunreuther & Michel-Kerjan, *At War with the Weather* (MIT Press, 2009) Preface**

“Insurance plays a vital role in America’s economy by helping households and businesses manage risks. When insurance prices reflect underlying economic costs they can encourage a more efficient allocation of resources. Efforts to keep premiums for insurance against catastrophe hazards artificially low, whether through regulation or through subsidized government programs, can encourage excessively risky behavior on the part of those who might be affected by future catastrophes.”

**Economic Report of the President (2007), pp.122-123.**

**[ THIS PAGE BLANK ]**

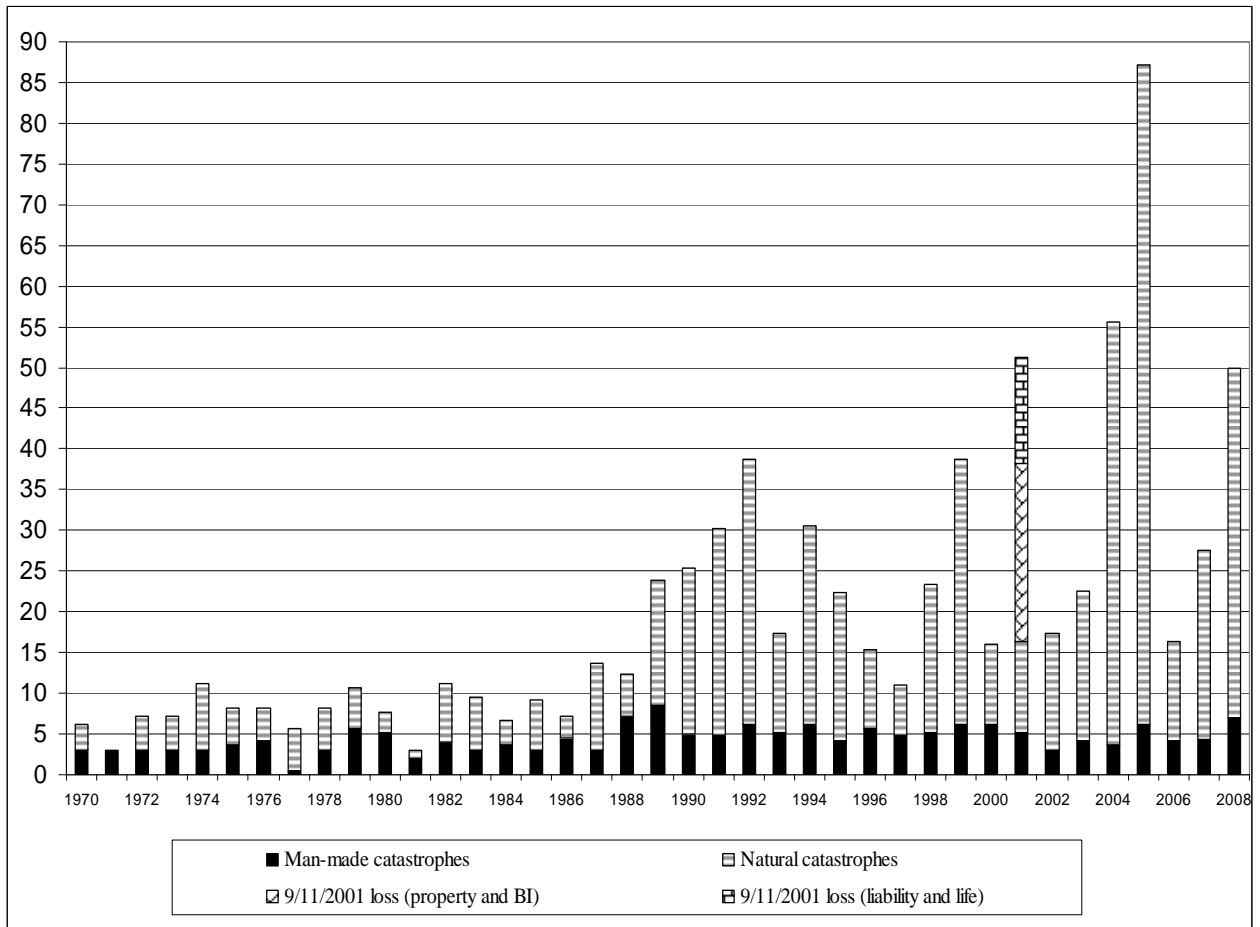
## 1. Introduction: More Frequent and Devastating Catastrophes

2007 was the first year that the *Economic Report of the President* devoted an entire chapter to catastrophe risk insurance. This decision recognized that the United States is facing increasingly greater losses from disasters so that new measures are required to deal with this situation. In fact, catastrophes have had a more devastating impact on insurers since 1990 than in the entire history of insurance. Between 1970 and the mid-1980s, annual insured losses from natural disasters (including forest fires) were in the \$3 billion to \$4 billion range. The insured losses from Hurricane Hugo, which made landfall in Charleston, South Carolina, on September 22, 1989, exceeded \$4 billion (1989 prices) which would be \$71.6 billion in 2008 prices. It was the first natural disaster to inflict more than \$1 billion of insured losses in the United States.

Figure 1 depicts the upward trend in worldwide insured losses from catastrophes between 1970 and 2008. There was a radical increase in insured losses in the early 1990s, with Hurricane Andrew in Florida (\$24.6 billion in 2008 dollars) and the Northridge earthquake in California (\$20.3 billion in 2008 dollars). The four hurricanes in Florida in 2004 (Charley, Frances, Ivan, and Jeanne) collectively totaled over \$33 billion in insured losses. Hurricane Katrina alone cost insurers and reinsurers an estimated \$48.1 billion, and total losses paid by private insurers resulting from major natural catastrophes were \$87 billion in 2005.<sup>1</sup> In 2008 Swiss Re estimates that insured losses soared to \$50 billion for the industry making it the second costliest year ever. Natural catastrophes accounted for \$43 billion of these losses with man-made disasters making up the remaining \$7 billion. Hurricane Ike which caused extensive damage to Houston and Galveston in September 2008 was the most expensive individual event during the past year with an estimated private insured loss of \$17.6 billion and another \$2.4 billion paid by the national flood insurance program for flood losses (Swiss Re, 2008). Table 1 ranks the 25 most costly catastrophes that occurred in the world since 1970. The data reveals that 16 of these 25 disasters occurred in the United States. With respect to the timing of these events, fourteen occurred since 2001, thirteen of these in the United States.

---

<sup>1</sup> It is also important to put these loss figures into perspective by looking at the historical development of U.S. policyholders' surplus which has grown very significantly over the past 40 years. It was \$100 billion in 1987, roughly \$300 billion in 1997, and reached an historical record of \$500 billion in 2007. When cat losses are considered as a proportion of this surplus, one can see that the proportion of U.S. cat losses has risen above 20 percent of the policyholders surplus only twice in the past 30 years, 2005 being the last time. (Sources: data from Swiss Re, AM Best and Insurance Information Institute).



**FIGURE 1. WORLDWIDE EVOLUTION OF CATASTROPHE INSURED LOSSES, 1970-2008**

*(9/11: All lines, including property and business interruption (BI); in U.S. \$ billion indexed to 2007; except 2008 which is current)  
 Source: Wharton Risk Center with data from Swiss Re and Insurance Information Institute*

**TABLE 1. THE 25 MOST COSTLY INSURED CATASTROPHES IN THE WORLD, 1970-2008**

<b>U.S.\$ Billion</b>	<b>Event</b>	<b>Victims (Dead or missing)</b>	<b>Year</b>	<b>Area of Primary Damage</b>
48.1	Hurricane Katrina	1,836	2005	USA, Gulf of Mexico, et al.
36.8	9/11 Attacks	3,025	2001	USA
24.6	Hurricane Andrew	43	1992	USA, Bahamas
20.3	Northridge Earthquake	61	1994	USA
17.6	Hurricane Ike	348	2008	USA, Caribbean, et al.
14.6	Hurricane Ivan	124	2004	USA, Caribbean, et al.
13.8	Hurricane Wilma	35	2005	USA, Gulf of Mexico, et al.
11.1	Hurricane Rita	34	2005	USA, Gulf of Mexico, et al.
9.1	Hurricane Charley	24	2004	USA, Caribbean, et al.
8.9	Typhoon Mireille	51	1991	Japan
7.9	Hurricane Hugo	71	1989	Puerto Rico, USA, et al.
7.7	Winterstorm Daria	95	1990	France, UK, et al.
7.5	Winterstorm Lothar	110	1999	France, Switzerland, et al.
6.3	Winterstorm Kyrill	54	2007	Germany, UK, NL, France
5.9	Storms and floods	22	1987	France, UK, et al.
5.8	Hurricane Frances	38	2004	USA, Bahamas
5.2	Winterstorm Vivian	64	1990	Western/Central Europe
5.2	Typhoon Bart	26	1999	Japan
5.0	Hurricane Gustav	138	2008	USA, Caribbean, et al.
4.7	Hurricane Georges	600	1998	USA, Caribbean
4.4	Tropical Storm Alison	41	2001	USA
4.4	Hurricane Jeanne	3,034	2004	USA, Caribbean, et al.
4.0	Typhoon Songda	45	2004	Japan, South Korea
3.7	Thunderstorms	45	2003	USA
3.6	Hurricane Floyd	70	1999	USA, Bahamas, Columbia

*Sources: Kunreuther and Michel-Kerjan (2009) with data from Swiss Re (2009) and Insurance Information Institute. Indexed to 2008 prices.*

These data convey a clear message. Twenty or thirty years ago, large-scale natural disasters were considered to be low-probability events. Today, they are not only causing considerably greater economic losses than in the past but also appear to be occurring at an accelerating pace. Insurance can play a creative role in dealing with these losses by encouraging property owners to invest in cost-effective mitigation measures while at the same time providing funds for recovery to those victims who suffer damage. For this to happen there needs to be a reorientation by insurers of their role in dealing with risk and a recognition by regulators and policy makers that the current process of restricting insurance premiums is no longer viable.

### **1.1 Challenges for Insurers**

Recently insurers have been reluctant to continue offering coverage against wind damage from hurricanes because they have been concerned with the impact that catastrophic losses from future storms will have on their balance sheets. They claim that they are unable to charge premiums that cover their exposure, administrative expenses and the cost of capital while still offering their shareholders an acceptable return on their investments.

This has been a major issue in virtually all coastal states from Texas to Maine. Florida has been particularly stringent with respect to rate regulation ever since Hurricane Andrew in 1992 when the state insurance commissioner allowed insurers to raise premiums only gradually over the decade. In 2006 following the severe hurricanes of 2004 and 2005, many insurers began to file for major rate increases in Florida, particularly in high-risk coastal areas, with many of these rate petitions being challenged by the state regulators.

Florida's property insurance residual market mechanism, the state-run Citizens Property Insurance Corporation (Citizens)—supposedly the insurer of last resort—has experienced significant growth in recent years. In fact, legislative changes in 2007 allowed Citizens to compete with the voluntary market. As a result of rate restrictions and competition from Citizens the top homeowners' insurers in the state with respect to market share have significantly reduced their concentration of exposures in high-risk areas to what they consider to be more sustainable levels. To illustrate, the combined market share of State Farm and Allstate homeowners' coverage in 1992 was 50.9 percent but dropped to 29.2 percent in 2006 with many small new insurers entering the Florida market.<sup>2</sup> In January 2009 State Farm announced that it would be withdrawing completely from the homeowners market in Florida because it was not allowed 47.1 percent rate increase. On August 6 2009 the Florida Office of Insurance Regulation (OIR) agreed to allow a rate increase which would average 28 percent across the state, on policies renewed on or after December 1, 2009, and policies issued on or after November 1, 2009. However, even after this rate increase was granted, State Farm reiterated its intention to withdraw from Florida.<sup>3</sup>

The main issue associated with the operation of these two entities is that if either suffers severe losses from a future hurricane and incurs a deficit, Citizens or the Florida Hurricane Catastrophe Fund (FHCF) can replenish its surplus by taxing all private insurers in the state. The FHCF provides catastrophic reinsurance to primary insurers underwriting property coverage in the state can follow a similar procedure. The residents in Florida face an unusual situation: a state company (Citizens) can offer very low rates and transfer a large portion of its exposure to a state reinsurer (FHCF), both knowing that any deficit either of them suffers will be paid *ex post* by its competitors (and their policyholders). This already occurred after the 2004 and 2005 hurricane season.

As of December 31, 2008, after several years without any major losses, Citizens, which has become the largest provider of homeowners insurance in the state, had \$4.18 billion in reserves (claims available from surplus), another \$4.17 billion of pre-event liquidity and had purchased nearly \$10 billion of reinsurance coverage (\$9.45 billion from the FHCF and \$.44 billion from private reinsurers). In other words, at the end of 2008 Citizens had 18.24 billion in claims paying capacity to cover its losses from a future hurricane. Given that Citizens expects to

---

<sup>2</sup> For more details on state regulation and its impact on the supply of insurance see Chapters 2 and 3 of Kunreuther and Michel-Kerjan (2009).

<sup>3</sup> State Farm (2009) "A Message to our Customers", <http://www.statefarm.com/florida/florida.asp> accessed August 20, 2009.

collect about \$2.8 billion in premiums during 2009, our analysis reveals that the state-run insurer would be able to handle its \$20.6 billion insured losses from a 500-year hurricane that occurred during the coming season according to our analysis using data from Risk Management Solutions.

