MANAGING LARGE-SCALE RISKS IN A NEW ERA OF CATASTROPHES
The Role of the Private and Public Sectors in Insuring, Mitigating and Financing Recovery from Natural Disasters in the United States

February 2007

A Wharton Risk Center Extreme Events Project, in conjunction with Georgia State University and the Insurance Information Institute

—Report on Phase I of the Study—
THE WHARTON RISK MANAGEMENT AND DECISION PROCESSES CENTER

Since its creation 23 years ago, the mission of the Wharton Risk Management and Decision Processes Center has been to carry out a program of basic and applied research to promote effective corporate and public policies for low-probability events with potentially catastrophic consequences. The Risk Center has focused on natural and technological hazards through the integration of risk assessment, risk perception and risk financing with risk management strategies. After 9/11, research activities extended also to national and international security issues (e.g., terrorism risk insurance markets, protection of critical infrastructure, global security).

Building on the disciplines of economics, decision sciences, finance, insurance, marketing and psychology, the Center’s research program has been oriented around descriptive and prescriptive analyses. Descriptive research focuses on how individuals and organizations interact and make decisions regarding the management of risk under existing institutional arrangements. Prescriptive analyses propose ways that individuals and organizations, both private and governmental, can make better decisions regarding risk. The Center supports and undertakes field and experimental studies of risk and uncertainty to better understand the linkage between descriptive and prescriptive approaches under various regulatory and market conditions. Risk Center research investigates the effectiveness of strategies such as risk communication, information sharing, incentive systems, insurance and regulation.

The Center is also concerned with training decision-makers and actively engaging multiple viewpoints, including the expertise of top-level representatives in the world 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.

The members of the Wharton Risk Center managing Large-scale Risks in the New Era of Catastrophes research team are Neil Doherty (Wharton), Martin Grace (Georgia State), Robert Hartwig (III), Robert Klein (Georgia State), Paul Kleindorfer (Wharton), Carolyn Kousky (Harvard), Howard Kunreuther (Wharton), Robert Lieberthal (Wharton), Erwann Michel-Kerjan (Wharton), Mark Pauly (Wharton), Irv Rosenthal (Wharton), Benjamin Shiller (Wharton) and Claire Wilkinson (III).

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PREFACE

Characterizing the problem

Natural disasters that have occurred in the United States and other parts of the world during the past five years have revealed an entirely new scale of devastation due to increased development in hazard-prone areas and a series of severe hurricanes, storms and floods. In 2005 three major hurricanes, Katrina, Rita and Wilma, made landfall in the Gulf of Mexico within a six-week time period, killing over 1,400 people and leading to insurance reimbursements and federal disaster relief of over $180 billion dollars in the United States alone; a historical record.

Even though alarming weather forecasts predicted a highly turbulent hurricane season in the North-Atlantic Ocean, not a single major hurricane made landfall in 2006. This uncertainty and wide variance from one year to another poses important challenges for decision-makers as to what to anticipate for the coming years.

Hurricane Katrina – a long-expected catastrophic scenario – was a wake-up call for the entire country and underscored the need for undertaking measures to reduce the risks associated with natural hazards and dealing with the economic consequences following future disasters.

The goal of this study is to develop an analysis and strategy document to help inform the current policy debate in the United States on the role that the private and public sectors can play in reducing future disaster losses and financing the recovery process through means such as insurance, mitigation and well-enforced building codes. We also believe this study will have value for other countries exposed to natural hazards. What is fundamentally at stake here is the cost and affordability of living and working in risky areas, the allocation of resources and the efficiency of catastrophe risk management, and who ultimately bears the costs and receives the benefits of alternative disaster insurance and mitigation programs.

The preliminary findings from this study have been brought into sharper focus by the decisions taken by the Florida legislature in the middle of January 2007 to reduce the competitive restrictions placed on Citizens Property Insurance Corporation and to expand the role of the Florida Hurricane Catastrophe Fund as the predominant reinsurer for public and private insurers in the state. For those supporting a purely market-based solution to the Florida insurance crisis of 2006, this outcome must have seemed a significant setback, yet it was an almost inevitable response, given the way in which the reaction to the significant rise in insurance costs since 2005 had risen to the top of the Floridian political agenda.

Private insurers and reinsurers, now anticipating reductions in their business in Florida, are undoubtedly considering how they could have handled the situation differently by explaining more effectively why such rate increases were warranted. Was this a result of rising levels of hurricane hazard, a belated recognition that the previous pricing regime was insufficient to fund the level of risk, an attempt to recover from two catastrophic years of hurricane losses in the state - or perhaps all of the above?

One conclusion, however, is clear from the actions in Florida in January 2007. The insurance industry should learn lessons from the experience in Florida to ensure that private market-based solutions can provide the predominant risk management mechanism in other frontline hurricane states. This has to include both better analysis and better communication. As set out in this study, central to the argument for the functioning of markets has to be the linkage
between risk quantification and a demonstration as to how risk reduction can be encouraged and incentivized through insurance and other mechanisms.

Building on extensive ongoing research on terrorism risk financing (Wharton’s TRIA and Beyond study)\(^1\), and over 20 years of experience on understanding, managing and financing low-probability, high-consequences events, the Wharton Risk Management and Decision Processes Center launched this initiative in February 2006. The Wharton Risk Center has teamed up with two leading organizations that have also been studying these issues for several decades: Georgia State University’s Department of Risk Management and Insurance, which constitutes one of the largest academic programs dedicated to risk management research and education, and the Insurance Information Institute, which for more than 40 years has provided definitive information, analysis and referrals concerning insurance.

During the past year, the Wharton team has had fruitful meetings and discussions with key individuals and organizations interested in developing risk management strategies for natural hazards. These include insurers, reinsurers, brokers, rating agencies, modeling firms, homeowners and firms affected by natural disasters, public interest groups, federal government and other public sector agencies, research institutions, trade associations, international organizations, and other universities.

We have benefited from insightful discussions at two workshops hosted by the Wharton Risk Center in June and December 2006 in Philadelphia, from the very helpful interchange with participants and the feedback we received on an ongoing basis following these events. The names of sponsors of this research and other organizations with whom we have interacted most are listed on page viii.

**Nature of this Report**

This report focuses on the role of insurance and other risk transfer mechanisms as well as hazard mitigation for managing catastrophic risks. It thus provides the foundation for undertaking Phase II of the study which will be completed in the next 9 months.

Using a large data set of residential exposure and property insurance coverage, our specific interest in 2007 is in developing and evaluating alternative insurance and mitigation programs involving the private and public sectors for tackling these issues so as to establish long-term sustainable solutions for providing protection against financial losses and reducing risks from hurricanes and floods on the key stakeholders. At the heart of the problem are four basic questions:

- What alternative programs should be considered?
- What economic impact will these programs have on the key interested parties affected by natural disasters?
- Who will pay for losses?
- What are the challenges in implementing these alternative programs?

Part E of this report describes Phase II of the project and provides a brief overview of the different alternatives we are currently contemplating. They range from a significant involvement of the public sector to a private market-based program.

Principles

Two key principles are guiding the analyses:

- **Risk-based Premiums**: 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.

- **Dealing with Equity and Affordability Issues**: Any special treatment given to lower income residents in hazard-prone areas who cannot afford the cost of living in those locations should come from general public funding and not through insurance premium subsidies.

Focus - Comparisons will be made of the cost/effectiveness of different approaches to promoting mitigation and financing recovery using four states where there is large exposure to weather-related disasters with significant difference in insurance market regulation and public-private risk sharing: *Florida, New York, South Carolina and Texas* and the following Metropolitan Areas: *Miami, FL, New York City, NY, Charleston, SC and Houston, TX.*

Timeline - Phase I of the project started in February 2006 and ended with this report. In 2007, data analysis will be performed over the summer; with a public conference in the autumn to present preliminary results, and the final report issued by the end of 2007.

The issues addressed in this report and those to be pursued in Phase II are now a major concern at the national political level. The February 2007 *Economic Report of the President* devotes an entire chapter to catastrophic risk insurance and supports the principle of risk-based premiums by stating:

“Effective insurance underwriting serves an important social function by tying the premiums and terms of insurance policies to the risks covered. 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.”

Over the coming months the project team will interact with stakeholders whose activities are affected by catastrophes. To that end, each of the twelve chapters constituting this report on Phase I concludes with a summary and a series of open questions to generate a broader debate. We would appreciate your assistance in disseminating this report to individuals and groups who can provide us with data, references to complementary work, and ideas so that the final report reflects the views of a broad-based constituency concerned with developing risk management strategies for dealing with natural disasters in this new era of catastrophes.

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2006 Project Sponsors (alphabetical order):

- Allstate
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- American International Group (AIG)
- Guardsmark, LLC
- Liberty Mutual
- Munich Re America (Munich Re Group)
- National Association of Mutual Insurance Companies (NAMIC)
- Nationwide Mutual Insurance Company
- Property Casualty Insurers Association of America (PCIAA)
- Reinsurance Association of America (RAA)
- State Farm Fire and Casualty Company
- St. Paul Travelers Companies
- Swiss Reinsurance Company
- WeatherPredict Consulting Inc (An Affiliate of Renaissance Re Holdings, Ltd.)
- Zurich

Other companies joining in 2007 as Project Sponsors³:

- Lockheed Martin Corporation
- Partner Re
- Société Générale Bank

This report also benefited from data and ongoing interaction with the following organizations:

- Citizens Property Insurance Corporation
- Department of Homeland Security, Federal Emergency Management Agency (FEMA) and National Flood Insurance Program (NFIP)
- Florida Hurricane Catastrophe Fund (FHCF)
- Fireman’s Fund Insurance Company
- Guy Carpenter (Marsh McLennan)
- Institute for Business and Home Safety (IBHS)
- National Association of Insurance Commissioners (NAIC)
- Organization for Economic Cooperation and Development (OECD)
- Risk Management Solutions (RMS)
- U.S. Census Bureau
- V.J. Dowling
- World Economic Forum

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³ For information regarding how to join as project sponsor, please contact Howard Kunreuther (Kunreuther@wharton.upenn.edu) and Erwann Michel-Kerjan (ErwannMK@Wharton.upenn.edu)
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Part A

Setting the Stage
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CHAPTER 1

A NEW ERA: FROM MAJOR EVENTS TO LARGE-SCALE DISASTERS

This chapter provides a picture of the increase in catastrophic losses in the United States and the challenges that various stakeholders face in managing the associated risks and costs coming from their different positions and, in some cases, different interests. Gaining an understanding of the perspectives of different stakeholders is critical to developing measures that will improve the management of catastrophic risk.

1.1. Recent Changes in the Impacts of Extreme Events

The economic and insured losses from natural disasters have increased significantly in recent years as shown in Figure 1.1 (each vertical bar represents the total economic losses, the darker zone the insured portion of it). A comparison of these economic losses over time reveals a huge increase: $44.9 billion (1950-59), $80.5 billion (1960-69), $147.6 billion (1970-80), $228 billion (1980-89) and $703.6 billion (1990-99). Although the first four years of the 21st century (2000-2003) were less severe than previous years, 2004 and 2005 produced historical records.

![Figure 1.1. Evolution of “Great Natural Catastrophes” 1960-2005: Economic versus Insured Impact](image)

Catastrophes have had a more devastating impact on insurers over the past 15 years 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 to 4 billion range. The insured losses from Hurricane Hugo that made landfall in Charleston, South Carolina on September 22, 1989...
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exceeded $4 billion (1989 prices). It was the first natural disaster to inflict more than one billion dollars of insured losses in the U.S. There was a radical increase in insured losses in the early 1990s with Hurricane Andrew in Florida ($20 billion) and the Northridge earthquake in California ($18 billion). The four hurricanes in Florida in 2004 (Charley, Frances, Ivan and Jeanne) collectively totaled over $29 billion in insured losses. Hurricane Katrina alone cost insurers and reinsurers an estimated $45 billion, and total losses paid by private insurers due to major natural catastrophes culminated at $83 billion in 2005. Figure 1.2 depicts the upward trend in worldwide insured losses from catastrophes between 1970 and 2005 (in 2005 indexed prices).

Table 1.1 reveals the 20 most costly catastrophes for the insurance sector over the past 35 years (in 2005 dollars). Several observations are important here. First, 18 of the 20 most costly events occurred during the past 15 years (in constant prices). Hurricane Andrew and the Northridge earthquake were the first two disasters that the industry experienced where losses were greater than $10 billion (designated as super-cats) and caused insurers to reflect on whether risks from natural disasters were insurable. To assist them in making this

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4 This figure thus excludes payment by the NFIP for damage due to 2005 flooding (over $20 billion in claims).

5 Munich Re and Swiss Re, the two leading reinsurers in the world, do not use the same definition of catastrophic losses. Natural disasters inflicting insured losses above 38.7 million dollars or total losses above 77.5 million dollars are considered a major catastrophes by Swiss Re (we use this threshold in Figure 1.2); Munich Re considers a higher threshold. For example, when Munich Re estimated insured loss at about $35 billion in 2004, Swiss Re’s estimate was $49 billion. As a result, most figures used in the literature regarding the evolution of catastrophe loss actually underestimate the real effect on insurers.
determination, many firms began utilizing catastrophe models to estimate the likelihood and consequences to their insured portfolios from specific disasters in hazard-prone areas (Grossi and Kunreuther, 2005). With the exception of the terrorist attacks on September 11, 2001, all of the events in the top 20 were natural disasters. More than 80 percent of these were weather-related events: hurricanes and typhoons, storms, and floods with nearly three quarters of the claims in the United States.

Table 1.1. The 20 Most Costly Insured Catastrophes in the World, 1970-2005

<table>
<thead>
<tr>
<th>Rank</th>
<th>U.S.$ billion (indexed to 2005)</th>
<th>Event</th>
<th>Victims (Dead or missing)</th>
<th>Year</th>
<th>Area of primary damage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>45.5*</td>
<td>Hurricane Katrina</td>
<td>1,326</td>
<td>2005</td>
<td>USA, Gulf of Mexico et al</td>
</tr>
<tr>
<td>2</td>
<td>35</td>
<td>9/11 Attacks</td>
<td>3,025</td>
<td>2001</td>
<td>USA</td>
</tr>
<tr>
<td>3</td>
<td>22.3</td>
<td>Hurricane Andrew</td>
<td>43</td>
<td>1992</td>
<td>USA, Bahamas</td>
</tr>
<tr>
<td>4</td>
<td>18.5</td>
<td>Northridge Quake</td>
<td>61</td>
<td>1994</td>
<td>USA</td>
</tr>
<tr>
<td>5</td>
<td>11.7</td>
<td>Hurricane Ivan</td>
<td>124</td>
<td>2004</td>
<td>USA, Caribbean et al</td>
</tr>
<tr>
<td>6</td>
<td>10.3</td>
<td>Hurricane Wilma</td>
<td>35</td>
<td>2005</td>
<td>USA, Gulf of Mexico et al</td>
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<tr>
<td>7</td>
<td>8.3</td>
<td>Hurricane Charley</td>
<td>24</td>
<td>2004</td>
<td>USA, Caribbean et al</td>
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<td>8</td>
<td>8.1</td>
<td>Typhoon Mireille</td>
<td>51</td>
<td>1991</td>
<td>Japan</td>
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<td>9</td>
<td>6.9</td>
<td>Winterstorm Daria</td>
<td>95</td>
<td>1990</td>
<td>France, UK et al</td>
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<tr>
<td>10</td>
<td>6.8</td>
<td>Winterstorm Lothar</td>
<td>110</td>
<td>1999</td>
<td>France, Switzerland et al</td>
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<td>11</td>
<td>6.6</td>
<td>Hurricane Hugo</td>
<td>71</td>
<td>1989</td>
<td>Puerto Rico, USA et al</td>
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<td>12</td>
<td>5.2</td>
<td>Hurricane Frances</td>
<td>38</td>
<td>2004</td>
<td>USA, Bahamas</td>
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<tr>
<td>13</td>
<td>5.2</td>
<td>Storms and floods</td>
<td>22</td>
<td>1987</td>
<td>France, UK et al</td>
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<tr>
<td>14</td>
<td>5.0*</td>
<td>Hurricane Rita</td>
<td>34</td>
<td>2005</td>
<td>USA, Gulf of Mexico et al</td>
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<tr>
<td>15</td>
<td>4.8</td>
<td>Winterstorm Vivian</td>
<td>64</td>
<td>1990</td>
<td>Western/Central Europe</td>
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<td>16</td>
<td>4.7</td>
<td>Typhoon Bart</td>
<td>26</td>
<td>1999</td>
<td>Japan</td>
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<tr>
<td>17</td>
<td>4.2</td>
<td>Hurricane Georges</td>
<td>600</td>
<td>1998</td>
<td>USA, Caribbean</td>
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<tr>
<td>18</td>
<td>4.1</td>
<td>Hurricane Jeanne</td>
<td>3,034</td>
<td>2004</td>
<td>USA, Caribbean et al</td>
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<td>19</td>
<td>3.7</td>
<td>Typhoon Songda</td>
<td>45</td>
<td>2004</td>
<td>Japan, South Korea</td>
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<td>20</td>
<td>3.5</td>
<td>Tropical Storm Alison</td>
<td>41</td>
<td>2001</td>
<td>USA</td>
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(* Excludes $2-3 billion in offshore energy losses)

Sources: Wharton Risk Center with data from Swiss Re and Insurance Information Institute

As this Report on Phase I of the Study goes to press, preliminary estimates of 2006 losses due to major natural and man-made disasters are around $40 billion, one third of which were covered by insurance ($11 billion for natural disasters; $4 billion for man-made). Over the past 20 years, only two years had insured losses lower than in 2006 (1988 and 1997) (Swiss Re, 2006).

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7 See Chapter 2 below for a discussion on the question of attribution.
1.2. Focus of Phase 1 of the Study (Florida) and of the Final Study (U.S.)

This study focuses on mitigating and financing catastrophe risks from natural disasters in the U.S. Figure 1.3a shows hazard prone areas and degree of exposure in different parts of the country.

Some attention needs to be paid to two other dimensions:

**The international dimension**-- The operation of insurance and reinsurance markets worldwide will have impacts on the U.S. market. Some of the key features of insurance programs developed abroad for dealing with disasters may also be relevant for the U.S.

**The local dimension**-- Local and state decisions highlight issues for the national debate regarding alternative disaster insurance and mitigation programs. We will focus in this report on the state of Florida. Figure 1.3b depicts the risks of natural disasters in different parts of the state. In the last chapter of this report we will indicate how our analysis will be extended in 2007 to three other states (New York, South Carolina and Texas).
1.3. Key Interested Parties

In this section we discuss the roles of the following key parties as they relate to mitigating and insuring property against losses from natural disasters: construction industry, homeowners and small businesses, banks and financial institutions, state and local governments (including insurance commissioners), insurers, reinsurers, brokers, capital markets, modeling firms, rating agencies, and investors.

Construction Industry

Real estate agents, architects, developers, engineers, contractors and other service providers play an important role in the management of risk from catastrophic events. In regions prone to natural disasters, federal or state regulations require real estate agents to inform the new owner of potential hazards. For example, the Alquist-Priolo Act requires that potential home buyers be told the location of their home relative to an earthquake fault line. But a study by Risa Palm (1981)\(^9\) revealed most home buyers did not understand or recall the risk warning. The National Flood Insurance Program (NFIP) is required to analyze and map the level of flood risk in different areas, including designating 100-year flood plains or zones. By federal law and regulations, the lender must require the borrower of federally-insured mortgages to purchase flood insurance if the building is in a 100-year flood zone.

However, the program has been criticized recently for having inaccurate maps. For example a 4-year study of the Pennypack Creek Watershed by the Center for Sustainable Communities at Temple University revealed that flood danger zones have changed significantly in Bucks, Montgomery and Philadelphia counties in Pennsylvania\(^10\). Although enforcement of the flood insurance requirement has improved, it is not clear whether compliance is up to the standards set by law. In June 2002, the GAO reported that the extent to which lenders were required to enforce mandatory purchase requirements was simply unknown\(^11\).

Engineers and contractors play a significant role in managing risks in high-hazard areas and most of them have an interest in designing structures built to high standards and to have their structures certified by reputable building officials to protect themselves from liability in the case of life or property loss. Developers, on the other hand, have an interest in selling homes at the lowest possible price and need to be convinced that the extra costs associated with designing a house to higher standards will not adversely affect demand for their homes. Of course, developers’ interests and perspective will be affected by how much buyers value construction measures that reduce the vulnerability of structures to natural perils.

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Residents and Firms Operating in Hazard-Prone Areas

Those locating in disaster-prone areas may be unaware of or underestimate the hazards that they face and hence do not focus on the importance of having a well-designed home that protects them against hurricanes, floods and earthquakes. Prior to a disaster, many individuals perceive its likelihood as sufficiently low that they believe, “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 houses or buying insurance. It is only after the disaster occurs that these same individuals claim they would like to have undertaken protective measures (Kunreuther, 2006)\textsuperscript{12}.

Banks and Financial Institutions

Banks and other financial institutions enable individuals in the United States to purchase a home or business by providing mortgages so the buyer only has to use a limited amount of his or her own capital. The property is the collateral in the event that the owner defaults on the mortgage. Lenders play a role in managing catastrophic risks by requiring insurance as a condition for a mortgage to protect their investment should the structure be destroyed by catastrophe and the homeowner decides to walk away from the property. In principle, lenders should be interested in insurance against catastrophic property damage regardless of cause. Lenders can also influence buying decisions with loan covenants or by varying interest rates, actions that could be used to encourage investments in cost-effective mitigation measures. Federal laws and regulations also are intended to compel or encourage lenders and their agents to require adequate property insurance coverage against all natural perils, except earthquakes or earth movement.

State Governments

State governments play a critical role in establishing building codes and assuring these standards are effectively implemented. Building codes are often characterized as "poorly enforced" in hazard-prone areas. Insurance experts, according to the Insurance Information Institute, have indicated that 25 percent of the insured losses from Hurricane Andrew could have been prevented through better building code compliance and enforcement (Insurance Research Council and Insurance Institute of Property Loss Reduction, 1995)\textsuperscript{13}. Many communities have inadequate staffing and training to enforce these codes effectively. In Dade County, the area struck by Hurricane Andrew, there were only 60 building inspectors who were required to conduct multiple inspections on an average of 20,000 new buildings each year. This translates into an average of 35 inspections per day for each inspector, a near impossible task when driving time, report writing and other administrative tasks are taken into account.

Local governments also control land use and can forbid new construction in areas that might be seen as too highly exposed to specific natural hazards. In reality, however, land use regulation often suffered pressure for new construction to sustain economic growth. After Hurricane Camille destroyed the Richelieu Apartment complex in Pass Christian Mississippi in 1969, a shopping center was built in the same location, housing a Winn Dixie and a Rite-Aid, among other retail businesses. Although the shopping center was leveled by Hurricane Katrina,


\textsuperscript{13} Insurance Research Council and Insurance Institute of Property Loss Reduction (1995), Coastal Exposure and Community Protection: Hurricane Andrew’s Legacy. Wheaton, III: IRC, and Boston: IILPR.
real estate developers already have plans to rebuild on the site, most likely a condominium development this time (Wharton Risk Center, 2005)\textsuperscript{14}.

In the United States, insurance is regulated at the state level with the principal authority residing with insurance commissioners. Primary insurers are subject to solvency regulation and rate and policy form regulation. Solvency regulation addresses the question as to whether the insurer or reinsurer is sufficiently capitalized to fulfill its obligations if a significant event occurs and inflicts major losses on its policyholders. Rate and policy form regulation refers to the price and terms of the insurance contract. Unlike insurers, reinsurers licensed in the United States are subject only to solvency regulation. Foreign reinsurers are also not price-regulated and are subject to differing degrees of solvency regulation, depending upon the state in which they are domiciled (see discussion in Chapter 8 on reinsurance pricing).

Insurance commissioners often regard solvency as a principal objective even if it means requiring higher premiums or other insurer adjustments (e.g., reducing their catastrophe exposures). On the other hand, insurance regulators face political pressure to keep insurance premiums “affordable” and coverage readily available. In balancing solvency and consumer protection goals, insurance regulators are required by state laws to ensure that rates are adequate but not excessive and not unfairly discriminatory. Regulators’ assessment of insurers’ rates and other practices involves some degree of subjectivity which can result in rate restrictions that reduce the supply of insurance or cause other market problems and distortions. “Parameter uncertainty” and different opinions on the level of risk of loss can lead to disagreements between insurers and regulators over what constitutes adequate rates and appropriate underwriting practices\textsuperscript{15}.

State legislatures, governors and the courts also play a significant role in the regulation of insurers and insurance markets. Consequently, insurance regulators are subject to a number of constraints on their authority and discretion and the other branches of state government may impose their preferences on how state laws, regulations and policies govern insurers and insurance markets. Ultimately, all elected officials and their appointees are subject to the will of the voters – if government officials act contrary to the preferences of voters, they are subject to being replaced by people who will obey the voters, even if their actions are economically unsound.

State governments also have created and operated catastrophe insurance programs following large-scale disasters to supplement private insurance and reinsurance. Following the Northridge earthquake of January 1994, many insurers in the state stopped selling new homeowners policies. This led to the formation of the California Earthquake Authority (CEA) in 1996 which limited the losses that insurers can suffer from a future earthquake (Roth, Jr.


1998)16. Florida created the Citizens Property Insurance Corporation replacing its prior wind pool. Louisiana also formed the Louisiana Citizens Property Insurance Corporation. Florida and Louisiana are the only two states who have implemented these "new" residual market structures in which a state sponsored corporate acts as a stand-alone insurance company.

Many states continue to maintain traditional wind-pool or beach plan structures (also known as joint underwriting associations). Most gulf and eastern seaboard states have such plans, but each plan has its own variations. Many of these facilities do not have the claims-paying capacity to cover obligations in the event of a major hurricane. Some states, including North Carolina and several New England states, are struggling to pay administrative and overhead costs even though they have not experienced a major catastrophe event in recent years. If a major hurricane struck one of these states, the state underwriting association would be forced to levy assessments against insurers, which would in turn pass this ex post assessment to all their policyholders.

Florida also has two state facilities that inject great influence over the insurance market. Following Hurricane Andrew in 1992, the Florida government formed the Florida Hurricane Catastrophe Fund that reimburses a portion of insurers’ losses following major hurricanes (Lecomte and Gahagan, 1998)17. The FHCF is a state run facility that provides reinsurance for personal and commercial residential properties. All insurers are required to participate in the FHCF. We discuss the FHCF and the Citizens Property Insurance Corporation in more detail in Chapter 3. The state also has the Florida Insurance Guaranty Association (FIGA) that pays the claims of insolvent insurers. For example, FIGA is currently financing the insolvenency of the Poe Financial Group which failed in 2005 as a result of hurricane losses.

**Federal Government**

The U.S. federal government has not been directly involved in providing insurance against natural disasters with the exception of flood damage which is provide through the National Flood Insurance Program (NFIP) established in 1968 and operated by the Federal Emergency Management Agency (FEMA). Today the NFIP is experiencing a major financial crisis following the storm surge and flooding from Hurricane Katrina and it is borrowing over $20 billion from the U.S. Treasury. Chapter 3 discusses the challenges associated with distinguishing coverage from losses due to wind (covered by the private sector) and those due to water damage (mostly covered by the NFIP) and Chapter 4 of the report discusses the flood insurance program in more detail.

The federal government also plays a key role in the aftermath of natural disasters by providing federal relief for non-insured and underinsured (residents and small business), cities and local governments through low interest loans, grants and tax benefits. Many have turned to the Small Business Administration for low interest loans to repair their damaged property; however, a property owner is only eligible for a loan if he or she can show the financial ability to repay it. Hence low income residents who suffered losses to property will have to make

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payments and, if they cannot do so, will have to find other sources of assistance for housing or losses to wealth.

Under the current system of disaster assistance, 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 process. This obviously raises the question of what are the key drivers of such a decision and whether some states are more likely to benefit from such declarations than others, and when.

Additionally, federal tax policy governing the deduction of uninsured catastrophe losses suffered by individuals and households and insurers’ reserves for catastrophe losses affect the risk mitigation incentives of property owners and insurers’ ability to finance catastrophe losses. Quite surprisingly current tax policy with respect to uninsured disaster losses has received little attention to date as it creates disincentives for efficient disaster risk management. This issue is discussed in Chapter 12 of this document.

Attention has also been given towards consideration of a federal reinsurance program covering natural catastrophes. A Congressional initiative, the Brown-Waite Buchanan Homeowner’s Insurance Protection Act was introduced in January 2007 to the House of Representatives and referred to the House Committee on Financial Services. This bill creates a federal funding facility that sits on top of state residual market and state catastrophe funds to finance residential losses that exceed the "claims-paying capacity" of the state funds.\(^\text{18}\)

**Insurers**

Insurers provide financial protection to those facing the risks of potentially large losses from events (e.g., earthquake, wind damage) by charging a relatively small fee to those who seek such protection ("premium") and agreeing to pay all or a portion of the financial losses incurred from the covered events. Insurers who write policies for a large number of properties in a single geographic area face the possibility of large losses from a single event (e.g. hurricanes, earthquakes, terrorist attack). Due to the potential impact of such losses on their surplus, insurers need to limit the amount of coverage they provide to property owners and employers in these hazard-prone areas in order to keep the chances of severe losses at an acceptable level. Insurers are more willing to provide coverage when they can estimate the likelihood of the events against which they are offering protection and the extent of losses they will incur.\(^\text{19}\)

The amount of insurance companies are willing to write depends on the firm’s capital management, regulatory approvals of rates, availability and price of risk transfer instruments and the insurer’s appetite for risk. Some insurers will retain a large amount of the risk while

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others will protect themselves against catastrophe losses through reinsurance, catastrophe bonds and other risk transfer instruments.

**Reinsurers**

The amount of coverage an insurer is willing to provide against risks in different hazard-prone areas partly depends on how much of its exposure it can transfer to reinsurers and at what cost. Reinsurers provide protection to private insurers in much the same way that insurers provide coverage to their policyholders. They charge a premium to indemnify an insurance company against a layer of catastrophic losses which the insurer would otherwise be responsible for covering. Reinsurers are also concerned with their concentration of risk and manage their exposure in catastrophe-prone areas to keep the chances of severe losses at an acceptable level. Large reinsurers who operate worldwide can diversify their risk geographically and per line of coverage much more easily than most insurers can. Still, reinsurers as well as insurers must cover the cost of capital committed to catastrophe risk and this cost increases with the level of risk and the demand for capital.

Reinsurers typically play a key role in sharing a significant portion of the insured losses with the insurers. For example, reinsurers shared about 50 percent of insured losses due to Hurricane Katrina. As a result of the 2004 and 2005 hurricane seasons, the price of catastrophe reinsurance in the U.S. has significantly increased in 2006 and capacity was scarce. After a non-hurricane season in 2006, prices started soften at the January 1, 2007 renewal and there have been indications of a greater availability of capacity (e.g., absence of shortfall covers).

**Brokers**

Brokers link those demanding financial protection with those who supply coverage. The broker can facilitate transactions between firms who would like to buy insurance and those who are willing to offer policies. Similarly, the broker can bring together insurers who want coverage against catastrophic events and reinsurers who are in the business of providing this protection. For medium to large businesses, the broker normally represents the insurance buyer. Brokers also play an important role in advising clients on risk and crisis management strategies.

**Capital Markets**

Capital markets have emerged in the 1990s as a complement to reinsurance for covering large losses from natural disasters through new financial instruments, e.g., industry loss warranties, catastrophe bonds and, more recently, sidecar reinsurers (see Chapter 8).

For example, the shortage of reinsurance following Hurricane Andrew in 1992 and the Northridge earthquake in 1994 led to higher reinsurance prices and made it possible for insurers to offer catastrophe bonds with high enough interest rates to attract capital from investors. In addition, the prospect of an investment that is uncorrelated with the stock market or general economic conditions is also attractive to capital market investors. Finally, catastrophe models have emerged as a tool for more rigorously estimating loss probabilities, so that disaster risk can be more accurately quantified than in the past, and then priced.

Since hurricane Katrina hit in 2005, there has been a significant increase in the number and volume of catastrophe bond issuances and the creation of sidecars, but the total volume of financial protection remains somewhat limited compared to what is currently provided by
traditional reinsurance. Hence, there is a need to assess the constraints on the availability and volume of securities that diversify catastrophe risk and how the use of these vehicles could be expanded to augment reinsurance capacity.

**Modeling Firms**

Many insurers and reinsurers have turned to firms specialized in the business of modeling catastrophe risks to assist them in determining how much coverage to offer and what premiums to charge for losses from natural disasters. Over the past ten years, these companies have become important players in the field of catastrophe insurance and reinsurance. These firms were subject to some criticism for failing to increase their risk assessment in advance of the 2004-2005 storm seasons. It should be noted that catastrophe modeling and risk assessment faces a number of informational challenges as well as market and regulatory acceptance. Ultimately, it may have been necessary to experience the recent increased hurricane activity in order for modeling firms to feasibly adjust their models to adjust their parameters. Due to parameter uncertainty it is never possible to know whether a given model has accurately estimated the true underlying risk of loss and associated probability distributions or loss exceedance curves.

**Rating Agencies**

Rating agencies, such as A.M. Best, Standard & Poor’s, Moody’s and Fitch, provide independent evaluations of insurers’ and reinsurers’ financial stability and their ability to meet their obligations to policyholders. The rating assigned to an insurer or reinsurer has significant consequences on the premiums it can set and its ability to raise capital. For example, many large publicly-traded companies have requirements that they only deal with insurers that have a rating above a certain minimum level. Similarly, insurers are less willing to cede their risks to a poorly rated reinsurer. A low rating has an impact on the premium an insurer or reinsurer can charge or the amount of coverage it is able to sell. It is also likely to have a negative effect on the share price of publicly traded firms. In the wake of the 2004 and 2005 hurricanes in the Gulf Coast, several major rating agencies have moved to adopt more stringent standards that will have the effect of requiring some insurers to carry more capital just to maintain the same rating.

**Investors in Insurers and Reinsurers**

The large increase in insured losses in the last ten years, the changes in the catastrophe risk models in 2006, and the more stringent requirement by rating agencies have important consequences for determining the insurability of hurricanes and other natural disasters. Moreover, recent catastrophes have revealed a much higher degree of volatility for any given portfolio than in the past. This will have also an impact on the cost of capital provided to insurers and reinsurers. With higher volatility investors will demand a higher return on equity. This requires insurers and reinsurers to restrict their coverage, charge higher premiums and/or improve their exposure management.
Chapter 1 - Summary

This introductory chapter highlights the major changes that have occurred in recent years with respect to losses from natural disasters. Between 1970 and the mid-1980s annual insured losses from natural disasters worldwide were in the $3 to 4 billion range. The four hurricanes in Florida in 2004 (Charley, Frances, Ivan and Jeanne) collectively totaled over $29 billion in insured losses and Hurricane Katrina alone cost insurers and reinsurers an estimated $45 billion.

A number of interested parties play a role in mitigating losses from natural disasters and providing funds for aiding victims during the recovery period. The chapter highlights the responsibilities and challenges facing the construction industry, homeowners and small businesses, banks and financial institutions, state and local governments (including insurance commissioners), insurers, reinsurers, brokers, capital markets, modeling firms, rating agencies, and investors.

In order to evaluate alternative strategies for providing insurance and mitigating disaster losses it is important to understand the values and goals of these different interested parties as well as the constraints under which they operate.

Chapter 1 - Key Questions

1. How does the increase in catastrophic risks during the past 15 years affect your view of the ability of the private sector to cover losses from natural disasters?
2. What are the key drivers towards more devastating events (population density, increased value at risk, possible effects of climate change)?
3. Are the programs and public policies initially established for dealing with major natural events still adequate for dealing with future large-scale disasters?
4. What roles can the state and federal governments play in partnering with the private sector in general and the insurance sector in reducing losses from future natural disasters and providing mechanisms and funds for recovery from catastrophic events?
5. How have the key interested parties (i.e. construction industry, banks, modeling firms and rating agencies) affected the ability of insurers and reinsurers to provide coverage against natural disasters in the United States?
6. Does the occurrence of less severe but more frequent disasters also create problems for insurers and reinsurers in terms of income volatility or decrease in firm value?
CHAPTER 2

UNDERSTANDING THE U.S. EXPOSURE:
ASSESSING AND MODELING CATASTROPHE RISKS

2.1. The Question of Attribution: A Focus on Weather-Related Events

In the preceding chapter, we discussed natural disasters without differentiating between weather-related events (e.g., storms, floods, droughts, heat waves, cold, and frost) and non-weather-related events (e.g., earthquakes). Given the focus on the Florida market in this interim report, it is important to focus on weather-related events.

Over the period between 1970 and 2004, storms and floods have been responsible for over 90 percent of the total economic costs of extreme weather-related events worldwide. Storms (hurricanes in the U.S. region, typhoons in the Japan region and windstorms in Europe) contribute to over 75 percent of insured losses. In constant prices (2004), insured losses due to weather-related events averaged $3 billion annually between 1970 and 1990 and then increased significantly to $16 billion annually between 1990 and 2004 (ABI, 2005). In 2005, 99.7 percent of all catastrophe losses worldwide were due to weather-related events (Mills and Lecomte, 2006).

What are the key drivers of the increase in these losses? More specifically, what role have socio-economic factors played? How is a change in climate likely to affect the number and severity of catastrophes in the future?

Increased Development in Hazard-Prone Areas

There are at least two principal socio-economic factors that directly influence the level of economic losses due to catastrophe events: degree of urbanization and value at risk. In 1950 approximately 30 percent of the world’s population, lived in cities. In 2000, about 50 percent of the world’s population (6 billion) resided in urban areas. Projections by the United Nations show...
that by 2025, that figure will have increased to 60 percent based on a world population estimate of 8.3 billion people.

Figure 2.1 depicts the increase in population by county in the U.S. between 1990 and 2002. One can observe significant increase in high risk areas.

![US Population Change between 1990 and 2000 by County by Quartile of Distribution](image)

**Figure 2.1. Evolution of the US population between 1990 and 2002**

In hazard prone areas, this urbanization and increase of population also translates into increased concentration of exposure. The development of Florida as a home for retirees is an example. The population of Florida has increased significantly over the past 50 years: 2.8 million inhabitants in 1950, 6.8 million in 1970, 13 million in 1990, and a projected 19.3 million population in 2010 (almost a 700 percent increase since 1950)\(^{25}\). The increase in property value exposed to natural significantly increased the potential for severe economic and insured losses unless cost-effective mitigation measures are implemented.

Florida also has a high density of insurance coverage with most houses covered against windstorm losses and about one third insured against floods under the U.S. National Flood Insurance Program (NFIP)\(^{26}\), according to a study undertaken by Munich Re (2000)\(^{27}\). The modeling firm AIR Worldwide estimates that nearly 80 percent of insured assets in Florida today are located near the coasts, the high-risk area in the state (Figure 2.2). This represents $1.9 billion in exposed assets.

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\(^{25}\) Sources: U.S. Bureau of the Census.

\(^{26}\) The NFIP is a public insurance program created in 1968, where insurers play the role of intermediaries between the policyholders and the federal government. Following Hurricane Katrina, the program had to borrow $20 billion from the federal government in 2006 to meet its claims. Congress is considering modifying the program substantially. For a more detailed discussion of the NFIP see Chapter 4.

Managing Large-scale Risks in a New Era of Catastrophes
Report on Phase I of the Study

trillion of insured exposure located in coastal areas ($1.4 trillion of commercial exposure and $900 billion of residential exposure) (Figure 2.3). Insurance density is thus another critical socio-economic factor to consider when evaluating the evolution of insured loss due to weather-related catastrophes.

Figure 2.2. Insured Coastal Exposure as a Percentage of Statewide Insured Exposure as of December 2004 (residential and commercial properties)
Source: Data from Applied Insurance Research (AIR) Worldwide

Figure 2.3. Total Value of Insured Coastal Exposure as of December 2004 (in $ billion; residential and commercial properties)
Source: Data from Applied Insurance Research (AIR) Worldwide
Another example in the U.S. relates to industrialized development in the Gulf of Mexico. The first off-shore oil platform was built for water depths higher than 100 meters in the 1960s. Today there are numerous such platforms in the Gulf of Mexico and North Sea, two regions highly exposed to major storms\textsuperscript{28}. Indeed, 75 percent of the 4,000 platforms administered by the Minerals Management Service were in the path of Hurricanes Katrina and Rita which destroyed a large number of them. Hurricane Katrina shut down an estimated 95 percent of crude production and 88 percent of natural gas output in the Gulf of Mexico, inflicting major business interruption insured losses.

According to the U.S. Department of Energy, two months after Katrina made landfall as a Category 3 hurricane (August 29, 2005), the shortfall of oil production was still 1 million barrels a day, compared to 200,000 barrels two months after Hurricane Ivan hit one year earlier. This example raises the question as to the economic cost and size of insurance claims payments related to business interruption\textsuperscript{29}.

These factors will continue to have a major impact on the level of insured losses from natural catastrophes. If one combines the size of a hurricane like Katrina (see Figure 2.4) and the still growing concentration of exposure on the Gulf Coast, this indicates that the next major hurricane that hits the Gulf Coast will very likely inflict significant direct losses (property damage) and indirect losses (business interruption) unless strong mitigation measures are put in place.

\textbf{Figure 2.4. Large-scale Disasters: Hurricane Katrina as of Sunday August 28, 2005}

\textsuperscript{28} At a state level, one estimates insured exposure in coastal areas of Texas to be nearly $750 billion today.

\textsuperscript{29} It is fair to say that the impacts on the energy infrastructure would have been much more devastating had a major hurricane hit a city like Houston, Texas. This scenario would result in large-scale property and business interruption losses for oil/chemical industry firms and their insurers.
Table 2.1 illustrates what the impact of major hurricanes that occurred in the U.S. in the past century would be today, adjusted for 2004 inflation, population and wealth normalization. This is basically estimation of what each of these hurricanes would have cost had they hit in 2004 (total direct cost).

### Table 2.1. Top 20 Past Hurricane Scenarios Ranked Using 2004 Inflation, Population, and Wealth Normalization

<table>
<thead>
<tr>
<th>Rank</th>
<th>Hurricane</th>
<th>Year</th>
<th>Category</th>
<th>Cost ($ billion) in 2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Miami (SE FL/MS/AL)</td>
<td>1926</td>
<td>4</td>
<td>101.97</td>
</tr>
<tr>
<td>2</td>
<td>ANDREW (SE FL/SE LA)</td>
<td>1992</td>
<td>5</td>
<td>81.20</td>
</tr>
<tr>
<td>3</td>
<td>North Texas (Galveston)</td>
<td>1900</td>
<td>4</td>
<td>43.15</td>
</tr>
<tr>
<td>4</td>
<td>North Texas (Galveston)</td>
<td>1915</td>
<td>4</td>
<td>37.54</td>
</tr>
<tr>
<td>5</td>
<td>Southwest Florida</td>
<td>1944</td>
<td>3</td>
<td>31.81</td>
</tr>
<tr>
<td>6</td>
<td>New England</td>
<td>1938</td>
<td>3</td>
<td>23.78</td>
</tr>
<tr>
<td>7</td>
<td>Southeast Florida</td>
<td>1928</td>
<td>4</td>
<td>23.45</td>
</tr>
<tr>
<td>8</td>
<td>BETSY (SE FL/SE LA)</td>
<td>1965</td>
<td>3</td>
<td>19.46</td>
</tr>
<tr>
<td>9</td>
<td>DONNA (FL/Eastern U.S.)</td>
<td>1960</td>
<td>4</td>
<td>17.54</td>
</tr>
<tr>
<td>10</td>
<td>CAMILLE (MS/SE LA/VA)</td>
<td>1969</td>
<td>5</td>
<td>16.99</td>
</tr>
<tr>
<td>11</td>
<td>AGNES (FL/NE U.S.)</td>
<td>1972</td>
<td>1</td>
<td>15.46</td>
</tr>
<tr>
<td>12</td>
<td>CHARLEY (SW FL)</td>
<td>2004</td>
<td>4</td>
<td>15.10</td>
</tr>
<tr>
<td>13</td>
<td>DIANE (NE U.S.)</td>
<td>1955</td>
<td>1</td>
<td>15.00</td>
</tr>
<tr>
<td>14</td>
<td>IVAN (NW FL/AL.)</td>
<td>2004</td>
<td>3</td>
<td>14.43</td>
</tr>
<tr>
<td>15</td>
<td>HUGO (SC)</td>
<td>1989</td>
<td>4</td>
<td>14.20</td>
</tr>
<tr>
<td>16</td>
<td>CAROL (NE U.S.)</td>
<td>1954</td>
<td>3</td>
<td>13.23</td>
</tr>
<tr>
<td>17</td>
<td>SE FL/LA/AL</td>
<td>1947</td>
<td>4</td>
<td>12.79</td>
</tr>
<tr>
<td>18</td>
<td>CARLA (N &amp; Central TX)</td>
<td>1961</td>
<td>4</td>
<td>12.20</td>
</tr>
<tr>
<td>19</td>
<td>HAZEL (SC/NC)</td>
<td>1954</td>
<td>4</td>
<td>11.72</td>
</tr>
<tr>
<td>20</td>
<td>Northeast U.S.</td>
<td>1944</td>
<td>3</td>
<td>9.97</td>
</tr>
</tbody>
</table>

Sources: Data from U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA)

**Climate Change and Hurricanes: Likelihood versus Intensity**

There have been numerous discussions and scientific debates as to whether the series of major hurricanes that occurred in 2004 and 2005 might be partially attributed in the impact

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of a change in climate, or not. Without passing judgment on these issues we feel it is important to summarize below the key questions and the scientific evidence presented to address them.

Is a change in climate likely to affect the number and severity of weather-related catastrophes? One of the expected effects of global warming will be an increase in hurricane intensity. This has been predicted by theory and modeling and substantiated by empirical data on climate change. Higher ocean temperatures lead to an exponentially higher evaporation rate in the atmosphere which increases the intensity of cyclones and precipitation.

Emanuel (2005) introduces an index of potential destructiveness of hurricanes based on the total dissipation power over the lifetime of the storm. He shows a large increase in power dissipation over the past 30 years and concludes that this increase may be due to the fact that storms have become more intense, on the average, and/or have survived longer at high intensity. His study also shows that the annual average storm peak wind speed over the North Atlantic and eastern and western North Pacific have increased by 50 percent over the past 30 years.

Another paper by Webster et al. (2005) published a few weeks later indicates that the number of Category 4 and 5 hurricanes worldwide has nearly doubled over the past 35 years. In the 1970s, there was an average of about ten Category 4 and 5 hurricanes per year globally. Since 1990, the number of Category 4 and 5 hurricanes has averaged 18 per year. Focusing only on the North Atlantic (Atlantic-Caribbean-Gulf of Mexico), Category 4 & 5 hurricanes have increased from 16 in the period of 1975-89 to 25 in the period of 1990-2004 (a 56 percent increase). The Webster et al. (2005) study concludes that “global data indicate a 30-year trend toward more frequent and intense hurricanes.” This significant increase in observed tropical cyclone intensities, linked to warming sea surface temperatures that may be associated with global warming, has been shown in another study published recently (Hoyos et al, 2006).

But this is not to say that there is consensus by scientists on the relationship between hurricane activity and global warming. In a perspective article published this summer in

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34 Category 4 hurricanes have sustained winds from 131 to 155 miles per hour; Category 5 systems, such as Hurricane Katrina at its peak over the Gulf of Mexico, have sustained winds of 156 mph or more.
Science, Landsea et al. (2006)37 point out that subjective measurements and variable procedures make existing tropical cyclone databases insufficiently reliable to detect trends in the frequency of extreme cyclones. This conclusion is reinforced in a recent summary of articles on global climate change by Patrick Michaels, past president of the American Association of State Climatologists. He notes that all studies of hurricane activity that claim a link between human causation and the recent spate of hurricanes must also account for the equally active period around the middle of the 20th century. Studies using data from 1970 forward begin at a cool point in the hemisphere’s temperature history and hence may draw erroneous conclusions regarding global climate change and hurricane activity (Michaels, 2006)38.

The current debate in the scientific community regarding changes in the frequency and intensity of hurricanes and their relationship to global climate change is likely to be with us for a long time to come. The results to date do, of course, raise issues for the insurance industry to the extent that an increase in the number of major hurricanes over a shorter period of time is likely to translate into a higher number hitting the coasts39. As discussed above, they are more likely to damage a much larger number of residences and commercial buildings today than they would have in the 1940s. This raises the question of catastrophe risk assessment to which we now turn.

2.2. Measuring Exposure to Natural Disasters: The Role of Catastrophe Models

Nature of Catastrophe Models

Catastrophe risk assessment often relies on estimates based on past data (e.g., loss history in a specific region) coupled with data on what experts know about a particular risk through the use of catastrophe models.

The four basic components of a catastrophe model are: hazard, inventory, vulnerability and loss, as depicted in Figure 2.5, and are illustrated for a natural hazard such as a hurricane. First, the model determines the risk of the hazard phenomenon, which in the case of a hurricane is characterized by its projected path and wind speed. Next, the model characterizes the inventory (or portfolio) of properties at risk as accurately as possible. This is done by first assigning geographic coordinates to a property and then determining how many structures in the insurer’s portfolio are at risk from hurricanes of different wind speeds and projected paths. For each property’s location in spatial terms, other factors that characterize the inventory at risk are the construction type, the number of stories in the structure, and its age.

The hazard and inventory modules enable one to calculate the vulnerability or susceptibility to damage of the structures at risk. In essence, this step in the catastrophe model quantifies the physical impact of the natural hazard phenomenon on the property at risk. How this vulnerability is quantified differs from model to model. Based on this measure of vulnerability, the loss to the property inventory is evaluated. In a catastrophe model, loss is characterized as direct or indirect in nature. Direct losses include the cost to repair and/or replace a structure, which has to anticipate the increase in cost of material and workforce due to the demand surge in the aftermath of a major disaster. Indirect losses include business interruption impacts and relocation costs of residents forced to evacuate their homes.

**Constructing Exceedance Probability Curves**

Based on the outputs of a catastrophe model, the insurer can construct an exceedance probability (EP) curve that specifies the probabilities that a certain level of losses will be exceeded in a specific location (or its entire portfolio) over a specific period of time (e.g., one year, 10 years, etc). These losses can be measured in terms of dollars of damage, fatalities, illness or some other unit of analysis.

Suppose one were interested in constructing an EP curve for an insurer with a given portfolio of policies covering wind damage from hurricanes in Miami/Dade County Florida. By combining the set of events that could produce a given dollar loss, one can determine the resulting probabilities of exceeding losses of different dollar magnitudes. In the hypothetical mean EP curve of Figure 2.6, the x-axis measures the loss to insurer in dollars and the y-axis depicts the probability that losses will exceed a particular level. Suppose the insurer focuses on a specific loss $L_i$. The likelihood that insured losses will exceed this $L_i$ is given by $p_i$. 

![Figure 2.5. Structure of Catastrophe Models](image)
An insurer utilizes its EP curve for determining how many structures it will want to include in its portfolio given that there is some chance that there will be hurricanes causing damage to some subset of its policies during a given year. More specifically, if the insurer wanted to reduce the probability of a loss from hurricanes that exceeds \( L_i \) to be less than \( \pi_i \), it could reduce the number of policies in force for these hazards, increase the premium or decide not to offer this type of coverage at all.

The uncertainty associated with the probability of an event occurring and the magnitude of dollar losses of an EP curve is reflected in the 5 percent and 95 percent confidence interval curves in Figure 2.7. The curve depicting the uncertainty in the loss shows the range of values, \( L_i^{0.05} \) and \( L_i^{0.95} \) that losses can take for a given mean value, \( L_i \), so that there is a 95 percent chance that the loss will be exceeded with probability \( \pi_i \).

In a similar vein one can determine the range of probabilities, \( \pi_i^{0.05} \) and \( \pi_i^{0.95} \) so that there is 95 percent certainty that losses will exceed \( L_i \). For low-probability, high-consequence risks, the spread between the 5 percent and 95 percent confidence intervals depicted in Figure 2.7 that show the degree of indeterminacy of these events can be quite large.
Figure 2.7. Confidence Intervals for a Mean Exceedance Probability (EP) Curve

The EP curve serves as an important element for evaluating risk management tools. It puts pressure on experts to make explicit the assumptions on which they are basing their estimates of the likelihood of certain events occurring and the resulting consequences. A key question that needs to be addressed in constructing an EP curve is the degree of uncertainty regarding both probability and outcomes. There will be considerably more uncertainty facing an insurer if one constructs an EP curve reflecting losses to a specific region (e.g., Miami/Dade County) than for a wider area (e.g., Florida).

Recent Changes in Cat Models

As a result of the 2005 hurricane season, Risk Management Solutions (RMS), one of the leading catastrophe modeling firms, announced in March 2006 that changes of hurricane landfall frequencies in its new model will increase its estimates of average annual insurance losses by 45 percent across the Gulf Coast, Florida, and the Southeast, and by 25-30 percent in the Mid-Atlantic and Northeast coastal regions relative to the older models those which used long-term 1900-2005 historical average hurricane frequencies (Risk Management Solutions, 2006)\textsuperscript{40}.

This revised view of the hurricane risk is driven by an increase of more than 30 percent in the modeled frequency of major hurricanes (Category 3-5 on the Saffir-Simpson scale) in the Atlantic basin that are expected to persist for at least the next five years. How the insurance market and regulators will react to this new magnitude of loss is still an open issue and will certainly depend on estimates by the other two leading modeling firms, AIR Worldwide and EQECAT, both of whom to date have adjusted their estimates upward by a much smaller

percentage than has RMS. These firms offer a near-term model that reflects higher rates due to current warming of sea surface temperatures that is likely to cause an increase in hurricane activity.

### 2.3. Application to Florida: Focus on Hurricane Risks

Risk Management Solutions has provided us with an analysis of the data from the Florida Hurricane Catastrophe Fund (FHCF) book of business as of 2005. Since the FHCF is a state mandatory reinsurance program (see Chapter 3 for more details) it has every residential insurance policy written in the state by private insurers and Citizens. Data collected for this simulation include all lines of coverage of the FHCF. Total insured value (TIV) by the fund at the end of 2005 was estimated to be $1.7 trillion for the entire state of Florida. We focus on wind coverage only.

Table 2.2 provides estimates of the annual probability that insured wind losses from hurricanes will equal or exceed different magnitudes for 18 thresholds ranging from $1 billion to $350 billion. More specifically, there is a 42.5 percent chance that there will be at least $1 billion of insured residential losses in Florida next year. The probability that hurricanes will inflict at least $10 billion of insured residential losses in Florida next year is 15 percent and there is a 1.7 percent chance that insured losses will be at least $50 billion.

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<td>0.005%</td>
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</table>

*Sources: Wharton Risk Center - FHCF 2005; simulation by RMS*

As one can see from this table, the probability decreases significantly as the threshold level of losses increases. For very high levels of insured losses ($100 billion and greater), the exceedance probability is less than 0.5 percent. This translates into a hurricane that occurs less than once in every 200 years. Of course, such an unlikely catastrophic event could occur during the next hurricane season. By undertaking this analysis for all possible levels of insured hurricane losses, one can generate the entire exceedance probability curve for the FHCF. Figure 2.8 provides this curve for losses up to $100 billion.

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41 We would like to thank Jack Nicholson of the Florida Hurricane Cat Fund (FHCF) for providing us with the FHCF data base and Patricia Grossi and Robert Muir-Wood of Risk Management Solutions (RMS) for their analyses of the FHCF data. They provided us with the relevant EP curves and tables presented in this section.

42 We use here the new generation of models developed by RMS in 2006.
In order to measure the uncertainty surrounding these estimates, one needs to utilize data on the average annual expected losses and the standard deviation for each zip code in the state. For all zip codes combined, the average annual expected loss for Florida residential insurance is $5.4 billion and the standard deviation is $13.9 billion (a 2.55 coefficient of variation).

Even if the average expected loss is identical in two regions, their standard deviations can differ significantly. To illustrate this point, we compared the insured losses from hurricanes in the zip codes within Miami/Dade County with 46 counties in the northern part of Florida, depicted in Figure 2.9. The 46 counties taken together had the same expected annual insured losses as in Miami/Dade County. Figure 2.10 depicts the two EP curves for these two regions. Although the EP curves between the two regions look similar, their standard deviations are quite different. For both Miami/Dade county and the 46 northern counties in Florida the average annual expected loss is approximately $900 million. The standard deviation of losses for Miami/Dade is $4.2 billion (a coefficient of variation of nearly 5) and for the 46 northern counties it is $2.8 billion (a coefficient of variation of nearly 3). This uncertainty in losses poses serious insurability problems for insurers as well as reinsurers that are discussed in Chapters 7 and 8 of this report.

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43 The coefficient of variation is the ratio of the standard deviation of a given variable to its mean.
Figure 2.9. 46 Counties Whose Combined Annual Expected Loss Equals Miami/Dade’s Alone

Figure 2.10. EP Curves of the Two Areas
Chapter 2 – Summary

This chapter quantifies the impact of increased population and development in hazard-prone areas on the economic and insured catastrophe losses over the past 20 years. We also discuss some of the most recent research on climate change and the possible impact of global warming on the number and intensity of major hurricanes that, in turn, will affect the potential for catastrophic losses in the future.

Catastrophe models help measure the U.S. exposure to natural disasters. Using a complete dataset of residential coverage in the state of Florida provided to us by the Florida Hurricane Catastrophe Fund, Risk Management Solutions developed an exceedance probability curve for insured losses from hurricanes in Florida. Comparisons are then made between exceedance probability (EP) curves for Miami/Dade County and 46 northern Floridian counties with the same combined annual expected insured losses from hurricane damage. The coefficient of variation for the Miami/Dade county area is 5 compared to 3 for the 46 counties. This implies that Miami/Dade is much more likely to suffer catastrophic losses from hurricanes in the future than are these 46 northern Floridian counties.

Chapter 2 - Key Questions

1. How does development in hazard-prone areas affect insurers’ and reinsurers’ decisions to offer coverage against wind damage from hurricanes in Florida?

2. What role does climate change play in insurers’ and reinsurers’ decisions with respect to the availability of coverage against wind damage from hurricanes in Florida?

3. How do revised estimates by modeling companies affect insurers’, reinsurers’, and insurance commissioners’ decisions with respect to wind damage from hurricanes in Florida? What role are they likely to play in the rate setting process by Florida?

4. How do insurers, reinsurers, and insurance commissioners utilize cat models in their decisions? How do they deal with uncertainty bands associated with the EP curve?
Part B

Current Institutional Arrangements
For Natural Disasters in the U.S.
CHAPTER 3

INSURING WIND DAMAGE FROM HURRICANES

This chapter discusses the role insurance plays in financing hurricane wind damage in the United States and shows how the public and private sectors are intertwined. We begin by focusing on the wind-water controversies that have surfaced following hurricanes with particular attention paid to the problems following Hurricane Katrina. We then turn to Florida where we examine the impact that the state-run company Citizens Property Insurance Corporation (CPIC) has had on the private market and the role that the Florida Hurricane Catastrophe Fund has played in providing reinsurance protection against catastrophic losses from recent hurricanes that have hit the state.

3.1. The Wind/Water Controversy

Current insurance programs for residents in hazard-prone areas in the U.S. are segmented across perils. Standard homeowners and commercial insurance policies, normally required as a condition for a mortgage, cover damage from fire, wind, hail, lightning, winter storms and volcanic eruption.

Coverage for flood damage due to rising water is explicitly excluded in homeowners insurance policies but coverage for these losses is available through the National Flood Insurance Program (NFIP) (see Chapter 4 for more detail on the NFIP). Despite the fact that the NFIP was created nearly 40 years ago, some homeowners contend that they were not aware of this exclusion.

Insurance disputes following hurricanes inevitably arise over the cause of damage. Which portion of the loss is due to wind (which is covered by a standard homeowners policy) and which is from rising water, whether from storm surges or flooding? Hurricane Katrina has brought the wind-water issue to the fore since there were a number of residents in the area who had homeowners insurance but not flood coverage and their damage was caused by rising water, not wind. Apparently lenders did not require flood coverage to the same extent as wind coverage. In addition, even those who did have flood insurance and suffered large losses from the rising waters were only able to cover a portion of their losses with their claim payments because the maximum coverage limit on the structure only (not including contents) of the NFIP is $250,000 for residential buildings and $500,000 for commercial ones. In addition, according to FEMA, as of November 2006, nearly 2 million of the 5.4 million policies in force had building coverage only, 3.3 million had both building and content coverage, and 100,000 had content coverage only44.

Following Katrina many residents disputed their insurers’ assessments that the damage to their homes was caused by rising water, contending that it was due to winds from the hurricane. This issue has generated considerable media coverage since suits have been filed in

44 http://www.fema.gov/business/nfip/statistics/
Gulf Coast states against insurance companies for not paying claims for water damage due to rising waters from storm surge or breaks in the levees.

Certain plaintiffs who reside in the Gulf Coast allege that they were covered for water damage from hurricanes when purchasing their homeowners policies. In fact, many lawsuits were filed in Gulf Coast states following Katrina and other hurricanes. Most of these are asking the courts to overturn flood exclusions in their homeowners policies. In a ruling on an Allstate Insurance Company case in April 2006, Judge L.T. Senter, Jr. of the U.S. District Court for the Southern District of Mississippi ruled that “the inundation that occurred during Hurricane Katrina was a flood, as that term is ordinarily understood, whether that term appears in a flood insurance policy or in a homeowners insurance policy. The exclusions found in the policy for damages attributable to flooding are valid and enforceable policy provisions.”45 This ruling was viewed as a setback to a class-action lawsuit filed by Mississippi’s Attorney General Jim Hood who claimed that homeowners policies should provide protection against water damage even though there are explicit clauses in the contract that excludes these losses.

In Louisiana, a class action lawsuit has been filed on behalf of 160,000 property and business owners against a group of insurance companies. The former Commissioner of Insurance Robert Wooley claimed that flooding was caused by negligence in the construction and maintenance of the levees which broke and inundated New Orleans rather than by an Act of God. On this basis the plaintiffs asked the court to issue an order requiring the insurance commissioner to nullify the exclusions for damage caused by rising water. Several other water damage exclusion cases involving levee breaches were consolidated into the In Re Katrina Canal Breaches Consolidated Litigation in the United States District Court for the Eastern District of Louisiana.

In November 2006 the United States District Court for the Eastern District of Louisiana, released an 85-page ruling by Judge Stanwood Duval in several consolidated cases in which plaintiffs argued that flood damage “arising out of all levee breaches which occurred in the aftermath of Hurricane Katrina” should be covered since such flooding is not specifically excluded in the policies. In contrast to the previous case, the judge cited “ambiguous language in the water damage exclusions in some policies” and denied insurers’ attempts to have the lawsuits dismissed.46 Indeed, the court held that the exclusion language in several of the policies was insufficiently clear with regard to damage caused by flooding which resulted from man-made causes. As of February 2007 the case is in appeal.

The uncertainty associated with the courts’ ex post re-interpretation of insurance policy terms and language substantially increases insurers’ risk. The rates charged for homeowners insurance policies did not account for the payment of flood losses because of the flood exclusion. This places insurers in a difficult position. If they incorrectly assume that the flood exclusion will be upheld, they will be subject to paying unanticipated losses with adverse financial consequences. If they assume otherwise, and raise their rates to reflect the increased risk, insureds will pay more for coverage that is redundant with the National Flood Insurance Program.

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45 United States District Court Southern District of Mississippi, Southern Division (2006), Buente versus AllState, Civil action No. 1:05CV712 LTS-JMR L. T. Senter, Jr., Senior Judge, April 11, 2006.

46 In Re Katrina Canal Breaches Consolidated Litigation, No. 05-4182 (E.D. La. Nov. 27, 2006).
3.2. State Insurance Coverage in Florida\(^{47}\)

In Florida, the state has played a significant role in providing insurance and reinsurance to homeowners through a myriad of state-sponsored facilities. As pointed out in Chapter 1, there currently are three main residual market facilities in Florida: (1) the Florida Insurance Guaranty Association (FIGA)\(^{48}\); (2) the Florida Hurricane Catastrophe Fund (FHCF); and (3) Citizens Property Insurance Corporation (Citizens). The FHCF was established to supplement private reinsurance and reimburse insurers for a portion of their losses from catastrophic events. Citizens was designed to provide property insurance where it is not available from the regular market. FIGA is the state mechanism that pays the claims of insolvent insurers. We examine the FHCF and Citizens in more detail below.

**Florida Hurricane Catastrophe Fund (FHCF)**

*Overview*  The FHCF is a state-run catastrophe reinsurance program and participation is mandatory for every residential property insurer writing policies in the state of Florida. The purpose of the fund is to improve the availability and affordability of property insurance in Florida by providing reimbursements to insurers for a portion of their catastrophic hurricane losses. Each company is required to pay a premium into the fund based on its hurricane exposure.

The FHCF provides hurricane reinsurance to primary insurers at rates that are one-quarter to one-third of rates in the private reinsurance market, and sometimes, depending on conditions in the private market, in quantities not available elsewhere. These lower rates are possible due to two features of the funds.

First, the Cat Fund's "tax exempt status, low administrative costs and lack of any profit or risk-load factor," the state Senate Banking and Insurance Committee noted in its staff summary on the bill (April 20, 2004). "As such, the FHCF acts to lower premiums for residential property insurance as well as to expand reinsurance capacity, which enables a greater amount of insurance to be written in the state than could otherwise be written if the fund did not exist." The FHCF was the first program in the country in which a state provided for tax-exempt accumulation of private cash to pay for major disasters. It has been studied by other states and by the federal government as a possible model for future federal natural disaster insurance

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\(^{47}\) For a detailed description of public-private insurance and reinsurance programs established in the U.S. to deal with catastrophes of all sorts, see R. Hartwig and C. Wilkinson (2006), “Public/Private Mechanisms For Handling Catastrophic Risks in the United States”, June 2006, New York: Insurance Information Institute, on which this sub-section is based.

\(^{48}\) The Florida Insurance Guaranty Association (FIGA) is the state's guaranty fund that pays claims of insolvent insurers. Until 2006, FIGA could assess insurers (who in turn pass it on to policyholders) up to 2% (roughly $225 million) of property and liability premium per year as regular assessments. Senate Bill 1980 approved by Florida governor in May 2006 permitted FIGA to increase that assessment another $225 million through a 2% Emergency Assessment pledged to support a debt offering. The recent legislation passed by Governor Crist on January 22, 2007 permits FIGA to make the additional 2% assessment without pledging a debt offering – effectively raising the FIGA assessment limit from $225 million per year to $450 million. Citizens is now subject to FIGA assessments, which greatly increases the assessment base to cover deficits.
Chapter 3  

Managing Large-scale Risks in a New Era of Catastrophes  

Report on Phase I of the Study

programs. As a public-private partnership, the FHCF had accumulated a multi-billion-dollar pool of cash and contingencies to pay part of the cost of rebuilding homes after major hurricanes.

The 2004 and 2005 hurricane seasons demonstrated the limits of the fund’s operation as its cash resources were exhausted by the 2004/5 hurricane seasons. In 2004 the total claims-paying capacity of the fund was expanded from $11 billion to $15 billion. Losses associated with the 2005 hurricane season left the FHCF with a projected deficit of $1.4 billion so it issued bonds for the first time in its history.

Second, because the FHCF can finance its deficits through ex post assessments, premiums do not have to reflect the real risk (contrary to what a reinsurer would have to charge). In fact, FHCF reinsurance premiums are based on average long term annual loss. These prices are much lower than rates currently charged by private reinsurers that reflect their loss experience in the post-2004/2005-hurricane seasons. One can expect most insurers to buy this additional reinsurance from the FHCF given its low cost. According to the legislation, insurers would have to file rates with the Florida department of insurance that reflect the savings due to expanded cheaper cover by the FHCF.49

Operation of the FHCF

The FHCF charges each insurer premiums that reflect the insured value of its residential property book of business, the properties locations, construction types, deductible amounts, and other factors. Table 3.1 provides an overview of the structure of the FHCF. Its 2007 capacity of $32 billion consists of its cash holdings, bonding capacity and perhaps access to general state revenues. This means that after insurers providing homeowners coverage absorb the first $6 billion in losses from the first two storms, they are eligible for reinsurance recoveries from the fund for additional losses up to $32 billion. When it is activated, the FHCF first uses its cash balance. Once the cash balance is exhausted, additional liabilities up to the $32 billion limit are financed through revenue bonds or other debt from the major financial markets.50

Newly-elected Florida Governor Charlie Crist signed legislation on January 22, 2007 that enacted a package of insurance "reforms" designed to reduce property insurance rates and instituted major changes to the FHCF. Although the insurance industry retention level has held steady at $6 billion, the new legislation expands the FHCF industry limit so that it may increase to as high as $32 billion.

This expansion in the exposure of the FHCF was not supplemented with upfront funding, thereby increasing the possibility of future assessments on all property and casualty premiums, except for workers’ compensation and medical malpractice liability insurance (see analyses in Chapter 2 regarding exceedance probability curves of the FHCF portfolio). This raises significant equity issues as to who will be paying for future disaster losses.

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49 Estimates of reinsurance premium reduction that will result from FHCF expansion are in the range of $1.5 to $2 billion (Sources: V.J. Dowling).

50 There is currently a legislative effort to lower the FHCF retention to about $3.5 billion.
MANAGING LARGE-SCALE RISKS IN A NEW ERA OF CATASTROPHES

Chapter 3

Report on Phase I of the Study

Table 3.1. Florida Hurricane Catastrophe Fund Overview

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Sources: Insurance Information Institute; Guy Carpenter, The World Catastrophe Reinsurance Market, 2005; Florida Hurricane Catastrophe Fund.

Florida’s Citizens Property Insurance Corporation

Overview Citizens Property Insurance Corporation (CPIC) (referred to as Citizens) was established in 2002 after the state passed legislation combining two separate high-risk insurance pools, known as the Florida Windstorm Underwriting Association (FWUA) and the Florida Residential Property & Casualty Joint Underwriting Association (FRPCJUA) in the wake of Hurricane Andrew in 1992. Citizens is a state-regulated, residual market entity that was originally intended to provide property insurance where it is not available from the regular market. It has tax-exempt status with three separate accounts: (1) the High Risk Account (HRA), (2) the Personal Lines Account (PLA) and (3) the Commercial Lines Account (CLA). The HRA provides wind-only and multi-peril policies. The PLA offers inland wind-only policies, excluding risks in the HRA zone, and multi-peril policies for residential properties regardless of location. The CLA offers wind-only policies, excluding risks in the HRA zone, and multi-peril policies for commercial-residential properties.

2007 Legislation Citizens was significantly changed by the Florida Legislature in January 2007 by decreasing rates and expanding its exposure. The rate increase that took place January 1, 2007 was reversed and Citizens was required to provide a significant rebate to those who paid this rate. There is no longer the requirement that Citizens provide coverage only to homeowners who cannot obtain policies from private insurers; Citizens can now compete with the private...
sector and is no longer required to charge rates at least as high as those charged by the top 20 insurers in the State; Citizens is authorized to provide commercial coverage statewide. These changes will encourage a large portion of Florida policyholders to switch to Citizens unless private insurers charge similar premiums which would be below the prices they are currently charging.

These changes will bring short term benefits to many policyholders in Florida who will pay a limited price for covering their assets against catastrophes. If there is no major hurricane in Florida during the next several years, it is likely that homeowners in Florida will see these changes as very positive. On the other hand, a major hurricane will demonstrate that these changes are not sustainable, unless the Florida legislature decides to finance disasters with higher assessments against all property and casualty insurance premiums, except worker’s compensation and medical malpractice, and/or using taxpayer funds.

An open issue that needs to be considered is whether financing losses through ex post assessment is equitable given that most policyholders in Florida will be responsible for paying for disaster losses for those residing in hazard-prone areas in the state. Furthermore there is the question as to how one can encourage property owners to adopt cost-effective mitigation measures when the premiums they are charged are highly subsidized, as is currently the case with this new legislation.

_Growth and Size of the Florida Residual Market_\[51\] Even before the new legislation, the Florida residual market has grown substantially since 2000. Figures 3.1(a) and 3.1(b) show trends in the residential portion of the Florida residual market, which is divided between “full coverage” and “high-risk”, e.g., wind only, policies. Figure 3.1(c) shows the combined exposures for both portions of the residential residual market. The number of policies and the amount of exposures increased substantially after Hurricane Andrew and then fell from 1995 through 2000 as new start-up insurers took policies out of the facility and pressure on the voluntary market eased. This trend reversed in 2001 when the start-up companies shed policies back to the residual market. The storm seasons of 2004-2005 reasserted pressure on the voluntary market.

As of December 31, 2006 the CPIC “personal-residential” pool had 743,592 policies and $137 billion in exposures. The wind-only pool also has increased substantially to 403,509 policies and $178 billion in exposures. The trends in the number of wind-only policies have been affected by the same factors that have had an impact on the full-coverage policies. Combined, exposures in the two pools have reached $315 billion.

CPIC’s total exposure to loss reached $409 billion and total policies in-force 1.3 million (for all business – residential, commercial and transitional), transforming the state’s insurer of last resort into Florida’s largest insurer. Today Citizens is the largest participant in the FHCF, consuming nearly 40 percent of FHCF capacity.

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\[51\] This section is based on Klein, R. W. (2006), “Catastrophe Risk and Insurance Regulation,” working paper, Georgia State University, November.
Figure 3.1(a). Florida Residual Market Residential Policies & Exposures: 1993-2006

Figure 3.1(b). Florida Residual Market Wind-Only Policies & Exposures: 1993-2006
Table 3.2 shows the full-coverage exposures written by the CPIC in 2006-Q2 relative to the total insurer exposures in the state by line or type of property. We can see from this table that the CPIC’s share of total exposures varies significantly by type of property. Overall, it insured only 6.5 percent of the exposures of all property types combined, but its share is much higher for certain product types. For example, CPIC insures 18 percent of condo associations, 83.2 percent of homeowners associations, 38.2 percent of apartment buildings, 21.2 percent of mobile homes, and 27.2 percent of dwelling fire/allied lines.

The availability of coverage is tighter and the residual market relatively larger in the highest risk areas of the state [Dade, Broward, Palm Beach and Monroe (DBPM) counties] as shown in Table 3.3 for 2003 (December 31) and 2006 (October 31)\textsuperscript{52}.

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|c|}
\hline
Line & CPIC & All Insurers & CPIC \\
\hline
Condo Assoc & 16,439,833,311 & 91,224,054,110 & 18.0\% \\
Homeowners Assoc & 2,138,084,531 & 2,570,672,000 & 83.2\% \\
Apt Bldg & 5,351,935,074 & 14,025,653,092 & 38.2\% \\
Homeowners & 43,773,376,676 & 1,207,824,853 & 3.6\% \\
Mobile Homes & 5,156,777,801 & 24,284,095,273 & 21.2\% \\
Condo Unit & 944,114,704 & 53,434,252,422 & 1.8\% \\
Dwelling Fire & 22,456,013,862 & 82,574,464,918 & 27.2\% \\
Tenant & 40,716,360 & 8,158,121,091 & 0.5\% \\
\hline
\textbf{Total} & \textbf{96,300,852,319} & \textbf{1,484,096,166,566} & \textbf{6.5}\% \\
\hline
\end{tabular}
\caption{CPIC Share of Total Exposures ($)}
\end{table}

\textsuperscript{52} As this report goes to press, total market figures in Tables 3.2 and 3.3 cannot be updated to year-end 2006 because of data reporting lags and the most current reports that are available from the FLOIR.
We can see from this table that the number of policies and amount of exposures insured by CPIC in its personal-residential account increased nominally from 2003 to 2006 in the DBPM counties but decreased relative to the CPIC’s total policies and exposures. Still, these counties accounted for the majority of high-risk policies insured by CPIC.

### Table 3.3. Comparison of Residential Policies in CPIC for High-Risk Areas and Rest of Florida

<table>
<thead>
<tr>
<th></th>
<th>Citizens Property Insurance Corporation</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Policies % Total</td>
<td>Exposures % Total</td>
</tr>
<tr>
<td><strong>Personal Residential</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>With Wind</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dade, Broward, Palm Beach, &amp; Monroe</td>
<td>185,985</td>
<td>35.7%</td>
</tr>
<tr>
<td>Rest of State</td>
<td>395,293</td>
<td>75.3%</td>
</tr>
<tr>
<td>Total</td>
<td>521,278</td>
<td>100.0%</td>
</tr>
<tr>
<td><strong>Personal Residential Excluding Wind</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dade, Broward, Palm Beach, &amp; Monroe</td>
<td>78,323</td>
<td>70.9%</td>
</tr>
<tr>
<td>Rest of State</td>
<td>32,371</td>
<td>29.2%</td>
</tr>
<tr>
<td>Total</td>
<td>110,694</td>
<td>100.0%</td>
</tr>
<tr>
<td><strong>Personal Residential Total</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dade, Broward, Palm Beach, &amp; Monroe</td>
<td>264,218</td>
<td>38.2%</td>
</tr>
<tr>
<td>Rest of State</td>
<td>427,864</td>
<td>61.8%</td>
</tr>
<tr>
<td>Total</td>
<td>692,082</td>
<td>100.0%</td>
</tr>
<tr>
<td><strong>High-Risk: Wind Only</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dade, Broward, Palm Beach, &amp; Monroe</td>
<td>245,805</td>
<td>62.3%</td>
</tr>
<tr>
<td>Rest of State</td>
<td>148,934</td>
<td>37.7%</td>
</tr>
<tr>
<td>Total</td>
<td>394,739</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Source: CPIC

This leads to several observations and comments. One would expect a certain increase in the number of policies and the amount of insurance or exposures due to the construction of more homes as well as increases in policy limits. The fact that there were decreases in the number of policies for certain account segments suggest that there has been some depopulation of the CPIC in these counties. Insurers can receive a $100 bonus for taking a policy out of the CPIC and it appears that these incentives have had a modest but not substantial positive effect as shown in Table 3.4.

What is most striking is CPIC’s growth in other areas of the state. It appears that prior to the recent storm seasons, other coastal areas were not as great of a concern to insurers as southern Florida. This perception appears to have changed significantly after 2003. Hence, other coastal areas experienced a greater change in terms of insurers’ adjustment of their exposures – an adjustment that Dade, Broward, Palm Beach and Monroe had already experienced prior to 2004. This probably reflects insurers’ recognition that the other coastal areas faced a higher level of hurricane risk than what they had previously assumed. Of course, the vulnerability of other coastal areas was demonstrated by the path of several hurricanes in 2004 and Hurricanes Katrina and Rita in 2005. Hence, these other coastal areas apparently suffered a greater decrease in the availability of coverage than southern Florida.
Table 3.4. Citizens Property Insurance Corporation Reduction in Exposure as a Result of Depopulation: 2003-2005

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Policies</th>
<th>Coverages A-D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2003</td>
<td>28,219</td>
<td>$8,140,681,9065</td>
</tr>
<tr>
<td>2004</td>
<td>145,959</td>
<td>$29,161,307,321</td>
</tr>
<tr>
<td>2005</td>
<td>218,128</td>
<td>$40,174,893,046</td>
</tr>
<tr>
<td>Total</td>
<td>392,306</td>
<td>$77,476,882,273</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Policies</th>
<th>Coverages A-D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2003</td>
<td>0</td>
<td>$0</td>
</tr>
<tr>
<td>2004</td>
<td>12,457</td>
<td>$1,501,769,159</td>
</tr>
<tr>
<td>2005</td>
<td>75,556</td>
<td>$13,483,947,013</td>
</tr>
<tr>
<td>Total</td>
<td>88,013</td>
<td>$14,985,716,172</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Policies</th>
<th>Coverages A-D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2003</td>
<td>28,219</td>
<td>$8,140,681,9065</td>
</tr>
<tr>
<td>2004</td>
<td>158,416</td>
<td>$30,663,076,480</td>
</tr>
<tr>
<td>2005</td>
<td>293,684</td>
<td>$53,658,840,059</td>
</tr>
<tr>
<td>Total</td>
<td>480,319</td>
<td>$92,462,598,445</td>
</tr>
</tbody>
</table>

Source: CPIC

Today the Florida residual market for residential full-coverage policies is at an all-time high in terms of policies and exposures. As insurers continue to retrench, it is likely that these figures will continue to increase until market pressures ease or some other way is found to move policies back into the voluntary market. Although several factors affect the size of the residual market, it is clear that the availability of coverage in the voluntary market has tightened considerably. How this situation will evolve in the future will also depend on several factors, including risk assessment, changes in capacity, the supply of reinsurance, and regulatory actions.

In South Florida, the riskiest part of the state, some 2,800 homes in Citizens’ portfolio are worth more than $1 million. In total, these homes represent $13.7 billion or 10 percent of the insured value of its high-risk policies but only 2 percent of the total number of policies written.  