Our analysis of the situation in Florida also reveals, however, that if a severe hurricane hits Florida in 2009 it is likely that the reinsured losses incurred by the FHCF will exceed its cash reserve which was only \$2.78 billion as of December 31, 2008. Given that the FHCF collects about \$1.3 billion of premiums annually, it would take it until 2024 to repay all its deficit from this 500-year hurricane should it occur in 2009 (making the assumption that it does not incur any additional loss in the meantime, which is quite unlikely). The FHCF deficit would be recouped against all policyholders in the state through an *ex post* assessment and possibly against taxpayers through the issuance of bonds.

We believe this situation is not sustainable in the long-run because Florida residents are given a false sense of security. Insurance premiums should provide a signal as to the degree of risk to which an individual is exposed. The artificially low premiums offered today by Citizens means that those residing in hazard-prone areas never learn the real cost of residing in hurricane-prone areas of the state. In fact, the Citizens Property Insurance Corporation Mission Task Force has recently recommended a statewide average rate increase of 10 percent for Citizens that would be implemented in 2010. The Task Force also recommended that rates increase no more than 15 percent in any given territory and no more than 20 percent for any given policy; we believe this is because of affordability and equity issues that we discuss later in the paper). The Florida Insurance Council noted that the recommended rate increase would be far less than that required to make Citizens rates actuarially sound (BestWire, 2009).

In any discussion about insurance prices, it is important to understand how residents in the state would modify their coverage if the price increases. As part of the Wharton Extreme Event Project, we partnered with Georgia State and undertook such an analysis using homeowners data provided by many of our sponsors for Florida.<sup>4</sup> We found that the demand for insurance is approximately unit elastic at the county level. “*Unit elastic*” meaning that a given percentage increase in price will result in a similar percentage decrease in demand. For example, our results indicate that a 10 percent increase in the average premium will result in an 8.9 percent decrease in the amount of insurance purchased. This level of sensitivity to price is not surprising as the home is typically the family’s largest asset and there is no other way to hedge fire or wind risks except through insurance. In Florida, the cross-elasticity between private insurance and insurance supplied by Citizens is 0.159. This cross-elasticity implies that a 10 percent increase in Citizens’ premium is associated with a 1.59 percent increase in the amount of insurance demanded by homeowners from private insurers. These results are important when the future of Citizen and insurance prices is discussed.

---

<sup>4</sup> For more details on this analysis see “A Multistate Empirical Analysis of Homeowners’ Insurance” (Chapter 10) in Kunreuther and Michel-Kerjan (2009).

The radical increase of state wind pools' exposure is not specific to Florida, however, as illustrated by the situation in Texas. In 1970, Hurricane Celia caused an estimated \$310 million in insured losses in Texas (\$1.8 billion in 2008 dollars). Many insurers sustained significant losses and discontinued coverage in the state's exposed coastal communities. As a result, in 1971, the state created the Texas Catastrophe Property Insurance Association, which later became the Texas Windstorm Insurance Association (TWIA). The TWIA provides wind and hail coverage for Texas Gulf Coast property owners as an insurer of last resort. As such, the TWIA writes higher-risk policies than other carriers. The TWIA writes policies in only the fifteen counties, all of which are on the coast. The number of structures insured by TWIA has been growing dramatically.

In 2001, it had 68,700 policyholders; as of August 31, 2009, 225,745 policies were in place. In 1992, TWIA had about \$5 billion exposure in these counties. At the end of August 2009, its exposure was approximately \$63.3 billion, not including loss of business coverage and additional living expense coverage. When business interruption and additional living expense coverage are included, the total TWIA exposure rises to over \$69.3 billion.

The issue here is that all companies licensed to write property insurance in Texas are required to contribute to the TWIA as pool members, so they are likely to be assessed after a disaster if the pool has not enough reserve to meet its claims. This happened in 2008, when hurricane Ike caused catastrophe losses across the states, a large part of which in coastal counties where the pool provided more than 50 percent of the coverage.<sup>5</sup>

In 2009, the Texas Legislature addressed TWIA funding with House Bill 4409, removing the possibility of unlimited assessments and providing a restructured funding formula to provide for better rating practices at TWIA. The law now provides for post event funding of up to \$2.5 billion in losses in 2009 with the expectation that the funding/reserves of TWIA will increase over the coming years to make the plan more self sustaining. Under the new structure, insurers could be assessed as much as \$800,000,000 following a catastrophic loss. If TWIA were to sustain losses over \$2.5 billion, the legislature would have to convene a special session to fund the shortfall.

## **1.2 Challenges for Political Leaders**

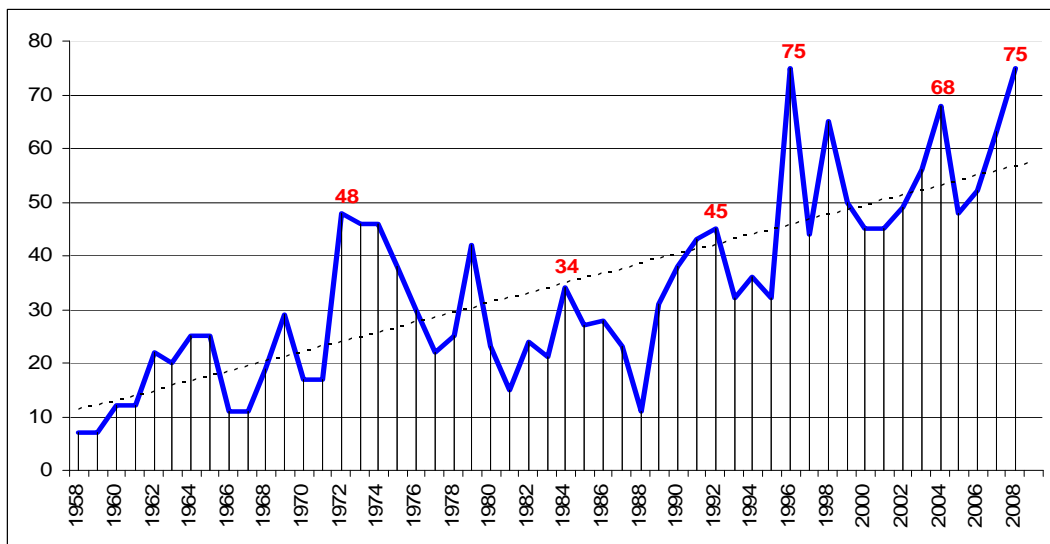
The challenge posed by this new era of catastrophes does not only apply to the private insurance sector. In the United States, federal and state governments have played an increasing role in providing relief to victims of these disasters. One way to see these changes is indeed to look at the evolution of the number of presidential disaster declarations over time. Under the current system, the Governor of the state(s) can request that the President declare a "major disaster" and offer special assistance if the damage is severe enough. Although the President does not determine the amount of aid (the House and Senate do), he is responsible for a crucial step in the

---

<sup>5</sup> For a detailed discussion of the political dynamics of insurance markets and recent changes in insurance regulation, see Klein (2009).

process. A look at the number of U.S. presidential disaster declarations over the past 57 years clearly reveals an upward trend (see Figure 2).

Overall, the number of Presidential disaster declarations has dramatically increased over the past 50 years: there had been 162 over the period 1955-1965, 282 over 1966-1975, increasing to 319 over the period 1986-1995 and 545 for 1996-2005 (Michel-Kerjan, 2008). On average, the average annual number of declarations has increased by 10 every decade since the 1950s. As Figure 2 also shows, many of the peak years correspond to presidential election years. This is consistent with recent research that reveals that election years spur disaster assistance all other things being equal. Four salient examples are the Alaska earthquake in 1964 (a Presidential election year), Tropical Storm Agnes in June 1972, Hurricane Andrew in September 1992 and the four hurricanes in 2004. In 2008 we saw the largest number of presidential declarations ever, 75, matched only by 1996 – another presidential election year.



Sources: Authors' calculation with data from the U.S. Department of Homeland Security

**FIGURE 2. DISASTER PRESIDENTIAL DISASTER DECLARATIONS PER YEAR  
(PEAK-VALUES ON THE GRAPH CORRESPOND TO SOME PRESIDENTIAL ELECTION YEARS)**

These data suggest that politics is an important element during the post-disaster period. In the immediate aftermath of the catastrophes as media coverage is intense and often focuses on the tragedy and the need for national solidarity, we are all taken by the images we see and want to help. Elected officials will want to help their constituencies, even those who chose to live in high-risk areas but had not undertaken adequate protection. But knowing that the state and federal government will intervene after a catastrophe sends the wrong signal to those at risk. In other words, what is the incentive for you to invest in costly risk reduction measures if you know you will be rescued should you suffer severe losses from a disaster anyway? No coherent national strategy currently exists that creates the right incentive system so we reduce federal relief *ex post*.

Can we as a society do better? We think we can. But it will take an understanding by both the public and private sectors as to appropriate strategies that should be considered. It might also

require both sectors to recognize that changes from the status quo are necessary. The next section proposes two principles for guiding the development of new catastrophe insurance programs and indicates the capability of private insurers to provide coverage against catastrophic risk if these principles are adhered to. Section 3 highlights the impact that investment in cost-effective mitigation can have on reducing future losses and the short-term biases and misperceptions of risk that deter homeowners and businesses from voluntarily adopting these measures. Section 4 suggests ways that other stakeholders in both the private and public sector can complement insurance in playing a key role in the adoption of mitigation measures to reduce future losses from natural disasters. Section 5 proposes that insurers consider long-term insurance as a way of ensuring coverage in hazard-prone areas and encouraging the adoption of encouraging adoption of mitigation measures. The challenge as we point out is providing adequate protection against catastrophic losses. The concluding section raises a set of questions that need to be addressed by private insurers and the public sector for moving forward on these initiatives.

## **2. Guiding Principles for Making Better Use of the Insurance Infrastructure**

We need a new approach for insuring these risks and encouraging individuals residing in hazard-prone areas to undertake cost-effective mitigation measures. Unless premiums reflect the risks of exposure to extreme events, insurers cannot provide premium incentives to policyholders, i.e. a reduction in what is already an inadequate rate. Hence our first guiding principle is:

***Principle 1 – Premiums Reflecting Risk** Insurance premiums should be based on risk to provide signals to individuals as to the hazards they face and to encourage them to engage in cost-effective mitigation measures to reduce their vulnerability to catastrophes.*

*Principle 1* is important because its application would provide a clear signal of relative damage to those currently residing in areas subject to natural disasters and those who are considering moving into these regions. Risk-based premiums also enable insurers to provide discounts to homeowners and businesses who invest in cost-effective loss-reduction mitigation measures. However, without the ability to charge risk-based premiums, insurers will be reluctant to offer these discounts. Further, insurers may choose not to offer coverage to owners of high risk property because doing so is a losing proposition in the long-run. Those policyholders in non-hazard prone areas who are assessed more than their risk-based exposure to cross-subsidize those in highly exposed areas may experience a decrease in their premiums if Principle 1 is implemented.

Principle 1 does raise two policy questions: What will happen to those who cannot afford to pay for premiums reflecting the true risk they are exposed to? How does one deal with the concerns by residents in high-hazard areas who are faced with large price increases if insurers are allowed to set premiums that reflect risk? These points lead to our second guiding principle.

***Principle 2 – Dealing with Equity and Affordability Issues:** Any special treatment given to residents currently residing in hazard-prone areas (e.g. low-income homeowners) should come from general public funding and not through insurance premium subsidies.*

As noted above, regulations imposed by State Insurance Commissioners keep premiums in many regions subject to hurricane damage artificially lower than their risk-based level. If Principle 1 is implemented there is likely to be a need for a transition period over time (e.g., 3 or 5 years) for premiums to increase up to their risk-based level.<sup>6</sup>

**Note:** Principle 2 applies only to those individuals who are now residing in hazard-prone areas. Those who decide to move to the area in the future should be charged premiums that reflect the risk. If they were given special treatment from general public funding, they would be encouraged to move into hazard-prone areas (or at least not refrained from doing so), thus exacerbating the potential for catastrophic losses from future disasters.

## **2.1 Designing Insurance Programs Using the Two Guiding Principles**

The above two principles can be used to design insurance programs where data are available to develop risk-based rates. During the past 20 years catastrophe models have been constructed with inputs by scientists and engineers to better estimate the likelihood and damages resulting from disasters of different magnitudes and intensities. Although there is uncertainty surrounding these figures, insurers and reinsurers have utilized these models to price the risk and determine how much coverage they want to offer in hazard-prone areas.

### ***Premiums Reflecting Risk***

The first step in developing an insurance program that would adhere to *Principle 1* is to estimate the risk-based rates that would apply to different regions of the country. A major issue that needs to be addressed is how to reach agreement on a given risk assessment, and the role that state regulators will play in the process. We believe that regulators should stay out of the rate setting business. If one allows a truly competitive market to operate, then insurers would not engage in price-gouging since they would be undercut by another competing company who would know that it could profitably market policies at a lower price. Regulators would still have an important role to play with respect to other aspects of the insurance operation (e.g. making certain that insurers have sufficient surplus to protect unsuspecting consumers against the possibility of their becoming insolvent following the next severe disaster).

### ***Affordability of Coverage***

Although issues of affordability of insurance have been widely discussed by the media, little economic analysis has been done on this issue using empirical data. To address this problem we utilized U.S. Census data to examine how severe this problem actually is today. The data revealed that many homeowners whose income is below the 100 or 200 percent of poverty level actually purchase homeowners' insurance while some individuals above this level do not buy this coverage.