As part of the hurricane insurance bill (SB. 1980) passed by the state legislature in May 2006, owners of $1 million-plus homes and vacation and second homes of any value will no longer be able to obtain coverage through Citizens. Instead, they will have to obtain coverage from the voluntary market including from surplus lines insurers, companies that provide coverage for risks that standard insurers have rejected in return for generally higher and less regulated rates. This change, which takes effect July 1, 2008, was one of many recommendations made by the Task Force for Long-Term Solutions for Florida’s Hurricane Insurance Market in March 2006.

Claims-Paying Capacity Citizens was hit hard by the 2004 and 2005 hurricane seasons, suffering record hurricane damage claims and incurring a deficit in both years. As a result of losses related to Hurricanes Dennis, Katrina and Wilma, Citizens has been left with an estimated deficit of $1.77 billion for 2005. This follows a reported deficit of $516 million in 2004, after

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53 These figures are excerpted from Hartwig and Wilkinson (2006), op cit.
Citizens incurred around $2.4 billion in losses from nearly 120,000 hurricane damage claims, of which $1.8 billion came from its HRA.

When Citizens losses exceed its claims-paying capacity in a single year, it is required by state law to impose a statewide assessment on every line of property and casualty insurance other than medical malpractice and worker's compensation. By law, insurers may recoup the amount from policyholders as part of the homeowners insurance rate-making process in the state. The surcharge is shown separately on premium notices when eligible insurance policies come up for renewal. To cover 2004’s $516 million shortfall, Citizens imposed a 6.8 percent surcharge on policyholders, amounting to about $100 per $1,500 in premiums. To offset Citizens’ 2005 deficit of $1.77 billion, the hurricane insurance bill (SB. 1980) provides for a $715 million appropriation of state general revenue dollars to the fund. This will reduce the assessment on policyholders from 11 percent to approximately 2.5 percent. Citizens also has the ability to finance loss payments by issuing tax-exempt bonds that carry low interest rates.
Chapter 3 – Summary

This chapter first focused on the challenges insurers face when dealing with hurricane damage given that some losses may be caused by wind (covered in a standard homeowners policy) and other losses by water (covered by flood insurance provided by the federal government). Hurricane Katrina has brought the wind-water issue to the fore since there were a number of residents in the area who had homeowners insurance but not flood coverage and were told that their damage was caused by rising water, not wind. Many lawsuits were filed in Gulf Coast states following Katrina and other hurricanes asking the courts to overturn flood exclusions in their homeowners policies. To date insurers have prevailed except for a very recent case, but the process has been a costly one.

The remaining portion of the chapter focused on how Florida has dealt with catastrophic losses from hurricanes. The Florida Hurricane Catastrophe Fund (FHCF) was the first program in the country in which a state provided for tax-exempt accumulation of private cash to pay for major disasters. It has improved the availability and affordability of property insurance in Florida and is now being studied by other states and by the federal government as a possible model for future federal natural disaster insurance programs.

We then turned to the changes in the residual market in Florida that provides insurance to homeowners, commercial residential properties and a limited number of commercial businesses primarily in coastal high-risk areas. This market has increased in recent years with the current state-run insurance company, Citizens, now the largest provider of homeowners insurance in Florida, facing large deficits from the recent hurricanes in Florida.

Chapter 3 - Key Questions

1. How adequate is protection in Florida against natural disasters under the current structure?

2. How serious is the wind-water controversy under the current insurance structure? What alternative arrangements should be considered?

3. How successful is the Florida Hurricane Catastrophe Fund in dealing with losses from catastrophic events? Is this a model for other states to follow?

4. What will be the impact of the new Florida legislation on the availability of insurance and reinsurance markets in Florida and on the economic incentives for homeowners to adopt cost-effective mitigation measures.
CHAPTER 4

FLOOD RISK FINANCING THROUGH PUBLIC INSURANCE

4.1. The Origin of the National Flood Insurance Program (NFIP)

The insurability of floods has been a challenge for many years. If an entire state, or large portions of it, are subject to flooding (such as Florida), risks across the whole state population become highly correlated and thus difficult to diversify for an insurer.

Individuals who experience damage from flood can lose a vast proportion of their assets, which for many individuals consists largely of their house and its contents. Individuals press for relief at the local, state or federal level, in which case the costs are borne by the broader community in the form of liberal disaster assistance. One such example is the possibility of a large bailout of the National Flood Insurance program (on the order of $20 billion) related to claims for Hurricane Katrina.

Originally, Congress created the National Flood Insurance Program in response to the lack of interest of private insurers to provide coverage for that type of risk. It came also in response to the rising cost of taxpayer-funded disaster relief for flood victims. When Congress established the National Flood Insurance Program (NFIP) in 1968, it noted that “many factors have made it uneconomic for the private insurance industry alone to make flood insurance available to those in need of such protection on reasonable terms and conditions.”

Evolution of the Program Up to September 2006

Federal flood coverage initially was available only via insurance agents who dealt directly with the Federal Insurance Administration (FIA). In 1979, the FIA was placed under the Federal Emergency Management Agency (FEMA), and since 1983 the “direct” policy program has been supplemented with a program known as the Write-Your-Own (WYO) Program.

The WYO program allows a pool of participating property/casualty insurance companies to write and service the Standard Flood Insurance Policy in their own names. The premium charged by the private insurer is the same as that charged by the federal government through the direct program. Nearly all of the flood policies issued today are written by 85 companies that write flood insurance through the WYO program.

The NFIP thus benefits from the private insurance industry’s marketing channels and existing policy base to sell flood insurance. These companies also process flood claims as well as settle, pay and defend all claims arising from the flood policies, while the NFIP retains responsibility for underwriting losses. In return, private insurers receive an expense allowance.

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54 This bill superseded the Federal Flood Insurance Act of 1956 (70 Stat. 1078) by implementing a federally run national flood program (the 1956 act was limited in scope requiring, for example, that where “reasonably priced” private coverage was available, the federal insurance would not be).
The NFIP program was not envisioned as insurance only. FEMA has implemented a number of direct campaigns to enhance the visibility of the flood program in recent years. FEMA introduced “Cover America” in 1995, a campaign which, according to FEMA, generated more than 500,000 inquiries to the NFIP. “Cover America II” was a new campaign launched in 1998. However, rather than risk per se, the campaign stressed “Prevention, Partnership and Protection” (Morris, 1999).55

More recently, the NFIP launched FloodSmart, a comprehensive campaign featuring a website (www.floodsmart.gov) that features community risk and estimated premium rates, as well as mitigation measures, and “Rain Cloud”, a Direct Response TV ad that focuses on local flooding events (Alabama Independent Insurance Agents 2005).56 Most of these measures do not directly communicate risk, but rather allude to the damage that flooding can cause. These communication campaigns have certainly contributed to increased take up rate in recent years. One key area for the NFIP in the future would be to aggregate and disseminate information about which areas are at risk for flooding.

The number of NFIP policies remained quite stable during the 1980s at nearly 2 million nationwide, before it started increasing in the late 80s. By 1997, this number had doubled to over 4 million, and then continued to slightly increase in the following years. A more significant increase started in 2004 and accelerated in the aftermath of Hurricane Katrina and major floods in Louisiana. As of September 30, 2006, 5.3 million policies were in place; that is 600,000 more than there were one year before, on September 2005 (Figure 4.1).

Over the same period, the total value of property insured under the NFIP has been growing rapidly. In just the past six years, the total exposure (sum of the limits on policies) doubled. It was nearly $265 billion in 1990 and $500 billion nationwide in 2000. In September 2006, it reached the critical threshold of 1 trillion dollars (Figure 4.2).

Premiums collected for flood coverage have naturally evolved in the same direction but at a much slower rate: from $670 million in 1990 to $1.32 billion in 2000 up to $2.25 billion at the end of 2005 and $2.51 billion end of September 2006 (Figure 4.3). It is interesting to note that despite radical change in the past 2 years in terms of new policies and total exposure of the program, the average “premium over limit” ratio per policy has remained very constant over the past 16 years at 0.25 percent.

Figure 4.1. Evolution of U.S. National Flood Insurance Policies in Force by Year (in millions)
Sources: Wharton Risk Center, Data from FEMA, Department of Homeland Security (November 2006)

Figure 4.2. Evolution of U.S. National Flood Insurance Coverage in Force by Year (in $ billion)
Sources: Wharton Risk Center, Data from FEMA, Department of Homeland Security (November 2006)
The amount of insurance homeowners can purchase from the program has evolved over time as well. It has always been the purpose of the program to have a maximum limit of coverage as well as a minimum standard coverage. The minimum has generally been the principal remaining on the outstanding mortgage (unless this amount is above the maximum coverage limit) with purchase being required for the life of the loan. A policy has typically two maximum limits: one for the structure and one for the content. This maximum has increased over time but has remained the same since 1994 (see Table 4.1)\(^{57}\).

**Table 4.1. NFIP Coverage Limits by Policy (nominal dollars)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Structure Limit</th>
<th>Contents Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>$250,000</td>
<td>$100,000</td>
</tr>
<tr>
<td>1994</td>
<td>$250,000</td>
<td>$100,000</td>
</tr>
<tr>
<td>1977(^{58})</td>
<td>$150,000</td>
<td>$50,000</td>
</tr>
<tr>
<td>1973</td>
<td>$35,000</td>
<td>$10,000</td>
</tr>
<tr>
<td>1968</td>
<td>$17,500</td>
<td>$5,000</td>
</tr>
</tbody>
</table>

*Source: 42 U.S.C. 4013 (as amended)*

According to FEMA, as of September 2006, nearly 2 million of the 5.3 million policies in forces had building coverage only, 3.2 million had both building and content coverage, and 100,000 had content coverage only. In order to compare the evolution of the real value of this

\(^{57}\) Commercial (non-residential) buildings are eligible for up to $500,000 in building coverage and up to $500,000 on personal property.

\(^{58}\) Since 1977, limits are the same for single family dwelling and multi-family dwelling.
maximum, we compiled these data by indexing this limit to 2005 prices (total maximum limit of $350,000 in 2005). Figure 4.4 depicts this 2005-index total policy limit over the period 1968-2005. Here we see the tension in the program between adequate provision of coverage and cost containment, a theme we will explore at greater length below.

![Figure 4.4. Flood Total Coverage Limits by Year (indexed to 2005 dollars)](image)

Source: 42 U.S.C. 4013 (as amended)

Complementary Flood Coverage through Private Insurance

Given the coverage limits of the NFIP, private flood insurance in excess of the coverage limits might be an attractive product for some policyholders. For example, the limit of federal flood insurance is well below the limit for a FNMA-backed mortgage which is $417,000. Several companies, including AIG and Chubb, offer private insurance in excess of the NFIP policy limits. However, the same problems of insurability that the NFIP was set up to deal with affect private programs. AIG only offers its coverage in a handful of states, including California, Colorado, Connecticut, Illinois and Massachusetts (Silverman, 2005). The Chubb Group is only offering its policies in Arizona, Colorado, Illinois, Idaho, Indiana, Michigan and Utah (Best's Review, 2006). Therefore, insurance is not available in the areas where homeowners need it the most. Even if it were, it is questionable whether people would buy it given the problems the NFIP has had with market penetration despite mandatory purchase rules.

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2004-2005: New Levels of Loss for the NFIP

The number of claims paid by the NFIP changes from year to year but between 1980 and 2002 was never higher than 62,400 which occurred in 1995. The severity of flood losses from the 2004 hurricane season led to 75,000 claims, a new record in the history of the program. The breach in the New Orleans levees from Hurricane Katrina coupled with the flood losses from Hurricanes Katrina, Rita and Wilma triggered some 239,000 claims with the NFIP in 2005, 80 percent of which were from Hurricane Katrina. It is estimated the NFIP will pay in excess of $20 billion in flood claims for the 2005 hurricane season, the equivalent of ten years of premiums. This raises major questions regarding the future of the program. Two bills are currently being discussed in Congress as to how modify its operation so it fits better with this new era of unprecedented losses. We summarize the key features of these bills in the last section of this chapter.

4.2. Rate Setting and Funding of the NFIP

Rate Setting

The premium rates charged by the NFIP have been a constant source of contention with the program walking a fine line between affordability and cost containment. For example, the program is officially structured to estimate rates on an actuarial basis and charge risk-based premiums that are adequate to provide reserves for anticipated losses.

The measure of risk in the NFIP is flood elevation. Flood elevation refers to the frequency of flooding that is expected for a given area with a given elevation (relative to sea level) and its geography relative to bodies of water. The program thus proposes and then finalizes (determines) flood elevations that it propagates and publishes in maps and other announcements. The 1973 Act required “regulated lending institutions” (federally regulated lending institutions) to notify borrowers of the flood hazard associated with their homes. Such lenders are also required to notify the NFIP of changes in lending servicers.

One important concept for rate setting is the difference between actuarial rates and subsidized rates. Indeed, the program was authorized by a statute of the 1973 Act to offer insurance at subsidized rates to “properties built before December 31, 1974 or the effective date of the initial FIRM, whichever is later.” Currently, these properties represent 26 percent of policies nationwide, with subsidized policyholders estimated to pay “between 35 percent and 40 percent of the full-risk premium needed to fund the long-term expectation for losses.” (Hayes and Sabade, 2004)

62 The meaning of reserves should be clarified – the program is prohibited from building reserves in the traditional sense. Here reserves mean that premiums collected in a year are available to pay that year’s claims or any debt arising from prior year’s underfunding.
63 The 2004 and 2005 seasons have raised major questions regarding the quality of the current mapping.
**Community Rating and Mapping**

In addition to this subsidized rate for older properties, the program has a pricing rule that offers discount on premiums related to mitigation efforts undertaken by the local community where the property is located. We now discuss this community rating system.

The program uses its own vocabulary. For the purposes of the NFIP, a “community” means “a State or a political subdivision thereof which has zoning and building code jurisdiction over a particular area having special flood hazards.”65 A “flood insurance rate map” (FIRM) “is the official map of a community on which FEMA has delineated both the special hazard areas and the risk premium zones applicable to the community.” These maps have three audiences: citizens and insurers, who use the maps to determine whether a property is in a flood zone, and what the level of the hazard is, officials who are in charge of floodplain management and lenders who determine whether flood insurance is a mandatory part of the mortgage on a property. (FEMA, 2006)66

One important face of community rating is the Community Rating System (CRS). CRS was introduced to the program as part of the National Flood Insurance Reform Act of 1994 to “provide incentives for measures that reduce the risk of flood or erosion damage” which went above and beyond the 100-year base flood elevation standard, “to encourage adoption of more effective measures that protect natural and beneficial floodplain functions; to encourage floodplain and erosion management; and to promote the reduction of Federal flood insurance losses.” (Gonzales, 1994)67

In order to obtain premium discounts under the CRS, communities (represented by officials in charge of flood plain management) must collect and document their efforts in three areas: Public Information, Mapping and Regulations, and Flood Damage Reduction. Examples of these three mitigation measures include passing out information on flood preparedness, open space preservation regulations and drainage system maintenance, respectively. There are 9 classes, class 9 being the one where the discount is the lowest (5 percent) and class 1 the highest (45 percent). There were 1,049 CRS communities (representing 67 percent of NFIP’s policy base) on October 1, 2006, 70 percent of which were lower classes 8 and 9, as shown in Figure 4.5 (FEMA, 2006)68.

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65 For example, the city of North Miami Beach in Florida is an incorporated city within Miami/Dade County, while the city of Brownsville is an unincorporated community within the same county. Since North Miami Beach issues building permits for construction in the community the NFIP considers it a “community.” The government of Miami/Dade issues the building permits for Brownsville, so it is part of the Miami/Dade NFIP “community.”


4.3. Application to Florida (Miami/Dade County)

In order to investigate the particulars of the flood program in Florida, we obtained a dataset of policies in force from the NFIP\textsuperscript{69} as of August 31, 2006 for the 78 ZIP codes in Miami/Dade County\textsuperscript{70}. Generally, flood risk can reflect proximity to the ocean, standing bodies of water, such as lakes, and rivers and streams. Figure 4.6, which shows the most recent flood map for Miami/Dade County with ZIP code boundaries, is a good example of how distance from the ocean is not the only determinant of risk for a community. The “flood zones” of a FIRM reflect the flood risks that affect different parts of the community and thus the premium for a property in that zone. The flood zones for the Miami/Dade map in figure 4.6 are A, AE, AH, OPW, VE, X and X-500. We provide the full definition of each zone in Appendix 4-A.

\textsuperscript{69} We would like to thank Ed Pasterick of FEMA and Tim Scoville of CSC who were instrumental in providing the data.

\textsuperscript{70} All results presented herein are for residential properties.
A count of residential properties in Miami/Dade County separated by flood zone and Pre/Post-FIRM status is shown in table 4.2. One interesting fact to note is that while 26 percent of the properties nationwide are paying subsidized rates, the figure is 36 percent in Miami/Dade County.
Table 4.2. NFIP Subsidized versus Actuarial Rates in Miami Dade County

<table>
<thead>
<tr>
<th>Flood Zone</th>
<th>Count of Policies in Force</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3,604</td>
<td>4.4%</td>
</tr>
<tr>
<td>AE, A1-A30</td>
<td>59,999</td>
<td>73.5%</td>
</tr>
<tr>
<td>AO, AH</td>
<td>852</td>
<td>1.0%</td>
</tr>
<tr>
<td>AOB, AHB</td>
<td>8,483</td>
<td>10.4%</td>
</tr>
<tr>
<td>D</td>
<td>21</td>
<td>0.0%</td>
</tr>
<tr>
<td>V, VE</td>
<td>144</td>
<td>0.2%</td>
</tr>
<tr>
<td>B, C, X</td>
<td>8,564</td>
<td>10.5%</td>
</tr>
<tr>
<td>Total</td>
<td>81,667</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Percent of All Policies 36.3%

<table>
<thead>
<tr>
<th>Flood Zone</th>
<th>Count of Policies in Force</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4,012</td>
<td>2.8%</td>
</tr>
<tr>
<td>AE, A1-A30</td>
<td>58,868</td>
<td>41.0%</td>
</tr>
<tr>
<td>AO, AH</td>
<td>2,053</td>
<td>1.4%</td>
</tr>
<tr>
<td>AOB, AHB</td>
<td>70,842</td>
<td>49.5%</td>
</tr>
<tr>
<td>D</td>
<td>4</td>
<td>0.0%</td>
</tr>
<tr>
<td>V, VE</td>
<td>158</td>
<td>0.1%</td>
</tr>
<tr>
<td>B, C, X</td>
<td>7,489</td>
<td>5.2%</td>
</tr>
<tr>
<td>Total</td>
<td>143,422</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Percent of All Policies 63.7%

Grand Total 225,089 100.00%

Source: Data on policies in force provided by FEMA

Table 4.3 summarizes CRS results for Miami/Dade. We can see that almost 90 percent of these flood insurance policyholders receive a discount on their premiums as a result of the community rating system, with 2/3 of them receiving the largest discount rate, 25 percent.

Table 4.3. Summary Statistics – Residential Policyholders in Miami/Dade

<table>
<thead>
<tr>
<th>Premiums by Origination</th>
<th>Amounts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount Collected by WYO Companies</td>
<td>$110.2 million</td>
</tr>
<tr>
<td>Amount Collected by NFIP Directly</td>
<td>$1.0 million</td>
</tr>
<tr>
<td>Total Amount Collected</td>
<td>$111.2 million</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Insurance Contracts by Origination (Number)</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contracts through WYO Companies</td>
<td>2,011</td>
</tr>
<tr>
<td>Contracts through NFIP Directly</td>
<td>223,209</td>
</tr>
<tr>
<td>Total Contracts</td>
<td>225,220</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Insurance Contracts by CRS Discount Level (Number)</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>25,331</td>
</tr>
<tr>
<td>5%</td>
<td>1,156</td>
</tr>
<tr>
<td>10%</td>
<td>36,556</td>
</tr>
<tr>
<td>15%</td>
<td>8,758</td>
</tr>
<tr>
<td>20%</td>
<td>1,656</td>
</tr>
<tr>
<td>25%</td>
<td>151,763</td>
</tr>
<tr>
<td>Total Policyholders</td>
<td>225,220</td>
</tr>
</tbody>
</table>

Source: Data on policies in force provided by FEMA
We were also able to investigate the penetration in Miami/Dade using the flood policy data along with household counts from Sourcebook America\textsuperscript{71}. We found penetration rates vary significantly, ranging from almost 0 percent in ZIP codes including 33135 to nearly 100 percent in ZIP codes such as 33178. Note that the former ZIP code is in a part of Miami designated flood zone X (non-mandatory purchase) which includes a swath of land beginning just to the west of the northern mouth of the Bay of Biscayne and extending west. ZIP code 33178 is the large area of Miami in the northwest corner of Miami/Dade designated flood zone AH by the NFIP (1-percent annual chance shallow flooding with a constant water-surface elevation (usually areas of pounding) with mandatory purchase requirement).

Among those who did buy flood insurance it is interesting to ask whether these policyholders tend to buy up to the maximum limit ($250,000 for the structure and $100,000 for contents) or prefer a lower limit to pay a lower premium. Data we collected for Miami/Dade County indicate that only 22 percent of policies (50,357 policies) had adopted the maximum limit on their coverage for the structure and 19 percent of them had chosen the maximum coverage limit on contents (42,802 policies). This implies that the policy limitations are important for a significant proportion of Miami/Dade residents. It is likely that we would observe a similar finding in other locations of Florida and in other states. This might be fine if the floods are of limited magnitude. But it would be problematic should these policyholders suffer a major flood that severely damaged or destroyed as occurred happened in New Orleans from Katrina.

In the second phase of the project, we will continue to work in conjunction with the NFIP to expand our analysis by gathering data to the entire state of Florida over several years as well as to for the three other states (New York, South Carolina, and Texas). This will allow us to analyze similarities and differences and draw more definitive conclusions at a national level on issues discussed here as well as key drivers of the demand for flood coverage. FEMA has also requested a series of analyses to be undertaken by other universities and think-tanks to evaluate the effectiveness—or lack of effectiveness—of the program and to offer recommendations as to how to reform the NFIP\textsuperscript{72}.

4.4. The Future of the NFIP

We conclude this chapter by discussing the two bills that have been introduced in Congress to reform the NFIP: one in the House and one in the Senate. As of end of November, none of them had gone through both the House and the Senate. The 109\textsuperscript{th} Congress adjourned for their electoral break without finalizing any new laws governing the program.

The House bill (H.R. 4973) was passed by the House on June 27, 2006 by a nearly unanimous vote (416-4). When the House bill was passed, the President issued a Statement of Administration Policy that was largely positive. The Senate bill (S. 3589) was referred to the full Senate by the Banking, Housing, and Urban Affairs Committee on June 28, 2006, but the Senate took no further action on this bill before taking its electoral recess.


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The major difference between the House and the Senate bills deals with the size of the program and its funded status going forward. Generally, the House bill is expansive while the Senate bill is not. The House bill would increase the flood insurance limits from $350,000 per residential property to $470,000 and increase the nonresidential (small business) limit from $500,000 to $670,000. The House bill also includes a payment of “…$1,000 per dwelling in additional living expenses following a flood loss when the residence is unfit to live in.” The Senate bill contains neither of these provisions.

With respect to funding, the Senate bill “…Requires the Secretary of the Treasury to completely eliminate any obligations owed to the Treasury by the NFIP for the 2005 hurricane season. Debt forgiveness for over $20 billion takes effect only after the Director of FEMA certifies to the Treasury that all financial resources have been obligated to pay claims.” The Senate bill combines this debt relief with a reduction in the NFIP’s borrowing limit to the pre-Katrina level ($1.5 billion), and gives the NFIP the ability to set up a loss reserve fund for the first time. The House bill has no debt forgiveness feature, dealing with the funded status issue by raising the borrowing limit to $25 billion. Both bills seek to put the NFIP on a sounder footing by increasing the maximum annually premium increase from 10 percent to 15 percent, as well as introducing steps to move towards actuarially fair rates (although the two bills take different approaches to this issue).

While it is not clear what reforms will be enacted by the new Congress, the sustainability of the program, especially with regards to its funding status, is uncertain. David Maurstad, the Director of FEMA’s Mitigation Division and Federal Insurance Administrator, testified before the Senate Committee on Banking, Housing, and Urban Affairs that the NFIP cannot handle its debt load. Annual interest on borrowing for the 2005 hurricanes (expected to exceed $23 billion) will exceed $1 billion. This amount could easily swamp premiums, currently on the order of $2.5 billion, which is enough to cover average annual losses and administration costs. Given this problem, it is clear that the 110th Congress will be forced to deal with the NFIP by reforming it in some way.
Chapter 4 – Summary

The insurability of floods in regions that are largely flood-prone areas has been a challenge for many years and led to the creation of the National Flood Insurance Program (NFIP) in 1968. The number of policies issued by the program has continuously increased over the past forty years and dramatically so as a result of the 2004 and 2005 hurricane seasons. Today the program issues over 5.3 million policies (2.5 million policies in 1990), and for the first time in September 2006 its national coverage as reached $1 trillion (it was only $265 million in 1990).

Hurricane Katrina has inflicted unprecedented losses that have forced the program to borrow over $20 billion from the Treasury. This financial crisis calls for a reform of the program. Two bills are currently in Congress, but it is not clear at this time what will happen.

Data collected for Miami/Dade County in Florida reveal a huge disparity in take-up rates by ZIP code, which is partially explained by flood insurance requirements imposed by FEMA in certain areas. Discussions have taken place regarding the necessity to increase the policy limit for coverage under the NFIP, although we note that a large majority (80 percent) of the policyholders in Miami Dade County have chosen lower limits than this maximum.

Additional analyses will be undertaken of Florida data and of other states as part of Phase II of the project. They will complement the series of studies FEMA has requested to evaluate the effectiveness—or lack of effectiveness—of the program and offer recommendations as to how to reform the NFIP. One open question is the role that private insurers can play in the future design of the program, and whether they want to do more than provide a second layer of coverage above what the NFIP currently covers, as some do today in a limited number of states.

Chapter 4 - Key Questions

1. How can we better understand the background and the effectiveness of the Community Rating System (CRS) scoring system?

2. How can one evaluate the accuracy of risk mapping currently in place?

3. What other analyses can be done to measure the demand for flood insurance?

4. What can we learn from the communities that are best at mitigating and insuring their flood risk? Can best practices be applied in other locations or for other types of risk (e.g. hurricane, earthquake)?

5. What are ways that the NFIP could be modified? What suggestions do you have for putting the NFIP on sounder footing?
## Appendix 4-A. Definition of the NFIP Flood Zones

<table>
<thead>
<tr>
<th>Flood Zone</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone A</td>
<td>Zone A is the flood insurance rate zone that corresponds to the 1-percent annual chance floodplains that are determined in the Flood Insurance Study by approximate methods of analysis. Because detailed hydraulic analyses are not performed for such areas, no Base Flood Elevations or depths are shown within this zone. Mandatory flood insurance purchase requirements apply.</td>
</tr>
<tr>
<td>Zone AE and A1-A30</td>
<td>Zones AE and A1-A30 are the flood insurance rate zones that correspond to the 1-percent annual chance floodplains that are determined in the Flood Insurance Study by detailed methods of analysis. In most instances, Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone. Mandatory flood insurance purchase requirements apply.</td>
</tr>
<tr>
<td>Zone AH</td>
<td>Zone AH is the flood insurance rate zone that corresponds to the areas of 1-percent annual chance shallow flooding with a constant water-surface elevation (usually areas of ponding) where average depths are between 1 and 3 feet. The Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone. Mandatory flood insurance purchase requirements apply.</td>
</tr>
<tr>
<td>Zone AO</td>
<td>Zone AO is the flood insurance rate zone that corresponds to the areas of 1-percent shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average flood depths derived from the detailed hydraulic analyses are shown within this zone. In addition, alluvial fan flood hazards are shown as Zone AO on the Flood Insurance Rate Map. Mandatory flood insurance purchase requirements apply.</td>
</tr>
</tbody>
</table>
| Zone AR    | Zone AR is the flood insurance rate zone used to depict areas protected from flood hazards by flood control structures, such as a levee, that are being restored. FEMA will consider using the Zone AR designation for a community if the flood protection system has been deemed restorable by a Federal agency in consultation with a local project sponsor; a minimum level of flood protection is still provided to the community by the system; and restoration of the flood protection system is scheduled to begin within a designated time period and in accordance with a progress plan negotiated between the community and FEMA. Mandatory purchase requirements for flood insurance will apply in Zone AR, but the rate will not exceed the rate for an unnumbered Zone A if the structure is built in compliance with Zone AR floodplain management regulations.  

For floodplain management in Zone AR areas, the property owner is not required to elevate an existing structure when making improvements to the structure. However, for new construction, the structure must be elevated (or floodproofed for non-residential structures) so that the lowest floor, including basement, is a minimum of 3 feet above the highest adjacent existing grade, if the depth of the Base Flood Elevation (BFE) does not exceed 5 feet at the proposed development site. For infill sites, rehabilitation of existing structures, or redevelopment of previously developed areas, there is a 3-foot elevation requirement regardless of the depth of the BFE at the project site.  

The Zone AR designation will be removed and the restored flood control system will be shown as providing protection from the 1-percent annual chance flood on the National Flood Insurance Program map upon completion of the restoration project and submittal of all the necessary data to FEMA. |
| Zone A99   | Zone A99 is the flood insurance rate zone that corresponds to areas within the 1-percent annual chance floodplain that will be protected by a Federal flood protection system where construction has reached specified statutory milestones. No Base Flood Elevations or depths are shown within this zone. Mandatory flood insurance purchase requirements apply. |
| Zone D     | The Zone D designation is used for areas where there are possible but undetermined flood hazards. In areas designated as Zone D, no analysis of flood hazards has been conducted. |
Mandatory flood insurance purchase requirements do not apply, but coverage is available. The flood insurance rates for properties in Zone D are commensurate with the uncertainty of the flood risk.

| Zone V | Zone V is the flood insurance rate zone that corresponds to areas within the 1-percent annual chance coastal floodplains that have additional hazards associated with storm waves. Because approximate hydraulic analyses are performed for such areas, no Base Flood Elevations are shown within this zone. Mandatory flood insurance purchase requirements apply. |
| Zone VE | Zone VE is the flood insurance rate zone that corresponds to areas within the 1-percent annual chance coastal floodplain that have additional hazards associated with storm waves. Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone. Mandatory flood insurance purchase requirements apply. |
| Zone B, C, and X | Zones B, C, and X are the flood insurance rate zones that correspond to areas outside the 1-percent annual chance floodplain, areas of 1-percent annual chance sheet flow flooding where average depths are less than 1 foot, areas of 1-percent annual chance stream flooding where the contributing drainage area is less than 1 square mile, or areas protected from the 1-percent annual chance flood by levees. No Base Flood Elevations or depths are shown within this zone. Insurance purchase is not required in these zones. |

Source: FEMA, U.S. Department of Homeland Security
CHAPTER 5

REGULATORY ISSUES ASSOCIATED WITH NATURAL DISASTERS

How have regulatory policies affected the supply of and demand for property insurance subject to catastrophe risks and specific catastrophe coverage? How might different regulatory policies affect insurance markets in the future? We focus on these two questions in this chapter.

Regulatory systems and policies affecting insurers’ rates and market practices vary somewhat among the states. To date we have assembled some information on regulatory policies and constraints on insurers’ rates and other practices. We hope to substantially expand this information to develop a more comprehensive and detailed picture of regulation and how it affects insurance markets in Phase II of the project. This will require the acquisition of more information directly from insurers on the disposition of their regulatory filings and their opinions of the relative stringency of each state’s regulation, as well as other sources.

We will also need to consider recent legislative and regulatory changes in the various states, which reflect an ongoing and dynamic process. For example, in January 2007 Florida enacted new legislation regarding the regulation of insurers and homeowners insurance which we discuss below. Thorough analysis of this more extensive information will help us identify regulatory policies that have aided insurance markets and those that have had adverse effects on the supply of coverage.

5.1. Scope of Regulation and Public Policy

The scope of regulation, or perhaps stated more correctly “government intervention”, is quite broad when we include various aspects of how government policies affect insurance markets. Many officials and all branches of government are also involved – insurance regulators, legislators, the courts, and other officials/agencies. Below, we list the relevant areas subject to regulation but the list is not exhaustive. We do not address other areas of government intervention in this chapter and confine our observations to insurance regulation per se.

Government Activities That Affect Insurance Markets and Risk Management

- Insurance regulation
- Land use and building regulation
- Other environmental policies and regulation
- Tax policy
- Disaster response and aid
- Government insurance/reinsurance programs
- Risk assessment
- Mitigation assistance
- Contract and common law, judicial decisions
- Consumer education and information

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73 This section is based on Klein, R. W. (2006), “Catastrophe Risk and the Regulation of Property Insurance,” working paper, Georgia State University, November.
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Regulation of Insurers

• Rates
• Policy forms/terms (e.g., deductibles, excluded perils, etc.)
• Underwriting practices (ability to decline or restrict coverage)
• Marketing and distribution
• Claims adjustment
• Entry, exit, financial condition (capital levels, reinsurance, catastrophe risk management)

Other Regulatory Activities

• Administration of residual market mechanisms
• Administration of government insurance funds
• Oversight of receiverships and guaranty associations
• Management of market assistance plans
• Adjuster certification and coordination
• Price controls following a disaster

We now discuss the following three issues in more detail: rate regulation, regulation of underwriting and policy terms, and regulation of residual market mechanisms.

5.2. Rate Regulation

Regulatory systems and policies differ considerably among the states. Some attempt to impose binding constraints on rates while others rely on the market to determine rates – the degree of rate regulatory stringency varies. Similarly, the stringency of regulation of the other areas listed above varies. Rate regulatory policy and actions can have significant effects in insurance markets. Suppression of overall rate levels or compression of geographical rate structures can compel insurers to tighten the supply of insurance which decreases the availability of coverage. Also, these policies can reduce insureds’ incentives to optimally manage their risk from natural disasters.

Type of Rate Regulatory System

One aspect of rate regulation is the type of rate regulatory system (e.g., prior approval, flex rating, competitive rating systems). States with prior approval systems vary to the extent to which they attempt to suppress rate levels and compress rate structures. Some states (e.g., Florida) with so-called “competitive rating systems” (e.g., use and file, etc.) administer them as if they were prior approval. Hence, the type of rate regulatory system does not necessarily determine the extent to which regulators will constrain insurers pricing. Table 5.1 below shows the type of rate regulatory system in each state. It is interesting to note that the Southeastern states tend to have prior approval systems for homeowners insurance whereas states in other parts of the country are more likely to have competitive rating systems. On paper, prior to 2007, insurers could opt to make a “file and use” or a “use and file” rate filing for homeowners

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74 Under a “Use and File” system, rates must be filed with the insurance department within a specified period after they have been placed in use. Under a “File and Use” system, rates must be filed with the insurance department prior to their use. Specific approval is not required but the department retains the right of subsequent disapproval.
insurance in Florida. In practice, the Florida Office of Insurance Regulation (FLOIR) subjected rate filings to review and challenged filings that it found to be “deficient”. The 2007 legislation suspends “use and file” for rate filings that increase the existing rate till January 31, 2009.

<table>
<thead>
<tr>
<th>State</th>
<th>System</th>
<th>Commissioner Selection</th>
<th>State</th>
<th>System</th>
<th>Commissioner Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alabama</td>
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<td>Nebraska</td>
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</tr>
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</tr>
<tr>
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<td>Connecticut</td>
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<td>Montana</td>
<td>File &amp; Use</td>
<td>Elected</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Source: NAIC, PCIAA*

**Rate Regulatory Stringency**

A number of factors affect regulatory stringency, including but not limited to:

- The underlying risk of loss – higher risks and costs tend to put more pressure on regulators to constrain rates in response to political pressures.
- “Philosophies” concerning regulation and the need to constrain insurers – some states exhibit prevailing philosophies that call for stricter regulation while others may be more willing to allow market forces to determine prices.
- Regulator Selection – there is some evidence that elected regulators are more likely to engage in rate suppression and compression, but studies suggest that this has only a small effect.
Our analysis of recent rate regulatory policies is still developing, but we can make several observations. After Hurricane Andrew, regulators resisted large rate increases in one swipe and only allowed insurers to gradually raise rates over the decade. Initially, this policy exacerbated availability problems because insurers were concerned about substantial rate inadequacy. Over time, as insurers were allowed to further increase rates, these concerns eased considerably although there was still some compression of rates in the highest-risk areas. By the beginning of 2004, most insurers probably viewed rates as being close to adequate and there was not substantial pressure to further increase rates. This began to change after the fourth major hurricane hit the U.S. in 2004.

It appears that the initial wave of filed rate increases in 2004 through early 2006 was approved for the most part although they were subject to some constraints (see Klein, 2006)\(^75\). The size of a particular rate increase depends on the number and size of rate changes previously filed by the insurer as well as its assessment of its adequacy of its rates at the time of the filing, among other factors. Given this variation and the factors causing it, it is somewhat difficult to offer observations on the “average” increase that have any meaning. It does appear that established insurers that have sought significant rate adjustments in 2006 have tended to file rate increases in the area of 20 to 50 percent.

In the latter half of 2006, further insurer rate hikes in Florida have been challenged and disapproved or reduced by regulators. A combination of growing consumer displeasure over previous rate increases as well as the lack of damaging hurricanes in 2006 are probably influencing regulators’ resistance to further rate hikes.

On January 29, 2007, Governor Charlie Crist issued an emergency rule that will freeze insurance rates through the end of hurricane season. The freeze encompasses new rate increase requests, pending requests, and requests that have been approved but not yet implemented. The new legislation and related regulatory rules could exacerbate market problems and delay market stabilization if insurers perceive that the new constraints will make it more difficult for them to supply insurance.

Florida’s “excess” profits regulations also have been tightened. If an insurer earns an underwriting gain (in Florida) in excess of 10 percent of its earned premiums above its anticipated underwriting profit over the most recent 10-year period, it must refund such “excess” profits to policyholders\(^76\). This could hamper insurers’ ability to accumulate funds to pay for large losses from a hurricane.

It is interesting to note that regulators in Louisiana and Mississippi have adopted a more cooperative regulatory system than Florida by allowing insurers to raise their rates. In these states, regulators appear to have prioritized the effort to maintain the supply of insurance over the desire to limit rate increases. Of course, both states started with a lower rate structure than that in Florida, so recent rate increases are not on top of what were already perceived as high rates.

We have not yet acquired information on rate levels and rate increases in these states prior to 2004, but given that there is a lack of media articles on rate disagreements between

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\(^76\) An insurer is subject to this requirement if its surplus exceeds its direct probable maximum loss for a “one in 250 year” event.
insurers and regulators during this period, it is possible that the rates filed were not high enough to generate regulatory opposition. Generally, if insurers file for annual rate increases less than 5 percent, they typically do not encounter regulatory opposition if insurers provide justification for the rate increases. When filed rate level changes exceed 5-10 percent, they are more likely to be challenged by regulators unless there is agreement that the risk of losses has significantly increased and regulators believe the increases are needed to preserve the supply of insurance. Prior to 2004, it appears and is quite plausible that neither insurers nor regulators perceived the risk of hurricane losses in Louisiana and Mississippi coastal areas to be as high as it was in Florida.

It also should be noted that there may be limits to regulators’ willingness to approve insurers’ filings and other changes. Efforts to further raise rates could encounter some opposition.

Clearly, we need to develop more comprehensive and specific information on states’ rate regulatory policies and actions. Ideally, we would like to do the following:
1. Determine the difference between the rate levels filed by insurers and what regulators approve.
2. Determine how much regulators compress rate structures by lowering the rate relativities for high-risk areas.
3. Poll insurers on their opinion of the degree of a state’s regulatory stringency (e.g., based on a scale of 1 to 5).

5.3. Regulation of Underwriting and Policy Terms

The states also regulate insurers’ ability to use their discretion in accepting new insurance applications or renewing existing policies. Regulators may constrain insurers’ preferred actions in this area by limiting the criteria they can use in underwriting or interfering with insurers’ attempts to reduce their portfolios of exposures to more manageable levels. For example, the emergency rule issued by Governor Crist in Florida prohibits insurers from cancelling or not renewing insurance policies until May 2007 and the 2007 legislation prohibits insurers from dropping insured during the “hurricane season” which starts on June 1 and ends on November 30. The legislation also requires, beginning in 2008, that insurers that sell homeowners insurance in other states must also offer it in Florida in order to be allowed to sell other types of insurance in the state.