---

<sup>6</sup>See Kunreuther, H. (2007) for more details as to why we need these principles for developing new approaches for dealing with disasters. [http://opim.wharton.upenn.edu/risk/library/oped\\_NYT2007-08-25.pdf](http://opim.wharton.upenn.edu/risk/library/oped_NYT2007-08-25.pdf)

Using data from the American Housing Survey on eight cities in four states exposed to hurricane risks (Florida, New York, South Carolina and Texas), between 16 percent (Dallas) and 31 percent (Tampa) of owner-occupied homes are owned by households that cannot afford insurance using 200 percent of the federal poverty line as the threshold level. At 125 percent of the federal poverty line, the percentage varies from nearly 7 percent in Dallas to 17 percent in Tampa. Among low-income households judged unable to afford insurance, a large fraction of homes are nevertheless insured, even when there is no mortgage requiring coverage. Fewer than 27 percent of low-income homeowners (San Antonio; 125 percent of the federal poverty line) fail to purchase insurance coverage in any of the cities studied. Any plan that directs subsidies to all low-income homeowners will allocate much of the payment to those who are already insured (Kunreuther and Michel-Kerjan, 2009, chapter 11).

There may also be a concept of equity that relates to the fairness in changes in homeowners' premiums. In particular, if changes in premiums are distributed unevenly across households, (e.g., greater increases for coastal property owners compared to those residing in non-coastal areas) one might take the view that those subject to large increases are not being treated fairly and justly. If some homeowners see their premiums jump by thousands of dollars in a single year while others experience modest changes, those residents may feel they are being treated unjustly relative to others with similar homes whose premiums remain unchanged.

To deal with these issues of equity and affordability we recommend that some type of insurance voucher be provided by the state or federal government that enables low income residents to purchase insurance while still charging them a risk-based premium. More specifically a homeowner would receive a bill from their insurance company that reflected the risk-based premium (e.g. \$2,000) but they could use their insurance voucher (e.g. \$600) to cover part of the cost so their actual expenditure for insurance would be affordable (e.g. \$1,400). The *insurance voucher* would thus be used to buy homeowners coverage in the same way that food stamps are used to buy groceries today. This type of in-kind assistance rather than an unrestricted grant assures that the recipients use the funds for obtaining insurance rather than having the freedom to spend the money on goods and services of their choosing. The magnitude of the voucher would be based on the income and assets of the resident.

Homeowners could also be provided with subsidies or loans to invest in cost-effective mitigation measures and in return be charged a lower insurance premium reflecting the reduced damage to their structure from a future disaster. The funds for supporting such a program could be raised through a surcharge on the property tax of all residents in the state or a surcharge on property insurance policies sold throughout the state. There are several existing programs that could serve as models for developing such a voucher system that are described in Appendix A.

## **2.2 Who Should Subsidize Insurance?**

The above programs have different arrangements in subsidizing low-income families for specific goods and services. With respect to homeowners' insurance, there are several different ways that vouchers could be provided which mirror these programs. We discuss each of these in turn.

*General Taxpayer.* If one takes the position that everyone in society is responsible for assisting those who reside in hazard-prone areas and who cannot afford insurance coverage, then one could utilize general taxpayer revenue from the federal government to cover the costs of insurance vouchers. This is what is currently done by the Food Stamp Program and the Low Income Home Energy Assistance Program.

*State Government.* An alternative (or complementary) source of funding would come from taxes on residents and/or commercial enterprises in the state exposed to natural disaster. One argument that could be made for this type of funding arrangement is that states obtain significant financial benefits from economic development in their jurisdictions through the collection of property taxes or other state revenue such as gasoline taxes, state income taxes or sales taxes. If residents in coastal areas receive greater benefits from the economic development in these regions than others in the state, they should be taxed proportionately more than those residing inland.

*Tax Credits.* A subsidy in the form of tax credits could be provided to those deserving special treatment. South Carolina implemented a tax credit that allows taxpayers to claim a credit against income tax for excess premiums paid for property casualty insurance providing coverage on the taxpayer's legal residence. "Excess" premiums are the amounts paid that exceed 5 percent of the taxpayer's adjusted gross income. The credit may not exceed \$1,250; if credit exceeds tax liability, unused credit may be carried forward for five succeeding taxable years.

Tax deductions can also be used to indirectly subsidize the costs of insurance by making it possible for property owners to carry higher deductibles, thus reducing premiums. For example, incentives can be provided through creation of tax deductible catastrophe savings accounts similar to a provision enacted in South Carolina and considered in Louisiana. Consumers could establish a tax deductible savings or money market account to pay for insurance deductibles or any self-insured losses arising from a catastrophic event. In South Carolina, for example, individuals with a deductible of \$1,000 or less may deposit up \$2,000; individuals who carry a deductible greater than \$1,000 may deposit the lesser of \$15,000 or twice the deductible; and for those who self-insure, the maximum is \$250,000, not to exceed the value of the residence.

### **2.3 Can Private Insurers Cover Catastrophic Losses if Principle 1 Applies?**

Assume that adequate voucher programs are now in place so the affordability is not a major issue. If insurers were permitted to charge premiums that reflect risk (Principle 1) they would have an interest in providing coverage against wind damage from hurricanes where they do not have an economic incentive to do so under the current regulatory climate. We focused our analysis on four states that are subject to potentially severe losses from hurricanes: Florida, New York, South Carolina and Texas. Using data on states' residential-only exposure to hurricane risk provided by Risk Management Solutions (RMS) as well as data from A.M. Best on statutory annual statements of individual insurance and reinsurance groups, we determined how much coverage insurers could provide against damage from hurricanes with return periods of 100, 250, and 500 years in each of these four states. We assume here that insurers will not allocate more

than 10 percent of their surplus to a given state for that risk based on 2005 data from A.M. Best. Appendix B describes the methodology utilized for this analysis.

We vary assumptions regarding risk reduction measures in place and the availability of reinsurance. We first assume that no risk reduction measures are in place. With respect to reinsurance we consider two cases: *Case 1*, insurers are not able to reinsure some their exposure; and *Case 2*, reinsurance is provided to insurers with the amount determined by utilizing probable maximum loss data from A.M. Best.

***Case 1. No risk reduction measures in place, and no reinsurance***

We first examine the case where none of the homes had adopted mitigation measures and insurers could **not** rely on reinsurance to protect themselves against future damage. Even when insurers are entirely on their own and use the strategy of *allocating 10 percent of surplus*, they will have enough capacity to provide protection to all homeowners in the state of New York and South Carolina for the 100- 250-and 500-year hurricanes as shown in Table 2. For example, insurers providing wind coverage in the state of New York would have to commit only 2.5 percent of their surplus to cover total losses to homes (except for the deductible portions of the policy) from a 100-year hurricane. This percentage would increase to 8.9 percent for a hurricane with a 500-year return period. The percentage of surplus required in South Carolina to cover hurricanes with these return periods would be even smaller than in New York.

**TABLE 2. PERCENTAGE OF LOSS COVERED AND REQUIRED SURPLUS FOR FULL COVERAGE BY INSURERS WITH NO MITIGATION OF CURRENT HOMES AND NO REINSURANCE AVAILABLE**

State	Surplus	Return Period	Gross Losses	Amount of Coverage (10% of Surplus)	Percent of Market Covered	Percent of Surplus Necessary for Full Coverage
FL	154.4	100	64.8	15.4	23.8%	42.0%
		250	96.4	15.4	16.0%	62.5%
		500	120.5	15.4	12.8%	78.1%
NY	167.8	100	4.2	16.8	100.0%	2.5%
		250	9.6	16.8	100.0%	5.7%
		500	14.9	16.8	100.0%	8.9%
SC	175.0	100	3.7	17.5	100.0%	2.1%
		250	5.8	17.5	100.0%	3.3%
		500	7.7	17.5	100.0%	4.4%
TX	139.2	100	14.5	13.9	96.2%	10.4%
		250	22.9	13.9	60.7%	16.5%
		500	31.4	13.9	44.4%	22.5%

Private insurers in Florida and Texas would need financial back-up to cover all the wind losses from a severe hurricane if homeowners have not undertaken mitigation measures. Even for a 100-year hurricane in Florida, the total amount of insurance in place would only cover 23.8 percent of the loss. Insurers providing wind coverage in Florida would have to allocate 42 percent of their surplus to provide full coverage to homeowners against this event. In Texas, the hurricane damage would be less severe than in Florida, so that insurers would be able to offer close to full protection (96.2 percent) against a 100-year event, but not against hurricanes with either a 250- or 500-year return period (Table 2). Again, this simulation is based on 2005 surplus and exposure data.

**Case 2. No mitigation, but reinsurance**

With reinsurance in place, we made the same assumption as in Case 1 regarding allocation of insurer surplus to homeowners insurance, but used different estimates of insured losses. We subtracted the amount of reinsurance obtained from total losses to obtain the claims that insurers would have to pay using the methodology described in Appendix B. The percentage of losses covered and the required surplus for full coverage in each of the four states studied is shown in Table 3.

**TABLE 3. PERCENTAGE OF LOSSES COVERED AND REQUIRED SURPLUS FOR FULL COVERAGE BY INSURERS WITH REINSURANCE IN PLACE (\$ BILLION)**

State	Surplus	Return Period	Gross Losses	Reinsurance Coverage	Unreinsured Losses	Amount of Coverage (10% of Surplus)	Percent of Market Covered	Percent of Surplus Necessary for Full Coverage
FL	154.4	100	64.8	39.1	25.7	15.4	60.0%	16.7%
		250	96.4	49.8	46.6	15.4	33.1%	30.2%
		500	120.5	51.9	68.6	15.4	22.5%	44.4%
NY	167.8	100	4.2	0.4	3.8	16.8	100.0%	2.3%
		250	9.6	1.9	7.7	16.8	100.0%	4.6%
		500	14.9	3.0	11.9	16.8	100.0%	7.1%
SC	175.0	100	3.7	0.4	3.3	17.5	100.0%	1.9%
		250	5.8	0.6	5.2	17.5	100.0%	3.0%
		500	7.7	0.8	7.0	17.5	100.0%	4.0%
TX	139.2	100	14.5	2.9	11.6	13.9	100.0%	8.3%
		250	22.9	6.9	16.1	13.9	86.7%	11.5%
		500	31.4	12.5	18.8	13.9	74.0%	13.5%

When reinsurance is available, the private insurance market is able to cover all the losses in Texas from a 100-year hurricane, 86.7 percent of the losses for a 250-year hurricane, and 74 percent of the losses for a hurricane with a 500-year return period even if homes had not undertaken mitigation measures. In Florida, 60 percent of the losses will be covered from a 100-

year hurricane, but the majority of the losses will still be uninsured for 250-year and 500-year hurricanes if mitigation measures had not been adopted by homeowners.

This analysis shows that there is a need to reduce the exposure from large-scale disasters for the private sector to cover all the losses from future major hurricanes. Hence the importance of providing economic incentives to homeowners so they will want to invest in mitigation measures, the topic to which we now turn.

### **3. Reducing Loss Exposure through Mitigation Measures**

In this section we demonstrate the key role that mitigation can play in reducing losses from future hurricanes and enabling private insurers to provide coverage so that most if not all homes are fully protected against severe hurricanes even in Florida, the most vulnerable state with respect to such storms. After providing a more detailed estimate of the savings from mitigation we examine why homeowners are reluctant to invest in cost-effective loss reduction measures.

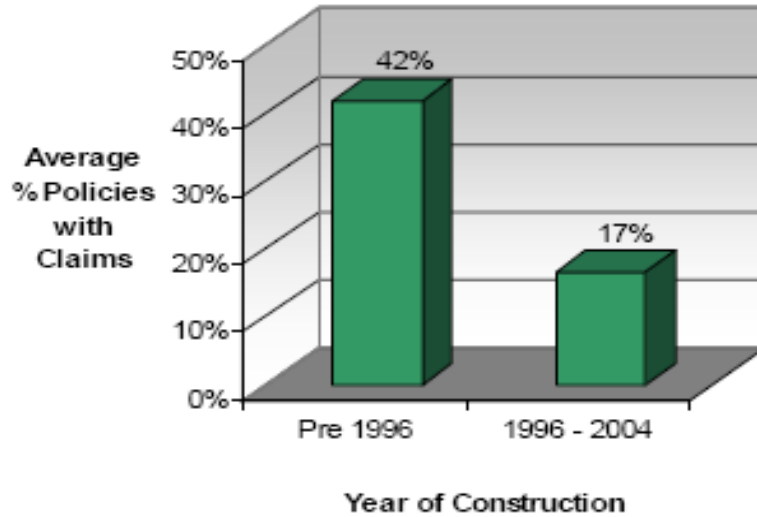
#### **3.1 Reduction in Losses from Catastrophic Hurricanes through Statewide Risk Reduction Measures in Place**

Florida provides a striking example of the effectiveness of well-enforced standards for reducing residential losses from hurricanes. Following Hurricane Andrew in 1992, the state reevaluated its building code standards and in 1995, coastal areas of Florida began to enforce high-wind design provisions for residential housing. Toward the end of the 1990s, the state began the process of developing and enforcing a statewide building code. The Florida Building Code (FBC) 2001 edition, adopted in mid-2002, was accompanied by an extensive education and training program that included a requirement that all licensed engineers, architects, and contractors take a course on the new building code.<sup>7</sup>

Hurricane Charley in 2004 demonstrated the effectiveness of the new building code. One insurance company provided the Institute for Business & Home Safety data on 5,636 policies in Charlotte County at the time that this hurricane made landfall on August 13, 2004. There were 2,102 reported claims from the hurricane (37 percent of all the homeowners' insurance policies in Charlotte County for this insurer). Figure 3 reveals that homes built under the new wind-resistant standards that were enforced in 1996 had a claim frequency that was 60 percent less than those that were built prior to 1996.