Another area in which regulators may constrain insurers’ actions is in the area of modifying policy terms, such as increasing wind or hurricane deductibles. It is our impression that insurers are allowed to offer up to 10 percent wind or hurricane deductibles in Florida but it is not clear whether they are allowed to offer larger deductibles. There is a desire to offer up to 15 percent deductibles to enable insurers to better manage their catastrophe risk exposure and also allow some homeowners to lower their premiums by accepting higher deductibles. During Phase II of the project we would like to work in conjunction with our sponsors, government officials and other experts to determine the exact nature of current regulatory policies governing this area and the states’ positions on allowing larger deductibles.
5.4. Regulation of Residual Market Mechanisms

Although residual market mechanisms may be headed by non-regulators, insurance regulators effectively control much of what these mechanisms are allowed to do in terms of setting rates and other actions. In Florida, Citizens is permitted to charge rates competitive with or below those of private insurers. Under the new legislation, it is no longer required to meet any standards of adequacy nor is Citizens expected to generate sufficient revenue to fund its liability. It appears that the Citizens’s rate structure has been constrained by regulators and its rates in many hurricane-prone areas in the state are currently below those charged by private insurers. Additionally, the Commercial Joint Underwriting Association (JUA) has been merged into Citizens – this could expand the commercial property exposure insured by the state and decrease the rates charged to insureds that would have been covered by the JUA.

The practices described above can cause several major problems. First, they will cause further growth of the Citizens book of exposures at inadequate rate levels. Second, they can have an artificial depressing effect on voluntary market prices. Third, they diminish insureds’ incentives to lower their disaster risk. Fourth, they can result in financial shortfalls that are assessed back to voluntary market insurers and insureds. Large and growing residual market mechanisms may be unavoidable during periods of market instability and adjustment, but using them as a long-term source of coverage for a large number of properties can unnecessarily sustain the problems identified above.

As discussed in Chapter 3, Citizens incurred substantial deficits due to its payouts for losses from the 2004 and 2005 storm seasons. The Florida legislature allocated $715 million to reduce the amount of the assessments that will be imposed by Citizens on voluntary and residual market insureds to cover its deficits. It is anticipated that the legislative appropriation will reduce the required surcharge from 11 percent to 2.5 percent. The remainder of the 2005 deficit will be collected over 10 years in “emergency assessments” if approved by the Citizens board in December 2006. The emergency assessment is expected to result in premium surcharges of 1.5 percent or less. The FLOIR has also approved a $163 million assessment that will be payable by assessable insurers when they receive an invoice from Citizens. The insurers are allowed to recoup the assessment through a surcharge on all lines of property-casualty insurance other than medical malpractice and worker's compensation (i.e., the assessment base now includes all commercial liability, commercial and personal auto and a myriad of other commercial products)77.

5.5. Solvency/Financial Regulation

Regulators also are responsible for regulating insurers’ solvency and financial condition, including their level of catastrophe risk exposure. As we mentioned above, regulators are placed into a position of balancing solvency requirements with their desire to reduce the magnitude of rate increases and preserve the availability of insurance coverage. Regulators in Florida have tended to favor price/availability objectives over solvency considerations. One example of such a policy is the fact that regulators allowed start-up insurers to write a large block of exposures in high-risk areas.

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Grace, Klein and Kleindorfer (2004) discuss the emergence of the startup companies and their special treatment. These insurers were capitalized largely from the $100 bonus they received for every policy they took out of the residual market. Most of these policies were in high-risk coastal areas so these insurers had large portions of their portfolios of exposures in these high risk areas.

Table 5.2 illustrates this phenomenon by showing certain data for insurers with a high concentration of their total exposures in Broward, Dade, Monroe and Palm Beach Counties. Eight of these companies were Florida-only companies established to absorb exposures rejected by other insurers. For each company, the table shows the amount of surplus or capital, its “net retention level,” the ratio of its exposures to its surplus, and its exposures, market share, and percentage of its total exposures in the four counties (HRC) for the years 1998 and 2001.

The surplus or capital held by these insurers was $10 million or less. The ratio of these companies’ exposures (adjusted to a net basis) in the four counties to their surplus ranged from 770 percent to 21,930 percent with the majority in the range of 2,000 percent to 12,000 percent. While the companies’ capital met Florida requirements, it is clear that they faced a very high catastrophe risk that regulators would not likely permit under “normal” circumstances. Of course, the situation in Florida then and now is far from normal.

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### Florida Insurers with Concentration of Exposures in Broward, Dade, Monroe and Palm Beach Counties

<table>
<thead>
<tr>
<th>FL</th>
<th>Company</th>
<th>GROUP</th>
<th>2001 Financials</th>
<th>1998</th>
<th>2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>United Property &amp; Casualty Insurance Co</td>
<td>None</td>
<td>5,966,000</td>
<td>63.9% (2026.6%)</td>
<td>3,577,726,700</td>
</tr>
<tr>
<td>X</td>
<td>New America Insurance Company</td>
<td>None</td>
<td>5,222,000</td>
<td>94.7% (1,967.4%)</td>
<td>1,891,200,271</td>
</tr>
<tr>
<td>X</td>
<td>Empire Insurance Company</td>
<td>None</td>
<td>13,000,000</td>
<td>14.5% (960.0%)</td>
<td>14,535,403,251</td>
</tr>
<tr>
<td>X</td>
<td>Universal Property and Casualty Inc. Co.</td>
<td>None</td>
<td>4,386,000</td>
<td>16.0% (610.7%)</td>
<td>4,369,382,583</td>
</tr>
<tr>
<td>X</td>
<td>First Prime</td>
<td>None</td>
<td>8,299,000</td>
<td>22.3% (4884.7%)</td>
<td>2,955,614,055</td>
</tr>
<tr>
<td>X</td>
<td>Atlantic Preferred Insurance Company</td>
<td>Fire Financial Group</td>
<td>8,483,000</td>
<td>69.3% (2645.4%)</td>
<td>761,303,491</td>
</tr>
<tr>
<td>X</td>
<td>The Miller Casualty Inc Co.</td>
<td>Miller American Group</td>
<td>9,738,000</td>
<td>21.7% (2171.8%)</td>
<td>3,489,442,318</td>
</tr>
<tr>
<td>X</td>
<td>Service Insurance Company</td>
<td>None</td>
<td>7,644,000</td>
<td>39.8% (793.3%)</td>
<td>187,749</td>
</tr>
<tr>
<td>X</td>
<td>Channelton National Insurance Company</td>
<td>HDI Insurance Group</td>
<td>281,983,000</td>
<td>8.5% (507.8%)</td>
<td>36,907,300</td>
</tr>
<tr>
<td>X</td>
<td>First Liberty Insurance Company</td>
<td>Liberty Mutual Group</td>
<td>17,451,000</td>
<td>7.8% (256.3%)</td>
<td>242,274,250</td>
</tr>
<tr>
<td>X</td>
<td>Great Northern Insurance Company</td>
<td>Chubb Group</td>
<td>116,938,000</td>
<td>30.4% (195.8%)</td>
<td>1,843,796,859</td>
</tr>
<tr>
<td>X</td>
<td>American Security Insurance Company</td>
<td>Assure Group</td>
<td>194,633,000</td>
<td>52.8% (149.6%)</td>
<td>1,059,779,715</td>
</tr>
<tr>
<td>X</td>
<td>Electric Insurance Company</td>
<td>Electric Insurance Group</td>
<td>232,087,000</td>
<td>94.7% (105.6%)</td>
<td>526,814,113</td>
</tr>
<tr>
<td>X</td>
<td>Federal Insurance Company</td>
<td>Chubb Group</td>
<td>3,954,917,000</td>
<td>88.3% (1.7%)</td>
<td>9,387,936,748</td>
</tr>
<tr>
<td>X</td>
<td>Atlantic Mutual Insurance Company</td>
<td>Atlantic Mutual Companies</td>
<td>471,006,000</td>
<td>64.5% (91.9%)</td>
<td>1,255,184,200</td>
</tr>
<tr>
<td>X</td>
<td>Centennial Insurance Company</td>
<td>Atlantic Mutual Companies</td>
<td>118,623,000</td>
<td>85.4% (35.1%)</td>
<td>196,378,770</td>
</tr>
<tr>
<td>X</td>
<td>Government Employees Insurance Company</td>
<td>Berkshire Hathaway Group</td>
<td>3,557,277,000</td>
<td>160.0% (25.2%)</td>
<td>2,550,042,209</td>
</tr>
<tr>
<td>X</td>
<td>American Home Assurance Company</td>
<td>AIG</td>
<td>3,627,862,000</td>
<td>61.5% (4.4%)</td>
<td>604,977,720</td>
</tr>
<tr>
<td>X</td>
<td>Utica Mutual Insurance Co.</td>
<td>Utica National Group</td>
<td>474,235,000</td>
<td>90.3% (2.7%)</td>
<td>775,000</td>
</tr>
<tr>
<td>X</td>
<td>Brightline Insurance Company</td>
<td>Chubb Group</td>
<td>34,770,000</td>
<td>0.0% (0.0%)</td>
<td>214,197,832</td>
</tr>
<tr>
<td>X</td>
<td>FLORIDA RICOJ/FLA</td>
<td>None</td>
<td>NA</td>
<td>NA</td>
<td>52,751,999,213</td>
</tr>
<tr>
<td>X</td>
<td>Ogden Insurance Company</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>8,872,441,580</td>
</tr>
</tbody>
</table>

Source: data from FLORICAR, A.M. Best, authors' calculations
The initial wave of start-up insurers were able to avoid insolvencies caused by their high-risk exposures because they were not hit by severe events before they were able to shed high-risk exposures to attain more viable long-term positions. However, the Poe companies, who commenced business between 1996 and 1998, were not so lucky and became insolvent due to their losses from the 2004-2005 storm seasons. FIGA, the Florida Insurance Guaranty Association, has assumed the claims-paying responsibilities of the insolvent Poe financial group.

There may be different views in the industry on how stringent solvency regulation should be for insurers that are absorbing a large number of high risk exposures. On the one hand, less stringent solvency regulation eases pressure on established insurers to retain these exposures. On the other hand, more lenient solvency requirements can result in insolvencies for which the costs are passed on to solvent insurers and their policyholders. However, from a public policy perspective, allowing small or regionally concentrated insurers to underwrite an excessive number of high-risk exposures creates several problems including moral hazard among overly exposed insurers as well as diminishing their insureds’ incentives to better control their disaster risk.

5.6. Political Economy of Catastrophe Risk and Insurance

As we monitor regulatory policies in the various states, we are becoming more impressed with how the political economy of catastrophe risk and insurance plays a significant role in how decisions are made and the extent to which markets are allowed to function. For example, strong “grass-roots” public opposition to insurer actions is building as regulatory disapprovals of insurer rate filings increase. Clearly, public opinion and the complaints of property owners regarding the cost and availability of insurance played a significant role in the enactment of 2007 Florida insurance legislation. Ultimately, government-imposed restraints on competitive, private insurance markets reduces the availability of insurance and can increase the subsidization of government-provided insurance.
**Chapter 5 – Summary**

Regulation and other government policies can significantly affect insurance markets and insureds’ incentives to control their vulnerability to natural disasters. Binding regulatory constraints on rates or other insurer actions can have negative effects on the supply/availability of insurance and the efficient management of catastrophe risk, as well as create other market problems and distortions.

It appears that insurers were allowed to implement the first wave of rate increases they filed following the 2004-2005 storm seasons, but resistance appears to be building towards further rate increases, at least in Florida. Florida legislation in 2007 further reflects political and government resistance to insurance market changes.

The extent to which regulators are constraining other aspects of insurers actions (e.g., underwriting and policy terms) is not clear and we need to gain a better understanding of this. Regulation of residual market mechanisms, especially in Florida, could be exacerbating market problems and diminishing insureds’ incentives to control their catastrophe risk. Regulators (at least in Florida) appear to have favored “affordability” and “availability” over solvency considerations. This could have adverse long-term effects on the management of catastrophe risk.

**Chapter 5 - Key Questions**

1. How do current regulatory policies constrain insurers and insurance markets and what are the effects of these constraints/mandates?
2. How can we obtain better information and document the nature of regulatory constraints in the states subject to significant catastrophe risk?
3. What kinds and to what extent are regulatory constraints/mandates necessary or helpful? What measures are harmful?
4. How should regulators balance solvency and availability considerations in allowing “small” or regionally concentrated insurers to write significant amounts of exposures in high-risk areas?
5. What are the pros and cons of allowing or encouraging the provision of residential property insurance by surplus lines (non-admitted) insurers?
6. How should residual market rates and policies be modified to improve their financial soundness and promote more efficient market and risk management outcomes?
7. How can sufficient political support be developed for beneficial regulatory reforms?
Part C

The Demand and Supply of Disaster Insurance
CHAPTER 6

DECISION MAKING BY HOMEOWNERS FOR PURCHASING INSURANCE

This chapter contrasts a normative theory of decision making for purchasing insurance with a descriptive model of choice. We provide an illustrative example as to how a typical homeowner would determine how much insurance (if any) to purchase against losses from a natural disaster by trying to maximize expected utility. While this model does have some predictive power, there are further subtleties to actual decisions that need to be addressed. People do not have access to perfect data and, even if they did, they may process information in somewhat different ways. We will review empirical evidence on how these behavioral and informational factors are likely to impact insurance buying.


The Waterman family in Orleans Parish with wealth $W$ is considering how much flood insurance coverage $(I)$ to purchase next year against water damage to their house from a future hurricane in the area. To keep the analysis simple and without loss of generality we assume only two states of nature---flood or no flood with annual probabilities $p$ and $1-p$ respectively. If a flood occurs, the damage to the Waterman house will be $L$ dollars. The cost of insurance per dollar coverage is $z$.

We assume that there are no moral hazard problems so that the Waterman family will not take advantage of purchasing insurance by either being more careless or putting objects in harm’s way (e.g. moving unwanted furniture to the basement). Furthermore we assume that the insurer has the same information about risk as the Waterman family, and charges risk-based premiums, so that there will be no adverse selection problems.

The optimal amount of insurance will be determined by maximizing the Waterman’s expected utility $E[U(I)]$ where:

$$E[U(I)] = p \cdot U(W - L + I(1-z)) + (1-p) \cdot U(W-zI)$$

where $0 \leq I \leq L$

According to this model, if the Watermans are averse to risk, which is why they are contemplating buying insurance, they should determine their insurance coverage based on the premium level. If the premium were equal to the expected loss, they should buy full insurance (i.e., covering all losses up to the value of their property with no deductible). This premium is unrealistic. With a more realistic premium loading built in, the family should scale down its coverage by taking a deductible.

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This model has interesting implications when premium regulation is introduced. For example, if premiums are held down below competitive levels by regulators, then people would buy more insurance by decreasing their deductibles. This means that insurers take a double hit – losing money but on an increasing volume of coverage. If regulators suppressed risk differences, implying that high-risk policyholders would be subsidized by low-risk policyholders, the model predicts that the low risks would ration their coverage by increasing their deductibles (or even canceling coverage and dropping out of the market) whereas the high risks would take advantage of their subsidy and insure up to full coverage. This implies that an increasingly large subsidy needs to be provided by a smaller base of low-risk coverage.

Government intervention can further reshape insurance buying patterns. According to federal income tax laws any uninsured loss from a natural disaster can be mostly written off on the family’s federal income taxes at the marginal tax rate $t$ based on the Waterman’s current income\textsuperscript{80}. $D (I, L)$ is the amount of disaster assistance the family will receive should they have $I$ dollars of insurance coverage and $L$ dollars of losses\textsuperscript{81}. The new utility function would now look as follows:

$$E[U (I)] = p \ U[ W - L + I (1-z) + t (L-I)] + D (I, L) + (1-p) U(W-zI)]$$

The combined effect of tax write-off and expectation of disaster relief may further dampen the demand for insurance – perhaps to the point where some people decide not purchase any coverage.

6.2. Factors Influencing Insurance Purchasing Decisions

\textit{Misperception of the Risk}

Individuals normally purchase insurance on an annual basis and thus must decide each year whether to renew or cancel their policy assuming they have this discretion. In the case of residents in hazard-prone areas the annual probability of a disaster damaging their structure is not high; it is within the range of $1$ in $50$ to $1$ in $500$. So, while the financial losses should such an event occur can be significant, the great majority of people will not have observed an event close at hand recently. The evidence on decision making under uncertainty in these low probability cases suggests that many individuals do not utilize an expected utility model such as the one characterized above to determine how much insurance coverage to purchase.

People have difficulty dealing with probabilistic information for small likelihood events because they need a context in which to evaluate the data. In one study individuals were presented with either a probability or an actuarially fair insurance premium characterizing the risks associated with the discharge of a hypothetical toxic chemical, Syntox\textsuperscript{82}. The chemical had the potential for causing fatalities to individuals living near the fictitious ABC chemical plant.

\textsuperscript{80} More details on the actual treatment of tax losses can be found in Chapter 12, Section 2.3.

\textsuperscript{81} The amount of disaster assistance is assumed to have no impact on the uninsured losses that a person can write off for tax purposes.

located on the outskirts of an urban center in New Jersey. To give some reference points, respondents were also provided with the probability of death from a car accident. Finally, the participants were asked a set of questions regarding how risky they perceived the facility to be.

People were not able to distinguish between probabilities which ranged from 1 in 10,000 to 1 in 1 million in judging the riskiness of the facility. Surprisingly, the study also found that subjects did not respond to insurance premiums as a signal of risk. While individuals may not be able to think meaningfully about what a 1 in 100,000 chance of death means, they certainly know what a $15 premium means. Yet individuals perceived no difference between the perceived risks of the ABC chemical plant, whether the annual premiums paid for coverage against fatalities from the release of Syntox were $15.00, $1.50 or 15 cents.

With respect to obtaining such data on their own, many potential victims of disaster perceive the costs of getting information about the hazard and costs of protection to be so high relative to the expected benefits that they do not even consider purchasing insurance. Research shows that decision makers use “threshold models,” whereby if the probability of a disaster is below some prespecified level they do not think about the event, in making decisions. In a laboratory experiment on purchasing insurance, many individuals bid zero for coverage, apparently viewing the probability of a loss as sufficiently small that they were not interested in protecting themselves against it (McClelland et al., 1993).

**Budget Constraints**

This reluctance to invest in protection voluntarily is compounded by budget constraints. For some homeowners with relatively low incomes, disaster insurance is considered a discretionary expense that should only be incurred if there are residual funds after taking care of what they consider to be the necessities of life. In focus groups on the topic, a typical reaction of such a homeowner living in a hazard-prone area to the question “Why don’t you have flood or earthquake insurance?” is “I live from pay day to pay day.” This implies that an increase in premiums will cause people to buy less insurance, and that this negative impact on demand would not be offset by a compensating increase in loss probability. In contrast to the expected utility model where the demand for insurance depends on the premium relative to the expected loss, demand appears to depend only on the premium for a given amount of coverage.

**Role of Disaster Relief**

Another factor that has been purported to limit homeowners from wanting to purchase insurance is the expectation of liberal disaster assistance following a catastrophic event (Kaplow, 1978).

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1992; Harrington, 2006; and Smetters, 2004). These studies claim that the expectation of federal disaster assistance creates a type of Samaritan’s dilemma: providing assistance after a catastrophe reduces the economic incentives of potential victims and the communities in which they live to invest in protective measures prior to a disaster. Empirical studies on this issue, however, suggest that decision makers do not report that they anticipate receiving any federal aid following a disaster. Kunreuther et al. (1978) found that most homeowners in earthquake and hurricane prone areas did not expect to receive aid from the federal government following a disaster. Burby et al. (1991) showed that local governments that received disaster relief undertook more efforts to reduce losses from future disasters than those that did not. This lack of expectation regarding disaster assistance prior to a disaster seems counter-intuitive and the reasons for it are not fully understood.

Whether or not individuals incorporate an expectation of disaster assistance in their pre-disaster planning process, a driving force with respect to the actual provision of government relief is the occurrence of disasters where the losses are large. Recent research has shown that election years constituted a very active time for disaster assistance. Three salient examples are the Alaska earthquake of March 1964 (a Presidential disaster year), tropical Storm Agnes in June 1972 and Hurricane Andrew in September 1992. These three disasters all occurred during an election year and led to special legislation by the U.S. Congress in the form of liberal disaster assistance. For example, following the Alaska earthquake in 1964 where relatively few homes and businesses had earthquake-resistant measures and insurance protection, the U.S. Small Business Administration provided 1 percent loans for rebuilding structures and refinancing mortgages to those who required funds through its disaster loan program. Hence the uninsured victims in Alaska were financially better off after the earthquake than their insured counterparts (Dacy and Kunreuther, 1968).

It has also been shown that a battleground state with 20 electoral voters has received more than twice as many presidential disaster declarations than a state with only three electoral votes (Reeves, 2004, 2005). Overall, the number of presidential declarations has dramatically increased over the past 50 years, as indicated in Table 6.1.

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91 It is, of course, possible that some of the respondents may, in fact, anticipate post-event funding from the government but did not want to admit it.
6.3. A Descriptive Model of Choice

Rather than using the expected utility model, many residents in hazard prone areas appear to follow a sequential model of choice. As a first stage in such a process individuals relate their perceived annual probability of a disaster causing severe damage to their property ($p$) to a threshold level of concern ($p^*$), which they may unconsciously set. If $p < p^*$ they assume that there is nothing to worry about and hence do not have to undertake protective measures such as purchasing insurance. Only if $p > p^*$ will the individual or family consider ways that they can reduce the risk of future financial losses.

The contingent weighting model proposed by Tversky, Sattath and Slovic (1988)\(^97\) provides a useful framework for characterizing individual choice processes with respect to this lack of interest in purchasing insurance voluntarily. In this descriptive model, individuals make tradeoffs between the various factors associated with alternatives, such as probability and outcomes. The weights they put on these factors are contingent, because they may depend on the problem context and the way information is presented. The decision to ignore events where $p < p^*$ may be justified if a person claims that there is limited time available to worry about the vicissitudes of life. Hence s/he needs some way of determining whether to pay attention to some risks. For these individuals only after the occurrence of a disaster does this event assume sufficient salience that it is on their radar screen.

Data supporting such a sequential model have been provided through homeowners surveys of insurance purchase decisions in flood, hurricane and earthquake-prone areas undertaken over 25 years ago\(^98\). More recent field surveys of homeowners in California

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undertaken by Risa Palm and her colleagues lend further confirming evidence to such a process. Four mail questionnaires undertaken since 1989 examine the spatial and demographic characteristics of those homeowners who had purchased earthquake insurance. The findings indicate that insurance purchase is strongly influenced by past experience but unrelated to any measure of seismic risk from experts.\textsuperscript{99}

To illustrate, consider the Loma Prieta earthquake of 1989, which caused substantial damage to property in Santa Clara County, and to a lesser extent, Contra Costa County, California. In these counties, there were major differences in responses to the 1989 and 1990 survey. In 1989, prior to the earthquake, about 34 percent of the uninsured respondents in both counties felt that earthquake insurance was unnecessary. By 1990, only about 5 percent gave this response. Insurance coverage by homeowners between 1989 and 1990 rose from 40.4 to 50.9 percent in Santa Clara County and from 22.4 to 29.3 percent in Contra Costa County. It is hard to explain this behavior by using a Bayesian learning model since most individuals residing in California know that the likelihood of another earthquake causing damage to their homes is lower after one has occurred because the stress in the fault lines have been relieved.

There is also empirical evidence that many homeowners who initially purchase insurance are likely to cancel policies if they have not made a claim over the course of the next few years (Kunreuther, Vetschera and Sanderson, 1989)\textsuperscript{100}. In the case of flood insurance this finding is particularly striking since the NFIP requires that homes located in Special Flood Hazard Areas purchase insurance as a condition for federally-backed mortgages.

To determine the extent to which residents in hazard-prone areas adhere to the law, FEMA examined applications for disaster assistance from 1549 victims of a flood in August 1998 in Northern Vermont and found that 84 percent of residents in special flood hazard areas did not have insurance, 45 percent of whom were required to have it. A study by Geotrac revealed that more than one-third of the properties damaged in a 1999 flood in Grand Forks, North Dakota were non-compliant with the mandatory insurance purchase requirement\textsuperscript{101}.

With respect to earthquake insurance, eight years after the creation of the California Earthquake Authority (CEA) in 1996 by the state of California, the take-up rate for coverage was down from 30 percent to 15 percent\textsuperscript{102}. Insurance appears to be treated by many individuals as an investment rather than a protective measure. Those who purchase coverage and do not collect on their policies over the next few years feel that their premium payments have been wasted. In the case of flood insurance, this finding also indicates that some banks, which were expected to enforce the requirement that individuals in high-hazard areas purchase flood coverage, looked the other way.

The effects of premiums on the demand for insurance in a sequential model are more ambiguous than in an expected utility model. As indicated above, given that \( p \) is high enough


that people pay attention, higher premiums do discourage purchasing coverage and lower premiums to some extent encourage it. However, many people choose not to obtain flood coverage even when their rates are highly subsidized because they perceive the likelihood of a flood to be below their threshold level of concern. It may also be the case that a decision to build or improve property is related to insurance premiums, with high premiums discouraging building in high risk areas and low premiums encouraging it, but we do not know the importance or magnitude of this incentive.

In short, even in the sequential model the minority who buy insurance voluntarily may pay attention to higher prices relative to lower prices, even when they do not discriminate between higher and lower loss probabilities when these likelihoods are below $p^*$ or there has been no recent loss-producing event. However, the empirical evidence on the ability of insured individuals to relate premiums to risk is at present inconclusive.
### Chapter 6 – Summary

Expected utility theory is the normative model of choice for characterizing how homeowners should make insurance purchase decisions. This chapter shows that this model does not characterize behavior of most individuals as they do not engage in benefit-cost tradeoffs in the way that the theory suggests they should.

Many individuals misperceive the risks and believe that the disaster will not happen to them until after the hurricane, flood or earthquake occurs. Only then do they consider purchasing insurance coverage. A significant number of them cancel their coverage if a disaster has not occurred within the next few years. Some homeowners are likely to face budget constraints which limit their interest and/or ability to voluntarily purchase coverage.

We characterize this choice process by developing a sequential model of behavior whereby homeowners do not focus on the insurance purchase decision unless they feel that the probability of a disaster is above some threshold level. The weights they put on probability and losses in their choice decision are contingent on the recency of the event and the individual’s past experience.

### Chapter 6 - Key Questions

1. What strategies should insurers follow in marketing insurance if many homeowners in hazard-prone areas do not believe that a disaster will happen to them until after it occurs?
2. How can insurers and other interested parties correct individuals’ misperceptions of the risk to their property of future natural disasters?
3. How can one address individuals’ budget constraints in encouraging them to purchase insurance against natural disasters?
4. Is it appropriate to require individuals to purchase coverage against natural disasters given the above characterization of their behavior with respect to low–probability, high-consequence events?
CHAPTER 7

PRIVATE INSURERS’ DECISION MAKING FOR SUPPLYING COVERAGE

This chapter focuses on the role that insurability plays in determining whether insurers are willing to provide coverage against the risks from natural disasters and how they price their policies\(^{103}\). We also discuss the impact that rating agencies have on these decisions to supply coverage against risks that have the potential for catastrophic losses.

7.1. The Concept of Insurability

Today insurers and reinsurers are reexamining their ability to provide protection against wind damage from hurricanes and are asking the question as to whether these events are insurable, and at what price.

To understand the concept of insurability consider a standard insurance policy whereby premiums are paid at the start of a given time period to cover losses during this interval (usually a year). Two conditions must be met before insurance providers are willing to offer coverage against an uncertain event. The first is the ability to identify and quantify, or estimate at least partially, the chances of the event occurring and the extent of losses likely to be incurred. The second condition is the ability to set premiums for each potential customer or class of customers at price that provides a competitive return at the assumed level of risk.

If both conditions are satisfied, a risk is considered to be insurable. But it still may not be profitable. In other words, it may be impossible to specify a rate for which there is sufficient demand and incoming revenue to cover the development, marketing, operating and claims processing costs of the insurer and yield a net positive profit over a pre-specified time horizon. In such cases, the insurer will opt not to offer coverage against this risk.

7.2. Determining Whether to Provide Coverage

Based on their knowledge of likelihood and outcome, an insurer has to make a decision as to whether to cover the risk (unless they are required to do so by law). In his study on insurers’ decision rules as to when they would market coverage for a specific risk, Stone (1973)\(^{104}\) develops a model whereby firms maximize expected profits subject to satisfying a constraint related to the survival of the firm\(^{105}\). An insurer satisfies its survival constraint by

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\(^{103}\) The next chapter discusses how reinsurers decide to cover risks, as this will have an impact on insurers’ capacity to handle catastrophe risks.


\(^{105}\) Stone also introduces a constraint regarding the stability of the insurer’s operation. Insurers have traditionally not focused on this constraint in dealing with catastrophic risks but reinsurers have as discussed in the next chapter.
choosing a portfolio of risks with an overall expected probability of total claims payments greater than some predetermined amount \((L^*)\) that is less than some threshold probability, \(p_1\). This threshold probability reflects the tradeoff between the expected benefits of another policy and the costs to the firm of a catastrophic loss that reduces the insurer’s surplus by \(L^*\) or more. This threshold probability does not necessarily correspond to what would be efficient for society. The value of \(L^*\) is determined by an insurer’s concern with insolvency and/or a sufficiently large loss in surplus that will lead a rating agency to downgrade its credit rating.

A simple example illustrates how an insurer would utilize its survival constraint to determine whether a particular portfolio of risks is insurable with respect to hurricanes. Assume that all homes in a hurricane-prone area are identical and equally resistant to damage such that the insurance premium, \(P\), is the same for each structure. Furthermore assume that an insurer has \(S\) dollars in current surplus and wants to determine the number of policies it can write and still satisfy its survival constraint. Then, the maximum number of policies, \(n\), satisfying the survival constraint is given by equation (7.1):

\[
\text{Probability } [\text{Claims Payments } (L^*) > (n \cdot P + S)] < p_1
\]  

(7.1)

The insurer will use the survival constraint to determine the maximum number of policies it is willing to offer, with possibly an adjustment in the amount of coverage and premiums, and/or a transfer of some of the risk to others in the private sector (e.g. reinsurers or capital markets). It may also rely on state or federal programs to cover its catastrophic losses.

Following the series of natural disasters that occurred at the end of the 1980s and in the 1990s, insurers focused on the survival constraint to determine the amount of catastrophe coverage they were willing to provide because they were concerned that their aggregate exposure to a particular risk did not exceed a certain level. Rating agencies, such as A.M. Best, focused on insurers’ exposure to catastrophic losses as one element in determining credit ratings, so insurers paid attention to this risk.

7.3. Setting Premiums

If the insurer decides to offer coverage, it needs to determine a premium rate that yields a profit and satisfies its survival constraint given by equation (7.1). As discussed in Chapter 5, state regulations often limit insurers in their rate-setting process. Competition can play a role as well as to what premium can be charged in a given marketplace. Even in the absence of these influences, an insurer must consider problems associated with the ambiguity of the risk, asymmetry of information (adverse selection and moral hazard), and degree of correlation of the risk in determining what premium to charge. We briefly examine each of these factors in turn.

Ambiguity of the Risk

The infrequency of major catastrophes in a single location implies that the loss distribution is not well specified. The ambiguities associated with the probability of an extreme event and with the outcomes of such an event raise a number of challenges for insurers with respect to pricing their policies. As shown by a series of empirical studies, actuaries and underwriters are averse to ambiguity and want to charge much higher premiums when the
likelihood and/or consequences of a risk are highly uncertain than if these components of risk are well specified. (Kunreuther et al., 1995)\textsuperscript{106}

Figure 7.1 illustrates the total number of loss events from 1950 to 2000 in the United States for three prevalent hazards: earthquakes, floods and hurricanes. Events were selected that had at least $1 billion of economic damage and/or over 50 deaths (American Re, 2002)\textsuperscript{107}. Looking across all the disasters of a particular type (earthquake, hurricane, or flood), for this 50-year period, the median loss is low while the maximum loss is very high. Given this wide variation in loss distribution, it is not surprising that insurers are concerned about the uncertainty of the loss in estimating premiums, or even providing any coverage in certain hazard prone areas.

The 2004 and 2005 seasons have already dramatically changed the upper limits in Figure 7.1. Hurricane Katrina is estimated to have caused between $150 billion and $170 billion in economic losses, more than four times higher than the most costly hurricane between 1950 and 2000. On the other hand, no hurricane made landfall in the U.S in 2006, despite predictions earlier in the year indicated higher-than-normal activity season.

**Adverse Selection**

If the insurer cannot differentiate the risks facing two groups of potential insurance buyers and each buyer knows her own risk, then the insurer is likely to suffer losses if it sets the same premium for both groups by using the entire population as a basis for this estimate. If only


the highest risk group is likely to purchase coverage for that hazard and the premium is below its expected loss, the insurer will have a portfolio of “bad” risks. This situation, referred to as adverse selection, can be rectified by the insurer charging a high enough premium to cover the losses from the bad risks. In so doing, the good risks might purchase only partial protection or no insurance at all because they consider the price of coverage to be too expensive relative to their risk\(^{108}\).

This was the argument made by private insurers regarding the non-insurability of flood risk that lead to the creation of the NFIP. Indeed, insurers thought that family who had lived in a specific flood-prone area for many years had a much better knowledge of the risk than any insurer would have unless it invested in costly risk assessment tools.

In the context of hurricane, however, it is not clear whether there is any adverse selection. Indeed, there is no evidence that those at risk have an informational advantage over the insurer. In fact, the opposite might be true: if insurance companies spend a lot of resources estimating the risk (which they actually do) they might gain an informational advantage over their policyholders who cannot afford or do not want to do so. Over the past five or six years, there has been a growing literature studying the impact of insurers being more knowledgeable about the risks than the insured themselves. Research in this field reveals that insurers might want to exploit this “reverse information asymmetry”, which results in low-risk agents being optimally covered while high risks are not (Henriet and Michel-Kerjan, 2006)\(^{109}\).

**Moral Hazard**

This refers to an increase in the expected loss (probability or amount of loss conditional on an event occurring) caused by insurance-induced changes in the behavior of the policyholder. An example of moral hazard is more careless behavior vis-à-vis natural hazards or other types of risk as a result of purchasing coverage. Providing insurance protection may lead the policyholder to change behavior in ways that increase the expected loss from what it would have been without coverage. If the insurer cannot predict this behavior and relies on past loss data from uninsured individuals to estimate rates, the resulting premium is likely to be too low to cover losses.

Even after the insurer is aware that people with insurance have higher losses, its inability to observe loss-enhancing behavior may create problems of moral hazard. The introduction of specific deductibles, coinsurance or upper limits on coverage can be useful tools in reduce moral hazard by encouraging insureds to engage in less risky behavior, as they know they will have to incur part of the losses from an adverse event.

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Correlated Risks

For extreme events, the potential for high correlation between the risks will have an impact on the tail of the distribution. In other words, at a predefined probability \( p \), the region below the EP curve is likely to expand for higher correlated risks covered by insurers. This requires additional capital for the insurer to protect itself against large losses. Insurers normally face spatially correlated losses from large-scale natural disasters. State Farm and Allstate Insurance paid $3.6 billion and $2.3 billion in claims respectively in the wake of Hurricane Andrew in 1992 due to their high concentration of homeowners policies in the Miami/Dade County area of Florida. Given this unexpectedly high loss, both companies began to reassess their strategies of providing coverage against wind damage in hurricane-prone areas (Lecomte and Gahagan, 1998)\(^{110}\).

Hurricanes Katrina and Rita that devastated the U.S. Gulf Coast in August and September 2005 had dramatic impacts on several lines, including life, property damage and business interruption. Edward Liddy, chairman of Allstate, which provided insurance coverage to 350,000 homeowners in Louisiana, Mississippi and Alabama, declared that “extensive flooding has complicated disaster planning ... and the higher water has essentially altered efforts to assess damage. We now have 1,100 adjusters on the ground. We have another 500 who are ready to go as soon as we can get into some of the most-devastated areas. It will be many weeks, probably months, before there is anything approaching reliable estimates” (Francis, 2005)\(^{111}\).

Role of Capital Costs

The importance of capital and its need to secure an adequate rate of return is often not sufficiently understood. In particular, the prices charged for catastrophe insurance must be sufficiently high to cover the expected claims costs and other expenses, but also must cover the costs of allocating risk capital to underwrite this risk. Moreover, because the large amounts of risk capital are needed to underwrite catastrophe risk relative to the expected liability, the capital cost built into the premium is high, often dominating the expected loss cost. Thus, an insurer usually needs to charge high prices relative to its loss expenses, simply to earn a fair rate of return on equity and thereby maintain its credit rating.

To illustrate we construct a hypothetical example that is somewhat conservative by ignoring taxes. Consider a portfolio that has $1000 in expected liabilities, \( E(L) \). Since actual losses will not equal expected losses, the insurer needs to hold considerable capital. Here we will assume that $1 of capital is needed for each $1 of expected liability to maintain the insurer's credit rating. Thus the insurer needs capital, \( E(L) = 1000 \). In addition to paying claims, the insurer has an additional 200 in upfront expected expenses that include commissions to agents and brokers, underwriting expenses. Moreover, given the risk characteristics of the portfolio, investors require a rate of return (ROE) of 15 percent on their investment to compensate for risk. The insurer invests its funds in lower-risk vehicles that yield an expected return, \( r \), of 10


percent. What premium, \( P \) would the insurer have to charge to secure a return of 15 percent for its investors?

The formula for the premium can be expressed as a function of the cash flows, the return on investment and the required return on equity (\( k \) is the ratio of equity to expected losses):

\[
P = \frac{X(1 + r) + E(L)}{(1 + r) - k(ROE - r)}
\]

\[
P = \frac{200(1 + 0.05) + 1000}{(1 + 0.05) - 1(0.15 - 0.05)} = 1210
\]

Premiums need to be 1210 to generate this required 15 percent return on equity.

This calculation is very sensitive to the ratio of capital to expected liability, \( k \), needed to preserve credit. In the above example, the ratio was one dollar of capital for one dollar of expected liability. This ratio is in the ballpark for many property liability insurers for their combined books of business. However, for catastrophe risk, with its very high tail risk (which severely affects credit risk), the capital to liability ratio needs to be considerably higher. Indeed, the capital to liability ratio depends on volatility (particularly the downside or tail risk), of the catastrophe liability and its correlation with the insurer’s remaining portfolio. For higher layers of cat risk, the expected loss is often quite low and the volatility very high. At these layers, the required capital to liability ratio can be considerably greater than one-to-one as shown in this example. An increase in the capital to liability ratio will increase the premium required to generate a fair return on equity.

A second issue with catastrophe risk is that it can be expensive to underwrite since it requires extensive modeling. Many companies will buy commercial models and/or use their own in-house modeling capability. If we re-work the above premium calculation now with the transaction costs set at 100 percent of expected losses and 4:1 capital to expected liability ratio the required premium is now 3154:

\[
P = \frac{1000(1 + 0.05) + 1000}{(1 + 0.05) - 4(0.15 - 0.05)} = 3154
\]

For very high layers even more capital may be needed thus further increasing the premium. There are other considerations that can dramatically increase the capital cost, notably the impact of double taxation. Harrington and Niehaus (2001)\(^{112}\) have simulated the tax burden over many parameters and show that tax costs alone can reasonably be as much as the claim cost and lead to further increases in premiums. When we account for all these factors, (i.e. high capital inputs, transaction costs and taxes), catastrophe insurance premiums often are several multiples of expected claims costs.

7.4. Role of Rating Agencies

During the past few years rating agencies have paid increasing attention to the impact that catastrophic risks will have on their view of the financial stability of insurers and reinsurers. The rating given to a company will affect its ability to attract business and hence its pricing and coverage decisions.

To illustrate how ratings are determined consider A.M. Best. It undertakes a quantitative analysis of an insurer’s balance sheet strength, operating performance and business profile. Evaluation of catastrophe exposure plays a significant role in the determination of ratings, as these are events that could threaten the solvency of a company. Projected losses of disasters occurring at specified return periods (a 100-year windstorm/hurricane or a 250-year earthquake) and the associated reinsurance programs to cover them are two important components of the rating questionnaires that insurers are required to complete.

For several years now, A.M. Best has been requesting such information for natural disasters. Their approach has been an important step forward in the incorporation of catastrophe risk into an insurer’s capital adequacy requirements. Up until recently the rating agency has been including probable maximum loss (PML) for only one of these severe events (100-year windstorm / 250-year earthquake, depending on the nature of the risk the insurer was mainly exposed to) in its calculation of a company’s risk-adjusted capitalization. In 2006 A.M. Best introduced a second event as an additional stress test. The PML used for the second event is the same as the first event in the case of hurricane (a 1-in-100 year event; the occurrence of one hurricane is considered to be independent of the other one). If the main exposure facing the insurer is an earthquake, the second event is reduced from a 1-in-250 year event to a 1-in-100 year event (A.M. Best, 2006). These new requirements have increased the amount of risk capital that insurers have been forced to allocate to underwrite this risk and have made them more reluctant to provide this coverage unless they are able to raise premiums sufficiently to reflect these additional costs.