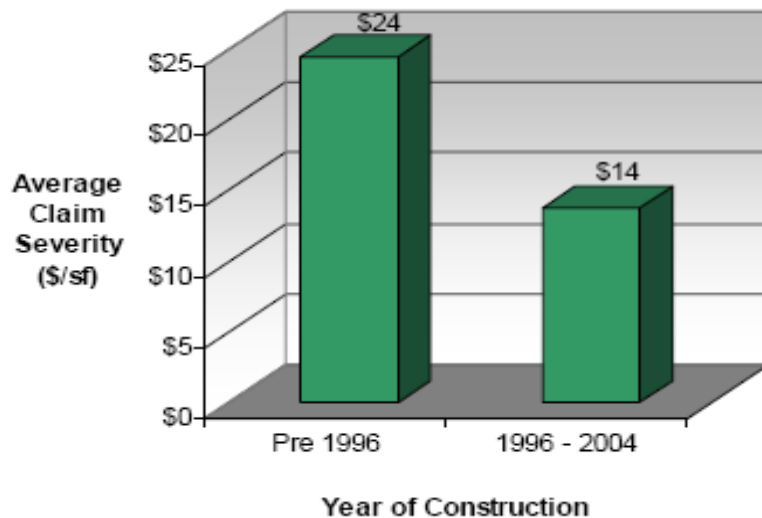
---

<sup>7</sup> More recent building codes were established in 2004, then in 2007. See [www.FloridaBuilding.org](http://www.FloridaBuilding.org).



**FIGURE 3. AVERAGE CLAIM FREQUENCY BY BUILDING CODE CATEGORY FROM HURRICANE CHARLEY**  
*Source: Institute for Business & Home Safety (IBHS)*

Moreover, this insurer’s claims for pre-1996 homes resulted in an average claim of \$24 per square foot, compared to \$14 per square foot for those constructed between 1996 and 2004, as shown in Figure 4. For an average home of 2,000 square feet, the average damage to each of these homes would be \$48,000 and \$28,000, respectively. In other words, the average reduction in claims from Hurricane Charley to **each** damaged home in Charlotte County built according to the newer code was approximately \$20,000.<sup>8</sup>



**FIGURE 4. AVERAGE CLAIM SEVERITY BY BUILDING CODE CATEGORY FROM HURRICANE CHARLEY**  
*Source: Institute for Business & Home Safety (IBHS)*

<sup>8</sup> Institute for Business & Home Safety (2007), *The Benefits of Modern Wind Resistant Building Codes on Hurricane Claim Frequency and Severity—A Summary Report*.

We now turn to a broader analysis of the impact of risk reduction measure at a state level. With respect to risk reduction we considered two extreme cases: either no risk reduction measure is in place or full mitigation on all residential homes. In New York, Texas, and South Carolina, we assumed that **all** houses and buildings conformed to the most recent standard (2002 standards or later ones) to measure the effects of full mitigation. Every structure was assumed to be mitigated in accordance with the latest building codes without determining whether or not it would be cost effective to do so. In Florida we assumed that the relevant homes met the standards of the “*Fortified...for Safer Living*” program.<sup>9</sup> This program offers strategies for reducing a residential structure’s vulnerability to natural hazards such as hurricanes that include measures such as adding roof anchors in the building process. As the “*Fortified...for Safer Living*” program is directed only at wood-frame or masonry dwellings, this program was only applicable to 80 percent of the residences in the state (the remaining structures were manufactured homes).

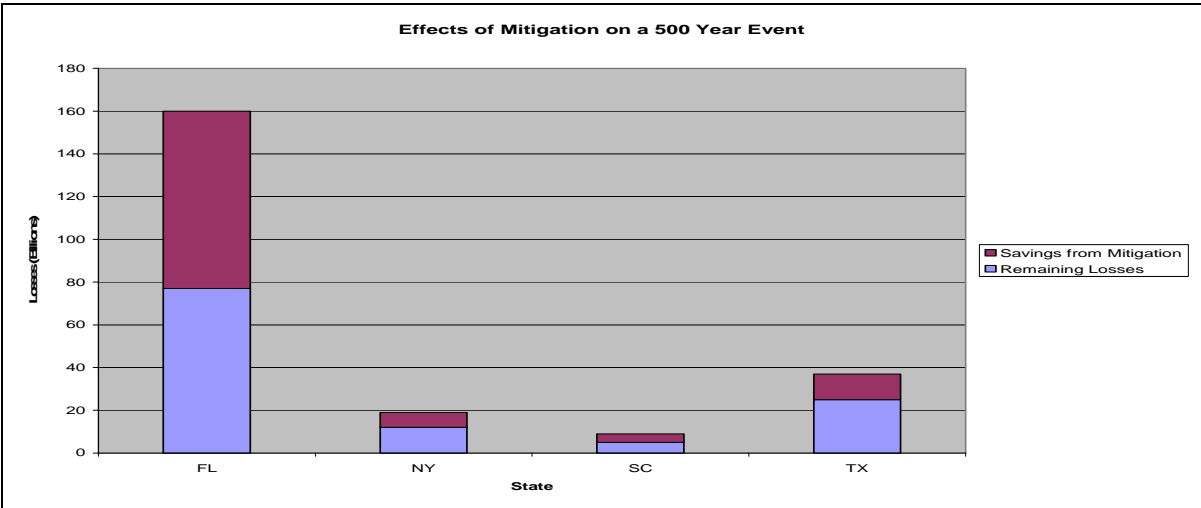
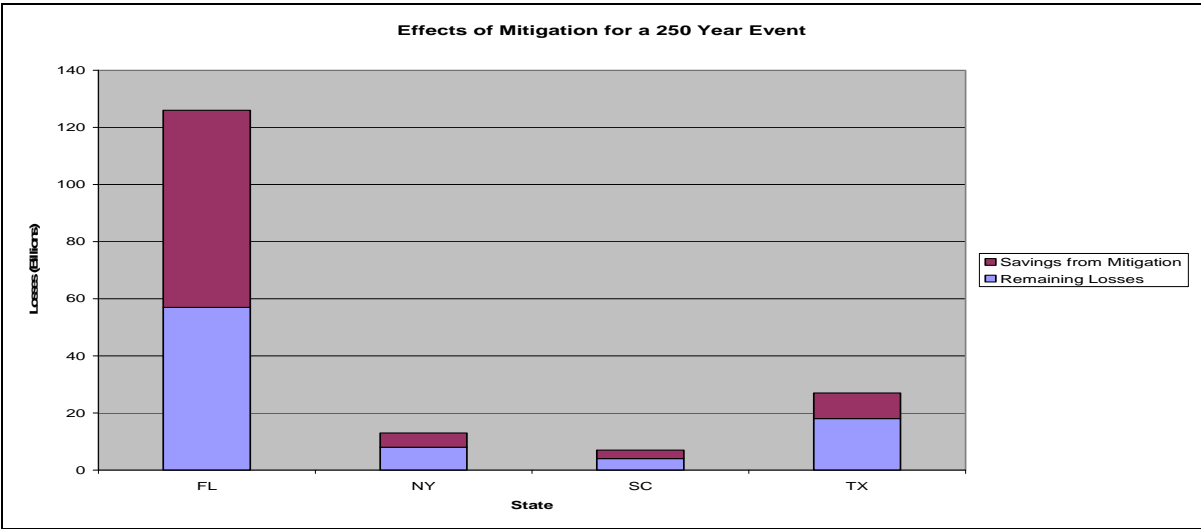
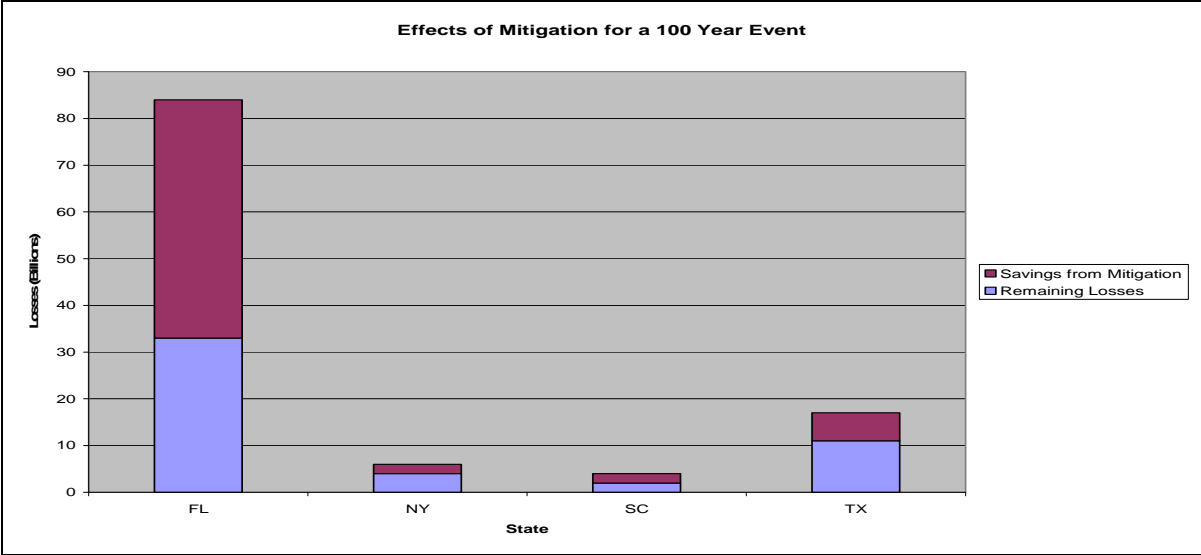
Table 4 indicates the differences in losses for hurricanes with return periods of 100, 250 and 500 years for each of the four states we studied when these loss-reduction measures are in place. The analysis reveals that mitigation has the potential to reduce hurricane losses significantly in all four states, ranging from 61 percent in Florida for a 100-year hurricane to 31 percent in New York for a 500-year event.

**TABLE 4. SAVINGS FROM REDUCED LOSSES FROM FULL MITIGATION FOR DIFFERENT RETURN PERIODS**

State	100-Year Event			250-Year Event			500-Year Event		
	Unmitigated Losses	Savings from reduced losses from mitigation	Savings from Mitigation (%)	Unmitigated Losses	Savings from reduced losses from mitigation	Savings from Mitigation (%)	Unmitigated Losses	Savings from reduced losses from mitigation	Savings from Mitigation (%)
FL	\$84 billion	\$51 billion	61%	\$126 billion	\$69 billion	55%	\$160 billion	\$83 billion	52%
NY	\$6 billion	\$2 billion	39%	\$13 billion	\$5 billion	37%	\$19 billion	\$7 billion	35%
SC	\$4 billion	\$2 billion	44%	\$7 billion	\$3 billion	41%	\$9 billion	\$4 billion	39%
TX	\$17 billion	\$6 billion	34%	\$27 billion	\$9 billion	32%	\$37 billion	\$12 billion	31%

Figure 5 depicts these differences in losses from mitigation graphically for hurricanes with return periods of 100, 250 and 500 years for each of the four states we studied.

<sup>9</sup> Information on this program is available on the website of the Institute for Business and Home Safety at [http://www.ibhs.org/property\\_protection/default.asp?id=8](http://www.ibhs.org/property_protection/default.asp?id=8) as of September 2007.



**FIGURE 5. EFFECTS OF MITIGATION ON LOSS FROM HURRICANES WITH 100, 250 AND 500 YEAR RETURN PERIODS**

We can now reanalyze how much of the losses from hurricanes will be covered by private insurance if all homes are mitigated according to the standards specified above and reinsurance was in place. Table 5 shows that private insurers will now be able to cover the entire losses from hurricanes with 100, 250 and 500 year return periods in all four states except for a hurricanes with a 500 year return period in Texas, and for 250-year and 500-year return periods in Florida. The percentage of the insurer’s surplus necessary to provide full coverage against losses associated with a 100-year hurricane range between 1 to 5.4 percent in the four states; for a 250-year hurricane, it ranges from 1.7 in South Carolina to 12.5 percent in Florida. Even for a Florida hurricane with a 500-year return period insurers would not have to put more than 15.1 percent of their surplus at risk to cover all losses.

**TABLE 5. PERCENTAGE OF LOSSES COVERED AND REQUIRED SURPLUS FOR FULL COVERAGE BY INSURERS WITH REINSURANCE IN PLACE (\$BILLION) AND FULL MITIGATION OF CURRENT HOMES**

State	Surplus	Return Period	Gross Losses	Reinsurance Coverage	Unreinsured Losses	Amount of Coverage (10% of Surplus)	Percent of Market Covered	Percent of Surplus Necessary for Full Coverage
FL	154.4	100	23.7	20.8	2.9	15.4	100.0%	1.9%
		250	42.9	23.6	19.3	15.4	80.1%	12.5%
		500	58.9	35.5	23.4	15.4	66.0%	15.1%
NY	167.8	100	2.4	0.2	2.1	16.8	100.0%	1.3%
		250	5.8	0.6	5.2	16.8	100.0%	3.1%
		500	9.4	1.9	7.5	16.8	100.0%	4.5%
SC	175.0	100	2.0	0.2	1.8	17.5	100.0%	1.0%
		250	3.3	0.3	3.0	17.5	100.0%	1.7%
		500	4.7	0.5	4.2	17.5	100.0%	2.4%
TX	139.2	100	9.4	1.9	7.5	13.9	100.0%	5.4%
		250	15.2	3.0	12.2	13.9	100.0%	8.8%
		500	21.1	6.3	14.8	13.9	94.2%	10.6%

The above analysis provides an important benchmark for future policy debates on the role that the insurance industry can play in covering future losses. With private insurers providing coverage at premiums reflecting risk, a system of insurance vouchers in place, and effective mitigation measures in place on residential homes, the catastrophe risk financing problem would virtually disappear.