In March 2006, Standard and Poor’s, another rating agency, indicated it would revise criteria for measuring catastrophe risk which has traditionally been based on premium charges. But the new criteria will measure catastrophe risk based on exposure of the insurer. This will include an exposure-based capital charge for insurers similar to what it does for reinsurers based on net expected annual aggregate property losses for all perils at 1 in 250 year return period. There will be a 6-12 month phase in period to allow companies to adjust risk profiles.

113 AM Best (2006), Methodology: Catastrophe Analysis in AM Best Ratings, April.
Chapter 7 – Summary

Today insurers are reexamining their ability to provide protection against wind damage from hurricanes and are asking whether these events are insurable. A risk is considered to be insurable if one has the ability to identify and quantify the risk and set premiums at a price that yields a competitive rate of return.

To determine whether to offer coverage against a specific risk, insurers look to maximize expected profits subject to satisfying a constraint related to the survival of the firm. The premium that the insurer would like to charge reflects not only the expected loss but how uncertain the risk is, whether there are potential problems of adverse selection and moral hazard and how correlated the losses are likely to be in the event of a severe disaster. The prices charged for catastrophe insurance must be sufficiently high to cover not only the expected claims costs and other expenses but also the costs of allocating risk capital. Because large amounts of risk capital are needed to underwrite catastrophe risk relative to the insurers’ expected liability, the capital cost built into the premium is high.

In recent years rating agencies have put more emphasis on the impact that catastrophic risks will have on the financial stability of insurers. Insurers have thus focused their attention on the amount of coverage that they are willing to provide against wind losses from hurricanes and damages from earthquakes given the need to allocate more risk capital to underwrite this risk.

Chapter 7 - Key Questions

1. What role does uncertainty of the risk play in insurers’ coverage and pricing decisions?
2. What role do highly correlated risks in a specific region play in insurers’ coverage and pricing decisions?
3. How do concerns with a large loss of surplus from a catastrophic disaster affect coverage and pricing decisions by insurers?
4. What is the basis for determining how much risk capital insurers are willing to allocate for protecting their surplus against large losses from future disasters?
5. How have recent changes in rating agencies criteria affected insurers’ coverage and pricing decisions?
6. What additional analyses should be undertaken with respect to Florida regarding coverage and pricing decisions by insurers? How can the analyses of Florida be generalized to other states?
CHAPTER 8

REINSURERS’ DECISION MAKING FOR SUPPLYING COVERAGE
AND THE EVOLUTION OF ALTERNATIVE RISK TRANSFER
INSTRUMENTS

8.1. Nature of Reinsurance

Reinsurers provide protection to private insurers in much the same way that insurers provide coverage to their policyholders. They provide coverage against the catastrophic portion of a loss for which insurers do not want to be financially responsible. In this type of arrangement, the reinsurer charges a premium to indemnify an insurance company against a layer of the catastrophic losses which the insurer would otherwise be responsible for covering.

There are two main types of reinsurance: pro rata (or quota-share) reinsurance, in which premium and loss are shared on a proportional basis, and excess of loss reinsurance, for which a premium is paid to cover losses between two attachment points. For example, a contract that specifies $200 million in excess of $500 million for hurricane losses in Florida means that an insurer who purchased such a layer would cede its exposure for claims from Florida hurricanes in the $500-$700 million range. Figure 8.1 illustrates how these types of reinsurance contracts relate to the entire risk transfer process. While a certain amount of pro rata reinsurance is used for catastrophe protection, excess of loss reinsurance is the predominant form.

Figure 8.1. Overview of Transfer Risk: Policyholder, Insurer, Reinsurer, Capital Market

8.2. How Reinsurers Determine Coverage and Set Premiums

Based on our discussions with brokers, reinsurers and insurers over the past twelve months we have a clearer understanding of how capital is allocated by the reinsurer for providing coverage against catastrophic risks and how prices are determined. Below we characterize this process.

Determining Whether to Offer Coverage

Reinsurers are concerned about having a high concentration of risk in any region for the same reason that insurers limit their coverage; they want to avoid a large decrease in their surplus from a catastrophic loss. They thus restrict their exposure in hazard-prone areas so as to keep the chances of severe losses at an acceptable level.

Consider a reinsurer who has $S$ dollars in current surplus that reflects the amount of its internal capital and the amount of capital it can raise from investors. The value of $S$ includes premiums received by the reinsurer on the risks in its current portfolio. The insurer wants to determine whether to cede a layer of excess of loss coverage ($\Delta$) to a reinsurer against hurricane losses in hurricane-prone regions of Florida. The reinsurer needs to determine whether it will take on this layer and if so what price it should charge. The reinsurer will make this decision based on the following considerations:

- The likelihood ($p$) of having to pay claims for this layer
- The distribution of the claim payments, ($L$), should this layer be affected by a hurricane
- The expected loss associated with the layer $E(L)$
- The incremental impact of the layer on the variance of the portfolio as $(\sigma_L)^2$
- The premium ($P_\Delta$) it would want to charge to the insurer should it decide to offer coverage
- The cost of equity capital ($ROE^*$)

Based on the above considerations the reinsurer will make his decision by first determining what his rate of return on equity ($ROE_\Delta$) will be if he reinsures this layer $\Delta$. If $ROE_\Delta > ROE$, then the reinsurer will want to provide this coverage as long as it has met a stability constraint similar to that faced by the insurer in determining whether it wants to offer coverage. More specifically, based on its current portfolio of risks, the reinsurer computes the distribution of expected total claim payments if he incorporates this layer in his book of business thus adding $P_\Delta$ to his current surplus $S$ and determines whether:

$$\text{Probability } [\text{Total Claims Payments} > z(P_\Delta + S)] < p_1 \quad (8.1)$$

The value of $z$ reflects the fraction of surplus that the reinsurer considers to be critical to its continued operation where $0 < z \leq 1$. If $z = 1$ then the critical value (i.e. $P_\Delta + S$) is where the reinsurer would become insolvent and equation (8.1) is equivalent to a survival constraint used by insurers in determining whether or not to offer coverage (see equation (7.1) in Chapter 7 of the report). The threshold probability, $p_1$, plays a similar role for the reinsurer as it does for the insurer. It reflects the tradeoff between obtaining a $ROE_\Delta$ should the reinsurer add $\Delta$ to its portfolio and the costs to the firm of a catastrophic loss that reduces the insurer’s surplus below a critical level. Reinsurers are concerned that, if their surplus falls below a critical level given by
z(PΔ +S), rating agencies are likely to downgrade them. Should this occur the reinsurer will be forced to offer a higher return on investment to attract new capital. They will also have to charge a lower premium to insurers for the same layer of coverage.115

It should be clear from the above simplified descriptive model that the order the composition of a reinsurer’s existing book of business plays a key role in whether to accept a certain contract and what price to charge for it. A layer that is not highly correlated with the existing book of business will be viewed as much more attractive to them than a layer in a hazard-prone region where the reinsurer already has a large amount of surplus at risk.

In summary the decision to offer coverage against catastrophic risk depends on the following three factors:

- Current portfolio and volatility of the layer (Δ) under consideration. Hurricane losses are more volatile than fire or wind. The higher the volatility of Δ, the less attractive it will be to the reinsurer at a given price.
- Price of coverage (PΔ). The higher the price for providing Δ, the greater the ROEΔ and the more likely the reinsurer will provide this layer of coverage.
- The amount of capital available to the reinsurer from either internal or external sources.

Setting Premiums for a Given Layer116

The pricing of a layer of reinsurance needs to cover the expected claims [(E(L)] as well as marketing, brokerage and claims processing expenses while at the same time ensuring that the coverage earns a high enough expected return on equity (ROE) so that it is attractive to the reinsurer. The reinsurer is also concerned with impact of the policy on the variance of its portfolio since this has an impact on the stability constraint given by (8.1). Hence it will charge a higher price for a given layer, the greater its variance as well as the more highly correlated this layer is with the reinsurer’s existing book of business (Kreps, 1990). For a prespecified layer Δ we denote the incremental impact of the policy on the variance of the portfolio as σΔ.

The model used by most reinsurers for determining the premium (PΔ) for a specific layer of excess loss coverage (Δ) that captures these concerns is given by the following simple formula:

\[ P_\Delta = E(L_\Delta)(1 + \lambda) + c\sigma_\Delta \]  

(8.2)

where

- \( \lambda \) = the loading costs
- \( c \) = the degree of conservatism of the reinsurer

---


See Kreps, R. (1990), “Reinsurer Risk Loads from Marginal Surplus Requirements”, Proceedings of the Casualty Actuarial Society, LXXVII, pp. 196-203 for a mathematical treatment as to how this constraint affects reinsurers decisions on whether to offer coverage or not.

116 Our thanks to Sean Mooney of Guy Carpenter who provided us with relevant material including an unpublished draft of his paper Pricing (1999) that helped us to better understand how reinsurers price different layers of coverage.

117 Kreps op. cit.
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The first term in (8.2) reflects the premium that a reinsurer would charge if it was unconcerned with the impact of a loss from layer \( \Delta \) on its surplus. The second term in (8.2) represents the risk load and reflects the concern that the reinsurer has with its stability constraint given by (8.1). The higher the value of \( c_{\Delta} \), the more the reinsurer will want to charge for providing \( \Delta \). A reinsurer who is highly conservative and specifies a very low value of \( p_{\Delta} \) in equation (8.1) will specify a higher value of \( c \) reflecting its concern with taking on any new book of business unless \( P_{\Delta} \) is sufficiently high to cover the cost of capital \( ROE_{\Delta}^{*} \). Hence an insurer with \( p_{\Delta} = 1/100 \) will have a smaller value of \( c \) than if it chose \( p_{\Delta} = 1/1000 \)\(^{118} \).

8.3. Empirical Data on Reinsurance Contracts

Empirical evidence supporting the above behavioral model comes from a detailed analysis by Froot and O'Connell (1999a, 1999b)\(^{119} \) of Guy Carpenter's reinsurance contracts for catastrophic risks over the period 1970-1994. Guy Carpenter is a leading reinsurance broker. The contracts covered a wide variety of natural hazards ranging from earthquake, fire, hurricane, winter storm and hurricane. Specifically, they examined the prices and quantities offered for excess of loss reinsurance contracts.

In their analyses of these data, Froot and O'Connell (1999b) found that following a $10 billion loss in a particular region, there is a decline in quantity of 5.2 percent in surplus on average over the next year. This decline in quantity leads to an average price increase of 19 percent across all reinsurance contracts. This price increase is independent of whether the reinsurer had contracts that were affected by the disaster, although there was an additional increase in prices by reinsurers who had higher exposure in the affected region. This price behavior implies that surplus is not instantly replaced after suffering catastrophic losses and suggests that reinsurers are concerned with the stability constraint when determining whether to offer new excess loss coverage for catastrophic risks. This post-loss phenomenon is known as the capacity constraint theory and is examined in detail in the next chapter of this report.

More generally Froot and O'Connell found that reinsurance premiums at that time were considerably above the expected loss, sometimes as much as 7 times higher. Moreover, the higher attachment point for a layer with the same expected loss, the higher on average was the premium multiple. These results reflect the cost associated with the very large levels of capital needed to underwrite reinsurance for catastrophe risks. They also found that a 10 percent increase in the variance of reinsurer exposure increased prices by about 6.8 percent. This behavior is also consistent with the premium-setting model given by equation (8.2) where the risk load plays a key role in determining the price of reinsurance.

The elasticity of supply for catastrophe reinsurance contracts analyzed by Froot and O'Connell was in the order of 7. This implies that a 1 percent increase in premiums above the expected losses increases reinsurance capacity by 7 percent. Froot and O'Connell (1999a) point


out that this is a very small increase from what capital markets could be expected to provide for liquid instruments. This behavior suggests the importance of a stability constraint given by equation (8.1) in determining the amount of excess loss coverage that a reinsurer will provide against catastrophic risks.

The authors conclude that capital market imperfections impede the flow of capital into the reinsurance sector leading to price increases and supply contractions following severe disaster losses. An open question for discussion is whether there has been a significant change in the capital markets so that the conclusions derived from an analysis of reinsurance contracts from 1970-1994 are not relevant for today.

As we discussed in Chapter 1 of this report, the catastrophe risk environment has radically changed in the last 10 years toward more extreme events that have hit the U.S. with severe effects. Our discussions with reinsurers coupled with recent data from the reinsurance market that we present below suggest that there are additional pressures today that have been placed on capital allocation in general, and on reinsurers in particular, by rating agencies that may restrict the supply of their coverage for catastrophic losses even more than in the period studied by Froot and O’Connell.

Below we discuss the evolution of reinsurance market in reaction to the 2005 hurricane season, the revisions in the catastrophic models and the increased concern by rating agencies with respect to catastrophe exposure management. We then turn to a comparison of the reinsurance market of January 1, 2005 and January 1, 2007 based on reports issued by reinsurance brokers in January 2007.

8.4. Reinsurance Market in 2005-2006

According to a report on the nature of the world reinsurance market during the period July 1, 2005 through June 30, 2006 prepared by Guy Carpenter (2006)¹²⁰, reinsurers behaved during this period of time in a manner that appears to be consistent with the model of Section 8.2 characterizing reinsurers’ decisions regarding coverage and premiums. The Guy Carpenter report is based on a sample of more than 200 layers of catastrophe data within Guy Carpenter’s catastrophe analysis database that has been tracked consistently from 1989-2006. We discuss some of the key findings from this report and related studies below. To our knowledge, this study constitutes the most complete to be published since July 2006.

Impact of Reinsurer Losses on Pricing, Coverage Availability and Profitability

The storms of 2005 placed a disproportionate burden on the reinsurance industry. Reinsurers estimated their losses for 2005 to be $40 billion, approximately half of which were due to Hurricane Katrina. Reinsurance premiums as measured by rate on line (ROL; premium charged for layer of coverage over the amount of coverage) increased significantly in the United States rising 76 percent between July 1, 2005 and June 30, 2006 as depicted in Figure 8.2. The large increase in premiums attracted new capital into the market with eight new major entrants. The Guy Carpenter report points out that “many investors viewed the anticipated reinsurance price increases and capacity shortages as compelling motivators to enter the market.” (p. 4). An estimated $26-27 billion of capital flowed into existing reinsurance companies, through new

start-ups and other alternative risk transfer instruments between Hurricane Katrina and June 30, 2006\textsuperscript{121} (see Section 8.3 below for a more detailed discussion).

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{Figure8_2.png}
\caption{Catastrophe Property Rate on Line (ROL) Index for United States (1989-2006)}
\label{fig:ROL_index}
\end{figure}

Despite the influx of new capital in the market, those regions with high exposure to windstorm, notably Florida and the Gulf Coast, experienced a much harder market for catastrophe reinsurance. This hard market has led to significant increases in ROL premiums. Private U.S. insurers have thus increased their retention limits in 2006 by 40 percent on average from the previous year as shown in Figure 8.3, which is based on a select group of companies tracked consistently between 1989 and 2006.

These same insurers also increased the average limit of reinsurance coverage by 11.4 percent. This increase reflects their concern with the possibility of increased catastrophic losses as indicated by the modeling companies as well as continued pressure from rating agencies on capital adequacy and the management of catastrophe exposures (see Section 7.4 for a more detailed discussion of these points). In addition, the increased population growth in hazard-prone areas and the large hurricane losses in 2004 and 2005 heightened insurers’ awareness of their catastrophe loss potential (see Chapters 1 and 2). The Guy Carpenter report also projects that the increased limits in reinsurance coverage would have been considerably higher if the ROL for catastrophe coverage had not increased dramatically and capacity had been more plentiful.

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Figure 8.3. Average Retention per Program Index for United States (1989-2006) (indexed to 1989)

An indication of the scarcity of reinsurance for catastrophe coverage in these high risk regions of the U.S. is highlighted, for a given reinsurance program, by an increase in attachment points, the reduction in expected loss and the higher premiums and risk loads between 2005 and 2006 for national companies, regional companies and insurers that only write in Florida as depicted in Figures 8.4-8.6 below.

The figures show that catastrophic reinsurance premiums increased significantly for all insurers between 2005 and 2006 but were noticeably higher for stand-alone Florida companies. The risk loads were also substantially higher than in the previous year. This reflects the reinsurers’ perception that the hurricane risk is now higher as indicated both by the modeling companies’ upward revisions in their estimates of frequency of hurricanes, as well as the more stringent requirements by rating agencies. As a result, reinsurers might end up being less exposed today (lower expected loss) because they are providing less coverage in these high-risk areas.

Figure 8.4. Comparison of Key Renewal Statistics for National Companies - 2005/2006
To determine the expected profitability of reinsurers for different layers of coverage for any given period one needs to compute several different measures:

- **Rate on Line (ROL<sub>J</sub>) for each layer J.** This is the ratio of the premium charged for this layer of coverage over the amount of coverage.

- **Loss on Line (LOL<sub>J</sub>) for each layer J.** This is the ratio of the expected loss over the amount of coverage for this layer of coverage. The expected loss for layer J is determined by multiplying the probability (p<sub|i</sub>) of each loss (L<sub|i</sub>) within a given layer J. LOL<sub>J</sub> = ∑<sub>i</sub> p<sub|i</sub>L<sub|i</sub>

- **Expected underwriting profitability for each layer J** E(Π<sub>J</sub>) = ROL<sub>J</sub> - LOL<sub>J</sub>

The higher the attachment point, the lower the LOL for a fixed layer of coverage because of the lower frequency at the higher attachment points. To illustrate this, if one provides excess loss reinsurance coverage to a given insurer for $50 million excess of $100...
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million (i.e. losses between $100 million and $150 million) one has to recognize that there is a higher LOL for this layer than for $50 million excess of $500 million.

Figure 8.7 indicates that the ROL (y-axis) for 2006 (upper line) was considerably higher than for 2005 (lower line) for all layers of reinsurance as reflected in the LOL (x-axis). Since the lines between the two years are approximately the same distance apart, this indicates that the increases in ROL for 2006 were proportionately higher at lower LOL, which corresponds to higher reinsurance attachment levels suggesting that reinsurers expected profits for a fixed layer of cover increases as the attachment point increases.

![Figure 8.7: Rate on Line (ROL) as a Function of Loss on Line (LOL) for 2005 and 2006](source)

There may be several explanations for this behavior which we would like to explore with the Sponsors:

- The LOL values in Figure 8.7 may not reflect the current estimates of expected loss based on the modeling companies upward revisions in the spring of 2006;
- Reinsurers are now more conservative because of more stringent rating agency requirements and the higher capital costs associated with holding more surplus to protect themselves against catastrophic losses;
- The expected profitability of a given layer is overstated if one defines it as $E(\Pi_J) = ROL_J - LOL_J$. There may be other expenses (e.g. capital costs) that need to be incorporated in determining $E(\Pi_J)$.

Reinsurance Capacity for Covering Catastrophic Natural Disaster Losses

One issue that is somewhat controversial today is the available capacity of the reinsurance industry to cover catastrophic losses from natural disasters. We have had considerable discussion on this point with our Sponsors as well as several large brokers. We have concluded that it is difficult to pinpoint any specific figure that would then be used as a “magic number” in the current policy debate regarding the role of the private and public sectors in providing coverage for high layers of catastrophe exposure. Even providing a range of values might be misleading for the following reasons:
• The amount of reinsurance provided by any company is partially determined by the premium that they can obtain for coverage. The higher the premium for a given layer, the more reinsurance that will be provided. In other words, the amount of available reinsurance depends on the insurers’ willingness to pay for coverage for a given exposure to loss.

• The U.S. market is only one of the markets where reinsurers operate. As discussed in Chapter 1, it is important to keep in mind the international aspect of insurance and reinsurance markets. Indeed, the way a given reinsurer will allocate its limited capacity between risks in different regions (e.g., earthquake in the U.S. or in Japan, storms in Europe, hurricanes in the U.S., typhoons in Asia) and increase/decrease capacity in some of these regions depends on many factors related to the specificities of its portfolio, the relative likelihood of these catastrophe risks, the demand for coverage in these different regions and the availability and price of other sources of capital to expand its capacity.

• The amount of capacity of a reinsurer will also depend on its loss experience and the amount of surplus it has available. For example, the absence of hurricanes during the 2006 season implies that there will be a larger surplus on hand to allocate for natural disaster risks in 2007 and hence capacity is likely to be expanded.

• The modelers’ upward estimates of expected losses coupled with more stringent rating agency criteria for dealing with catastrophic risks may make reinsurers more conservative in their willingness to provide certain layers of coverage against catastrophic losses.

• Finally, there is no standard for defining and measuring capacity, so it varies across reinsurers.

Florida Reinsurance Market in 2006

The Florida property insurance market relies heavily on the Florida Hurricane Catastrophe Fund (FHCF) and the private reinsurance market for protection. Approximately 50 percent of primary residential insurance premiums are typically ceded to reinsurers in comparison with the national average of approximately 33 percent (State Board of Administration of Florida, 2006)122.

According to V.J. Dowling (IBNR Weekly August 28, 2006) total direct written premiums (DWP) in the private insurance market for Florida was $5.6 billion of which $4.1 billion is written by insurance carriers writing only in Florida. A comparison of Figures 8.3-8.5 reveals that the Florida-only companies experienced the sharpest increase in cat reinsurance premiums (about 150 percent). Many were unable to find capacity or decided not to buy at the elevated prices. Hence they are exposed to more risk today. It is unclear how they will fare should another severe hurricane hit Florida next year.

One of the key issues that we will be exploring in the coming year is what is required for premiums to reflect risk. According to V.J. Dowling (IBNR Weekly October 2, 2006) Florida gross premiums need to reach $10.6 billion or 56 percent above pre-rate approval base to generate a 12 percent return on equity (ROE). In other words, if insurers are forced to provide coverage in high-risk areas of Florida at the current regulated premiums their ROE will be less than the

return that will be competitive given their earnings on other coverage they provide. If one factor in approved rate increases to date and assuming all pending rate increases are approved in their entirety the rates need to rise another 22 percent from existing levels.

We also obtained data on the reinsurance programs of Florida’s Citizens so it is possible to compare the programs for 2005 and 2006. Our understanding is that Citizens has elected in the spring of 2006 to forego $500 million of private reinsurance should its losses exceed $5 billion because of the relatively high cost for this coverage ($137 million). (i.e., the Rate on Line (ROL) is $137 million / $500 million = 27.4 percent). Instead, Citizens purchased $5 billion of coverage in excess of $1.35 billion for only $250 million from the Florida Hurricane Catastrophe Fund (FHCF) (i.e. ROL: $250 million / $5 billion = 5 percent or 6 times lower than what was available from the private market as of June 2006 as shown in Figure 8.8. These figures have been confirmed by Citizens. It is not yet clear what the new reinsurance program between Citizens and the FHCF will be after 2007 renewal.

The new legislation passed in Florida in January 2007 (see Chapter 3 for details) is likely to have a significant impact on the private reinsurance market in Florida. An important feature of this new legislation is the significant expansion of reinsurance coverage provided to insurers by the Florida Hurricane Catastrophe Fund (FHCF). FHCF will charge insurers reinsurance prices based on average long term annual loss that are likely to be lower than current rates charged by private reinsurers. It is unclear whether the reinsurers will reduce their premiums to compete with the FHCF or maintain their current premiums which result in a decrease in demand by insurers for private reinsurance coverage against wind damage from hurricanes.

Profitability of the Reinsurance Industry in 2006

The absence of major catastrophe losses combined with better catastrophe exposure management and a significant increase in reinsurance prices contributed to what is likely to be a record profit year for reinsurers in 2006. According to Guy Carpenter, profits for 2006 are replenishing the capital that was extracted from the reinsurance market in 2004 and 2005. In addition, $17 billion in new capital that entered the reinsurance market in 2006 bolstered capacity in the marketplace. Coupled with the $25 billion of new capital in the fall of 2005, the reinsurance industry has had an infusion of approximately $40 billion since Hurricane Katrina.

8.5 Reinsurance Market at January 2007’s Renewals

Data provided by reinsurance brokers provide a picture of the changes in the market between January 1, 2006 and January 1, 2007. According to Benfield, January 1, 2007 pricing for national and multi-regional companies was slightly below July 1, 2006 but still remains 30 to 50 percent higher than they were for the January 1, 2006 renewals and significantly higher than January 1, 2005 prices.

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123 V.J. Dowling estimates that the expansion of the FHCF will reduce total reinsurance premiums by between $1.5 billion and $2 billion according to a report by Guy Carpenter, “U.S. Reinsurance Renewals at January 1, 2007” (p. 3)


The Guy Carpenter report cited above confirms this trend suggesting a slight decline from the July 2006 market peak. Figures 8.8 and 8.9 depict the average evolution of pricing (rates on line) for lower and higher layers of reinsurance programs for national and regional companies (excluding Florida-only account) between January 1, 2005 and January 1, 2007. On average, national companies saw prices for lower layers of reinsurance programs decreased by 17 percent and prices for higher layers by 14 percent from July 1, 2006 to January 1, 2007. Still, the January 1, 2007 prices represent a 28 percent for lower layers (9 percent for higher layers) increase when compared to January 1, 2006 pricing of coverage. Figure 8.8 also reveals that January 1, 2007 prices are more than twice as high as they were at the January 1, 2005 renewals for both the lower and higher layers for national companies. As shown in Figure 8.9, regional companies followed a similar path between January 2006, July 2006 and January 2007. On average both the lower and higher layers saw a nearly 30 percent reduction in price during the past 6 months, but are 20 to 30 percent higher than the previous and more than twice what they were in January 1, 2005.

Sources: Guy Carpenter (2007) op. cit
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8.9. Comparison of Rate on Line for Regional Companies – 01/2005-01/2007

Sources: Guy Carpenter (2007) op. cit

As reinsurance prices are high relative to what they were two years ago, there is an opportunity for investors to provide capital for protecting insurers against catastrophic losses. Some have entered this market by offering alternative risk transfer mechanisms.

8.6. Growing Capacity Provided by Alternative Risk Transfer Instruments

Alternative Risk Transfer (ART) instruments provide risk-bearing entities with coverage or protection that complements traditional insurance and reinsurance. The field of ART grew out of a series of insurance capacity crises in the 1970’s through 1990’s that drove purchasers of traditional coverage to seek more robust ways to buy protection. While ART can comprise a wide range of alternative solutions (including the creation of captives or risk retention groups\(^\text{126}\)), here we focus on instruments that cover catastrophes by transferring part of the exposure to investors in the financial markets. Most of these risk transfer techniques permit investors in the capital markets to take a more direct role in providing insurance and reinsurance protection.

The development of ART instruments grew out of the insurers’ and reinsurers’ need for addition capacity to cover their exposure against catastrophe risks. Investors saw these products

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as a good way to enhance their returns by putting funds in instruments that are not highly correlated with other financial risks (e.g. fluctuations in interest rates).

As we discussed above, there has been a significant increase in reinsurance prices for catastrophe risks in the U.S. in the aftermath of the 2005 hurricane season. In particular the fact that the size of the retrocession market (reinsurance of reinsurers) has been dramatically reduced, compared to where it was two years ago, has increased uncertainty for reinsurers as to whether or not such cover will be available to them in the long term.

We now discuss three types of ART instruments provided by the capital markets: industry loss warranties (ILWs), catastrophe bonds and sidecars. The first two are similar to excess-of-loss reinsurance, while sidecars are more often quota-share-like coverage and hence are similar to proportional reinsurance.

**Industry Loss Warranties (ILW)**

The first ILWs were issued in the 1980s to cover airline industry losses and then were developed in the property and casualty insurance industry in the aftermath of major natural disasters that occurred in the past 15 years. As the name indicates, an Industry Loss Warranty (ILW) (also known as Original Loss Warranty, OLW) is a financial instrument designed to protect insurers or reinsurers from severe losses due to extreme events such as natural disasters. The ILW market today focuses almost exclusively on catastrophe risks and has increased significantly after Hurricane Katrina.

The buyer pays the seller a premium at the inception of the contract. In return, the buyer can make a claim in the event of a major industry loss—hence the name. The payout of an ILW can be structured such that the buyer can make a claim equal to the limit of the ILW if a pre-defined industry loss index (IL) exceeds a threshold known as the trigger (T), regardless the buyer’s actual amount of incurred loss\(^{127}\):

\[
\text{Claims} = \begin{cases} 
L & \text{if } IL \geq T \\
0 & \text{if } IL < T 
\end{cases}
\]

For example, the buyer of a "$200 million limit U.S. Wind ILW in Florida in 2007 attaching at $20 billion" will pay a premium to a protection writer (generally a reinsurer) and in return will receive $200 million if total losses to the insurance industry from a single U.S. hurricane in Florida in 2007 exceed $20 billion. The Insurance Services Office (ISO) is often used as the reference for estimating the industry loss. The trigger can be of different forms. For example, an ILW could be structured so that a payment will only be made to an insurer if the industry insured losses from a single U.S. hurricane in Florida in 2007 were between $20 and $30 billion.

In this sense, ILWs are similar to excess-of-loss reinsurance but where the insurer now has some basis risk: the covered loss of the insured’s book of business does not necessarily correlate perfectly with the amount of claim collectable from the index-based contracts (Zeng,

\(^{127}\) We give here the example of a derivative swap, which is the most commonly used ILW contract. But it does not have to be. There could be a first indemnity-trigger (loss encounter by the buyers), then a second trigger based on industry loss.
ILWs might thus be more attractive for single state insurers/reinsurers or companies with a higher concentration of business in a limited number of locations, thus enabling them to take on larger books of business in their primary area of operation.

To date most ILW purchasers have been large companies who see these instruments as another way to spread their exposure. For those that write a large portion of market share, the basis risk might be reduced as well because their losses are likely to be representative of the industry losses in the aftermath of a major natural disaster.

One of the main advantages of ILWs is that they involve relatively low transaction costs for both the buyers (insurers or reinsurers) and sellers (e.g. hedge funds). The sellers do not have to evaluate the expected loss to the (re)-insured portfolio of a specific company from the trigger event, only the exceedance probability curve of the entire industry (which typically reduces the uncertainty, thus the cost associated with a higher level of volatility).

In April 2006, Lane Financial published an analysis of the evolution of ILWs premiums between 2005 (pre-Katrina), January 1, 2006 and April 1, 2006 for different levels of trigger (from $5 billion up to $50 billion insurance industry losses) and different types of risk (wind in Florida, wind nationwide, quake in California). The study is based on information contained from specialist dealers over the last five years. Although this information is not exhaustive, we feel Table 8.1 provides a reasonably accurate picture of the nature of those changes. (Lane, 2006)


<table>
<thead>
<tr>
<th>ILW Strike</th>
<th>Florida Wind</th>
<th>US All Natural Perils</th>
<th>California Earthquake</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1/1/06</td>
<td>4/1/06</td>
<td>1/1/06</td>
</tr>
<tr>
<td>$5.0</td>
<td>19%</td>
<td>54%</td>
<td>33%</td>
</tr>
<tr>
<td>$10.0</td>
<td>27%</td>
<td>83%</td>
<td>26%</td>
</tr>
<tr>
<td>$12.5</td>
<td>33%</td>
<td>87%</td>
<td>23%</td>
</tr>
<tr>
<td>$15.0</td>
<td>38%</td>
<td>92%</td>
<td>24%</td>
</tr>
<tr>
<td>$20.0</td>
<td>32%</td>
<td>132%</td>
<td>0%</td>
</tr>
<tr>
<td>$25.0</td>
<td>39%</td>
<td>164%</td>
<td>-4%</td>
</tr>
<tr>
<td>$30.0</td>
<td>42%</td>
<td>176%</td>
<td>-15%</td>
</tr>
<tr>
<td>$40.0</td>
<td>56%</td>
<td>178%</td>
<td>0%</td>
</tr>
<tr>
<td>$50.0</td>
<td>38%</td>
<td>113%</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>36%</strong></td>
<td><strong>120%</strong></td>
<td><strong>10%</strong></td>
</tr>
</tbody>
</table>

Sources: Data from Lane Financial (2006)

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As the table indicates, for a $5 billion trigger, estimated prices increased by 54%, and by 113% for a $50 billion insurance industry loss due to a major hurricane in Florida compared from what they were prior to Katrina. Despite of this increase, the market has grown significantly in the aftermath of Katrina, which indicates a strong appetite from insurers and reinsurers to access other sources of capital than traditional reinsurance or retrocession. It is estimated that nearly $4 billion ILW were issued between September 2005 and September 2006 (SBA Florida, 2006)\(^{130}\).

**Catastrophe Bonds (“Cat Bonds”)**

Catastrophe bonds enable an insurer or reinsurer to access funds if a severe disaster producing large-scale damage occurs in a similar manner to an ILW. Cat bonds typically cover narrowly defined risks on an excess of loss basis and are issued by an insurer or reinsurer in the form of debt with high coupons\(^{131}\).

How does this work? Consider an insurer or reinsurer, SafeCompany, who would like to cover part of its exposure against catastrophe losses. In order to do so, it creates a new company, BigCat, whose only purpose is to cover SafeCompany and not any other company. In that sense, BigCat is a single purpose reinsurer (also called “special purpose vehicle” or SPV). When the reinsurance contract is signed, the sponsor (SafeCompany) pays premiums to BigCat.

On the other side, investors place their funds with the SPV BigCat; these funds constitute the initial principal for the bond to be issued by BigCat. Reinsurance premiums collected from SafeCompany will be used to provide the investors with a bond with a high enough interest rate to compensate for a possible loss should a disaster occur. In financial terms, this new arrangement is such that investors receive a contingent put on principal and interest, and the sponsor receives a call option on the principal and interest (see Figure 8.10).

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\(^{131}\)Note that the sponsor does not have to be an insurer. For instance, Vivendi Universal (Universal Studios) issued a $175 million bond in 2002, Studio Re, to cover its production studios against an earthquake in Southern California. The first European corporate bond was issued in 2003 by EDF, the French electrical company. This $230 million bond, Pylon, covers the company against windstorms in France. Bonds do not have to cover only natural disasters either. For example, the first bond that covered terrorism losses was issued in Europe in August 2003. The world governing organization of association football (soccer) (FIFA), which organized the 2006 World Cup in Germany, developed a $262 million bond to protect its investment. Under very specific conditions, the catastrophe bond covered losses resulting from both natural and terrorist extreme events that would have resulted in the cancellation of the World Cup game without the possibility of it being re-scheduled to 2007. See H. Kunreuther and E. Michel-Kerjan (2004), “Challenges for Terrorism Insurance in the United States”, *Journal of Economic Perspectives*, 18(4), Fall, pp. 201-214.
What happens next? If the losses exceed a pre-specified trigger, then the interest on the bond, the principal, or both, are forgiven depending on the specifications of the issued catastrophe bond. These funds are then provided to SafeCompany to help cover its claims from the event. In addition to the interest rate on the cat bond, there are at least four other components for the investor to consider: the protection of the principal, the nature of the trigger, the size of the bond and the maturity of the bond. We explain each of them now.

**Protection of the principal**  The principal of a catastrophe bond often consists of different tranches, which are either protected or not. A protected tranche guarantees that the investor will receive the principal from this tranche when the bond matures. For this tranche if a covered event occurs, the SPV stops paying interest and can extend the maturity of the loan for several years. An unprotected tranche has both principal and interest at risk should a covered event occur.

**Trigger**  The nature of the trigger varies from one bond to another. The trigger can be indemnity-based, meaning that the transaction is based on the actual losses of the sponsor. This eliminates the basis risk for the sponsor, but also reduces the transparency of the transaction for the investors. The trigger can also be based on industry losses using a predetermined industry index of losses (e.g., the index is calculated by the Property Claim Services or “PCS” in the United States). The trigger can also be determined by a parametric index such as an earthquake of magnitude 7 or greater on the Richter scale occurring in the San Francisco Bay area or a category 4 hurricane in Florida. A parametric trigger provides transparency for the investors, but sponsors may have significant basis risk (see discussion on basis risk above for ILWs).
Size of the bond The size of the issued bonds has increased over time. For example, of the 5 bonds that were issued in 1997, only one had capitalization higher than $200 million; in 2000 there were two such bonds and in 2005 there were four (out of a total of 10). Likewise, there were two bonds with capital lower than $50 million in 1997 (out of a total of 5), but none of the 23 new bonds issued between 2003 and 2005 had a capital lower than $50 million (Guy Carpenter, 2006)\(^\text{132}\). The transaction costs associated with the complex execution of these instruments (compared to traditional reinsurance) contributes to this trend toward larger size bonds.

Maturity of the bond The maturity of a bond is the period during which the SPV will cover SafeCompany. One advantage of cat bonds over traditional one-year reinsurance contracts is that they can typically offer longer term coverage: one to five years. Over time the proportion of cat bonds with longer maturity has increased, an indication that these instruments are gaining trust within the reinsurance/finance community. Table 8.2 describes the maturity of cat bonds that were issued between 1997 and 2005. The average maturity is about three-years with some cat bonds having only a 1-year maturity and others having 5 years or more.

To understand how large the cat bond market is with respect to new issuance and present and past issuances, one need to understand the difference between issued bonds and outstanding bonds. Consider the following example. If a $200 million bond is issued on January 1, 2007 for one year, then the 2007 risk capital issuance is $200 million and the capital outstanding is also $200 million. Imagine now that this bond is issued for five years: the maturity of the bond is thus December 31, 2011. For 2007, the capital issued is $200 million, but for the next 4 years, the capital issued is $0. As the bond is outstanding for 5 years, each year between 2007 and 2011, the amount of capital outstanding is $200 million (if the bond has not been triggered in the meantime). In other words, issuance tells us about new deals, while outstanding bonds tells us about past deals.

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Table 8.2. Maturity of Cat Bonds issued between 1997 and 2005

<table>
<thead>
<tr>
<th>Maturity</th>
<th>1 year</th>
<th>2 year</th>
<th>3 year</th>
<th>4 year</th>
<th>5 year</th>
<th>10 year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>1998</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>1999</td>
<td>5</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>2000</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2001</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2002</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2003</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>2004</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>2005</td>
<td>1</td>
<td>2</td>
<td>7</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Total (71)</td>
<td>21</td>
<td>9</td>
<td>26</td>
<td>5</td>
<td>9</td>
<td>1</td>
</tr>
</tbody>
</table>

Source: Guy Carpenter (2006)

Cat bonds have been in the market for about 10 years now, which enables one to make some comparisons as to the evolution of issuances and capital outstanding. At the end of 2004 there was nearly $4 billion in cat bond principal outstanding (including $1.14 billion of new issuances that year). At the end of 2005, outstanding risk capital grew to nearly $5 billion with nearly $2.1 billion of that issued.

Figures 8.11 and 8.12 illustrate the evolution of risk capital issued and outstanding, and the number of bonds issued between 1997 and the first five months of 2006. The market recorded total issuance of over $2.1 billion in 2005 (10 new issuances), a 75 percent increase over the $1.14 billion issued in 2004, and 20 percent increase over the $1.73 billion issuance in 2003 (the previous record holder). For the first five months in 2006 the total issuance was close to the total capital issued for the entire year of 2005. Bonds outstanding increased as well, which reflects the issuance of multi-year bonds in previous years.

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133 The figure combines bonds for natural disasters in the U.S. and abroad, as well as the first liability cat bond (Avalon Re) issued by Oil Casualty Company in 2005 for $405 million.

Figure 8.11. Catastrophe bonds: Capital risk issued and outstanding 1997-June 2006
Sources: Data from Swiss Re Capital Markets, Marsh McLennan and Goldman Sachs

Figure 8.12. Annual Number of Cat Bonds Issued – 1997-June 2006
Sources: Data from Swiss Re Capital Markets, Marsh McLennan and Goldman Sachs

**Sidecars**

A phenomenon of the post-Katrina market environment has been the development of so-called “sidecars”. A sidecar is a special purpose company that provides reinsurance coverage exclusively to its sponsor (a reinsurer or a large insurer) by issuing debt to investors. The sidecar operating company has to be licensed as a reinsurer. Unlike ILWs or cat bonds that generally provide excess-of-loss reinsurance, sidecars are often based on quota-share reinsurance. The sidecar company shares the risks of certain insurance/reinsurance policies with the underwriter in exchange for a portion of the premiums (generally up to 50 percent) and dividends in shares. Figure 8.13 shows a simplified diagram to illustrate the stakeholders involved in a sidecar.
It seems that most rating agencies view sidecars as neutral as far as the sponsor is concerned. This is surprising because it is likely that the sponsor has written business that it would not otherwise have written, thus increasing the problem of liquidity or even ruin. Indeed, some sidecar structures are such that the investors collateralize the full amount of the limit that is written to the sponsor, limiting this risk. However, other sidecars are such that the collateralized capital is only partial, residual exposure falling to the sponsor.

Like cat bonds, sidecars are complex financial transactions. They typically require a much larger investment ($200 million at a minimum) than cat bonds and are of a shorter duration. A sidecar company is designed to last two years or less, and then self-liquidate or renew, depending on market conditions. As we discussed above, cat bonds would typically cover a longer period of time.

Between November 2005 and July 2006, over $3 billion of hedge fund money has been sunk into sidecars that cover natural disasters in North America. Figure 8.14, compiled by Goldman Sachs, indicates the name, capital and sponsor of each of the 10 sidecar companies that were created over the period of time.

While all these sidecars are sponsored by reinsurance companies, in August this year Lexington Insurance Company, a member of AIG, set up its own sidecar, Concord Re, to reinsure business on a quota-share basis. This is the first-ever sidecar structured for a primary insurance company. Concord Re is capitalized with $730 million from equity securities issued by Concord Re’s parent holding company, Concord Re holdings.
Other sidecars were created after July 2006. Two noteworthy sidecars were the ones formed by two of Lloyd’s syndicates. This Special Purpose Syndicate (SPS 6103) was set up very late in the year, for the 2007 account, to underwrite a 33.33% share of Lloyd’s Syndicate 2791’s US Catastrophe XL account. The syndicate is being started to enable it to capitalize on what is viewed as excellent underwriting conditions that are being experienced in the U.S. Catastrophe XL market at the moment. SPS 6103 is capitalized with nearly $90 million by traditional Lloyd’s Names.

The insurer Hiscox also signed a quota-share reinsurance arrangement with a newly formed Bermuda sidecar company, Panther Re, at the end of 2006. This agreement allows Hiscox (more precisely Hiscox Syndicate 33\textsuperscript{135}), to grow its book of property catastrophe reinsurance business during 2007 and 2008. Panther Re’s sole activity is to participate in the property catastrophe reinsurance business of its only client, Syndicate 33. Panther Re is a $360 million sidecar ($144 million of equity and $216 million of term loans).

**Summary**

The 2005 hurricane season led insurers and reinsurers to use alternative risk transfer instruments at an unprecedented level. The combination of additional capital that was invested in existing companies and used to form new reinsurance companies, the issuance of new catastrophe bonds and the formation of more than ten sidecars provided an additional $26-27 billion in capital to cover catastrophe losses from natural disasters as shown in Figure 8.15.

\textsuperscript{135} Hiscox underwrites inside Lloyd’s as Syndicate 33, one of Lloyd’s largest syndicates.
Whether we should expect the number and volume of these new transfer mechanisms to grow significantly in the coming years remains to be seen. If reinsurance premiums remain high, many of these ART instruments will likely expand and others may be developed. Our discussion of reinsurance pricing for January 1, 2007 renewals indicates that this might be the case since the average prices are higher than a year ago. If the market becomes softer due to lower than average catastrophe losses, or if industry losses are so extreme that they trigger payments from sidecars and cat bonds, investors' interest in these ART instruments might slacken.

As discussed earlier, Hurricane Katrina swamped KampRe, a $190 million catastrophe bond arranged last year by Swiss Re for Zurich. It is the first cat bond issued to totally call in investor funds. The 2005 hurricane season also wiped out a $650 million sidecar, Olympus Re, arranged in 2001 by White Mountain Insurance (Moyer, 2006). These losses, which represent about 1 percent of total private and public insurance/reinsurance payments for the 2005 hurricane season (including flood losses paid through the NFIP), did not stop investments in those new instruments. Investors who bet against the odds of another devastating Atlantic hurricane season in 2006 have now been rewarded as the season turned out to be the mildest in years.

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136 Although not all the relevant insurance claims affecting this issue have been processed, the bonds are trading as though complete loss is expected.

Chapter 8 – Summary

This chapter focuses on the role of reinsurance and alternative risk transfer instruments in providing financial protection to insurers against catastrophic losses from natural disasters. We first develop models for characterizing reinsurers’ decisions on what coverage to offer and, if so, how to price specific layers of protection. The 2005 hurricane season has created a hard market that has similar features to the post-Hurricane Andrew environment in 1992-1993. The data collected by Guy Carpenter, a large insurance and reinsurance broker, reveals significant increases in price (in the 50 percent-100 percent range) in Florida as well as other parts of the U.S. even though new capital of nearly $8 billion entered the market. As a result of this harder market insurers’ retention before accessing reinsurance also increased.

Recently there has been a growing capacity provided by capital markets through alternative risk transfer instruments. Industry loss warranties (ILWs), catastrophe bonds, and reinsurance sidecars have assumed increasing importance as sources of protection to insurers against catastrophic losses. More than $12 billion in capital has been raised from investors (e.g., hedge funds) between September 2005 and September 2006 for these three types of instruments alone. We explain how each of these instruments functions, their advantages and limitations, as well as similarities and differences between them.

Chapter 8 - Key Questions

1. What are the expectations for reinsurance availability and pricing in the coming years?
2. What role does variance and correlation of losses play in pricing and coverage decisions by reinsurers?
3. How do concerns with large loss of surplus from a catastrophic disaster affect coverage and pricing decisions by reinsurers?
4. What role does reinsurance availability play in insurers’ decisions on whether to offer coverage?
5. What types of capacity problems should we be paying attention to in our analyses of reinsurers’ decisions?
6. How will the presence of Florida Hurricane Cat Fund and the recent changes in its operation affect private reinsurers’ coverage and pricing decisions?
7. What additional analyses should be undertaken with respect to availability of reinsurance in Florida?
8. What lessons can we draw from the increased use of ART instruments?
9. What type of insurer/reinsurer is most likely to use these instruments and under what circumstances?
10. What are the current limitations to more aggressive development of ART instruments?
11. At a broader level, what is the likely impact of supplementary federal reinsurance of mega-disasters?
CHAPTER 9

A FRAMEWORK FOR SUPPLY AND DEMAND OF DISASTER INSURANCE

In order to evaluate the effectiveness of alternative disaster insurance programs, one needs to understand more fully the supply of coverage and demand for protection by homeowners. This chapter complements analyses provided in previous chapters and develops a framework at a conceptual level for understanding the interaction of supply and demand prior to a natural disaster as well after a catastrophe occurs.

Our intention is to see whether the insurance market is functioning effectively given the play of market forces as shaped by existing regulations. To do this, we need some normative benchmarks to see whether the market provides an appropriate balance between the needs of consumers for adequate coverage and the needs of investors who provide this protection to secure an appropriate return on their investment. We will separately look at the conditions governing the intersection of insurance demand and supply and ask whether the market clears at an acceptable price.

9.1. Supply of Disaster Insurance

Investors will supply capital for insurers if they believe they can make an expected rate of return that more than compensates them for their risk. In turn, the insurer will allocate capital to underwriting catastrophe risk, if the addition of that business improves (or at least maintains) the risk-return properties of its existing portfolio. Another way of expressing this is that the additional risk capital needed to underwrite that cat risk must bring a return that at least compensates the insurer or reinsurer for the additional costs of risk bearing that are imposed by the additional business.

As we discussed earlier in the report, the problems with insurance supply are affected by the possibility of catastrophic losses due to high correlation of risks within any confined region, thus imposing considerable tail risk. To deal with this problem, insurers writing books of business where there is the likelihood of catastrophe risk will need to be highly capitalized to deal with these potentially large losses. This implies that the cost of capital is a very important factor in determining insurance supply as shown in Chapter 7. Alternatively, the insurer can economize on capital by reinsuring (or otherwise hedging) its catastrophe exposure. In this case, the supply of insurance is largely conditioned by the price and availability of reinsurance which is primarily determined by the cost of capital to the reinsurer (see Chapter 8).

“Cycles” in insurance

Insurance lore is that the insurance market is cyclical with hard markets (capacity is scarce and prices are high) alternating with soft markets (capacity is abundant and prices are accordingly low). There is considerable research on the insurance cycle and it is clear that markets are indeed sometimes hard and sometimes soft. However, the notion of a “cycle”
implies there is some regularity and predictability in the turning of the market and it is this regularity that is questionable.

The mainstream theory of the cycle is known as the “capacity constraint” model (see Gron, 1994 and Winter, 1988)\. The short run insurance supply of each firm, and therefore of the market, is determined by the level of required capital. Short run insurance supply is price elastic up to the point at which regulators, rating agencies and customers consider existing capital to be inadequate given the additional liabilities. This is the known as the capital constraint model. Additional supply will only come if additional capital is forthcoming. To induce investors to invest more capital requires higher premium rates. Moreover, the supply of additional capital will take time as insurers, like most firms, prefer to accumulate capital internally rather than going to the capital market for new equity\. This supply function is shown in Figure 9.1 along with an insurance demand function. The short run equilibrium is shown as price, \(P^*\) and quantity, \(Q^*\), and is this is met within the capital capacity of the industry. The capacity constraint is shown as \(Q^C\).

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\(^{139}\) The so called *Pecking Order* theory explains the preference for internal capital. In addition to the direct transaction costs of external capital, there are also agency costs which take the form of controls to prevent insiders diverting wealth to themselves. For more details see Myers, S. and Majluf, N. (1984), “Corporate Investment and Financing Decisions When Firms Have Information That Investors Do Not Have,” *Journal of Financial Economics* 13, pp. 187-222.
Now the dynamics of the model are thrown into play when the industry suffers a capital shock, caused by either a sudden loss, such as Katrina or 9/11, or by an asset loss such as what happened at the end of the bull market in 2000. This loss of capital reduces insurance capital and thereby shifts the insurance supply function upwards as shown in Figure 9.2. Depending on the circumstances of the loss, the demand function also might shift to the right. For example, as noted in Chapter 6, after major disasters, more people purchase insurance to make sure they are protected should such an event happen again.

The new equilibrium price and quantity are shown as \( P^{**} \) and \( Q^{**} \) in this diagram. Notice several things. The equilibrium price has increased considerably, thus illustrating the post-loss hard markets that are typically experienced after such capital shocks.

Also, as shown in Figure 9.2, the new output, \( Q^{**} \) exceeds the new capital constraint \( Q_{C}^{'2} \) and supply can only be met with a very large price increase to compensate the insurer for its deterioration in credit quality. Such pressure on credit quality was felt, for example, by all reinsurers in the early 2000's following the combination of the burst of the asset bubble (which affected mostly European insurers who tended to be more heavily invested in stocks) and the cost of insured losses due to the 9/11 terrorist attacks. Thus the post-loss hard market interestingly combines higher prices and pressure on credit quality.

![Diagram showing supply and demand curves before and after a capital shock](image)

**Figure 9.2. The Gron-Winter Capital Constraint Model**

The hard market typically does not last. Since internal capital is cheaper than external capital, insurers will prefer to replenish gradually through retained earnings because of the hard market. However, if the price rise is sufficient to overcome the additional costs of external capital, then new capital may indeed flow in. For example, while Hurricane Katrina alone
accounted for $40.6 billion in insured losses, the new capital flow to the industry as of June 30, 2006 is estimated to be $27 billion (see previous chapter).\(^\text{140}\)

The combination of retained earnings and new capital will begin to push the supply function outwards again as shown in Figure 9.3. Eventually a new equilibrium is established with the market clearing at an output level within the limits of the replenished capital.

The capacity constraint model shows that the cycles of hard and soft markets (triggered by capital shocks) is a normal market mechanism for allocating scarce and varying capital. It does lead to the uncomfortable results that price and availability of insurance are adversely impacted by catastrophic losses: the markets will clear, though at a higher price (the market will self-correct in time with the inflow of new capital). Under this model, insurance is not rationed. Further empirical evidence suggests that the disruption can be more severe.

Prices usually rise after major losses and this alone (absent other effects such as an increase in the demand function) would tend to depress insurance purchases. However, insurers sometimes wish to ration coverage even at the higher prices. There may be several reasons for this. One is that insurers need to keep the geographical diversity of their portfolios in balance. If a catastrophe loss in one region leads to a remodeling of risk which shows an increase in local probability or severity, then insurers may need to reduce local capacity. This will be necessary to rebalance their spread of risk and thereby preserve their credit status. However, there is a compounding reason why coverage might be rationed after a loss. Insurers will be more willing to allocate capacity to states, if they retain the flexibility to withdraw that capacity after loss when their capital is highly depleted (Doherty and Posey, 1997).\(^\text{141}\) This model, for which there is empirical support, suggests that any attempt by regulators to retain capacity in a post-loss situation is likely to impede the future flow of capital into that state.

\[\text{Figure 9.3. Long Run Equilibrium with Capital Replenishment}\]


9.2. Demand for Catastrophe Insurance and Role of Deductibles

The demand for insurance stems from a latent aversion to risk and the consequent desire to transfer risk to another party who can absorb that risk more effectively. The demand is also influenced by the consumer’s knowledge of the risk he or she faces. In an ideal world, where consumers were fully informed of the risk they face, the risk perfectly known, and where there is an insurer who can bear that risk with no transaction costs, consumers would buy full insurance.

Consumers would avoid all the costly risk they would otherwise face, without imposing any real cost on insurers who can easily diversify that risk. This ideal is not what we are dealing with. Consumers may be ill informed of their risk exposure, even insurers cannot model this risk with great accuracy, and the risk itself is not easily diversifiable thereby requiring insurers to hold considerable costly capital to support the underwriting of catastrophe risk.

Just as it would be nice to offer all people unlimited and free medical care and education, it would be nice to also make available unlimited “free” risk transfer, i.e. where the premium simply equals expected claim cost and no reward is given to the insurer for transferring risk. But of course, there is an opportunity cost and the best we can do is to allocate coverage (and health care and education) in a manner that balances the costs and benefits. In effect, this means that full coverage is not ideal. Rather, it is reasonable for policyholders to carry a deductible on their policy.

Paying for small losses doesn’t usually stress people’s budgets or indeed increase their risk very much (since small losses are affordable and fairly frequent). Furthermore, deductibles can result in significant premium savings. First, they avoid the transaction costs of handling small claims (which would have to be built into the premium). Second, deductibles put some of the policyholder’s “skin in the game” thus providing an incentive for loss mitigation. This reinforces the social objective of reducing overall exposure to catastrophes.

The benefit of insurance to the policyholder is more than the value of the expected losses transferred to the insurer; the benefit includes the removal of the uncertainty or risk surrounding the expected loss. In Figure 9.4 we show the benefit declining as the level of the deductible increases. With small deductibles there is little decline, because the small losses are frequent and predictable and bearing such losses imposes little uncertainty on the policyholder. Increasing the deductible significantly reduces the benefit because the policyholder now has a large stake in the low-frequency, high-consequence losses. In contrast, the premium may fall quite dramatically because the insurer avoids the transactional expenses of handling frequent small claims. A further reduction in premiums can arise because the policyholder now has a stake in the loss and will be more inclined to invest in protective measures such as anchoring walls to the foundation and installing shutters. The optimal deductible maximizes the difference between expected benefits and costs as illustrated in Figure 9.4.
9.3. Market Clearing Prices and Quantities

Like other markets, the interaction of supply and demand should result in a price that will clear the market. The above considerations suggest that the clearing price for catastrophe insurance might be high relative to the expected losses. This does not necessarily reflect profit making, but simply the high cost of capital associated with this difficult type of risk.

Impact of Regulation

One way in which regulation can impact insurance supply is through price regulation. Insofar as regulators are able to hold prices below their clearing level, there will be excess demand (supply shortage) for insurance. The normal mechanism adopted by regulators to address this excess demand is to establish a residual market mechanism (see our discussion of Florida’s Citizens in Chapter 3). This can lead to a higher volume of insurance transacted at a lower price than for an unregulated market, as shown in the Figure 9.5.
Figure 9.5. Suppressing the Market Clearing Price with a Residual Market

Undiversifiable Catastrophe Risk and Policy Design

As we have shown above, basic economic theory holds that, when insurance encounters transaction costs (so that the competitive premium exceeds the expected loss), then it is desirable for a policyholder to retain some risk in the form of a deductible. In other words, individuals should really share in their own risk, absorbing the smaller losses which they can usually afford to pay, and thereby saving on expensive insurance premiums. We now make further supply side arguments as to why it is desirable for policyholders to share in their own losses.

It is the nature of catastrophes that risk is highly correlated amongst sections of the population. The same hurricane hits many property owners in the same coastal region and the same earthquake damages houses of many thousands of people in that locale. The implication is that the insurer cannot simply diversify the risk away by holding more and more policies in its portfolio. Certainly, insurers can and do reinsure, and reinsurance companies will hold geographically diversified portfolios. This helps spread the catastrophe risk widely through the market, but the diversification is not complete. Thus insurers can, and do, have sudden spikes in their profitability and sudden hits to their capital when large catastrophes occur.

For this reason, catastrophe insurance is not like automobile or life insurance where pooling in the insurance market, in effect, makes the risk disappear. No matter how far catastrophe insurance risk is spread, there is some unavoidable residual risk cost that must be absorbed somewhere. If this were to be borne by investors, then insurers would charge a risk

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142 Strictly, the average risk per policy converges to zero as the number of policies in the pool gets very large. Thus the average burden of risk in a large pool is close to zero.
premium and policyholders would be better off economizing on their premiums by accepting a co-share in the risk, such as a deductible.

Alternatively the remaining risk could be borne by the government. The government could be the last-resort reinsurer, or could provide ex post compensation to victims, as happened after Katrina. But, of course, the government is the people and firms who would end up bearing their own risk (or the one of others) either through additional taxes or cuts in other programs.

This reasoning takes us to the basis of modern insurance theory; the Borch theorem143. Insofar as risk is undiversifiable, then the optimal social arrangement is that individual risk is insured, but the undiversifiable component is shared amongst the population. Thus, each policyholder should retain a stake in the social risk. In practical terms this can be achieved in several ways:

• Deductibles could vary according to the size of the aggregate loss. With large losses such as Katrina, the deductible would be very large, and conversely would be small when smaller catastrophes occurred.
• Policyholders could be paid in full but pay an ex post assessment so that the industry could recover part of its capital. The practical problem with such assessments is that they may not be collectable, especially from victims with low income and/or those who suffer severe damage.
• Policyholders could pay higher initial premiums to contribute to the insurance pool’s capital and be given an ownership stake in the insurance pool. In other words, insurance could be mutualized. Policyholders would then receive a dividend which would vary according to the overall results of the pool so that when a large catastrophe occurred, the dividend would fall to zero (or perhaps be negative – an assessment).

The policy task is to recognize that insurance does not work completely when applied to catastrophe risk and that we all have to bear the undiversified risk. What then is the most efficient way of distributing this lumpy risk over policyholders or over society more widely? The answer to this question should account both for the impact on mitigation and for the spread of risk.

Chapter 9 – Summary

The supply of catastrophe insurance is determined mostly by the capital that insurers can and wish to allocate to protect themselves against large losses and by the availability of reinsurance and other capital substitutes. In turn, reinsurance capacity is determined by the reinsurers’ capital base. However, the underlying capital varies according to both claims experience and investment experience of insurers and reinsurers, thus causing the “cycle” in prices and insurance capacity. The hard markets (capacity is scarce and price are high) following major losses do arouse policy concerns, though these conditions are usually self correcting with the inflow of new capital.

The price of catastrophe insurance is usually high relative to expected losses because of high transaction costs, most importantly the high cost of capital needed to back this type of coverage. Earlier analysis showed that rational consumers would react to price loadings by accepting deductibles. Thus, requiring policyholders to take deductibles is not some form of market failure, but rather an efficient device to ration expensive insurance capacity – thus releasing capital to more productive uses.

While we expect an unregulated market to clear with some risk sharing in the form of deductibles and at prices that reflect claim and transaction costs, this equilibrium will be disturbed by regulation. Price suppression and the inability of insurers to base premiums on risk, affect both insurance capacity, the incentive to mitigate risk and the participation of different risk groups in the insurance market.

Chapter 9 - Key Questions

1. What are the indicators of so-called “market failure”?
2. Are cycles, deductibles and high insurance prices, indicators of “market failure” or are they indicators that the market is effectively allocating scarce capital to its most productive uses?
3. What are the welfare arguments for price suppression and risk subsidies?
4. Should policy makers be concerned about post-loss hard markets?
5. Would any attempts to smooth out the cycle distort incentives to invest in insurance capacity?
6. If market clearing prices are considered to be “unaffordable” is there any welfare case for subsidizing premiums – or should subsidies be directed to home ownership or directly to income?
CHAPTER 10

EMPIRICAL STUDY OF DEMAND AND SUPPLY OF INSURANCE PRIOR AND FOLLOWING A DISASTER: THE CASE OF FLORIDA

In this chapter we discuss the estimation of the supply and demand for catastrophe insurance in several states prone to catastrophe risk. The purpose is to examine how effectively the private market functions and the resulting prices and availability of insurance coverage. We also address the impact on private insurance of various public sector interventions ranging from price controls to residual market mechanisms. We have assembled much of the data to conduct this exercise but are still in the modeling and empirical analysis stages. We describe below the structure for the model of demand for insurance. We are still in the initial stages in developing the supply model. The Appendix to this chapter summarizes empirical analyses of recent developments in the Florida market.

10.1. Developing a Model of the Demand for Insurance

The basic demand problem for the homeowner is to select the best policy from among the menu of policies offered in the market. Demand arises from the optimal consumer choice of a bundle of product and company attributes, given the personal characteristics of each homeowner and the economic and demographic characteristics of the neighborhood (i.e., ZIP code) where (s)he resides. The theoretical foundation for this demand analysis, and the interacting market equilibrium, are based on a model of price-quality competition (Gal-or 1983). In a perfectly competitive market, the differences in what homeowners are willing to pay for various features will be reflected in the price at which various bundled products with these features sell. Thus, we model a regression of observed price in the market against various features of the products sold and the companies that sell them. We are interested in the factors that seem to influence demand, we determine whether these factors appear reasonable on the basis of theory and, if so, we quantify the effect of each of these factors. Since there is considerable evidence that many homeowners do not search thoroughly for “best offers”, we are also interested in aspects of the market that appear to arise from behavioral considerations (Kunreuther, 1998), including the price dispersion of similar policies offered in the same territory.

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147 We should note that one source of price dispersion is the fact that insurance companies differentiate themselves in term of underwriting stringency. Insurers with more stringent underwriting standards, labeled “preferred insurers”, tend to have the lowest prices. “Standard” and “non-standard” companies tend to have higher prices. Some insureds may pay higher than necessary prices if they would qualify for coverage from a preferred insurer, but intentionally or inadvertently purchase coverage from a standard or non-standard insurer.
At the outset, we rely on the following features of the homeowner’s insurance market in our modeling. While the structure of this market may be workably competitive, it is nonetheless a regulated market (Klein, 1998; Klein, 2006). On the demand side, this does not cause any theoretical difficulties as the model we develop attempts only to explain, for policies actually offered in the market, how various features are valued, within a feature (e.g., various deductible levels) and across features (e.g., deductible levels versus type of coverage). It is important to bear in mind that, because of regulation, the set of policies offered in the market, and their prices in particular, are not the result of a perfectly competitive market.

We assume that insurers seek to maximize profits, subject to regulatory constraints in designing their policies. This suggests that insurance companies find the regulatory constraints imposed not so onerous as to cause them to leave the state. Nonetheless, because of such constraints, catastrophe coverage in some areas might require “underbracing” or cross subsidies from other lines of business, non-catastrophe coverage and catastrophe coverage in low risk areas.

These cross subsidies may be sustainable if they allow insurance companies to earn a reasonable rate of return on all lines of business and if they are supported by consumer preferences for certain feature bundles and cross-marketing. At the same time, we must recognize that there are limits to the magnitude of the cross subsidies that can be sustained in a private, competitive market when consumers can choose among multiple insurers. The continuation of these cross subsidies over time implies further inertia that may, at least in part, be due to regulatory restrictions on terminating policies and other insurer and consumer considerations. Beyond the obvious implications for understanding rate adequacy and precision, this suggests the importance of detecting cross-marketing synergies in the demand and supply analysis, as well as detecting trends in the aggregate supply of particular insurers in terms of increasing the diversification of their portfolios of insurance policies.

Defining Price and Modeling Demand for Homeowner Policies

Assume that a particular homeowner, with characteristics $Z$ (income, family status, type of structure of the house or apartment building, etc.), faces a choice among different policy options for insuring his home, where the set $H$ gives the available policy options in the homeowners market. A typical such option $“h”$ in the set $H$ would be one offered by insurer $i$, with characteristics $X_i$ (such as implied quality levels based on surplus level, size and visibility in the market, distribution system type—direct marketing or independent agent), Or a typical such option $“h”$ in the set $H$ would be one offered by insurer $i$ (with characteristics $X_i$, which include characteristics such as claims paying ability, organizational form, marketing methods, and the ability to offer complementary products such as auto insurance) with certain policy features (such as deductible levels, loss settlement provisions, actual cash value or replacement cost), and with premium $P(h)$. The homeowner must choose one of the options in $H$ and does so by

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maximizing his expected utility over the risks or gambles implied by each choice \( h \). Let us represent this expected utility \( U(h, P(h)) \) in quasi-linear form\(^{150}\) as:

\[
U(h, P(h), Z) = V(F(h), Z) - P(F(h), Z)
\]

where \( V \) represents the consumer’s willingness to pay for various type of coverage or "features" of an insurance policy and \( F(h) \) represents the vector of such features, including the characteristics of the company offering the policy that may make a difference to consumers.

Note that both \( V \) and \( P \) depend only on the vector of features \( F \) and the characteristics of the homeowner (possibly only the type of structure, but perhaps also locational characteristics such as community rating or location of nearest fire department). This is without loss of generality since one of these features could itself be the premium level \( P(h) \). The homeowner then maximizes the function \( U(h, P(h), Z) \) over the set \( H \).

Assuming that that is, there is a rich menu of policies available in the market, we can represent the choice problem as selecting an insurance policy by choosing optimal features of the policy. This leads to a solution to the homeowner’s maximization problem characterized by \( MV/MFi = MP/MFi \), which varies with consumer characteristics \( Z \). This reveals how premiums vary with policy features\(^{151}\). This leads to estimation problems of the following general type, neglecting for the moment the details here of functional form:

\[
P(F, X, Z) = aF + bX + cZ + \varepsilon
\]

where we have separated the policy features into categories: those pertaining to the policy itself (the vector \( F \)); those that pertain to the company (the vector \( X \)); and those pertaining to neighborhood characteristics (the vector \( Z \)). In this model, \( P(F, X, Z) \) could be either the total premium for a given policy or more likely, normalizing by units of coverage (e.g., the expected or indicated loss costs), premium per unit of coverage.

The "price" for insurance products, as for other products and services, is defined as the value-added per unit (in this case, per dollar) of output. At the policy level, this value-added measure of price can be captured by subtracting the discounted value of expected losses covered by the policy from the premium\(^{152}\). Denoting by \( L(F, Z) \), the expected losses for a policy

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\(^{150}\) As Willig (1976) has shown, this form, with constant marginal utility of income, is appropriate for demand modeling when the good in question does not absorb a significant fraction of the homeowner’s budget, a reasonable assumption in the case of insurance (the typical homeowners insurance premium is around $300-$500 and somewhat higher in catastrophe-prone areas). This is not to say, of course, that there are no income effects across consumers, only that the marginal utility of income for each consumer is assumed constant over the range of policy options offered.

\(^{151}\) Indeed, if \( V \) and \( P \) are estimated using bilinear or translog families of functions, then knowledge of one will lead (up to a constant of integration) to knowledge of the other.

Chapter 10
Managing Large-scale Risks in a New Era of Catastrophes
Report on Phase I of the Study

We consider a function \( h \) with features \( F \) and by \( p(F, X, Z) \) its premium, we obtain the following definition of price \( p(F, X, Z) \) for a homeowners policy \( h = (F, X, Z) \) characterized by the parameters \( (F, X) \) and indexed by consumer and loss characteristics \( Z \):

\[
p(F, X, Z) = \frac{P(F, X, Z) - PV[L(F, Z)]}{PV[L(F, Z)]} = \frac{(1+r)P(F, X, Z) - L(F, Z)}{L(F, Z)}
\]

(10.3)

where \( PV[L(F, Z)] = L(F, Z)/(1+r) \) is the present value of expected losses on the policy for the policy period and \( r \) is the insurer’s return on equity for the period. \( L(F, Z) \) is the indicated loss costs per unit of coverage for the policy features \( (F) \) and structure \( (Z) \) in question. This was the underlying methodology in Grace, Klein and Kleindorfer (2004)\(^ {153} \).

**Quantity Demanded**

In our previous work, we employed the Indicated Loss Costs (ILCs) as our measure of the risk shifted to the insurer through the insurance contract. We hypothesized that the ILCs offered a good proxy for the expected losses of the policy contract. In our current dataset we do not have an indicator for losses. Thus, we employ as an alternative measure of demand the coverage A (dwelling) limit. While this is a maximum probable loss, rather than an expected loss it is used to proxy for quantity of insurance coverage demanded. In Phase II of the project, we plan to develop and incorporate estimates of non-cat and cat indicated losses with assistance from participating insurers and other potential sources of this information. The inclusion of indicated loss variables is critical to the modeling and estimation of the supply of insurance.

We have received data from five sponsoring companies (Allstate, Liberty Mutual, Nationwide, St Paul/Travelers and State Farm,) and from Fireman’s Fund and Citizens Property Insurance Corporation. These insurers account for approximately 50 percent of the Florida homeowners’ insurance market in 2005. Data were provided for a number of years over the period 2000-2005. Not every company was able to provide data for all years.

Our data consists of individual contract information from the various insurers in Florida. We then summed the data by company to the ZIP code level. Table 10.1 shows the descriptive statistics for some of the variables we employ. Thus we have an observation for each company in each year and for every ZIP code the insurer wrote during the time period for which we have data. The table provides the average company premium, the standard deviation of the premiums, the minimum and the maximum premium for a company observation in the ZIP code. We thus have approximately 13,366 unique company ZIP code observations. The mean is the average for the variable in each ZIP code over the time period. The standard deviation represents the deviation around the mean of the variable in question. A larger standard deviation would mean that the distribution is more disperse.

Table 10.1. Descriptive Statistics for Contributing Companies’ Data
Measured at the ZIP Code Level for 2000-2006\textsuperscript{154}

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Obs</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Premium in the Zip Code</td>
<td>13366</td>
<td>$1,886.14</td>
<td>2489.096</td>
<td>$45.00</td>
<td>$31,676.00</td>
</tr>
<tr>
<td>Average Hurricane Deductible in the Zip Code</td>
<td>13366</td>
<td>$3,981.13</td>
<td>3175.735</td>
<td>-</td>
<td>$42,213.33</td>
</tr>
<tr>
<td>Average Policy Deductible in the Zip Code</td>
<td>13366</td>
<td>$961.44</td>
<td>1290.076</td>
<td>$2.00</td>
<td>$25,000.00</td>
</tr>
<tr>
<td>Average Wind Deductible in the Zip Code</td>
<td>7045</td>
<td>$87.30</td>
<td>288.591</td>
<td>-</td>
<td>$7,142.86</td>
</tr>
<tr>
<td>Percentage of Homes in Zip with Replacement Cost Coverage</td>
<td>13366</td>
<td>74.49%</td>
<td>0.040</td>
<td>0.00%</td>
<td>100.00%</td>
</tr>
<tr>
<td>Median Family Income in Zip Code (Census)</td>
<td>13366</td>
<td>$48,799.27</td>
<td>18418.2</td>
<td>-</td>
<td>$200,001.00</td>
</tr>
<tr>
<td>Average Price Mark-up* in the Zip code</td>
<td>13366</td>
<td>1.200</td>
<td>0.016</td>
<td>0.016</td>
<td>27.132</td>
</tr>
</tbody>
</table>

Companies included: Allstate, Citizens, Travelers, Nationwide, and Firemens Fund.

The minimum represents the lowest ZIP code company observation in the data and the maximum represents the maximum company ZIP code observation. For the average premium in the ZIP code for example, we see that the mean premium is approximately $1,886 with a standard deviation of 2489.01 which suggests that the if distribution of average premium in the ZIP code is normal then 95 percent of the premiums fall between the range -$2,992 - +$6,764. This large standard deviation suggests that the distribution of the average premium is quite dispersed. The minimum and maximum of the average premium are approximately $45 (and probably represents a partial year’s payment) and $31,676 respectively. This implies that for some ZIP code–company combination the minimum premium charged for homeowners insurance was $45 and for some other ZIP code–company combination the premium in the ZIP code was $31,676.

Our demand estimation procedure will be based on a process similar to that used in our previous work. Currently we are in the process of developing a method for ascertaining loss costs for the various insurance territories.

10.2. Conclusions

In this chapter we provide an outline for how we plan to analyze the demand for and supply of insurance in markets subject to significant catastrophe risk. We first need better measures of price and quantity demanded which we hope to procure in Phase II. Our initial results suggest that the price elasticity of demand has declined over time and that this decline is likely because the risks seem to have increased and that one firm (Citizens) is supplying relatively more coverage. These results concerning the price elasticity are consistent with economic theory, but we are not sure of the precision since the variables we use as proxies for price and quantity could be improved upon in subsequent work. In terms of understanding supply, we are at the initial stages of quantifying the key drivers of the market.

\textsuperscript{154} State Farm’s data are not included in this analysis due to a technical problem that will be resolved.
## Chapter 10 – Summary

This chapter presents background information about deriving price and quantity demanded variables for an econometric analysis of the demand for homeowners insurance in Florida.

We are in the beginning stages of understanding supply. However, we can say a number of things about the Florida market. In the appendix to this chapter, we examine some supply indicators as measured by premiums and exposure in Florida. County level markets tend to be less concentrated in higher risk areas. Furthermore, the leading companies in the high-risk areas tend to have smaller market shares today than they had in the past. Finally, insurance prices have increased more in high-risk areas relative to other areas in the state.

## Chapter 10 - Key questions

1. Can we get better measures of Expected Loss, both for non-cat and cat exposures?
2. Alternatively can we get a company-specific Expense Ratio so we can make our price mark-up more accurate?
3. Can we understand better the consequences of the cat and non-cat exposure mix on expense ratios and pricing?
4. Can we gain a better idea about how reinsurance pricing influences supply? What micro data are available that describe reinsurance prices?
5. We need to understand the effect of regulation more precisely? Can we understand the impact of rate adequacy and rate compression on supply and demand?
APPENDIX 10-A

In this appendix, we present a preliminary analysis of data and information accumulated to date with the main focus on Florida. Subsequent iterations of this work will extend the analysis to other states and probe market developments in greater depth and detail. Also, as new data become available, it will be possible to update our understanding of more recent developments.

The sections of this appendix examine the structure, conduct and performance of the homeowners insurance market in Florida with particular emphasis on recent developments in 2006. The last section concludes with a summary of the key observations and the plans for further research.

I. Insurance Market Structure in Florida

The next three subsections dissect insurance market developments using an established industrial organization approach – the structure-conduct-performance framework. The basic notion underlying this framework is that structure affects conduct and conduct affects performance. However, it is also understood that the path of effects moves in both directions, i.e., conduct and performance can affect structure. Furthermore, this framework is harnessed to analyze developments in a market that is subject to several factors that are not typically found in other industries, requiring some creative extension and application of standard methods. We look at market structure from both a company and a group level to examine how business is being shifted among companies within the same group, as well as groups’ overall market exposure. We also assess market structure using both premiums and amounts of insurance as measures of quantity.

Insurer Cost Conditions

The cost conditions facing firms are a major determinant of the number and size distribution of firms within an industry or market. Typically, economists analyze the relationship between output and cost to determine how many firms can viably operate in a market and the optimal size of a firm in terms of the quantity of a good or service it produces. A typical firm cost function might reflect increasing returns to scale up to some level of output (average costs decline over this range of output) and decreasing returns to scale beyond this level of output (average costs increase past this point). The amount of fixed costs or sunk investments and the optimal output level, if high, can potentially impede entry by new firms.

Cost functions in many industries, including insurance, reflect decreasing average costs over an initial range of output and rising average costs beyond this point. The low point in the average cost curve is the minimum efficient scale (MES). This is reflected in the shape of the typical average cost curve which is convex or U-shaped as shown by $AC_{nec}$ (the average cost

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curve when there are no correlated exposures or catastrophe risk) in Diagram 1. The explanation for a U-shaped cost curve is that the firm initially benefits from spreading fixed costs over a larger amount of output but at some point this effect is offset by rising variable costs due to rising input prices or other factors that cause the productivity of inputs to fall as production is pushed beyond a certain level.\(^{156}\)

However, the problem of correlated risk exposures or catastrophe risk adds a significant new dimension to insurer cost functions. As an insurer increases the amount of insurance it sells in a given geographic area, its risk of catastrophic losses increase. This means that variable costs increase as an insurer adds correlated risk exposures. The increase in variable costs can be reflected in the insurers’ need to carry additional surplus, buy reinsurance, or pay a higher return to its owners to compensate them for the higher risk retained by the insurer.

\[\text{Diagram 1} \]

\[\text{Average Cost Curves} \]

\[AC_{cr} \quad AC_{ncr} \]

\[MAC_{cr} \quad MAC_{ncr} \]

\[MSE_{cr} \quad MSE_{ncr} \quad Q \]

The important implications of this conception of insurers’ cost functions are twofold: 1) the cost function pivots upward; and 2) the shape of the cost function changes. Specifically, the slope of the average cost curve to the left of the MES becomes more shallow, the MES shifts to the left (i.e., decreases), and the average cost curve climbs more steeply to the right of the

\(^{156}\) For example, when production is pushed beyond some point communication and coordination among workers and units within a firm can suffer leading to diminishing productivity. See Varian (1992) for an explanation of firm cost functions.
MES. The average cost curve with catastrophic risk is depicted as \( AC_r \) in Diagram 1. These changes in an insurer’s cost function will compel it to charge a higher price for the insurance it sells and its maximum efficient scale or output level will be lower than if its loss exposures were not correlated.

In terms of market structure, the catastrophe risk cost factor would be expected to decrease the market shares of the leading insurers, all other things equal. The leading insurers will find it more costly to acquire a large share of the market than if catastrophic risk was not a factor. Small insurers also may find it difficult to sustain operations in catastrophe-prone markets because they lack sufficient capital and geographic diversification to counter the risk of the correlated exposures they would encounter. Hence, we would expect that the market shares of the leading insurers will decrease and some smaller insurers may also exit the market. Overall, we would expect measures of market concentration to decrease as they tend to be based on or dominated by the market shares of the leading insurers.

Of course, in the real world, the cost factors that affect the supply of insurance and market structure are more complex than what we have described above. For example, insurers also must consider “economies of scope”, e.g., the efficiencies gained from selling both home insurance and auto insurance to the same household. If an insurer is unwilling to sell home insurance to some homeowners, they lose the associated scope economies from selling auto insurance to the same homeowners. Also, these homeowners may decide to move their auto insurance to another carrier. There are other considerations such as the sunk costs associated with establishing a reputation and distribution networks and adverse regulatory responses. These other factors may dampen the hypothesized structural effects of higher costs due to catastrophe risk, but it is quite possible that they will not eliminate them. Hence, we believe that the predictions in the preceding paragraph should still hold.

The Regulatory Factor

The government framework under which firms operate also has significant effects on market structure, conduct and performance. The regulation of insurers is particularly intensive and, hence, can greatly influence insurance markets. Regulation is discussed in greater detail in Klein (2006) but we note several important regulatory factors here. One such factor is the regulation of insurers’ entry into and exit from a market. The evidence suggests that regulators impose some costs on market entry and these costs, in turn, could impede entry to some degree (Klein, 1995). In turn, regulators can also make it costly to exit markets. In particular, some states require an insurer to exit all lines of business if it seeks to exit a line subject to availability problems, such as home insurance. This policy could delay the exit of insurers from a state

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157 \( MAC_r \) and \( MAC_{rer} \) refer to “minimum average cost” with and without catastrophe risk respectively.

158 MESr and MESrer refer to “maximum efficient scale” with and without catastrophe risk respectively.


market but not ultimately prevent it. At the same time, raising the cost of exit can have the undesired effect of discouraging entry.

The extent to which regulators constrain insurers’ discretion with respect to pricing, policy terms and underwriting can also affect entry and exit and other aspects of market structure. Severe regulatory constraints can deter entry and also hasten insurers’ retrenchment or exit from a market. As we discuss below, after an initial period of severe regulatory constraints following Hurricane Andrew, it appears that Florida’s regulators approval of gradual rate increases during the 1990s helped to encourage new insurers to enter the market and may also have eased pressure on established insurers to retrench or withdraw from the market (Grace, Klein and Kleindorfer, 2004). However, regulators’ continued compression of rates in some high-risk areas and more recent resistance to further rate increases could push insurers to retrench from the market to a greater degree than they would under more flexible regulatory policies.