A major challenge in this regard is to encourage owners of *existing* homes to adopt cost-effective mitigation measures. They do not have to comply with new building codes so there is a need to develop economic incentives for them to want to adopt these measures. There is an opportunity for homeowners, insurers and elected public officials to work together to make this happen. We first examine why property owners are reluctant to invest in cost-effective risk reducing measures and then turn to why insurers and local elected officials might be reluctant to

encourage them to do so. We then propose ways to overcome this resistance that could significantly enhance the adoption of these measures in the coming years.

### **3.2 Why Property Owners Do Not Invest in Cost-Effective Mitigation Measures**

Recent extreme events have highlighted the challenges in encouraging homeowners to adopt cost-effective measures for reducing losses from hurricanes and other natural hazards resulting in the *natural disaster syndrome* (Kunreuther, 1996). Since many homeowners, private businesses and the public sector do not voluntarily adopt cost-effective loss-reduction measures, these areas are highly vulnerable and unprepared should a severe hurricane or other natural disaster occur. The magnitude of the destruction following a catastrophe often leads governmental agencies to provide disaster relief to victims even if prior to the event the government claimed that it had no intention of doing so. This combination of underinvestment in protection prior to the catastrophic event, together with the general taxpayer financing some of the recovery can be critiqued on both efficiency and equity grounds.

There is extensive evidence that residents in hazard-prone areas do not undertake loss-prevention measures voluntarily. A 1974 survey of more than 1,000 California homeowners in earthquake-prone areas revealed that only 12 percent of the respondents had adopted any protective measures (Kunreuther et al., 1978). Fifteen years later, there was little change despite the increased public awareness of the earthquake hazard. In a 1989 survey of 3,500 homeowners in four California counties at risk from earthquakes, only 5 to 9 percent of the respondents in these areas reported adopting any loss reduction measures (Palm et al., 1990). Burby et al. (1988) and Laska (1991) have found a similar reluctance by residents in flood-prone areas to invest in mitigation measures.

In the case of flood damage, Burby (2006) provides compelling evidence that actions taken by the federal government, such as building levees, make residents feel safe, when in fact, they are still targets for catastrophes should the levee be breached or overtopped. This problem is reinforced by local public officials who do not enforce building codes and/or impose land-use regulations to restrict development in high hazard areas. If developers do not design homes to be resistant to disasters and individuals do not voluntarily adopt mitigation measures, one can expect large scale losses following a catastrophic event, as evidenced by the property damage to New Orleans caused by Hurricane Katrina.

Even after the devastating 2004 and 2005 hurricane seasons, a large number of residents had still not invested in relatively inexpensive loss-reduction measures with respect to their property, nor had they undertaken emergency preparedness measures. A survey of 1,100 adults living along the Atlantic and Gulf Coasts undertaken in May 2006 revealed that 83 percent of the responders had taken no steps to fortify their home, 68 percent had no hurricane survival kit and 60 percent had no family disaster plan (Goodnough, 2006).

There is a range of informal mechanisms that explain this natural hazard syndrome. One relates to framing the problem imperfectly: experts focus on the likelihood and consequences as

two key elements of the risk. Several studies show, however, that individuals rarely seek out probability estimates in making their decisions. When these data are given to them, decision makers often do not use the information. In one study, researchers found that only 22 percent of subjects sought out probability information when evaluating several risky managerial decisions (Huber, Wider and Huber, 1997).

People have particular difficulty dealing with probabilistic information for small likelihood events. They need a context in which to evaluate the likelihood of an event occurring. They have a hard time gauging level of concern about a 1 in 100,000 probability of death without some comparison points. Most people just do not know whether 1 in 100,000 is a large risk or a small risk. In one study individuals could not distinguish the relative safety of a chemical plant that had an annual chance of experiencing a catastrophic accident that varied from 1 in 10,000 to 1 in 1 million (Kunreuther, Novemsky and Kahneman, 2001).

There is also evidence that firms and residents tend to ignore risks whose subjective odds are seen as falling below some threshold. Prior to a disaster, many individuals perceive its likelihood as sufficiently low that they argue, “It will not happen to me.” As a result, they do not feel the need to invest voluntarily in protective measures, such as strengthening their house or buying insurance. It is only after the disaster occurs that these same individuals express remorse that they didn’t undertake protective measures.

Another reason that individuals do not invest in protective measures is that they are highly myopic and tend to focus on the returns only over the next couple of years. In addition, there is extensive experimental evidence showing that human temporal discounting tends to be hyperbolic, where temporally distant events are disproportionately discounted relative to immediate ones. As an example, people are willing to pay more to have the timing of the receipt of a cash prize accelerated from tomorrow to today, than from the day-after-tomorrow to tomorrow (Loewenstein and Prelec, 1991). The implication of hyperbolic discounting for mitigation decisions is that we are asking residents to invest a tangible fixed sum now to achieve a benefit later that we instinctively undervalue—and one that we, paradoxically, hope never to see at all. The effect of placing too much weight on immediate considerations is that the upfront costs of mitigation will loom disproportionately large relative to the delayed expected benefits in losses over time.

### **3.3 Why Insurers Do Not Encourage the Adoption of Risk Reduction Measures**

There are at least three principal reasons why insurers do not encourage the adoption of risk reduction measures. Insurers have been reluctant to offer premium discounts to residents who adopt mitigation measures in hazard-prone areas in large part because the premiums they charge to many of these homeowners are artificially low, so that there is usually no economic incentive to reduce them even further. A second reason for not offering premium discounts even if rates accurately reflect risk is that insurers feel they would be perceived as small relative to the cost of the mitigation measure and hence would be viewed as unattractive and unfair by the policyholder. A third reason is that insurers would need to monitor the protection measures in

place and measure their effectiveness over time for the entire portfolio of clients. This process can be costly relative to the expected benefits from having a well-designed mitigation in place given the low probability of hurricanes occurring. Additionally, it may be difficult to quantify the appropriate discount. The science is still too new to develop clear assumptions; and little is known about how to measure the combined effect of certain mitigation measures, or the effect of the presence of some mitigation measures where others are lacking.

However, failure to confirm that appropriate risk-reduction measures are in place can be very costly when a hurricane does occur. Insurers learned this lesson following Hurricane Andrew when experts indicated that 25 percent of the insured losses from this hurricane could have been prevented through better building code compliance and enforcement (Insurance Services Office, 1994).

### **3.4 Why Local Governments Do Not Encourage the Adoption of Risk Reduction Measures**

Politicians can benefit from their generous actions following a disaster by satisfying the needs of their constituency who will reward them by reelecting them. In the current economic environment, policymakers lack the incentive to provide tax incentives to encourage mitigation. This raises basic questions as to the capacity of elected representatives at the local, state and federal levels to induce people to adopt protection measures before the next disaster. The difficulty in enforcing these mitigation measures has been characterized as the *politician's dilemma* (Michel-Kerjan, 2008).

Imagine an elected representative at the city or state level. Should s/he push for residents and businesses in his/her constituency to invest in cost-effective mitigation measures to prevent or limit the occurrence of a disaster? From a long-term perspective, the answer should be *yes*. Clearly taxpayers will pay less in the long run if taxpayers' money is used for preparation and mitigation before catastrophe strikes. But given short-term re-election considerations, the representative is likely to vote for measures that allocate taxpayers' money elsewhere where they yield more political capital. Little consideration is given to supporting mitigation measures prior to a disaster (*ex ante*) because elected officials believe that their constituencies are not concerned about these events. There is likely to be a groundswell of support for generous assistance to victims from the public sector after a disaster (*ex post*) to aid their recovery. In other words, "risk reduction" is not an appealing proposition for politicians. We discuss how this issue can be addressed in the next section.

### **3.5 Encouraging Mitigation Measures through Public-Private Sector Initiatives**

As we have just discussed, there may be good reasons why homeowners do not necessarily invest in cost-effective mitigation measures on their own if not required to do so. This section discusses several ways to encourage the adoption of cost-effective mitigation measures using long-term loans, seals of approvals, tax incentives and zoning ordinances. These approaches can complement homeowners and flood insurance as a way of reducing losses to property in hazard-prone areas.

### ***Long-Term Mitigation Loans***

If long-term loans for mitigation were offered by banks, individuals would be encouraged to invest in cost-effective risk reduction measures. To highlight this point, consider the following hypothetical example. Suppose a property owner could invest \$1,500 to reinforce his roof to reduce wind damage by \$30,000 from a future hurricane that has an annual probability of 1 in 100. If the amount of the premium necessary to cover windstorm sufficiently reflected risk, the insurer may be willing to reduce the annual premium by \$300 (i.e.,  $1/100 \times \$30,000$ ) to reflect the lower expected losses that would occur if a hurricane hit the area in which the policyholder was residing. If the house was expected to last for 10 or more years, the net present value of the expected benefit of investing in this measure would exceed the upfront cost at an annual discount rate as high as 15 percent.

Today many property owners might be reluctant to incur the \$1,500 expenditure, because they would get only \$300 back next year and are likely to consider only short-term benefits over the next few years when making their decisions. If they underweight the future, the expected discounted benefits would likely be less than the \$1,500 upfront costs. In addition, budget constraints could discourage them from investing in the mitigation measure. Other considerations would also play a role in a family's decision not to invest in these measures. The family may not be clear how long they will reside in the house and/or whether their insurer would reward them again when their policy is renewed. The homeowner may also fail to appreciate the interdependencies associated with floods, earthquakes and other disasters. Investing in mitigation measures will not only reduce the potential losses to one's own property but alleviate damage to neighboring structures. A 20-year \$1,500 home improvement loan at an annual interest rate of 10 percent would result in payments of \$145 per year. Even if the insurance premium was only reduced by \$200, the savings to the homeowner each year would be \$55 plus the resulting mortgage interest tax deductible amount.

### ***Providing Mitigation Seals of Approval***

One way to encourage the adoption of cost-effective mitigation measures is to require banks and other lenders to condition their mortgages on sellers (in the case of new homes) and buyers (for purchases of existing homes) demonstrating that they have obtained a seal of approval from a certified inspector that the structure meets or exceeds building code standards. This requirement could either be legislated or imposed by the existing government sponsored enterprises (GSEs) (Fannie Mae, Freddie Mac, and Ginnie Mae). Current homeowners may want to seek such a seal of approval as well, if they knew that insurers would provide a premium discount akin to the discounts that insurers now make available for smoke detectors or burglar alarms, and if home improvement loans for this purpose were generally available.

A mitigation seal of approval should be of interest to homeowners. Such a seal should increase the property value of the home should the owner want to sell it, by informing the potential buyer that the house is built safely. There are other direct financial benefits from having a seal of approval. Under the *Fortified...for safer living* program of the Institute for Business &

Home Safety, an independent inspector, trained by IBHS, verifies that disaster resistance features have been built into the home that exceed the minimum requirement of building codes and may enable the property owner to receive homeowners' insurance credits in some states. The success of such a program requires the support of the building industry and a cadre of qualified inspectors to provide accurate information as to whether existing codes and standards are being met or exceeded. Such a certification program can be very useful to insurers who may choose to provide coverage only to those structures that are given a certificate of disaster resistance.

Evidence from a July 1994 telephone survey of 1,241 residents in six hurricane-prone areas on the Atlantic and Gulf Coasts provides supporting evidence for some type of seal of approval. Over 90 percent of the respondents felt that local home builders should be required to adhere to building codes, and 85 percent considered it very important that local building departments conduct inspection of new residential construction.

We recommend the following procedure. The inspection required to establish a seal of approval be undertaken by certified contractors. For *new* properties, the contractor must provide the buyer with this seal of approval. For *existing* properties, the buyer should pay for the inspection and satisfy the guidelines for a seal of approval. If the house does not satisfy the criteria, then banks and other mortgage lenders should roll into their mortgage loans the cost of such improvements. We will return to the role banks and other lending institutions could play to help homeowners invest in risk reduction measures over the long run when we discuss our proposal for long-term insurance below.

### ***Providing Local, State and Federal Tax Incentives***

Another way for communities to encourage residents to pursue mitigation measures is to provide them with tax incentives. For example, if a homeowner reduces the chances of damage from a hurricane by installing a loss reduction measure, then this property owner would get a rebate on state taxes to reflect the lower costs for disaster relief. Alternatively, property taxes could be reduced for the same reason. In practice, communities often create a monetary disincentive to invest in mitigation. Those who improve their homes by making it safer are likely to have their property reassessed at a higher value and, hence, be required to pay higher taxes. California has recognized this problem, and in 1990 voters passed Proposition 127, which exempts seismic rehabilitation improvements to buildings from reassessments that would increase property taxes.

The city of Berkeley in California has taken an additional step to encourage home buyers to retrofit newly purchased homes by instituting a transfer tax rebate. The city has a 1.5 percent tax levied on property transfer transactions; up to one-third of this amount can be applied to seismic upgrades during the sale of property. Qualifying upgrades include foundation repairs or replacement, wall bracing in basements, shear wall installation, water heater anchoring, and securing of chimneys.

The principal reason for using tax rebates to encourage mitigation is the broader benefit associated with these measures. If a house is not damaged because it is protected in some way,

then the general community gains more than just the reduced damage to the house. For example, residents who would have to leave their unmitigated homes after a disaster, but who were now able to stay there because it was protected, would not have to be fed or housed elsewhere. These added benefits cannot be captured through insurance premium reductions, which normally cover damage only to the property. Taxes are associated with broader units of analysis, such as the community, state, or federal level. To the extent that the savings in disaster costs accrue to these units of government, tax rebates are most appropriate.

South Carolina has established Catastrophe Savings Accounts that allow residents to set money aside, state income tax-free, to pay for qualified catastrophe expenses. The amount placed in the account reduces the taxpayer's South Carolina taxable income and, as a consequence, reduces the state income tax that the homeowner has to pay. A homeowner may deduct contributions to a Catastrophe Savings Account to cover losses to their legal residence against hurricane, rising floodwaters, or other catastrophic windstorm event damages.<sup>10</sup>

South Carolina also offers tax credits for retrofitting, allowing individuals to take state income tax credits for costs to retrofit homes. In order to qualify for the tax credit, costs must not include ordinary repair or replacement of existing items. The individual may take a credit in any taxable year for costs associated with specific fortification measures as defined by the Director of Insurance.

In addition to obtaining tax credits for retrofitting properties in the mitigation process, consumers will also receive tax credits on the mitigation materials they buy. (For more details on this program go to <http://www.doi.sc.gov/faqs/CatSavingsAcct.htm>.)

### ***Encouraging or Mandating Better Zoning***

One of more vexing problems facing policy makers after major catastrophes is whether to permit rebuilding in areas that have been damaged. As the response after Katrina demonstrated, there is usually strong political support for wanting to rebuild. Indeed, not to do so somehow seems unpatriotic. But in some cases, common sense should take precedence. In areas that have suffered multiple catastrophes – say, three or more – nature may be telling us that these locations are much more likely to be damaged than others. In effect, this is recognized in FEMA's flood maps, which the agency is in the process of updating. We urge that this reality be recognized more widely, not just for floods, but for hurricanes and earthquakes as well. Ideally, local authorities should realize this and adopt zoning policies that do not permit rebuilding in these areas. A countervailing force is the pressure at the local level to permit, if not encourage, rebuilding to increase population and economic activities, and tax revenue. This pressure is unlikely to be as intense at the state level, and thus we recommend that states adopt policies that

---

<sup>10</sup> Tax incentive programs such as this one should encourage homeowners to take out a larger deductible on their insurance policy and contribute more to the Catastrophe Savings Account. In the process they pay lower insurance premiums and save taxes at the same time. The insurer benefits by having to pay out lower claims following a disaster. If many homeowners take advantage of this program by raising their deductible the insurer's catastrophic exposure could be significantly reduced.

prevent or discourage localities from allowing rebuilding in areas that have been the subject of multiple natural catastrophes (at least three catastrophes over some reasonable time period, say two decades).

An even bolder suggestion is to have the *federal government* encourage state governments to take this step. This could be done through positive incentives, such as premium discounts on reinsurance sold by the federal government to a state CAT plan. It would be important to evaluate the possible impact of such a measure on insurance prices.<sup>11</sup> Further, premium discounts on federal reinsurance should be reflective of reductions in high-risk land use but should be designed to assure that states do not, in turn, rely on them for the purpose of artificially suppressing rates. Alternatively, the federal government could use penalties or *sticks* to accomplish the same objective. For example, federal highway funds could be withheld if the state did not adopt a zoning policy that restricts new development of property in high hazard-areas.

#### **4. A New Concept: The Development of Long-Term Contracts<sup>12</sup>**

Over the past several years, the Wharton Risk Center has undertaken research projects on ways to more effectively deal with extreme events prior to their occurrence. Given the increase in catastrophic losses over the past two decades we believe there is an urgent need to rethink the problem systematically by moving from the status quo to institute new programs for encouraging long-term thinking. For these programs to be successful we need to recognize systematic behavioral features of homeowners, insurers and elected officials discussed above: we all tend to suffer from myopia and focus on the most recent crisis rather than think long term. In the context of property insurance, policies are normally annual contracts, which lead to short-term thinking with respect to the relevant risks (i.e. only next year is relevant).

We propose moving from the standard one-year insurance contracts for homeowners and flood insurance for residential properties to long-term insurance (“LTI” hereafter) so as to encourage property owners to invest in cost-effective mitigation measures. In the case of homeowners coverage (which includes protection against wind damage but not flood losses), some insurers have recently restricted the sale of new homeowners policies in hurricane prone areas. Policyholders cannot help but worry that their existing coverage might be subject to unexpected cancellation or very significant premium increases, particularly if there is severe hurricane damage in the near future.

##### **4.1 Need for Long-Term Insurance**

One-year insurance policies foster significant social costs. Evidence from recent disasters reveals that consumers who fail to adequately protect their home or even insure at all, suffer a welfare loss and impose a cost to all taxpayers in the form of government disaster assistance.

---

<sup>11</sup> For more details see Kunreuther and Michel-Kerjan (2007), “Federal CAT Reinsurance Backstop: Details and Issues”, paper prepared for the Blue Ribbon Commission on Mega-Catastrophes, Financial Services Roundtable, New York.

<sup>12</sup> This section draws heavily on Jaffee, Kunreuther and Michel-Kerjan (2008).

The development of LTI should also encourage individuals to invest in cost-effective mitigation measures. As pointed out above many homeowners do not adopt these measures due to myopia and budget constraints. They are unwilling to incur the high upfront cost associated with these investments relative to the small premium discount they would receive the following year that reflects the expected reduction in insured claims should a disaster occur (Kunreuther, Meyer and Michel-Kerjan, forthcoming). If an LTI policy were coupled with a long-term home improvement loan tied to the mortgage, the reduction in insurance premiums would exceed the annual loan payment. The social welfare benefits of LTI coupled with long-term mitigation loans over  $N$  years could be significant: there will be less damage to property, reduction in costs of protection against catastrophic losses by insurers, more secure mortgages and lower costs to the government for disaster assistance.

#### **4.2 Why Does a Market for Long-Term Insurance Not Exist Today?**

In his seminal work on uncertainty and welfare economics, Kenneth Arrow defined “the absence of marketability for an action which is identifiable, technologically possible and capable of influencing some individuals’ welfare (...) as a failure of the existing market to provide a means whereby the services can be both offered and demanded upon the payment of a price.” (Arrow, 1963). Here we shall discuss several factors which have contributed to the non-marketability of LTI for protecting homeowners’ properties against losses from fire, theft and large-scale natural disasters. We discuss elements which affect both the supply and demand sides.

##### ***Supply Side***

Today insurance premiums in many states are restricted to be artificially low in hazard-prone areas, as illustrated by Florida’s actions in recent years. The result is that the risks most subject to catastrophic losses also become the most unattractive for insurers to market. A second stumbling block, derived from premium regulation, is that insurers are unclear as to how much they will be allowed to charge for premiums in the future. Uncertainty regarding costs of capital and changes in risk over time may also deter insurers from providing long-term insurance. In principle, of course, insurers could add a component in their rate structure to account for the costs created by these factors. The problem is that the insurance regulator, presumed to be representing consumers’ interests, may not allow these costs to be embedded in the approved premiums. Furthermore, it is unclear what the voluntary demand for coverage will be, given the resulting premium. In a real sense, a new and less intrusive format for government regulation of insurance markets may be required if the private sector is to be successful in dealing with time-varying risks and capital costs.

Insurers might also be concerned about possible change in the level of risk over time. For example, global warming could trigger more intense weather-related disasters, and/or local environmental degradation might change the risk landscape in the next several decades. One way to address this concern would be to have renegotiable contracts every  $X$  years (e.g. 10 years) based on new information validated by the scientific community in the same way that there are renegotiable loans with adjustable rates. A decadal risk index validated by a well-respected third party could be used to price the new contracts.

## ***Demand Side***

Some homeowners may worry about the financial solvency of their insurer over a long period, particularly if they feel they would be locked-in if they sign an LTI contract. Consumers might also fear being overcharged if insurers set premiums that reflect the uncertainty associated with long-term risks. Furthermore, those who have not suffered a loss for 10 years but have a 25-year LTI may feel that the premiums are unfairly priced. It is thus essential that the design of an LTI contract anticipates these concerns and be transparent to the policyholder.

### **4.3 Developing an LTI Policy**

Jaffee, Kunreuther and Michel-Kerjan (2008) have developed a simple two-period model in a competitive market setting where premiums reflect risk to compare the expected benefits of annual contracts vs. LTI. We show that an LTI policy reduces the marketing costs for insurers over one-period policies and also reduces the search costs to the consumer if their insurer decides to cancel its policy at the end of period 1. If the policyholder is permitted to cancel an LTI policy at the end of period 1 if he learns that the cost of a 1-period policy is sufficiently low to justify paying a cancellation cost ( $C$ ), then it is always optimal for the insurer to market an LTI policy and for a consumer to purchase one. The insurer will set  $C$  at a level which enables it to break even on those policies that are canceled before the maturity date.

Developing any type of LTI policy that would be marketed by the private sector requires that *premiums reflect risk* (Principle 1). By giving insurers this degree of freedom, they will have economic incentives to develop new products. Under the current state regulatory arrangements no insurance company would even entertain the possibility of marketing an LTI policy for homeowners coverage. They would be concerned that the regulator would clamp down on them now or in the future regarding the premiums they could charge, so that an LTI policy would be an infeasible financial contract.

### **4.4 Protecting Against Catastrophic Losses**

If insurers are permitted to charge premiums that reflect risk, they are likely to seriously consider marketing long-term policies if they know they can protect themselves against the possibility of a catastrophic loss that will seriously reduce their surplus and possibly threaten their solvency. There are several ways that insurers can deal with this issue:

- Diversify their portfolio so that they reduce the likelihood of highly correlated losses from a catastrophic disaster
- Purchase reinsurance and alternative transfer instruments (e.g. catastrophe bonds, industry loss warranties, sidecars) to protect themselves against a cat loss
- Make use of some type of federal/state reinsurance should the private market not be able to provide full coverage as discussed in sections 2.3 and 3.1.

## ***Portfolio Diversification***

If insurers are able to spread the risk geographically they should be able to reduce the likelihood that they will suffer a serious loss from any disaster. Large companies have an easier time taking this step than smaller firms domiciled in a single state. However, even in this case the insurer can limit the number of policies it will hold in a specific region subject to hurricanes or other severe disasters.

## ***Purchase Reinsurance and Alternative Risk Transfer Instruments from the Private Sector***

In order to diversify their portfolio, insurers can continue to transfer part of it to traditional reinsurance. In addition, there has been a significant development of so-called alternative risk transfer (ART) instruments that allow an insurer (or any companies for that matter) to transfer some of its exposure directly to the financial market. Most of these risk-transfer techniques permit investors in the capital markets to play a more direct role in providing insurance and reinsurance protection. Investors see these products as a way of enhancing their returns by allocating funds to instruments that are not highly correlated with other financial risks (e.g., fluctuations in interest rates).

The field of ART grew out of a series of insurance capacity crises in the 1970s through the 1990s that led purchasers of traditional reinsurance coverage to seek more robust ways to buy protection. The significant increase in reinsurance prices after the 2005 hurricane season in the United States, along with more stringent criteria by rating agencies for providing protection against catastrophic risk, has led to a significant expansion of the insurance-linked securities (ILS) market. For instance, in 2006, twenty catastrophe bonds (typically multi-year contracts; e.g. 3 years) were issued (\$4.7 billion issued and \$8.7 billion capital outstanding), compared with eleven in 2005 (\$2.1 billion issued and \$2.9 outstanding), the previous record. In 2007, the total value of cat bonds issued for natural disasters alone was \$7 billion. Twenty-seven transactions were completed in 2007, a new record compared with the twenty transactions in 2006 and the ten transactions closed in 2005. Because of the financial crisis in 2008, only \$2.1 billion was issued through cat bonds in 2008 (Michel-Kerjan and Morlaye, 2008).

Securitization still represents a small proportion of the capital in the global insurance market today. Over \$25 billion of outstanding capital was in place in 2007 for property and casualty coverage (including cat bonds, sidecars, and industry loss warranties). As with any other financial instruments, catastrophe bonds have suffered from the 2008-2009 financial crisis. After the 2007 record-setting year, catastrophe bond issuances fell 62 percent by volume (\$2.7 billion in new and renewal capacity) and nearly by half in transaction account (13), with almost no transactions taking place in the second two quarters of 2008. Indeed, given the uncertainty associated with the future of financial markets, the cost of capital, and due to more favorable reinsurance rates, many transactions were postponed. Still, with \$2.7 billion of new issuances, 2008 was the third busiest year since catastrophe bonds were introduced in 1997. As of June 2009, it seems that 2009 will not be a record-year but should bring enough capacity into this market to replace capacity from maturing deals (Michel-Kerjan, 2009).

## ***Public Sector Involvement***

Several initiatives have been proposed to involve the public sector more actively in providing an additional layer of financial capacity to complement what insurers, reinsurers and ART instruments can provide to protect insurers against catastrophic losses. Following Hurricane Andrew in 1992, Lewis and Murdoch (1996) proposed that federal government engage in a process of *auctioning reinsurance contracts* to cover truly cataclysmic events. More specifically, the U.S. Treasury department would auction a limited number of contracts indexed on the total industry loss associated with a single natural disaster. Originally they proposed contracts covering industry losses between \$25 billion and \$50 billion but the concept could apply to any tranche one would judge appropriate and be expanded so it could cover multiple events over one year or even a multi-year period (e.g., 5 years). Today, many European countries provide federal reinsurance at a price for high layers of exposure to complement private reinsurance.