**Entries, Exits and Market Concentration**

The effects of increased hurricane losses and risk on the structure of the Florida market are still developing and there is a lag in the data available to track market changes. Still, it is important to glean what we can from these data and offer observations on how insurers appear to be adjusting their market positions. We can examine data through 2005 and augment these data with anecdotal observations on insurers’ actions in 2006. We begin by looking at shifts in the market positions of leading writers of homeowners insurance in Table 1(a).

Table 1(a) ranks the top 20 homeowners insurers (on a group basis) in Florida in 2005 and also shows their market rankings and shares (in terms of direct premiums written) for the years 1992, 1995 and 2000. We do not include the Citizen’s Property Insurance Corporation (CPIC) in this aspect of our analysis as it is a residual market mechanism and our interest here is in the voluntary market in which insurers compete and make decisions about how much insurance they are willing to supply. We can see from this table that there have been dramatic changes in the Florida market since 1992. The top two groups in 2005 – State Farm and Allstate – were also the top two groups in 1992. However, their combined market share has dropped from 50.9 percent to 29.9 percent. It is apparent that these two insurers have significantly reduced their “relative presence” in the Florida market (as measured by premiums). This does not mean that these insurers’ premiums in Florida have necessarily decreased, but the increase in their premiums has not increased at the same rate as the expansion of total premiums in the state. This development is not surprising given these insurers’ expressed need to limit their catastrophe exposures to what they consider more sustainable levels.

It is also interesting to note that while State Farm’s market share remained essentially unchanged since 2000, Allstate’s share declined from 11.2 percent to 8.9 percent. This appears to be consistent with Allstate’s stated intention to substantially reduce its concentration of

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160 As discussed by Grace, Klein and Kleindorfer (2004), it is reasonable to expect that there is a point where the losses from staying in a market exceed the costs from exit, even with the additional constraints on and costs of exit.

exposures in high-risk areas to a level that it believes is more economically viable\textsuperscript{162}. Other mid-tier insurers appear to have essentially maintained the same market shares over this period through 2005.

Another significant development has been the entry/expansion of some insurers as other companies have retrenched or withdrawn from the market. Ten of the top 20 groups in 2005 entered the market after 1995. This reflects several phenomena. Two important factors were the startup of several new insurers in Florida during the 1990s and entries by other established insurers. The retrenchment or exit of some insurers created opportunities for other insurers to fill the gap.

Table 1(a)

Changes in Leading Insurers' Market Share

<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rank</td>
<td>DPW</td>
<td>MS(%)</td>
<td>Rank</td>
<td>DPW</td>
<td>MS(%)</td>
<td>Rank</td>
<td>DPW</td>
<td>MS(%)</td>
<td>Rank</td>
<td>DPW</td>
</tr>
<tr>
<td>State Farm Group</td>
<td>1</td>
<td>1,175,850,317</td>
<td>21.0</td>
<td>1</td>
<td>583,296,400</td>
<td>20.1</td>
<td>1</td>
<td>523,718,334</td>
<td>31.1</td>
<td>1</td>
<td>653,427,313</td>
</tr>
<tr>
<td>Allstate Ins Group</td>
<td>2</td>
<td>495,663,212</td>
<td>8.9</td>
<td>3</td>
<td>325,641,465</td>
<td>11.2</td>
<td>2</td>
<td>293,679,212</td>
<td>17.4</td>
<td>2</td>
<td>436,329,616</td>
</tr>
<tr>
<td>Poe Financial Group</td>
<td>3</td>
<td>402,430,257</td>
<td>7.2</td>
<td>16</td>
<td>38,322,429</td>
<td>1.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tower Hill Ins Group</td>
<td>4</td>
<td>285,914,090</td>
<td>5.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nationwide Corporation</td>
<td>5</td>
<td>274,919,617</td>
<td>4.9</td>
<td>5</td>
<td>144,675,744</td>
<td>5</td>
<td>5</td>
<td>80,912,210</td>
<td>4.8</td>
<td>5</td>
<td>88,595,495</td>
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<tr>
<td>USAA Group</td>
<td>6</td>
<td>253,944,356</td>
<td>4.5</td>
<td>4</td>
<td>152,088,271</td>
<td>5.2</td>
<td>4</td>
<td>91,130,417</td>
<td>5.4</td>
<td>3</td>
<td>95,171,018</td>
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<tr>
<td>Liberty Mutual Group</td>
<td>7</td>
<td>172,197,758</td>
<td>3.1</td>
<td>10</td>
<td>51,714,570</td>
<td>1.8</td>
<td>13</td>
<td>28,536,397</td>
<td>1.7</td>
<td>12</td>
<td>32,534,992</td>
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<tr>
<td>St Paul Travelers Group</td>
<td>8</td>
<td>124,905,507</td>
<td>2.2</td>
<td>6</td>
<td>92,445,712</td>
<td>3.2</td>
<td>3</td>
<td>115,474,673</td>
<td>6.9</td>
<td>4</td>
<td>89,664,452</td>
</tr>
<tr>
<td>Chubb &amp; Son Inc American International Group</td>
<td>9</td>
<td>124,290,363</td>
<td>2.2</td>
<td>8</td>
<td>68,324,921</td>
<td>2.4</td>
<td>11</td>
<td>31,015,810</td>
<td>1.8</td>
<td>6</td>
<td>62,874,910</td>
</tr>
<tr>
<td>Hartford Fire &amp; Casualty Group</td>
<td>10</td>
<td>119,271,708</td>
<td>2.1</td>
<td>15</td>
<td>38,442,829</td>
<td>1.3</td>
<td>21</td>
<td>9,557,402</td>
<td>0.6</td>
<td>53</td>
<td>3,771,785</td>
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<tr>
<td>ARX Holding Corp Group</td>
<td>11</td>
<td>117,479,131</td>
<td>2.1</td>
<td>7</td>
<td>76,738,521</td>
<td>2.6</td>
<td>6</td>
<td>43,881,208</td>
<td>2.6</td>
<td>9</td>
<td>49,288,247</td>
</tr>
<tr>
<td>GeoVera Holdings Inc Group</td>
<td>12</td>
<td>116,834,632</td>
<td>2.1</td>
<td>25</td>
<td>27,120,693</td>
<td>0.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Hannover Group</td>
<td>13</td>
<td>111,695,287</td>
<td>2.0</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>United Prop &amp; Cas Ins Co</td>
<td>14</td>
<td>109,706,978</td>
<td>2.0</td>
<td>2</td>
<td>330,849,854</td>
<td>11.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gulfstream Prop &amp; Cas Ins Co</td>
<td>15</td>
<td>104,978,215</td>
<td>1.9</td>
<td>42</td>
<td>14,473,319</td>
<td>0.5</td>
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<tr>
<td>Universal Insurance Group</td>
<td>16</td>
<td>93,418,769</td>
<td>1.7</td>
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<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Southern Farm Bureau Casualty 21st Century Holding Group</td>
<td>17</td>
<td>81,510,111</td>
<td>1.5</td>
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<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Vanguard Fire &amp; Cas Co</td>
<td>18</td>
<td>78,785,158</td>
<td>1.4</td>
<td>9</td>
<td>59,636,471</td>
<td>2.1</td>
<td>7</td>
<td>41,734,721</td>
<td>2.5</td>
<td>71</td>
<td>1,781,096</td>
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<td></td>
<td>19</td>
<td>77,513,454</td>
<td>1.4</td>
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<td></td>
<td>20</td>
<td>73,489,860</td>
<td>1.4</td>
<td>35</td>
<td>16,630,455</td>
<td>0.6</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Source: NAIC Financial Database

However, entry into the Florida market carries risk, especially for insurers with large portions of their portfolios in the state. This was demonstrated by the rapid rise of the 3rd and 4th leading groups in 2005 – the Poe and Tower Hill groups. Poe was hit hard by the 2004 and 2005 storm seasons and has been placed into receivership. Tower Hill has been more diversified.

\textsuperscript{162} See, for example, “Allstate Considers More Cancellations,” \textit{Tampa Tribune}, May 19, 2006.

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with business throughout the Southeast but it also has received increased scrutiny due to its large number of exposures in Florida. Poe’s three companies and a fourth company, Florida Select, have been placed in receivership and more insurers may follow. This demonstrates the drawbacks of relying heavily on local or regional insurers to fill large gaps left by larger, national insurers. Smaller insurers can bolster their capacity with extensive use of reinsurance but this comes at a cost along with some retention of risk at a primary level that may be unavoidable.

Several national and regional insurers entered or increased their market presence but their market shares were still relatively modest in 2005, i.e., less than 3 percent. This may reflect a more reasonable strategy of acquiring small, “digestible” shares of a potentially lucrative but risky market by more broadly diversified insurers, and not going beyond this in order to limit their catastrophe risk to reasonable levels.

The associated trends in market concentration from 1992-2005 are shown in Table 1(b). The combined market share for the top 4 groups in Florida decreased steadily from 55.3 percent to 42.2 percent. This is likely to decline further in 2006 given Allstate’s efforts to reduce its exposures and Poe’s insolvency. The combined market shares for the top 8 and top 20 insurer groups also declined over this period but to a lesser degree and these measures contain more insurers who have experienced smaller decreases in their market shares as well some insurers who have increased their market shares. The HHI decreased from 1,440 in 1992 to 776 in 2000, increased, then fell again to an all-time low of 714 in 2005. While the HHI includes all insurers in its calculation, it weights the market shares of the larger insurers more heavily so it is not surprising that it has also declined given the decrease in the market shares of the market leaders.

<table>
<thead>
<tr>
<th>Year</th>
<th>CR4</th>
<th>CR8</th>
<th>CR20</th>
<th>HHI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992</td>
<td>55.3%</td>
<td>70.9%</td>
<td>85.2%</td>
<td>1,440</td>
</tr>
<tr>
<td>1993</td>
<td>59.5%</td>
<td>71.6%</td>
<td>86.6%</td>
<td>1,438</td>
</tr>
<tr>
<td>1994</td>
<td>60.0%</td>
<td>71.9%</td>
<td>86.7%</td>
<td>1,236</td>
</tr>
<tr>
<td>1995</td>
<td>60.2%</td>
<td>72.2%</td>
<td>87.4%</td>
<td>1,406</td>
</tr>
<tr>
<td>1996</td>
<td>57.5%</td>
<td>71.5%</td>
<td>87.0%</td>
<td>1,266</td>
</tr>
<tr>
<td>1997</td>
<td>50.0%</td>
<td>63.8%</td>
<td>82.9%</td>
<td>1,046</td>
</tr>
<tr>
<td>1998</td>
<td>51.3%</td>
<td>64.9%</td>
<td>83.1%</td>
<td>920</td>
</tr>
<tr>
<td>1999</td>
<td>50.1%</td>
<td>62.7%</td>
<td>80.0%</td>
<td>846</td>
</tr>
<tr>
<td>2000</td>
<td>48.0%</td>
<td>61.2%</td>
<td>78.7%</td>
<td>776</td>
</tr>
<tr>
<td>2001</td>
<td>47.5%</td>
<td>60.1%</td>
<td>78.4%</td>
<td>783</td>
</tr>
<tr>
<td>2002</td>
<td>46.4%</td>
<td>59.2%</td>
<td>79.6%</td>
<td>829</td>
</tr>
<tr>
<td>2003</td>
<td>45.0%</td>
<td>59.9%</td>
<td>81.7%</td>
<td>839</td>
</tr>
<tr>
<td>2004</td>
<td>44.9%</td>
<td>61.4%</td>
<td>83.8%</td>
<td>832</td>
</tr>
<tr>
<td>2005</td>
<td>42.2%</td>
<td>60.0%</td>
<td>78.7%</td>
<td>714</td>
</tr>
</tbody>
</table>

Source: NAIC Financial Database

The decline in market concentration and the relative changes for the market leaders versus the mid-tier insurers is consistent with what we would expect to see based on our discussion of the impact of catastrophe risk on insurers’ cost functions and exposure management. One’s view of whether this decline in concentration is good or bad depend on one’s perspective. Normally, economists associate lower concentration with greater
competition but the situation in Florida’s homeowners insurance market is peculiar. While insurers may be competing to maintain a “sustainable” market share, many are not currently seeking to increase their market share through price and product competition. Also, homeowners who have been dropped or rejected by their preferred insurer would not view this as a favorable development. State Farm and Allstate have maintained larger shares of other markets because of characteristics that consumers apparently prefer.

On the other hand, less concentration implies that there is a greater dispersion of exposures among carriers in Florida which could be viewed as a positive development in terms of greater diversification of risk, especially if nationally diversified insurers are part of this development. In markets subject to high levels of catastrophe risk, lower concentration levels may be a necessary condition to allow insurers to maintain their catastrophe risk at manageable levels.

Another caveat to the observation about market de-concentration in Florida is the movement of exposures from national carriers to smaller state or regional insurers that are not pooling risk across a wide base of countrywide exposures. One aspect of this phenomenon is the movement of exposures to Florida-only companies within the national groups to increase the transparency of their Florida performance. If the smaller state and regional insurers are making good use of reinsurance to spread their catastrophe exposure, then the positive objective of broader risk diversification would still be achieved. Single-state companies within national groups can receive support from their affiliates in the event of large losses, but as we explain below, these national groups cannot engage in sustained cross-subsidies of their Florida insureds. These are aspects of market structure trends that warrant more investigation. Some homeowners also must find new carriers to underwrite their coverage and others may be forced into residual market mechanisms, at least for a period of time.

**Insurer Exposure Patterns**

Insurers’ statewide market shares (based on premiums) tell one part of the story on changes in the structure of Florida’s homeowners insurance market. Another important part of the story is the distribution of insurers’ shares of exposures (the amount of insurance coverage) in different areas in the state – hurricane risk varies significantly among these areas so this aspect of market structure is important in terms of how insurers are managing their catastrophe risk as well as the associated implications for homeowners.

We were able to obtain data on insurers’ exposures by county by year/quarter from the Florida Office of Insurance Regulation (FLOIR). These data are reported by insurers to the FLOIR under its QUASR system. To make the data compilation more manageable, we requested and obtained data for first quarter of every year from 1997-2006. This is sufficient to allow us to track trends and major changes in the distribution of insurers’ exposures at a county level.

Tables 2(a) and 2(b) compare the company level and group level HHI (based on the amount of insured homeowners property) by county between 1997 and 2006. Tables 3(a)-3(b) compare the market shares of the 10 leading insurers in Dade County in 1997 and 2006 at a company and group level. We see two important developments from these data. The first is decreased concentration in the higher risk counties (along the coasts). The second thing we see is that the leading insurers in the state have decreased their shares of exposures in the highest risk counties. This is evident in both the company level data and the group level data. We also see from Table 2 that “new” insurers have moved in to underwrite a significant proportion of
exposures in Dade County. These are understandable developments as the leading insurers have had to reduce their catastrophe exposure to more manageable levels that do not impose excessive financial risk.

### Table 2(a)

**Homeowners Exposure Company Level HHIs by County in 1997 & 2006**

<table>
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<tr>
<th>County</th>
<th>HHI 1997</th>
<th>HHI 2006</th>
<th>Change</th>
<th>County</th>
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<th>HHI 2006</th>
<th>Change</th>
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Source: data from FLOIR; authors' calculations
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Source: Data from FLOIR; authors' calculations
Table 3(a)
Leading Insurance Companies in Dade County: 1997 & 2006

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<th>Rank</th>
<th>1997 Company</th>
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<th>2006 Company</th>
<th>Mkt. Share</th>
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<td>20.3%</td>
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<tr>
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<td>Florida Residential Property JUA</td>
<td>29.5%</td>
<td>CITIZENS PROPERTY INSURANCE CORP</td>
<td>12.2%</td>
</tr>
<tr>
<td>3</td>
<td>ALLSTATE INSURANCE COMPANY CO</td>
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<td>GULFSTREAM PROP &amp; CAS INS CO</td>
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<td>METROPOLITAN PROP &amp; CAS INS UNI</td>
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<td>5</td>
<td>ALLSTATE FLORIDIAN INS CO</td>
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Top Ten 85.6% Top Ten 67.1%

Source of Data: Florida Office of Insurance Commissioner

Table 3(b)
Leading Insurance Groups in Dade County: 1997 & 2006

<table>
<thead>
<tr>
<th>Rank</th>
<th>1997 Company</th>
<th>Mkt. Share</th>
<th>2006 Company</th>
<th>Mkt. Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>State Farm Group</td>
<td>38.0%</td>
<td>State Farm Group</td>
<td>20.3%</td>
</tr>
<tr>
<td>2</td>
<td>FL Residential P&amp;C JUA</td>
<td>29.5%</td>
<td>Citizens Property Ins Corp</td>
<td>12.2%</td>
</tr>
<tr>
<td>3</td>
<td>Allstate Insurance Group</td>
<td>6.6%</td>
<td>Liberty Mutual Insurance Companies</td>
<td>7.8%</td>
</tr>
<tr>
<td>4</td>
<td>Liberty Mutual Insurance Companies</td>
<td>4.8%</td>
<td>Gulfstream Property and Casualty Ins Co</td>
<td>7.5%</td>
</tr>
<tr>
<td>5</td>
<td>USAA Group</td>
<td>3.3%</td>
<td>Poe Insurance Group</td>
<td>7.3%</td>
</tr>
<tr>
<td>6</td>
<td>St. Paul Travelers Group</td>
<td>3.0%</td>
<td>United Property &amp; Casualty Ins Co Inc</td>
<td>4.5%</td>
</tr>
<tr>
<td>7</td>
<td>Hartford Insurance Group</td>
<td>2.1%</td>
<td>Tower Hill Group</td>
<td>4.5%</td>
</tr>
<tr>
<td>8</td>
<td>MetLife Auto &amp; Home Group</td>
<td>2.0%</td>
<td>First Home Ins Company</td>
<td>3.5%</td>
</tr>
<tr>
<td>9</td>
<td>Chubb Group of Insurance Companies</td>
<td>1.8%</td>
<td>HDI U S Group</td>
<td>3.2%</td>
</tr>
<tr>
<td>10</td>
<td>Bankers Insurance Group</td>
<td>1.4%</td>
<td>Federated National Ins Co</td>
<td>2.9%</td>
</tr>
</tbody>
</table>

Top Ten 92.7% Top Ten 73.6%

Source of Data: Florida Office of Insurance Commissioner

This reinforces an important point. Florida cannot rely on small or geographically-concentrated insurers to underwrite a large number of homes in high-risk areas. A more sustainable approach is to encourage a large number of insurers to each write a “reasonable” number of homes in high risk areas, commensurate with the capacity and risk diversification of each company. Of course, saying this is easier than achieving it. At the same time, if regulators allow insurers to charge fully adequate, risk-based rates and make other reasonable adjustments in their underwriting and policy terms, insurers should be more amenable to writing a manageable amount of high-risk exposures.
II. Insurance Market Conduct and Performance

Insurers’ conduct and ultimately market performance or outcomes are of the greatest interest to various stakeholders. The key outcomes include the price of insurance, the availability of coverage, policy terms, and profitability. For obvious reasons, property owners are most interested in the price of insurance as this can have a significant effect on their housing costs and budget. They are also interested in the availability of coverage as this can affect how much insurance they can purchase, the insurers they can purchase insurance from and whether they will need to obtain coverage in the residual market. Insurers have a stake in these outcomes, but their profits (or losses) and financial viability are of particular concern. If insurers are unable to recover their cost of capital (at least in the long run), it becomes difficult for them to justify and sustain operations in a market. Also, continuing operations under such conditions can ultimately threaten their financial strength and solvency, with adverse consequences for their owners and all of their policyholders. In this section, we focus primarily on market performance but we also discuss aspects of insurers’ conduct to a limited extent. In subsequent iterations of this paper, we will delve more deeply into insurers’ conduct (as well as performance) as we attempt to divine the full dynamics of property insurance markets and the factors affecting them.

Prices

The price of home insurance is a primary area of interest and concern. A number of insurers have filed and implemented significant rate increases to reflect the higher degree of risk and cost of reinsurance. There are a number of ways to measure prices and price changes – no one measure reveals everything one would want to know but each provides some information. There are also different definitions of the price of insurance. Economists tend to use a “net price” measure which is the loading added to the expected loss or “pure premium”. Here, we use a “full price” definition that includes the loss cost portion of the premium or rate charged. Consumers, regulators and others tend to focus on the full price rather than the net price.

Some indication of the price increases faced by insureds is provided by Figure 1 which plots trends in average homeowners premiums in Florida and the U.S. between 2001 and 2006. The source of data for this figure is the PCIAA/ISO Fast Track Monitoring System that compiles data on premiums, exposures, and losses on a quarterly basis from a subset of insurers representing approximately 60 percent of the total market countrywide. We calculated the average premium (total premiums divided by insured house-years) for the first quarter of each year of the series.

We can see from this figure that Florida has experienced a greater increase in the average premium from $673 to $1,193 than what has occurred for the U.S. as a whole. In fact, among all the states, Florida experienced the highest rate of increase. Of course, this is not surprising given the changes in insurers’ rate structures discussed above. From the insurers’ perspective, the significant price increase in Florida is necessary to finance the higher risk of losses. From the insureds’ perspective, the increase is a matter of concern and an additional financial burden. It could compel some homeowners to opt for larger deductibles or other
coverage adjustments to lessen the impact of higher rates. This, in turn, increases political pressure on legislators and regulators to lower prices or at least prevent further increases.

An important caveat to the indications of these average premium trends is they reflect the weighted distribution of the premium increases on all policies in the underlying data. In Florida, rates vary greatly between the lowest and highest risk area and the average statewide premium encompasses all areas. We would expect premiums to be significantly higher in the coastal areas and they may experience a higher relative increase than interior areas within the state. Also, the average premiums calculated for the 2006-Q1 will not reflect the full impact of recent rate changes by insurers. As policies come up for renewal or new policies are written, the rates in effect at the time of renewal/issuance will determine the premiums written on those policies and the corresponding average premiums. Hence, we would expect average premiums to increase through the remainder of 2006 and beyond.

There are other data that provide information on average premiums at a sub-state level in Florida. The first set of these data are drawn from “annual statistical data” provided by the PCIAA. These data contain premiums, exposures (house-years), losses and the number of claims by standard rating territory for the years 2000-2004. We calculated average premiums for homeowners HO-3 policies (premium written divided by house-years) for each year and territory that are shown in Table 4 – the territories are ranked in descending order of their average premium in 2004.

163 Note, the average premium will reflect coverage adjustments as it based on the premiums that insureds actually pay.
We can see from this table that average premiums do vary significantly across the state. The territory comprising Indian River, Martin and St. Lucie counties had the highest average premium in 2004 – $1,674 – and also experienced the largest increase over the period – 104 percent. The lowest rate territory – Jacksonville – had a $464 average premium in 2004. It should be noted that these average premium measures are affected by several factors including the amounts of insurance on homes and the terms of the policies covering those homes, as well as the rate structures of insurers. Hence, we cannot distinguish (from these data) how much of the average premium increase is attributable to rate changes. Still, it is reasonable to surmise that rate increases were a major factor causing the differences in the average premium among territories as well as their increase over time. Also, because the latest year available for these data was 2004, they do not reflect the most recent market changes.

Table 4
Homeowners (HO3) Average Premiums: 2000-2004

<table>
<thead>
<tr>
<th>Territory</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indian River/Martin/St. Lucie</td>
<td>$820</td>
<td>$890</td>
<td>$1,042</td>
<td>$1,311</td>
<td>$1,674</td>
</tr>
<tr>
<td>Miami</td>
<td>$1,009</td>
<td>$1,059</td>
<td>$1,207</td>
<td>$1,444</td>
<td>$1,653</td>
</tr>
<tr>
<td>Palm Beach County</td>
<td>$881</td>
<td>$923</td>
<td>$1,054</td>
<td>$1,261</td>
<td>$1,461</td>
</tr>
<tr>
<td>Miami Beach</td>
<td>$872</td>
<td>$856</td>
<td>$754</td>
<td>$881</td>
<td>$1,404</td>
</tr>
<tr>
<td>Broward County</td>
<td>$978</td>
<td>$985</td>
<td>$1,043</td>
<td>$1,171</td>
<td>$1,320</td>
</tr>
<tr>
<td>Dade County II</td>
<td>$1,128</td>
<td>$1,104</td>
<td>$1,088</td>
<td>$1,133</td>
<td>$1,258</td>
</tr>
<tr>
<td>Martin County</td>
<td>$828</td>
<td>$886</td>
<td>$1,021</td>
<td>$1,133</td>
<td>$1,213</td>
</tr>
<tr>
<td>Broward/Palm Beach</td>
<td>$670</td>
<td>$715</td>
<td>$828</td>
<td>$958</td>
<td>$1,170</td>
</tr>
<tr>
<td>Fort Lauderdale/Hollywood</td>
<td>$794</td>
<td>$802</td>
<td>$838</td>
<td>$920</td>
<td>$1,023</td>
</tr>
<tr>
<td>Dade County I</td>
<td>$559</td>
<td>$944</td>
<td>$832</td>
<td>$887</td>
<td>$1,003</td>
</tr>
<tr>
<td>Hialeah</td>
<td>$1,048</td>
<td>$1,091</td>
<td>$1,117</td>
<td>$979</td>
<td>$935</td>
</tr>
<tr>
<td>Tampa</td>
<td>$614</td>
<td>$631</td>
<td>$683</td>
<td>$773</td>
<td>$916</td>
</tr>
<tr>
<td>Bay &quot;et al&quot; I</td>
<td>$504</td>
<td>$634</td>
<td>$725</td>
<td>$821</td>
<td>$912</td>
</tr>
<tr>
<td>Hillsborough/Pinellas</td>
<td>$522</td>
<td>$558</td>
<td>$625</td>
<td>$715</td>
<td>$850</td>
</tr>
<tr>
<td>Key West</td>
<td>$363</td>
<td>$351</td>
<td>$216</td>
<td>$290</td>
<td>$844</td>
</tr>
<tr>
<td>St. Petersburg</td>
<td>$450</td>
<td>$473</td>
<td>$554</td>
<td>$655</td>
<td>$776</td>
</tr>
<tr>
<td>Pinellas County</td>
<td>$362</td>
<td>$470</td>
<td>$451</td>
<td>$517</td>
<td>$729</td>
</tr>
<tr>
<td>Bay &quot;et al&quot; II</td>
<td>$475</td>
<td>$516</td>
<td>$593</td>
<td>$654</td>
<td>$709</td>
</tr>
<tr>
<td>Polk County</td>
<td>$468</td>
<td>$533</td>
<td>$610</td>
<td>$680</td>
<td>$704</td>
</tr>
<tr>
<td>Escambia County</td>
<td>$474</td>
<td>$510</td>
<td>$607</td>
<td>$664</td>
<td>$693</td>
</tr>
<tr>
<td>Orange</td>
<td>$519</td>
<td>$540</td>
<td>$570</td>
<td>$609</td>
<td>$670</td>
</tr>
<tr>
<td>Monroe County</td>
<td>$421</td>
<td>$379</td>
<td>$228</td>
<td>$290</td>
<td>$664</td>
</tr>
<tr>
<td>Osceola/Seminole</td>
<td>$537</td>
<td>$561</td>
<td>$578</td>
<td>$564</td>
<td>$567</td>
</tr>
<tr>
<td>Brevard/Volusia</td>
<td>$431</td>
<td>$455</td>
<td>$498</td>
<td>$522</td>
<td>$545</td>
</tr>
<tr>
<td>Duval County I</td>
<td>$449</td>
<td>$453</td>
<td>$482</td>
<td>$519</td>
<td>$530</td>
</tr>
<tr>
<td>Duval County II</td>
<td>$414</td>
<td>$425</td>
<td>$451</td>
<td>$465</td>
<td>$507</td>
</tr>
<tr>
<td>Alachua &quot;et al&quot;</td>
<td>$454</td>
<td>$511</td>
<td>$511</td>
<td>$477</td>
<td>$469</td>
</tr>
<tr>
<td>Jacksonville</td>
<td>$420</td>
<td>$446</td>
<td>$468</td>
<td>$469</td>
<td>$465</td>
</tr>
<tr>
<td>Mean</td>
<td>$624</td>
<td>$668</td>
<td>$703</td>
<td>$777</td>
<td>$917</td>
</tr>
<tr>
<td>Median</td>
<td>$521</td>
<td>$560</td>
<td>$618</td>
<td>$697</td>
<td>$847</td>
</tr>
</tbody>
</table>

Source of Data: PCIAA; authors' calculations
An alternative approach to measuring sub-state differences and changes in prices is to calculate an average rate per $1,000 of coverage. This approach is less affected by differences in the amount of insurance but still confounds other coverage terms with rates. We can employ this approach with county-level QUASR data and our calculations for the years 1997-2006 are reflected in Tables 5(a)-5(b). The results are quite striking and revealing as the county with the highest rate was Monroe with a rate of $30.70; the county with the lowest rate was Clay with a rate of $2.35. Monroe also experienced the greatest increase from its rate of $18.98 in 1997. This reflects the high level of risk in Monroe County which includes the Florida Keys. Also, the fact that counties’ rankings differ somewhat between the average premium figures and the rate per $1,000 figures reveals that differences in the average amount of insurance can mask or offset differences in the price of insurance.

### Table 5(a)

<table>
<thead>
<tr>
<th>County</th>
<th>1997</th>
<th>2006</th>
<th>County</th>
<th>1997</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alachua</td>
<td>$2.61</td>
<td>$2.76</td>
<td>Lake</td>
<td>$2.83</td>
<td>$2.70</td>
</tr>
<tr>
<td>Baker</td>
<td>$3.49</td>
<td>$2.97</td>
<td>Lee</td>
<td>$3.34</td>
<td>$4.49</td>
</tr>
<tr>
<td>Bay</td>
<td>$3.64</td>
<td>$4.83</td>
<td>Leon</td>
<td>$2.42</td>
<td>$2.38</td>
</tr>
<tr>
<td>Bradford</td>
<td>$3.41</td>
<td>$3.17</td>
<td>Levy</td>
<td>$3.93</td>
<td>$4.02</td>
</tr>
<tr>
<td>Brevard</td>
<td>$3.15</td>
<td>$4.33</td>
<td>Liberty</td>
<td>$4.15</td>
<td>$3.56</td>
</tr>
<tr>
<td>Broward</td>
<td>$5.35</td>
<td>$7.20</td>
<td>Madison</td>
<td>$4.04</td>
<td>$3.34</td>
</tr>
<tr>
<td>Calhoun</td>
<td>$3.80</td>
<td>$3.54</td>
<td>Manatee</td>
<td>$3.37</td>
<td>$3.87</td>
</tr>
<tr>
<td>Charlotte</td>
<td>$3.16</td>
<td>$4.47</td>
<td>Marion</td>
<td>$2.98</td>
<td>$2.90</td>
</tr>
<tr>
<td>Citrus</td>
<td>$2.98</td>
<td>$3.40</td>
<td>Martin</td>
<td>$3.66</td>
<td>$5.63</td>
</tr>
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<td>Clay</td>
<td>$2.55</td>
<td>$2.35</td>
<td>Monroe</td>
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</tr>
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<td>Collier</td>
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<td>$4.93</td>
<td>Nassau</td>
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</tr>
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<td>$2.96</td>
<td>Okaloosa</td>
<td>$3.90</td>
<td>$4.53</td>
</tr>
<tr>
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<td>$7.23</td>
<td>$10.57</td>
<td>Okeechobee</td>
<td>$3.54</td>
<td>$4.29</td>
</tr>
<tr>
<td>Desoto</td>
<td>$3.55</td>
<td>$3.96</td>
<td>Orange</td>
<td>$2.66</td>
<td>$2.91</td>
</tr>
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<td>Dixie</td>
<td>$4.70</td>
<td>$4.72</td>
<td>Osceola</td>
<td>$2.67</td>
<td>$2.97</td>
</tr>
<tr>
<td>Duval</td>
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<td>$2.67</td>
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<td>$2.95</td>
<td>Pinellas</td>
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<td>Polk</td>
<td>$3.00</td>
<td>$3.49</td>
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<td>$4.48</td>
<td>Sarasota</td>
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<td>$4.14</td>
</tr>
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<td>$4.90</td>
<td>$7.36</td>
<td>Seminole</td>
<td>$2.53</td>
<td>$2.92</td>
</tr>
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<td>$4.14</td>
<td>$3.78</td>
<td>St. Johns</td>
<td>$2.71</td>
<td>$2.79</td>
</tr>
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<td>$3.87</td>
<td>$4.08</td>
<td>St. Lucie</td>
<td>$3.95</td>
<td>$4.97</td>
</tr>
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<td>$3.42</td>
<td>$4.22</td>
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<td>$2.72</td>
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<td>$3.46</td>
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<td>$3.62</td>
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<td>$6.29</td>
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<td>Jefferson</td>
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<td>$3.11</td>
<td>Washington</td>
<td>$3.81</td>
<td>$3.70</td>
</tr>
<tr>
<td>Lafayette</td>
<td>$4.36</td>
<td>$3.71</td>
<td>Total</td>
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<td>$4.73</td>
</tr>
</tbody>
</table>

Source: data from FLOIR; authors' calculations
### Table 5(b)
#### Homeowners Insurance Rates per $1,000 by County

<table>
<thead>
<tr>
<th>County</th>
<th>1997</th>
<th>2006</th>
<th>County</th>
<th>1997</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monroe</td>
<td>$18.98</td>
<td>$30.70</td>
<td>Hamilton</td>
<td>$4.14</td>
<td>$3.78</td>
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<td>$10.57</td>
<td>Gadsden</td>
<td>$3.61</td>
<td>$3.78</td>
</tr>
<tr>
<td>Franklin</td>
<td>$6.42</td>
<td>$8.13</td>
<td>Lafayette</td>
<td>$4.36</td>
<td>$3.71</td>
</tr>
<tr>
<td>Gulf</td>
<td>$4.90</td>
<td>$7.36</td>
<td>Washington</td>
<td>$3.81</td>
<td>$3.70</td>
</tr>
<tr>
<td>Broward</td>
<td>$5.35</td>
<td>$7.20</td>
<td>Highlands</td>
<td>$3.24</td>
<td>$3.62</td>
</tr>
<tr>
<td>Palm Beach</td>
<td>$4.45</td>
<td>$6.48</td>
<td>Gilchrist</td>
<td>$3.89</td>
<td>$3.57</td>
</tr>
<tr>
<td>Walton</td>
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<td>$6.29</td>
<td>Liberty</td>
<td>$4.15</td>
<td>$3.56</td>
</tr>
<tr>
<td>Indian River</td>
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<td>$5.67</td>
<td>Calhoun</td>
<td>$3.80</td>
<td>$3.54</td>
</tr>
<tr>
<td>Martin</td>
<td>$3.66</td>
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<td>Volusia</td>
<td>$2.77</td>
<td>$3.50</td>
</tr>
<tr>
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<td>$3.07</td>
<td>$5.15</td>
<td>Polk</td>
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<td>$3.49</td>
</tr>
<tr>
<td>Pinellas</td>
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<td>$5.13</td>
<td>Union</td>
<td>$3.78</td>
<td>$3.48</td>
</tr>
<tr>
<td>Escambia</td>
<td>$3.68</td>
<td>$5.01</td>
<td>Suwannee</td>
<td>$3.91</td>
<td>$3.46</td>
</tr>
<tr>
<td>St. Lucie</td>
<td>$3.95</td>
<td>$4.97</td>
<td>Citrus</td>
<td>$2.98</td>
<td>$3.40</td>
</tr>
<tr>
<td>Collier</td>
<td>$3.88</td>
<td>$4.93</td>
<td>Madison</td>
<td>$4.04</td>
<td>$3.34</td>
</tr>
<tr>
<td>Bay</td>
<td>$3.64</td>
<td>$4.83</td>
<td>Jackson</td>
<td>$3.64</td>
<td>$3.30</td>
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<tr>
<td>Dixie</td>
<td>$4.70</td>
<td>$4.72</td>
<td>Putnam</td>
<td>$3.60</td>
<td>$3.22</td>
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<td>Okaloosa</td>
<td>$3.90</td>
<td>$4.53</td>
<td>Bradford</td>
<td>$3.41</td>
<td>$3.17</td>
</tr>
<tr>
<td>Lee</td>
<td>$3.34</td>
<td>$4.49</td>
<td>Jefferson</td>
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<td>Glades</td>
<td>$3.96</td>
<td>$4.48</td>
<td>Nassau</td>
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<td>$3.07</td>
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<tr>
<td>Charlotte</td>
<td>$3.16</td>
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<td>$3.49</td>
<td>$2.97</td>
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<td>Santa Rosa</td>
<td>$3.06</td>
<td>$4.34</td>
<td>Osceola</td>
<td>$2.67</td>
<td>$2.97</td>
</tr>
<tr>
<td>Brevard</td>
<td>$3.15</td>
<td>$4.33</td>
<td>Columbia</td>
<td>$3.35</td>
<td>$2.96</td>
</tr>
<tr>
<td>Hernando</td>
<td>$2.84</td>
<td>$4.32</td>
<td>Flagler</td>
<td>$2.76</td>
<td>$2.95</td>
</tr>
<tr>
<td>Okeechobee</td>
<td>$3.54</td>
<td>$4.29</td>
<td>Seminole</td>
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<td>$2.92</td>
</tr>
<tr>
<td>Wakulla</td>
<td>$4.26</td>
<td>$4.24</td>
<td>Orange</td>
<td>$2.66</td>
<td>$2.91</td>
</tr>
<tr>
<td>Hendry</td>
<td>$3.42</td>
<td>$4.22</td>
<td>Marion</td>
<td>$2.98</td>
<td>$2.90</td>
</tr>
<tr>
<td>Holmes</td>
<td>$3.89</td>
<td>$4.20</td>
<td>St. Johns</td>
<td>$2.71</td>
<td>$2.79</td>
</tr>
<tr>
<td>Sarasota</td>
<td>$3.30</td>
<td>$4.14</td>
<td>Alachua</td>
<td>$2.61</td>
<td>$2.76</td>
</tr>
<tr>
<td>Hardee</td>
<td>$3.87</td>
<td>$4.08</td>
<td>Sumter</td>
<td>$3.36</td>
<td>$2.72</td>
</tr>
<tr>
<td>Levy</td>
<td>$3.93</td>
<td>$4.02</td>
<td>Lake</td>
<td>$2.83</td>
<td>$2.70</td>
</tr>
<tr>
<td>Taylor</td>
<td>$3.76</td>
<td>$3.97</td>
<td>Duval</td>
<td>$2.76</td>
<td>$2.67</td>
</tr>
<tr>
<td>Desoto</td>
<td>$3.55</td>
<td>$3.96</td>
<td>Leon</td>
<td>$2.42</td>
<td>$2.38</td>
</tr>
<tr>
<td>Manatee</td>
<td>$3.37</td>
<td>$3.87</td>
<td>Clay</td>
<td>$2.55</td>
<td>$2.35</td>
</tr>
<tr>
<td>Hillsborough</td>
<td>$3.44</td>
<td>$3.81</td>
<td>Total</td>
<td>$3.87</td>
<td>$4.73</td>
</tr>
</tbody>
</table>

Source: data from FLOIR; authors’ calculations
Still, at least one caveat should be noted. While the rate per $1,000 of coverage controls for the amount of insurance, we would expect this rate to decline with amount of insurance, all other things equal, because the fixed costs of writing and servicing a policy are spread over a larger amount of insurance. This likely accounts for some of the differences in counties’ rates per $1,000. Hence, it is not a perfect measure of price differences and changes but we would expect it to more heavily influenced by the price of insurance than the average premium measures.

In sum, all of these price measure comparisons tell a similar story. The price of homeowners insurance is: 1) much higher in some areas of the state than others; and 2) the price of insurance has substantially increased, especially in the highest risk areas. Of course, this is no great surprise, but our calculations reveal some of the magnitude of the differences and changes and why property owners in high-risk areas are unhappy about the rising cost of insurance and increasing their pressure on legislators and regulators to “ease their pain.”

Availability of Coverage

The availability of insurance coverage also is an important performance outcome and an area of attention and concern to property owners, government officials and other stakeholders. “Availability” is a somewhat elusive thing to measure or quantify and can mean different things to different people. The preferred definition might be how easy or difficult it is for homeowners to obtain the coverage they want in the voluntary market from the insurers they prefer but acquiring information on this or even measuring availability so defined is difficult.