Another proposal is the establishment of a *Coastal Hurricane Zone* where regulations are specified and enforced by the federal government and would be similar in each state. This would allow insurers to make long-term commitments of capital to provide coverage against wind damage. Premiums would reflect the risk and states could continue their regulatory oversight. The zone would also include a mechanism to equitably adjust premiums after periods of significant weather-related profits or losses.<sup>13</sup>

## **5. A Natural Pilot for Long-Term Insurance: Flood Insurance through the NFIP**

We recognize that given the existing tension between state insurance regulators and the insurance industry, the development of long-term insurance coupled with long-term risk reduction loans is likely to take time to emerge unless there is strong leadership from both constituencies. For this reason, we focus initially on long term policies for flood insurance since this coverage is provided on a national basis by the federal government. The National Flood Insurance Program (NFIP) was created in 1968 because private insurers viewed flood risk as uninsurable. Over the years NFIP has expanded dramatically. In 2008 it sold over 5.5 million policies compared to 2.5 million in 1992 and provided over \$1.1 trillion in coverage compared to \$237 billion in 1992. Given that the NFIP is scheduled for renewal in Congress, there may be an opportunity to explore our long-term contract concept as part of the legislative process. More specifically, it would be useful to consider whether one could make flood insurance policies long-term by tying them to mortgages. By instituting such a program insurance would be connected directly with the property rather than to the homeowner. One might also consider requiring all homeowners in flood prone areas to purchase the insurance just as those who own a car are required to take out automobile insurance today whether or not they are financing the purchase of their car. If a homeowner moved to another location, the flood insurance policy would remain with the property.

---

<sup>13</sup> More details appear in Kunreuther and Michel-Kerjan (forthcoming).

### ***Why Have a Long-Term Flood Insurance Policy?***

A long-term flood insurance program would offer homeowners currently residing in flood-prone areas a fixed rate for a prespecified time period (e.g. 5, 10 or 20 years). If the homeowner moved away from the area before the end of the policy period, then the insurance policy would automatically be transferred to the new property owner at the same rate. For those homeowners who were being charged subsidized rates because their homes were constructed prior to the time that their community joined the NFIP, these premiums would be maintained for the length of the policy period. For homeowners who constructed homes after the date that their community joined the program, their rates would be actuarially based.

There are a number of reasons why such a long-term flood insurance policy would be a great improvement over the current annual policies from the perspective of the relevant stakeholders: homeowners, FEMA, banks and financial institutions, and the general taxpayer. By establishing flood insurance rates at a fixed price, homeowners would be provided with financial stability. They would also have knowledge that they are protected against water damage from floods and hurricanes. This would reduce the legal problems that have plagued victims of recent hurricanes (e.g. the Florida hurricanes of 2004, Hurricane Katrina, Hurricane Ike). Homeowners would not have to argue that the losses were due to wind so they could collect on their homeowners' policy. There would still be a question as to whether the government would be paying for some of the loss because it was caused by water or whether private insurers would be responsible because it was wind-related damage.

Long-term flood insurance would also assure the spread of risk within the program since most homeowners in flood prone areas would be covered. If flood insurance were required for all homeowners residing in hazard-prone areas, then there would be even a larger spread of risk. This would provide much needed financial revenue for the program over time increasing the size of the policy base.

Long-term policies would prevent individuals from cancelling their policies after they have not experienced a flood for several years. There is empirical evidence that this occurs today even when homeowners are required to purchase flood insurance as a condition for a federally insured mortgage. Some banks and financial institutions have not enforced this regulation because few of them have been fined and/or the mortgages are transferred to financial institutions in non-flood prone regions of the country that have not focused on either the flood hazard risk or the requirement that homeowners may have to purchase this coverage. To highlight this point, consider the flood in August 1998 in northern Vermont. Of the 1549 victims of this disaster, FEMA found 84 percent of residents in Special Flood Hazard Areas (SFHAs) did not have insurance, 45 percent of whom were required to purchase this coverage (Tobin and Calfee, 2005). A recent study of flood insurance in Florida revealed that of the one million residential NFIP flood insurance policies in place in Florida in 2000, one third had been cancelled by 2002 and about two thirds had been cancelled by 2005 (Michel-Kerjan and Kousky, forthcoming).

### ***Coupling Long-Term Mitigation Loans with Long-Term Flood Insurance***

As pointed out above long-term loans for mitigation offered by banks would encourage individuals to invest in cost-effective risk reduction measures. If a long term flood insurance policy were tied to the property, then the homeowner could take out a home improvement loan tied to the mortgage to spread the cost of mitigation over a number of years. Alternatively, this loan could be incorporated as part of the mortgage at even a lower interest rate than 10 percent.

Long-term insurance and mitigation loans would constitute new financial products. A bank would have a financial incentive to provide this type of loan, since it is now better protected against a catastrophic loss to the property, and the NFIP knows that its potential loss from a major disaster is reduced. Moreover, the general public will now be less likely to have large amounts of their tax dollars going for disaster relief. Indeed, following Hurricanes Katrina, Rita and Wilma in 2005 and the resulting floods, FEMA, which administers the NFIP, paid \$19.28 billion in claims. This amount exceeded the \$2.2 billion in premiums earned annually by the NFIP. As a result, the borrowing capacity of the program was expanded to \$20.775 billion so all outstanding claims could be paid (Michel-Kerjan and Kousky, forthcoming).

## **6. Open Questions and Conclusions**

In this concluding section we pose a set of questions that need to be addressed for insurers to be willing to play a more active role in providing protection against catastrophic risks:

- Can principles 1 and 2 be operationalized so that State Insurance Commissioners will want to implement them?
- What insurance voucher system to deal with equity and affordability issues is most likely to be politically acceptable and who will sustain it financially (taxpayers, insurance policyholders, insurers, etc)?
- With premiums reflecting risk and those needing special treatment being assisted financially so they can purchase insurance, how can insurers interact with other key stakeholders (e.g. banks and financial institutions, public sector organizations) to encourage property owners to invest in cost-effective mitigation measures so that national exposure to disasters is significantly reduced?
- Given the gravity of the situation, should these measures be mandated? If so, what type of *mitigation* loan/voucher system can be implemented? Who will sustain this system financially?
- Are there ways to increase the role that alternative risk transfer instruments can play in providing insurers and other businesses with financial protection against catastrophic losses at reasonable prices?

- What role could and should state funds and the federal government play in providing protection against catastrophic losses to complement private sector initiatives? Are there tax incentives that argue for more public sector involvement in this regard?
- Given the current economic situation, states have a hard time issuing bonds under favorable conditions. How this will impact the private insurers who eventually might be responsible for bailing out state pools (by assessing their policyholders in the aftermath of a catastrophe)?

It is not an understatement to say that the United States has entered a new era of catastrophes. Local interests and myopic behaviors have created the seeds for the perfect storm to occur. In 2005 Hurricane Katrina cost \$45 billion to the insurers—or about 11 percent of the U.S. property and casualty insurers' surplus at the time. Katrina was the most devastating disaster in U.S. history, but the hurricane caused damage in one of the poorest parts of the country with low degree of insurance penetration. Had this hurricane been more intense and damaged another part of the coast, insured losses could have been considerably higher. Katrina should have been a wake-up call to rethink our national strategy for disaster resiliency and recovery.

But economic development continues in high hazard-prone areas so that population and values exposed to risk are much higher today than they were several years ago. According to data from the modeling firm AIR Worldwide, between December 2004 and December 2007 the total insured residential and commercial values located on the coast of Florida alone went from \$1.9 up to \$2.4 trillion. If one sums up insured values located on the large *coastal* area ranging from Texas to Maine, estimated privately insured exposure is now in the \$9 trillion range—that is 200 times the insured losses due to Hurricane Katrina.

The new era of catastrophes coupled with the current economic crisis facing this country requires the key interested parties to reflect on their values and goals and how best to achieve them. In the context of natural disasters, it is urgent to rethink how we as a country can mitigate future losses so as to reduce the likelihood of a future cataclysmic event somewhere in the United States.

In the current economic environment, making our nation less vulnerable to future natural disasters should be seen at a top priority for the new administration, Congress and state officials alike. Indeed, another series of catastrophes will likely have a much more enduring impact on an already fragile economy. Keeping insurance prices artificially low by concentrating the risk in wind pools which often don't have the financial capacity to handle true disasters is a losing proposition over time even though it may be politically attractive in the short-run and if no disaster happens: residents in these regions can access coverage at a lower price. But after the next catastrophe occurs victims in devastated states will realize that these funds do not have to capacity to pay for all the losses and will then ask all of the insured residents in the state to pay *ex post* assessments.

## REFERENCES

- Arrow, K. (1963), "Uncertainty and the Welfare Economics of Medical Care," *American Economic Review*, 53(5):941-973.
- BestWire (2009), "Florida Panel Suggests Rate Increase for State-Run Homeowners Insurer," January 7.
- Burby, R. (2006), "Hurricane Katrina and the Paradoxes of Government Disaster Policy: Bringing About Wise Governmental Decisions for Hazardous Areas "The ANNALS of the American Academy of Political and Social Science 604: 171-191.
- Burby, R., S. Bollens, E. Kaiser, D. Mullan and J. Sheaffer (1988), *Cities Under Water: A Comparative Evaluation of Ten Cities' Efforts to Manage Floodplain Land Use*. Boulder, CO: Institute of Behavioral Science, University of Colorado.
- Goodnough, A. (2006), "As Hurricane Season Looms, State Aims to Scare," *The New York Times*, May 31. <http://www.nytimes.com/2006/05/31/us/31prepare.html>
- Huber, O., R. Wider, and O. Huber (1997), "Active Information Search and Complete Information Presentation in Naturalistic Risky Decision Tasks," *Acta Psychologica*, 95: 15-29.
- Institute for Business & Home Safety (2007), *The Benefits of Modern Wind Resistant Building Codes on Hurricane Claim Frequency and Severity—A Summary Report*.
- Insurance Services Office (1994), *The Impact of Catastrophes on Property Insurance* (New York, N.Y.: Insurances Services Office).
- Jaffee, D., H. Kunreuther, and E. Michel-Kerjan (2008), "Long Term Insurance (LTI) for Addressing Catastrophe Risk" NBER Working Paper # w14210.
- Klein, R.W. (2009), "Hurricane Risk and the Regulation of Property Insurance Markets" Working paper, department of Risk and Insurance, Georgia State University. July 27, 2009.
- Kunreuther, H. (2007), "Who Will Pay for the Next Hurricane?" *New York Times*, August. [http://opim.wharton.upenn.edu/risk/library/oped\\_NYT2007-08-25.pdf](http://opim.wharton.upenn.edu/risk/library/oped_NYT2007-08-25.pdf)
- Kunreuther, H. (1996), "Mitigating disaster losses through insurance," *Journal of Risk and Uncertainty* 12: 171-187.
- Kunreuther, H. et al. (1978), *Disaster Insurance Protection: Public Policy Lessons*, New York: John Wiley & Sons.
- Kunreuther, H., R. Meyer and E. Michel-Kerjan (forthcoming), "Overcoming Decision Biases to Reduce Losses from Natural Catastrophes," in E. Shafir (ed), *Behavioral Foundations of Policy*, Princeton University Press.
- Kunreuther, H. and E. Michel-Kerjan (forthcoming), "From Market to Government Failure in Insuring U.S. Natural Catastrophes: How Can Long-Term Contracts Help." In *Private Markets and Public Insurance Programs*. J. Brown (ed.). Washington, D.C., American Enterprise Institute Press.

- Kunreuther, H., and E. Michel-Kerjan (2009), *At War with the Weather: Managing Large-Scale Risks in a New Era of Catastrophes*. MIT Press.
- Kunreuther, H. and E. Michel-Kerjan (2007), “Federal CAT Reinsurance Backstop: Details and Issues”, paper prepared for the Blue Ribbon Commission on Mega-Catastrophes, Financial Services Roundtable, New York.
- Kunreuther, H., N. Novemsky and D. Kahneman (2001), “Making Low Probabilities Useful” *Journal of Risk and Uncertainty* 23:103-120.
- Laska, S.B. (1991), *Floodproof Retrofitting: Homeowner Self-Protective Behavior*. Boulder, CO: Institute of Behavioral Science, University of Colorado.
- Lewis, C. and K. Murdock (1996), “The Role of Government Contracts in Discretionary Reinsurance Markets for Natural Disasters” *Journal of Risk and Insurance* 63: 567-597.
- Loewenstein, G. and D. Prelec (1991), "Negative Time Preference," *American Economic Review*, Vol. 81(2), pages 347-52, May.
- Michel-Kerjan, E. (2009), "Hedging against Tomorrow's Catastrophes: How Sustainable Financial Solutions Can Help Protect against Extreme Events." in H. Kunreuther and M. Useem (eds.), *Learning from Catastrophes*, World Economic Forum Global Agenda Council on Natural Disasters. Wharton School Publishing.
- Michel-Kerjan, E. (2008), “Disasters and Public Policy: Can Market Lessons Help Address Government Failures,” proceedings of the 99th National Tax Association Conference, Boston, MA.
- Michel-Kerjan, E. and C. Kousky (forthcoming), “Come Rain or Shine: Evidence on Flood Insurance Purchases in Florida”, *Journal of Risk and Insurance*.
- Michel-Kerjan, E. and F. Morlaye (2008), “Extreme Events, Global Warming, and Insurance-Linked Securities: How to Trigger the ‘Tipping Point’”, *The Geneva Papers on Risk and Insurance*, 33(1): 153-176.
- Palm, R., M. Hodgson, R.D. Blanchard and D. Lyons (1990), *Earthquake Insurance in California: Environmental Policy and Individual Decision Making*. Boulder, CO: Westview Press.
- Swiss Re (2009), *Natural Catastrophes and Man-Made Disasters in 2008. North America and Asia Suffer Heavy Losses*. Sigma, 2/2009.
- Swiss Re (2008), Media Release, December 18.
- Tobin, R. and C. Calfee (2005), “The National Flood Insurance Program’s Mandatory Purchase Requirement: Policies, Processes, and Stakeholders” American Institutes for Research , Washington, DC.
- White House (2007), Economic Report of the President. Council of Economic Advisors, Washington, DC, February.

## APPENDIX A

### Existing Voucher System Programs

*Food Stamp Program.* Under the Food Stamp Program, a family is given vouchers to purchase food based on its annual income and size of the family. This program concept originated in the late 1930s, was initiated as a pilot program in 1961 and extended nationwide in 1974. The current program structure was implemented in 1977 with a goal of alleviating hunger and malnutrition by permitting low-income households to obtain a more nutritious diet through normal purchasing of food from grocery stores. Food stamps are available to most low-income households with limited resources regardless of age, disability status or family structure. Households, except those with elderly or disabled members, must have gross incomes below 130 percent of the poverty line. All households must have net incomes below 100 percent of poverty to be eligible.<sup>14</sup> The program is funded entirely by the federal government. Federal and state governments share administrative costs (with the federal government contributing nearly 50 percent). In 2003, total federal food stamp costs were nearly \$24 billion.

*Low Income Home Energy Assistance Program (LIHEAP).* The mission of this program is to assist low income households that pay a high proportion of their income for home energy in meeting their immediate energy needs. The funding is provided by the federal government but is administered by the states and federally recognized tribes or insular areas (e.g., Guam, Puerto Rico, Virgin Islands) to help eligible low-income homeowners and renters meet their heating or cooling needs (eligibility based on similar criteria than the food stamp program).<sup>15</sup> The Federal government became involved in awarding energy assistance funds to low-income households program as a result of the increase in oil prices resulting from the Organization of Petroleum Exporting Countries (OPEC) oil embargo in 1973. Over the past few years the annual appropriation of this program has averaged \$2 billion.<sup>16</sup>

*Universal Service Fund (USF).*<sup>17</sup> The USF was created by the Federal Communications Commission in 1997 to ensure that consumers in all regions of the nation have access to and pay rates for telecommunications services that are reasonably comparable to those in urban areas. To achieve this goal, the program first provides discounts to all households living in a particular high cost area (e.g., rural areas) so they all pay the same subsidized rate regardless of income. Then there are universal service programs that are strictly aimed at low income people households, regardless of whether they live in high or low cost areas.

---

<sup>14</sup> More details on this program can be found at [http://www.frac.org/html/federal\\_food\\_programs/programs/fsp.html](http://www.frac.org/html/federal_food_programs/programs/fsp.html).

<sup>15</sup> For instance, at the end of August 2007, Secretary of Health and Human Services (HHS) Mike Leavitt announced that \$50 million in emergency energy assistance will be given to 12 states that experienced much hotter than normal conditions during the summer.

<sup>16</sup> More details on this program can be found at *U.S. Department of Health and Human Services* at <http://www.acf.hhs.gov/programs/liheap/>

<sup>17</sup> For more details on this program see <http://www.usac.org/about/universal-service> as of December 2008.

## APPENDIX B

### B1. Assumptions and Methodology for the Competitive Market Analysis

#### *Databases*

The *competitive market* analysis relied on two different datasets. We used the Risk Management Solutions (RMS) data from the status quo analysis to develop projections of gross losses (with and without mitigation) for different locations and return periods. Gross losses are the total losses to insured structures covered by insurance. We used the gross losses instead of the ground up losses because we assumed full coverage in the status quo, meaning the additional losses contained in the ground up figures reflect the deductibles.

A.M. Best provided us with publicly available data on 1,379 insurance and reinsurance groups. From this dataset, we had the direct premiums written (DPW) for homeowners multi-peril insurance in each of the four states. We were then able to derive a market share for each group  $i$  in each state using the following formula:  $MarketShare_i = DPW_i / TotalDPW$ . There are 75 groups with DPW in Florida, 100 groups with DPW in New York, 62 groups with DPW in South Carolina, and 68 groups with DPW in Texas. The A.M. Best data also included the total surpluses of each of the groups, which we used to determine the amount of coverage they would offer in the competitive market.

#### *General Assumptions*

In undertaking the analyses of a competitive insurance market, we made the following general assumptions: Total insurance is based on the amount of surplus each group is willing to put at risk in the studied state for the relevant hurricane return period; Insurers allocate their surplus to each state independently; Total surplus used by companies is equal to total surplus for the entire group<sup>18</sup>; Reinsurance and other risk transfer amounts are the same as in the status quo. This assumption can be justified given that reinsurers are not restricted by state regulators under the status quo.

#### *Insurance Calculation*

To determine the amount of insurance coverage offered in the competitive market, we focused on the surpluses of the top 25 insurers by market share in each state. These 25 companies typically represent more than 90 percent of the private market for homeowners coverage. Note that this surplus data came from A.M. Best for every company except for State Farm,<sup>19</sup> which is unique in that it has separate entities for different lines of insurance. We took

---

<sup>18</sup> State Farm, which groups its companies differently, is the exception. See next footnote for a full explanation of how we handled this special case.

<sup>19</sup> State Farm is a parent company that has an atypical structure, in that it divides its sub-units by line of business. Other companies do not separate their surpluses at all or they do it based on state-level companies which still handle all of the different types of insurance. The A.M. Best data gave the total surpluses for entire conglomerate companies. Typically, this entire surplus is available for property insurance since the companies are not separate entities. However, State Farm does separate property insurance so their A.M. Best figure is too high. In order to rectify this, we used the sum of the surpluses for State Farm's four property insurance subsidiaries: State Farm Fire

the sum of the surpluses from their four property companies instead of using the A.M. Best figure. To determine how much capacity insurers are willing to provide to cover hurricane risk under a competitive market, we assumed that each insurance group would risk 10 percent of its surplus<sup>20</sup> to provide coverage for a 100-year, 250-year, or 500-year event. More specifically, we have: *Insurance Offered by Insurer i* = 0.10\*(Total Surplus of Insurer i)

By aggregating the amount of coverage provided by each insurer in the state, we obtained the *amount of coverage* available to cover losses from hurricanes. For example, there was about \$150 billion of surplus available amongst the top 25 private insurers operating in Florida. We thus assumed that \$15 billion would be available for coverage against hurricane wind damage in the competitive market in Florida.<sup>21</sup> We derived the percentage of the residential market covered in each of the states when no reinsurance was in place by using the following formula:

$$\text{Percent of Market Covered in State Y} = \frac{\text{Insurance Offered in State Y}}{\text{Gross Loss in State Y}}$$

In a complementary series of analyses we also calculated the percent of total insurers' surplus that would have to be allocated against insured losses from hurricanes in each state so that all residential structures would be provided with full coverage. These figures were determined by the following formula:

$$\text{Necessary Percent of Surplus for Full Coverage in State Y} = \frac{\text{Gross Loss in State Y}}{\text{Total Surplus}}$$

We conducted this analysis of competitive market insurance for the 100-year, 250-year, and 500-year return periods both with and without mitigation in place. A separate analysis was undertaken to account for the impact of reinsurance and other risk transfer instruments on insurers' ability to provide coverage.

### ***Insurer Surplus Assumption***

We used the surplus from the top 25 insurers within each state for undertaking our base case analyses. We also examined other amounts of total surplus by the top insurers writing coverage that comprise 95 percent of the market and all insurers writing coverage in the state (i.e., 100 percent of the market).

**Note on Competitive Market Insurer Surpluses:** The competitive market insurer surplus allocations may differ from how these companies actually allocate their surpluses. This is a theoretical analysis of what these companies are capable of doing based on their total conglomerate surplus reported in the A.M. Best dataset. However, in practice they may make their capital allocation decisions differently.

---

and Casualty: \$8.95 billion; State Farm General (CA): \$1.85 billion; State Farm Florida: \$0.72 billion; Texas Lloyds: \$1.29 billion; Total: \$12.81 billion.

<sup>20</sup> This 10 percent figure was confirmed by the insurers and rating agencies with whom we spoke as a reasonable assumption for these analyses. In reality, of course, the determination by each insurer as to how much surplus it is willing to assign to a specific risk (e.g., wind damage) in a given state depends on its financial characteristics and the distribution of its portfolio in other states and countries. The capacity insurers are willing to offer also is likely to vary with the return period of the catastrophic event under consideration and the price they can charge for providing coverage.

<sup>21</sup> In the other three states, storm surge damage is also included as part of the hurricane loss borne by insurers.

## B2. Reinsurance Assumptions and Calculations

The RMS data specifies the gross losses to insurers from any hurricane without taking into account reinsurance and other risk transfer instruments. Note that hereafter, when we refer to *reinsurance* we mean all types of alternative risk transfer (ART) instruments such as industry loss warranties, cat bonds and sidecars. To estimate the aggregate amount of reinsurance we rely on probable maximum loss (PML) data from A.M. Best. We use the national pre-tax per-occurrence hurricane gross and net PMLs for the 100-, 250- and 500-year return periods for the insurance groups categorized within the personal lines and homeowners' segments using 2005 data. These groups included in the analysis represent companies that submitted a Supplemental Rating Questionnaire (SRQ) to A.M. Best. Groups that provided the PML information verbally or in a group presentation are not included in the study.

Although some groups were omitted from the analysis, we believe this is an accurate portrayal of the industry. Furthermore, we used PML ratios, not the absolute value. These ratios from our sample should be generally applicable to the entire industry. The gross PML is the total projected loss from a catastrophic event for an insurer, while the net PML is the total projected loss from this event after subtracting reinsurance and other alternative risk transfer payments.

The percentage of losses paid by reinsurance is derived using the following formula:

$$\% \text{ Reinsurance} = 1 - (\text{net PML}/\text{gross PML})$$

To illustrate, suppose that for a 100-year return period, an insurer had a gross PML from hurricanes in Florida of \$500 million and a net PML of \$300 million. The equation above implies that the Percent of Reinsurance =  $1 - (\$300/\$500) = 40$  percent. A.M. Best estimated gross and net PMLs for the insurance industry from hurricanes using data at the group level for the 100-, 250- and 500-year return periods. This enabled us to estimate the percent of reinsurance that insurers had purchased for these catastrophic losses as shown in Table B-1 below

**TABLE B-1. ESTIMATING REINSURANCE PERCENTAGES USING PML DATA  
ON HOMEOWNERS' LOSSES FROM HURRICANES**

Return Period	Gross PML	Net PML	Net/Gross	Reinsurance (incl. ART)
100	21.3	8.5	39.7%	60.3%
250	33.3	16.1	48.3%	51.7%
500	44.7	25.4	56.9%	43.1%

*Source: Data from A.M. Best; Authors' calculations*

Because these reinsurance percentages are based on aggregate group PMLs, we feel they are accurate only for Florida hurricanes with no mitigation in place, since the losses from these disasters comprise most of the nation’s PML. Furthermore, reinsurance is linked to damage amounts instead of return periods. Using the Florida RMS data for no mitigation, we find that gross losses for the insurance industry are \$76 billion for the 100-year return period, \$113 billion for the 250-year return period, and \$141 billion for the 500-year return period. The gross losses for the other three states are somewhat lower. Based on PML analysis and on discussions with several reinsurers, we developed the following assumptions for reinsurance percentages for the spectrum of gross loss amounts, as shown in Table B-2.

**TABLE B-2. ASSUMED PERCENTAGES OF REINSURANCE  
AS A FUNCTION OF CATASTROPHIC LOSS**

<b>Gross Loss</b>	<b>Reinsurance</b>
\$0-10 billion	10%
\$10-20 billion	20%
\$20-30 billion	30%
\$30-50 billion	40%
\$50-90 billion	60.3%
\$90-120 billion	51.7%
\$120-145 billion	43.1%

## **WHARTON RISK MANAGEMENT AND DECISION PROCESSES CENTER**

Established in 1984, the **Wharton Risk Management and Decision Processes Center** develops and promotes effective corporate and public policies for low probability events with potentially catastrophic consequences. Building on the disciplines of economics, decision sciences, finance, insurance, marketing and psychology, the Wharton Risk Center supports and undertakes field and experimental studies to better understand how individuals and organizations make choices under conditions of risk and uncertainty. Natural disasters, technological hazards and national and international security issues are among the extreme events that are the focus of the Center's research. The Center's neutrality allows it to undertake large-scale projects in conjunction with other researchers and organizations in the public and private sectors. The Center's research team – over 50 faculty, fellows and doctoral students – investigates the effectiveness of strategies such as risk communication, information sharing, incentive systems, insurance, regulation and public-private collaborations at a national and international level.

### **ABOUT THE AUTHORS**

**Howard C. Kunreuther** is the Cecilia Yen Koo Professor of Decision Sciences and Public Policy at the Wharton School and co-director of the Wharton Risk Management and Decision Processes Center. He has a long-standing interest in ways that society can better manage low-probability, high-consequence events related to technological and natural hazards and has published extensively on the topic.

Dr. Kunreuther is a Fellow of the American Association for the Advancement of Science (AAAS); a member of the National Academy of Sciences Panel on Adaptation Strategies for Climate Change, and a Distinguished Fellow of the Society for Risk Analysis, receiving the Society's Distinguished Achievement Award in 2001. He co-chaired the World Economic Forum's Global Agenda Council on "*Innovation and Leadership in Reducing Risks from Natural Disasters*" and is a member of the OECD's High Level Advisory Board on Financial Management of Large-Scale Catastrophes.

**Erwann O. Michel-Kerjan** is managing director of the Wharton Risk Management and Decision Processes Center at the Wharton School, and chairman of the OECD High Level Advisory Board on Financial Management of Large-Scale Catastrophes established by the Secretary General of the OECD. His work focuses on developing strategies and policies for managing and financing extreme events, primarily natural disasters and mega-terrorism, optimal catastrophe risk sharing in public-private partnerships, climate change, the economics of national security, energy interdependence, and nonproliferation. His work also includes projects on critical services protection in collaboration with the defense industry and federal agencies.

In 2007, Dr. Michel-Kerjan was named a Young Global Leader by the World Economic Forum (Davos), a five-year nomination bestowed to recognize and acknowledge the most extraordinary leaders of the world under the age of forty.