Hence, economists tend to use other availability indicators such as the proportion of uninsured homes or the size of the residual market. However, there are problems with and caveats to these measures. It is difficult to obtain data on the proportion or number of uninsured homes and the lack of insurance on a home may be at least partly a matter of choice on the part of the homeowner. Also, a home may have insurance, but the amount or breadth of coverage may be considerably less than what the homeowner would prefer. Similarly, the number and proportion of homes/policies in the residual market are affected by a number of factors, of which insurers’ willingness to supply insurance is only one. Finally, this measure can confound prices with the “availability” of coverage – some homeowners may be able to choose to obtain insurance in the residual market because it costs less than what they would be required to pay in the voluntary market.

A discussion of the residual market trends is presented in Chapter 3 of this report which document its significant growth. This is one of several indicators of the tighter availability of homeowners insurance in Florida.

Distribution of Coverage Provisions

The provisions of the insurance policies that property owners buy are also of some interest to policymakers and other stakeholders. The various homeowners insurance policy forms are fairly standard among insurers and insureds but there are certain provisions that are “selected” by insureds that are important. Perhaps the most important provisions are the deductibles on a policy. To better manage their catastrophe exposure and provide insureds with an option to lower their premiums, insurers have offered larger deductibles for wind or
hurricane losses. These larger deductibles are typically expressed as a percentage of the dwelling (Coverage A) limit and could range from 1 to 10 percent in 2006.

To gain some understanding of the distribution and trend of deductible levels, Table 6 shows the distribution of HO-3 policies (house-years) by deductible levels in Florida for 2000 and 2004. These data were obtained from the Insurance Services Office (ISO) and reflect information from insurers reporting statistical data to ISO (which represent approximately 50 percent of the total market). We should also note that, in 2004, the highest wind or hurricane deductible allowed was 5%.

<table>
<thead>
<tr>
<th>Wind/Hurricane Deductible</th>
<th>Pct. of Total House Years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2000</td>
</tr>
<tr>
<td>$1,000 Hurricane</td>
<td>0.46%</td>
</tr>
<tr>
<td>$2,000 Hurricane</td>
<td>0.05%</td>
</tr>
<tr>
<td>$500 Hurricane</td>
<td>7.25%</td>
</tr>
<tr>
<td>1% Hurricane</td>
<td>1.51%</td>
</tr>
<tr>
<td>1% Wind/Hail</td>
<td>0.07%</td>
</tr>
<tr>
<td>2% Hurricane</td>
<td>43.00%</td>
</tr>
<tr>
<td>2% Wind/Hail</td>
<td>3.79%</td>
</tr>
<tr>
<td>5% Hurricane</td>
<td>0.34%</td>
</tr>
<tr>
<td>5% Wind/Hail</td>
<td>0.01%</td>
</tr>
<tr>
<td>All Other</td>
<td>43.53%</td>
</tr>
</tbody>
</table>

Source: data from ISO; authors’ calculations

As is evident in this table, “large” wind deductibles apply to a large and growing proportion of HO-3 policies in Florida. In 2004, almost 47.4 percent of HO-3 policies (issued by ISO reporting companies) carried a 2 percent hurricane deductible and another 11.9 percent carried a 2 percent wind/hail deductible, up from 43 percent and 3.8 percent in 2000, respectively. The proportion of policies with smaller deductibles shrunk by almost 12.5 percentage points to 40.7 percent. Interestingly, policies with a 5 percent wind or hurricane deductibles represented a very small percentage of all policies in 2004, but this could be changing. It would be reasonable to expect that the proportion of policies with larger deductibles has continued to grow and is currently at a higher level than that indicated in the 2004 data.

In subsequent iterations of this paper, we will further analyze the distribution of policies by their deductible levels and other characteristics at a sub-state level and compare Florida’s experience with that of New York.

**Profitability**

Firms’ profitability is an important market performance outcome. In an efficient, competitive market, long-run profits would be expected to provide firms a “fair” rate of return equal to their risk-adjusted cost of capital. If firms’ profits are too low, it will encourage market exit or retrenchment that could have adverse effects on consumers. On the other hand, if firms
sustain high profits over the long term, it would raise questions about the competitiveness of the market\textsuperscript{164}.

The problem in insurance markets, especially in lines like homeowners insurance, is that profits can be highly volatile from year to year. In other words, insurers can earn low or negative profits in some years and what appear to be high profits in other years. Still, over the long-run, profits would be expected to “average out” near what would be considered a fair rate of return. This is close to being the case in homeowners insurance markets that are subject to “normal” weather-related perils, but hurricane-prone markets are subject to much greater volatility and much longer “return periods”. Insurers might have been prepared to handle an occasional severe hurricane (e.g., a Hurricane Andrew level event every 10 years) but not the back-to-back multiple-event years experienced in 2004 and 2005.

Even the relatively frequent occurrence of more modest level hurricanes, e.g., $1-$10 billion in losses for each, can drive insurers’ state and regional results deep into the “red” and keep them there for some time. This generates significant concern among their owners (stockholders or member-owners for mutual companies) who do not expect the managers of these insurers to continue to subject their companies to such sustained losses in any segment of their business. For those who would question the problems created by such scenarios, one might ask whether they would be comfortable having a substantial portion of their savings invested in insurers subject to these kinds of losses.

There are several different profit measures that are used in insurance, including loss ratios, underwriting ratios, operating ratios, profits on insurance transactions, and estimates of the return on equity. We focus on “profits on insurance transactions” (PIT), which is a measure published by the NAIC by line and by state, with some supplemental observations on other profit measures. This PIT measure includes incurred losses, all expenses, investment income attributable to loss and premiums reserves (not surplus), and estimated federal taxes on the income earned (or tax credits on negative income)\textsuperscript{165}. The resulting profit (or loss) is divided by direct premiums earned to produce a profit rate. The NAIC has published profitability data only through 2004 – it has not yet published profitability results for 2005. Hence, we attempt to approximate a PIT figure for 2005 based on information from the NAIC’s financial database and other sources.

Figure 2 plots insurers’ annual PIT rates for homeowners insurance in Florida for the period 1992-2005. As can be seen from this figure, insurers earned positive profits in most of the years during this period, but had losses (negative profits) in 1992, 1993, 2004, and 2005. Insurers generated negative profits of -172.8 percent in 2004 and -87.8 percent in 2005\textsuperscript{166}. Of

\textsuperscript{164} The term “long-run” can be ambiguous in the context of catastrophe risk. In homeowners insurance markets not subject to catastrophe risk, 5-10 years might be sufficient for insurers to balance out their profits and losses. However, in homeowners insurance markets subject to catastrophe risk, it may take much longer for profits and losses to balance out (assuming that rates were set at adequate levels). This makes it difficult to assess whether profits approximate a fair rate of return over the long run.

\textsuperscript{165} Readers should note that all of the data used in these profit calculations are based on statutory financial statements filed by insurers.

\textsuperscript{166} Our estimate of 2005 profits is conservative – it is likely that insurers’ PIT was worse than what we have estimated. Also, some of the losses arising from 2005 events are likely to be reflected in the 2006 results.
course, the negative profits in these years stemmed from Hurricane Andrew and the hurricanes that struck the state in 2004 and 2005.

These results reflect the volatility in insurers’ results caused by hurricanes discussed above. Also, as we discussed, insurers expect income volatility in hurricane-prone areas but there are issues with respect to how much volatility they can “comfortably” accommodate as well as the impact of hurricane losses on their long-term profitability and firm value.

Figure 3 plots cumulative profits (losses) for homeowners insurance in Florida for the period 1992-2005 – each year represents accumulated profits and losses from previous years. We can see from this figure that insurers on the whole have remained under water over the entire period. Cumulative losses decreased over the period until 2004. If insurers had earned positive profits in Florida in 2004-2005, they would have dug themselves out of the hole created by Hurricane Andrew. Even with more modest losses in 2004, they could have looked forward to eventually generating positive profits for the entire period (barring more hurricane losses), but the heavy storm seasons of 2004 and 2005 quashed any such hopes. On a cumulative basis as of the end of 2005, insurers were $14.7 billion in the red on their Florida’s homeowners business (representing -41.0 percent of cumulative premiums earned). Hence, insurers perceive that they are again deep in the hole with respect to their Florida and Southeast operations and it will require a sustained period of positive profits to dig themselves out of this hole. If insurers earn positive profits in 2006, it helps improve their long-term performance, but additional profitable years will be needed to pull long-term profits above the red line\(^{167}\).

Of course, historical losses might be viewed as sunk costs and irrelevant to insurers’ decisions regarding the future. However, if an insurer believes that this history will repeat itself, i.e., they are likely to continue to incur losses over the years ahead and are unlikely to ever earn a fair rate of return on a long-term basis, then it would be understandable that they would be reluctant to continue to maintain the same level of operations under current conditions.

Some critics of the industry have argued that insurers’ losses in a particular state or region should not be a problem if their operations in other states/lines are profitable. These critics argue that this view is consistent with the notion of pooling exposures and losses across geographic areas and lines of business. There is a problem with this argument, however. Insurers are prepared to use income from and capital dedicated to other areas and lines to absorb \textit{unexpected} loss shocks from a particular line and state or region. Sustained or continuing losses from a particular segment of business are another matter. No firm would be expected to maintain operations in a segment of business that continued to generate losses over a long period and decreased firm value.

Insurers are now doing what would be expected of prudent stewards of the funds and assets entrusted to them. Ultimately, insurers have to reach a position where they believe that they will generate reasonable profits over the long term and not put the solvency of their companies at significant risk or create cross-subsidies from their insureds in low-risk states to their insureds in high-risk states\(^{168}\). Until they reach that position, it is reasonable to expect that there will be further market changes. If, when and where a new equilibrium will be reached will

\(^{167}\) Profits in 2006 may be diminished by losses arising from 2005 claims as discussed above. The same pattern occurred after Hurricane Andrew when insurers sustained negative profits in 1992 and 1993.

\(^{168}\) Given the competitiveness of home insurance markets in the various states, it would be difficult for insurers to sustain substantial cross-subsidies. The payers of such subsidies would be expected to seek out insurers with lower rates that were not engaging in cross subsidization.
depend on a number of factors, including actual loss experience, medium and long-term weather forecasts, risk assessments and the confidence in them, and regulatory and other government policies and actions.

Figure 2. Homeowners Insurance - Profit Rates (% of Premiums Earned), Florida: 1992-2005

Figure 3. Homeowners Cumulative Profit Rates in Florida: 1992-2005
III. Conclusions and Further Research

Our analysis of developments in the Florida homeowners insurance market confirm and measure the significant changes that are occurring as a result of increased hurricane risk. There has been substantial market restructuring, with leading insurers decreasing their shares of the market and other insurers retrenching or exiting from the market, especially in the highest risk areas. Other insurers are maintaining their relative market positions and some have entered or expanded their business. Overall, market concentration has decreased significantly at statewide and sub-state levels.

The price of property insurance also has increased significantly, particularly in the highest risk areas. At the same time, the availability of coverage has tightened considerably, reflected in the growing number of policies and amount of exposures insured in the residual market mechanism – the CPIC. One interesting finding is that the greatest price increases and tightening of availability have occurred in coastal areas other than southern Florida. This suggests that insurers saw a greater need to make larger adjustments in these other coastal areas which had not previously experienced the magnitude of the rate increases and residual market shifts that had occurred in southern Florida prior to 2004.

Finally, it is apparent that insurers suffered substantial losses (negative profits) in 2004 and 2005 due to the hurricanes that hit Florida in these years. Prior to 2004, insurers were about to raise their cumulative profits (since Hurricane Andrew) to a positive level, but the 2004-2005 storms drove them deeper into the red on a cumulative basis. This has contributed to insurers’ price and underwriting adjustments and concerns about the economic feasibility of writing home insurance in Florida and other high-risk areas under the prices and terms of coverage that proceeded these storm seasons. If storm activity continues to ebb as it did in 2006, it will allow insurers to improve their long-run profitability and ease market pressures. On the other hand, if more active storms seasons return, they could worsen insurers’ results and prompt further market adjustments.

Clearly, there is a need to update, expand and deepen our analysis of market conditions to increase our understanding of how property insurance markets are changing and the factors that are driving the changes. In future papers, we will expand our analysis to other coastal states and probe further into market structure, conduct and performance trends. We will also be able to update our data on what has occurred in 2006 which, based on anecdotal information, has seen the most dramatic market adjustments. Expanding and deepening our understanding of market conditions and changes will help us determine the magnitude of and factors driving these changes and what economically-sound strategies might have the most beneficial effects for both insurers and property owners.
Part D

Protecting Homeowners Against Natural Disasters
CHAPTER 11

INCREASING DEMAND FOR PROTECTIVE MEASURES THROUGH PUBLIC-PRIVATE PARTNERSHIPS

Up until now we have concentrated primarily on financial protection against natural disasters with a focus on insurance and reinsurance. This chapter discusses the role that mitigation measures can play in reducing losses from natural disasters and the positive role that insurance can play in encouraging homeowners to adopt cost-effective protective measures.

11.1. The Role of Insurance as a Bridge between Mitigation and Risk Financing

The challenge society faces today is how to promote investments in cost-effective loss reduction mechanisms while at the same time placing the burden of recovery on those who suffer losses from natural disasters. In theory, insurance is one of the most effective policy tools for achieving both objectives because it rewards investments in cost-effective mitigation with lower premiums and provides claims payments to policyholders should a disaster occur.

In practice, insurance has not played this role so much in recent years. Insurers generally have not fully implemented pricing adjustments which encourage the adoption of cost-effective loss prevention measures for several reasons. First, they feel that few people would voluntarily adopt these measures based on the small annual premium reductions compared to the upfront cost. If individuals have short time horizons then there would be little interest in investing $1500 in return for a reduction in annual premiums of say $200.

As pointed out in Chapters 1 and 5, insurance is a highly regulated industry with rate changes and new policies generally requiring the approval of state insurance commissioners. If premiums are highly subsidized in hazard-prone areas, insurers have no economic incentive to offer premium discounts for those who adopt mitigation measures. In fact, they prefer not to offer coverage to these property owners because it is a losing proposition in the long-run.

To link mitigation with risk financing through insurance one needs to have risk-based insurance rates so that insurers will want to provide premium reductions for those adopting these measures. Furthermore there is a need to better understand decision making of homeowners as to why some invest in mitigation measures when others do not.

There is also a need to bring in other key interested parties from the private sector, such as the construction industry and the banks, so that mitigation can be seen as an attractive investment by property owners. Well-enforced building codes may play a key role in encouraging the private sector to take a proactive role with respect to fostering cost-effective mitigation measures. We now discuss each of these issues in more detail.

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169 We would like to thank Ankush Bajaj for his research assistance on issues discussed in this chapter. For further discussion and recommendations as to ways to reduce future disaster losses through mitigation, see The Financial Services Roundtable, Blue Ribbon Commission on Mega-Catastrophes Comprehensive Report, Chapter 4 (in press).

Table 11.1 summarizes the level of damage associated with different categories of hurricanes along with sustained wind speed and anticipated storm surge.

<table>
<thead>
<tr>
<th>Scale Number (Category)</th>
<th>Sustained Winds (MPH)</th>
<th>Damage</th>
<th>Storm Surge</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>74-95</td>
<td>Minimal: Damage is done primarily to shrubbery and trees, unanchored mobile homes are damaged, some signs are damaged, no real damage is done to structures.</td>
<td>4-5 feet</td>
</tr>
<tr>
<td>2</td>
<td>96-110</td>
<td>Moderate: Some trees are toppled, some roof coverings are damaged, and major damage is done to mobile homes.</td>
<td>6-8 feet</td>
</tr>
<tr>
<td>3</td>
<td>111-130</td>
<td>Extensive: Some structural is done to roofs, mobile homes are destroyed, and structural damage is done to small homes and utility buildings.</td>
<td>9-12 feet</td>
</tr>
<tr>
<td>4</td>
<td>131-155</td>
<td>Extreme: Extensive damage is done to roofs, windows, and doors; roof systems on buildings completely fail; some curtain walls fall.</td>
<td>13-18 feet</td>
</tr>
<tr>
<td>5</td>
<td>More than 155</td>
<td>Catastrophic: Roof damage is considerable and widespread, windows and door damage is severe, there are extensive glass failures, some complete buildings fall.</td>
<td>Greater than 18 feet</td>
</tr>
</tbody>
</table>

Source: FEMA\textsuperscript{170}

Of course damage will depend on the level of mitigation measures in place at the time of the disaster. The damage to property from natural disasters falls into two categories – structural damage and contents damage (damage to the land itself can also occur, but it is generally not a major consideration). Structural damage refers to the damage to the foundation, frame, roof and other features, exterior and interior, of the property at risk. Contents damage refers to the damage to valuable internal contents of a property – automobiles, furniture, fixtures, appliances, electronics and other contents with a monetary or non-monetary value (the latter can include irreplaceable documents and items with sentimental value)\textsuperscript{171}.

**Earthquakes**

To reduce damage from seismic events requires both contents mitigation and structural mitigation. Contents mitigation consists of attaching itinerant objects and fixtures or storage units to the frame of the property. This includes fixing lighting, bookshelves and large appliances to the structure of the house, making sure that cabinets fasten securely and that windows and


\textsuperscript{171} These two types of damage also interact in that structural damage can cause contents damage to occur (when a broken window allows in water from a flood or hurricane) and contents damage can cause structural damage to occur (as when an unsecured water heater topples following an earthquake, causing fire damage to the property). Additionally, either kind of damage can cause injury or loss of life, whether from broken glass windows or a structure that collapses or is destroyed by fire.
doors are secured and protected from breakage. Fastening the water heater to the wall is a major mitigation measure, not only because of the cost of replacement but because it might start a fire that could damage the house and possibly spread to neighboring properties. Structural mitigation for earthquakes largely consists of tying a structure together (IBHS, 2001). For example, a wood frame structure should have its cripple wall braced and the foundation secured with additional anchor bolt. Other components of the structure, including the roof and exterior components (such as garages, additions and chimneys) should be strong enough to withstand an earthquake.

**Wind Damage Due to Rising Water**

The major danger posed wind from windstorms and hurricanes is to the structure of the property. The major areas of focus are the roof and windows and doors. Roofs should be secured by replacing old or damaged sheathing, sealing sheathing joints and installing a roof covering that can withstand high winds. Connections, where the roof meets the walls and where the walls meet the foundation, should be well anchored. Windows and doors, the most vulnerable portion of the structure to wind damage, can be breached causing interior structure and contents water damage. Windows can be secured with impact resistant window systems or storm shutters, patio doors should be non-sliding and high–wind-resistant garage door and track systems are recommended. Another mitigation measure is to ensure that objects on the property that could become debris in a windstorm, especially overhanging tree branches, are cleared.

**Water Damage**

To reduce water damage from floods and hurricanes property owners can undertake a variety of flood proofing measures that include building their homes with flood-resistant material, bracing roof trusses, and gable end walls, applying wood adhesive where the roof decking and roof supports meet, installing hurricane straps or clips where the roof framing meets the top of the studs, and elevating the structure.

**Wildfires**

Exposure to wildfires is highest for those properties in close proximity to uncleared wild land. The roof of a structure is most vulnerable to wildfires, and the best mitigation measure is fire resistant roofing materials. The same measure is appropriate for the walls of the structure. Double pane windows will reduce the amount of heat allowed into the structure better than single pane windows. Eaves of roofs should be enclosed and attics and subfloors should be vented. Chimneys should be fitted with spark arrestor overhangs and other structural

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attachments should be assessed for vulnerabilities. Flammable materials on the property, such as overgrown trees and dry brush, should be kept well maintained (“survivable space”).

Table 11.2 summarizes some of the examples of mitigation measures for different types of perils.

Table 11.2. Examples of Natural Hazards and Mitigation Measures

<table>
<thead>
<tr>
<th>Peril</th>
<th>Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>• Building Codes</td>
</tr>
<tr>
<td>Earthquake</td>
<td>• Secure water heater</td>
</tr>
<tr>
<td></td>
<td>• Secure structure to foundation</td>
</tr>
<tr>
<td></td>
<td>• Secure roof to walls</td>
</tr>
<tr>
<td>Windstorms</td>
<td>• Storm shutters</td>
</tr>
<tr>
<td></td>
<td>• Keep trees trimmed</td>
</tr>
<tr>
<td></td>
<td>• Secure roof to walls</td>
</tr>
<tr>
<td>Wildfires</td>
<td>• Fire resistant roofing</td>
</tr>
<tr>
<td></td>
<td>• Maintaining survivable space</td>
</tr>
<tr>
<td>Water</td>
<td>• Flood-resistant material</td>
</tr>
<tr>
<td></td>
<td>• Bracing roof trusses</td>
</tr>
<tr>
<td></td>
<td>• Elevating the structure</td>
</tr>
</tbody>
</table>

11.3. Cost-effectiveness of Mitigation Measures

One of the challenges associated with mitigation of catastrophic risks lies in demonstrating the effectiveness of mitigation measures and that they provide a sufficient expected return on investment over a certain period of time. As government has been allocating money to support mitigation efforts, an important question relates to the effectiveness of these governmental grants.

That was the purpose of a multi-year study undertaken by the U.S. National Institute of Building Science and released in 2005. This initiative systematically assessed the future savings from hazard mitigation activities supported by the U.S. Federal Emergency Management Agency’s grants for a period of 10 years (1993-2003). The study quantified these savings for three types of hazards: wind, flood and earthquake. Benefits were defined as losses avoided and included reduced direct property damage, reduced direct business interruption, reduced indirect business interruption (“ripple” effects), reduced environmental damage (to wetlands, parks or historical structures), and reduced human losses (deaths, injuries, homeless). Benefits also included reduced cost of emergency responses as well as reduced federal funds that would be used otherwise for disaster assistance/recovery (including post-disaster tax revenue decrease because of tax-break or interruption of activities).

These findings are interesting because they demonstrate a high benefit/cost ratio of mitigation grants. The study estimates that aforementioned benefits from FEMA mitigation grants represent 14 billion dollars (in 2005 dollars), compared to 3.5 billion dollars for grants spent by FEMA on the studied programs. In other words, using a statistically representative sample of FEMA grants awarded between 1993 and 2003, it can be shown that 1 dollar spent on mitigating the risk of wind, flood and earthquake in the United States saves an average of 4 dollars (U.S. National Institute of Building Science, 2005).\(^{174}\)

On the human side, it is estimated that these mitigation measures are likely to save over 200 lives and prevent almost 4,700 injuries in the long term (50 years). The U.S. National Institute of Building Science’s Multihazard Mitigation Council rightly indicates that federal grants are not only cost effective, but that they also often lead to additional mitigation measures to be implemented that are supported by other sources, especially in communities/parishes that have implemented specific mitigation programs in a systematic way.

As the Council recommended: the “federal government should support ongoing evaluation of mitigation by developing a structured process for assessing the performance of buildings and infrastructure after all types of natural disasters and by measuring the benefits that accrue from process mitigation activities.”\textsuperscript{175} This is certainly something insurers and reinsurers would have an interest in, because the implementation of effective risk protection measures will decrease insurance claims after the next disaster as well.

11.4. Role of Building Codes

Building codes require property owners to meet standards on new structures but normally do not require them to retrofit existing structures. Often such codes are necessary, particularly when property owners are not inclined to adopt mitigation measures on their own due to their misperception of the expected benefits resulting from adopting the measure and/or their inclination to underestimate the probability of a disaster occurring.

Cohen and Noll (1981)\textsuperscript{176} provide an additional rationale for building codes. When a structure collapses, it may create externalities in the form of economic dislocations and other social costs that are beyond the financial loss suffered by the owners. For example, if a poorly designed structure collapses in a hurricane, it may cause damage to other buildings that are well designed and still standing from the storm. Knowing this, an insurer may offer a smaller premium discount than it would otherwise have given to a homeowner investing in loss reduction measures.

Two agencies that rate building codes in the U.S. are the International Code Council (ICC) and ISO. ICC is a membership association which produces model building codes which can then be implemented or modified by individual states. 47 states plus Washington, D.C. use the International Building Code (which focuses on non-residential property), 45 states plus Washington, D.C. use the International Residential Code (which deals with the construction of one- and two-family dwellings and townhouses up to three stories high) and 42 states plus Washington, D.C. use the International Fire Code (which addresses fire safety in new and existing buildings) (International Code Council, 2006)\textsuperscript{177}.

ISO’s Building Code Effectiveness Grading Schedule (BCEGS) “…assesses the building codes in effect in a particular community and how the community enforces its building codes, with special emphasis on mitigation of losses from natural hazards.” The Insurance Services Office (ISO) uses the BCEGS as part of the Community Rating System (CRS), a component of the

\textsuperscript{175} Ibid., Vol. 1, p. 7.
\textsuperscript{177} International Code Council (2006); http://www.iccsafe.org/government/adoption.html, as of December 2006.
National Flood Insurance Program (NFIP) which allows communities to achieve lower flood insurance rates through mitigation (ISO, 2006)\(^{178}\).

The level of enforcement of building codes determines their effectiveness. The BCEGS is one way to judge adherence to building codes since the score is based not only on the building code in place but also on field inspector staffing and qualifications. However, only a small number of communities (around 1,000 at risk from flooding nationwide) participate in the CRS, so it is an incomplete national indicator of code adherence. More detailed assessment of building code enforcement at the local level often takes place on an *ex post* basis with disasters such as the Northridge Earthquake or Hurricane Katrina serving as the impetus for such a review.

### 11.5. Factors Influencing the Adoption of Mitigation Measures\(^{179}\)

**A Normative Model of Choice: Benefit-Cost Analysis**

Consider the Adamses, a hypothetical family whose home was destroyed by one of the four hurricanes that hit Florida in 2004. They have decided to rebuild their property in the same location but are unsure, however, whether they want to invest in a wind reduction measure (e.g., storm shutters; secure roof to walls)\(^{180}\). Suppose that scientific experts have estimated that the annual chances of a severe hurricane in the area where the Adamses live is 1 in 100. If they invested in a wind mitigation measure they would reduce damage from this hurricane by $40,000. In other words, the expected annual benefit from investing in such a measure would be $400 (i.e. 1 in 100 x $40,000). The longer the time period \(T\) that the Adamses expect to live in their house, the greater the expected benefit from hurricane-proofing their house. More specifically, let \(B\) represent the expected net present value of the benefit of mitigation over the entire time horizon \(T^{181}\).

Suppose the extra cost to the Adamses of undertaking windproofing measures is \(C = \$1200\). Let \(T^*\) represent the minimum number of years for the loss-reduction investment to be cost-effective. In other words \(T^*\) is the smallest time period where \(B/C > 1\). The second column in Table 11.3 depicts the expected benefit-cost ratio as a function of \(T\) associated with such an investment if the Adamses’ annual discount rate was 10 percent.

It is clear that if the family planned to live in their home for more than 4 years they would want to windproof their house if they were risk neutral. If the Adamses were risk averse, then \(T^* < 4\) because they would be more concerned with the financial consequences of suffering a large loss from the next disaster and would thus find the expected benefits of mitigation even more attractive than if they were risk neutral.

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\(^{181}\) If the resale value of the house were increased due to mitigation this would be an additional benefit.
The Adams family and other residents of Florida could have debated whether to windproof their homes prior to 2004 but suppose they decided not to do so. It is instructive to ask why they chose not to adopt cost-effective mitigation measures.

### Table 11.3. Expected Benefit/Cost Ratio of Investing in Mitigation Measure as a Function of Time Horizon, Perceived Loss Reduction and Perceived Probability (p)

<table>
<thead>
<tr>
<th>Time Horizon (in years)</th>
<th>Loss Reduction ($40,000)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>p=1/100</td>
</tr>
<tr>
<td>1</td>
<td>.30</td>
</tr>
<tr>
<td>2</td>
<td>.58</td>
</tr>
<tr>
<td>3</td>
<td>.83</td>
</tr>
<tr>
<td>4</td>
<td><strong>1.06</strong></td>
</tr>
<tr>
<td>5</td>
<td>1.26</td>
</tr>
<tr>
<td>10</td>
<td>2.05</td>
</tr>
<tr>
<td>15</td>
<td>2.54</td>
</tr>
<tr>
<td>20</td>
<td>2.83</td>
</tr>
<tr>
<td>25</td>
<td>3.03</td>
</tr>
</tbody>
</table>

**Why Individuals Do Not Voluntarily Undertake Cost-Effective Mitigation Measures**

**Underestimation or Ignoring Probabilities**

Many individuals perceive the probability of a disaster causing damage to their home as being sufficiently low that they cannot justify investing in mitigation even if they evaluate the risk systematically by comparing the expected benefits with the cost of protection. Suppose the Adams family perceived the annual chances of a severe flood damaging their home to be 1 in 300 rather than the scientists' estimate of 1 in 100. As shown in Column 3 of Table 11.3, the value of $T^*$ is now more than six times higher, so the Adams would have to expect to live in their home for at least the next 25 years in order to want to invest in this mitigation measure\(^{182}\).

According to the 2004 Housing survey for the New Orleans Metropolitan Area, the median tenure of occupancy is 11 years for owner-occupied residences, so if most residents with neighboring homes similar to the Adamses’ misperceived the risk in this manner, they would not want to floodproof their structure (U.S. Department of Housing and Urban Development and U.S. Census Bureau 2004)\(^{183}\).

Prior to Katrina many inhabitants of Louisiana did not focus on the likelihood of their house being flooded when making decisions on whether it should be mitigated. As a result they did not even think about the consequences of future flooding from a hurricane and hence did not make the tradeoffs between expected benefits and costs.

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\(^{182}\) Note that we are assuming that they will not recoup some of the cost of mitigation should they sell their house.

Research shows that decision makers use “threshold models,” whereby if the probability of a disaster is below some prespecified level they do not think about the event\textsuperscript{184} in making decisions. In the case of damage from floods or hurricanes, levees or other flood control projects are likely to have given residents a false sense of security. In fact, Gilbert White pointed out many years ago that when these projects are constructed individuals believe that they are fully protected against future disasters and hence there are increased developments in these “protected” areas\textsuperscript{185}. Should a catastrophic disaster occur in which residents of the area are flooded, the damage is likely to be considerably greater than before the flood control project was initiated. This behavior and its resulting consequences are known as the \textit{levee effect}. If the Adams family believed they were protected by the levees, they would not have any interest in investing in a loss mitigation measure no matter how large the savings would be.

\textbf{Short Time Horizons} In making decisions that involve cost outlays individuals are often myopic and hence only take into account the potential benefits from such investments over the next year or two. This is one reason that consumers are often reluctant to buy energy-efficient appliances that promise to reduce their monthly electricity bills over the life of the appliance\textsuperscript{186}. In the example in Table 11.3 if the Adams family wanted to recoup their investment in less than 5 years, then if they had utilized the experts’ estimate of the risk, they would still not have windproofed their house.

In one study, subjects indicated the maximum they were willing to pay for such protective measures as investing in a dead bolt lock for their apartment, purchasing a steering wheel club and strengthening their homes against earthquakes (Kunreuther et al. 1998)\textsuperscript{187}. Many of the arguments used by respondents suggest that they focused on the cost of the product in determining how much they are willing to pay to invest in a protective measure and do not take into account the expected benefits over more than one year. These justifications are consistent with experiments by Schkade and Payne (1994)\textsuperscript{188} and Baron and Maxwell (1996)\textsuperscript{189}, which revealed that the willingness to pay for public goods was affected by cost information. This tendency toward myopia is one of the most widely-documented failings of human decision


making. As a rule, we have difficulty considering the future consequences of current actions over long time horizons (Meyer and Hutchinson 2001)\textsuperscript{190}.

\textit{Budget Constraints} \hspace{1em} If the Adams family focuses on the upfront cost of windproofing their house and they have limited disposable income after purchasing necessities, then they will not even consider taking this step. The budget constraint for investing in protective measures may extend to higher-income individuals if they set up separate mental accounts for different expenditures. Thaler (1999)\textsuperscript{191} suggests that dividing spending into budget categories facilitates making rational trade-offs between competing use of funds and acts as a self-control device. He points out that poorer families tend to have budgets defined over periods of a week or a month while wealthier families are likely to use annual budgets. Heath and Soll (1996)\textsuperscript{192} provide further evidence on the role of budget categories by showing how actual expenses are tracked against these budgets.

A response by several individuals when asked why they were only willing to pay a fixed amount for a dead bolt lock when the lease for the apartment was extended from 1 to 5 years supports this mental accounting argument. One responder said simply:

“$20 is all the dollars I have in the short-run to spend on a lock. If I had more, I would spend more—maybe up to $50.” (Kunreuther, Onculer and Slovic (1998) p. 284)\textsuperscript{193}.

\textit{Social Norms and Interdependencies} \hspace{1em} Suppose the Adams family was considering elevating their house on piles so as to reduce flood losses from a future hurricane. If none of their neighbors have taken this step their house would look like an oddity in a sea of homes at ground level. Should the Adams choose to move, they would be concerned that the resale value of their home would be lower because the house was different from all the others. Given that there is a tendency not to think about a disaster until after it happens, the Adamses may reason that it would be difficult to convince potential buyers that elevating their house should increase its property value.

The question as to how actions of others impact one’s own decisions relates to the broader question of social norms and interdependencies. With respect to social norms, if all homes in the neighborhood had put strong storm shutters, then the Adams would very likely want to follow suit; if none of them had taken this step, then they would not have an interest in doing so. The problem of interdependencies arises if there is the possibility that unprotected homes can cause damage to a home that has adopted mitigation measures. In this example, if the Adamses decide to install storm shutters for their home but its neighbors have not taken


this action, then one of these non-protected homes could be severely hit during the next hurricane and pieces of it could cause damage to the Adamses' home which would otherwise have been spared.

It is conceivable that if a few leaders in the community protect their house then others would do the same. This type of tipping behavior is common in many situations and has been studied extensively by Schelling (1978) and popularized by Gladwell (2000). Heal and Kunreuther (2005) provide a game theoretic treatment of the topic and indicate that there is a wide range of problems that come under this rubric. They suggest ways to coordinate actions of those at risk ranging from subsidization or taxation to induce tipping or cascading to rules and regulations such as well-enforced building codes.

11.6. The Need for Public-Private Collaborations for Encouraging Mitigation

Recent extreme events have highlighted the challenges associated with reducing losses from hurricanes and other natural hazards due to what one of us has termed the “natural disaster syndrome” (Kunreuther, 1996). It consists of ex ante and ex post components that are interconnected. Before a disaster, most homeowners, private businesses and the public sector do not voluntarily adopt cost-effective loss reduction measures. Hence the area is highly vulnerable and unprepared in the case of a severe hurricane or other natural disaster. The magnitude of the destruction following a catastrophe leads the government to provide disaster relief to victims even if it claimed it had no intention of doing so prior to the event. This combination of underinvestment in protection prior to the event and liberal use of taxpayers' funds after a disaster does not augur well for the future.

There is extensive evidence that most 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.

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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 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 so that they are resistant to disasters and individuals do not voluntarily adopt mitigation measures, one can expect large scale losses following a disaster, as evidenced by the property damage to New Orleans caused by Hurricane Katrina.

Kydland and Prescott (1977)\textsuperscript{201} in their Nobel Prize winning contribution show that a discretionary policy, which may be optimal given the current situation, may not necessarily result in a socially optimal policy in the longer run. As a specific example of this general proposition, the authors note that unless individuals are initially prohibited from locating in a flood plain, it will be very difficult politically to force these people to leave their homes. In making their decisions to locate there, Kydland and Prescott indicate that these individuals believe that the Corps of Engineers will subsequently build dams and levees if enough people choose to build homes these flood plains. A large number of homeowners then decide to locate in these high hazard areas for that reason and the Corps of Engineers is forced to invest in flood control projects. Hence there is a need for having explicit, enforced rules, such as land use regulations and well-enforced building codes, rather than giving people the freedom to locate where they want and to build whatever type of structure they would like to live in.

In the U.S., even after the 2004 and 2005 hurricane seasons that considerably raised the level of awareness, a large number of residents have not invested in loss reduction measures with respect to their property or undertaken emergency preparedness measures. In a survey of 1,100 adults living along the Atlantic and Gulf Coasts undertaken in May 2006, 83 percent had taken no steps to fortify their home this year, 68 percent had no hurricane survival kit and 60 percent had no family disaster plan\textsuperscript{202}.

The Politician’s Dilemma

The fact that politicians can benefit from their generous actions following a disaster raises basic questions as to the capacity of elected representative 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, 2006)\textsuperscript{203}.

Imagine an elected representative at the city or state level. Should he push for people and firms in this city or state to invest in cost-effective mitigation measures to prevent or limit the occurrence of a disaster? The long-term answer should be “yes”. But the short-term answer


influenced by re-election considerations might lead this individual to allocate taxpayers’ money elsewhere where he can gain more political capital.

As a result, he might resist investing in disaster reduction measures particularly if he believes that his constituency does not worry about these events, but then support federal assistance should a disaster occur in his area. Following a disaster, when residents in an area are concerned with the possibility of future losses, politicians will often favor stronger building codes and other ways to reduce the damage from the next catastrophe. This mitigation dilemma facing politicians has received little attention in the hazards literature.

**Linking Mitigation with Insurance and Mortgage Loans**

In reexamining strategies for reducing losses from disasters in the future, one needs to strike a balance between satisfying the objectives of the individual living in a hazard-prone area and the general public. Banks can play a key role in this regard by working with insurers and the housing government-sponsored enterprises (GSEs) to provide home improvement loans that finance mitigation.

Consider a family who is residing in an area subject to damage from hurricanes. If they have mortgage, then banks require them to purchase homeowners insurance that covers wind damage from hurricanes. Banks could also require that a third-party inspector ensure that structures meet the relevant building codes. To make the adoption of these mitigation measures financially palatable from the property owner’s perspective, banks holding the mortgage on the property could provide funds for this purpose through a home improvement loan with a payback period identical to the life of the mortgage.

Suppose the mitigation measure considered by the family costs $1,500. A 20-year loan for $1,500 at an annual interest rate of 10 percent would result in payments of $145 per year (i.e., $12 per month). If the annual insurance premium reduction due to the adoption of the mitigation measure is greater than $145, the insured homeowner would have lower total payments by investing in mitigation. Suppose he expected annual insurance premium reduction on homeowners insurance if rates were risk-based was $300. If the insurance premium were reduced by this amount, the annual savings to the property owner would be $155 (i.e. $300-$145).

A bank would have a financial incentive to provide this type of loan. By linking the expenditure in mitigation to the structure rather than to the property owner, the annual payments are lower and this would be a selling point to mortgagees. The bank will also feel that it is now better protected against a catastrophic loss to the property and the insurer knows that its potential loss from a major disaster is reduced. These mitigation loans would constitute a new financial product. Moreover, the general public will now be less likely to have large amounts of their tax dollars going to disaster relief. A win-win-win-win situation for all!

There is an additional benefit to insurers from having banks ensure that their mortgagees have met existing building codes. The costs of reinsurance that protects insurers

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against catastrophic losses should now decrease. If reinsurers know that they are less likely to make large payments to insurers because each piece of property in a region now has a lower chance of experiencing a large loss, then they will reduce their premiums to the reinsurer for the same reason that the insurer is reducing its premium to the property owner.

Suppose that an insurer had 1,000 identical insurance policies in the area in which the above family lived, each one of which would expect to make claims payments of $50,000 following a hurricane if homes were not mitigated in the way that the Adamses were considering. The insurer’s expected loss from such a disaster would be $50 million. To protect its surplus the insurer would want to have $25 million in coverage from a reinsurer. If the hypothetical hurricane has a 1 in 100 chance of hitting the region where these families reside, the expected loss to a reinsurer would be $250,000 and the premium charged to the insurer would reflect this. If the bank required that all 1,000 homes have their roofs mitigated to meet the local building code and each homeowner’s loss were reduced to $10,000, then insurer’s total loss would be $10 million should all 1000 homes be affected and it would not require reinsurance. This savings would be passed on to the insurer in the form of a lower premium.

Ideally, banks would work together with insurers to jointly develop a mortgage product that is attractive to homeowners. This will only occur, however, if homeowners know that they will receive a premium discount for investing in mitigation. Furthermore, banks would have greater incentives to provide home improvement loans if they knew that the housing GSEs—Fannie Mae, Freddie Mac, and Ginnie Mae—would guarantee them, as they do now for conventional mortgage loans. This presumably would happen automatically for purchasers of new or existing homes, provided that the purchasers otherwise meet down payment requirements and the total mortgage loans are below the applicable ceilings. Indeed, to facilitate the guarantees of such loans, we the GSEs could raise their ceiling modestly to allow for such home improvement loans.

As for existing homeowners who want to take out home improvement loans, the GSEs could approve a separate loan program for this purpose (allowing extended maturities, such as 20 years) so that banks could extend these loans knowing that they could be sold easily in the secondary market.

**Providing Seals of Approval**

Another and complementary way to encourage the adoption of cost-effective mitigation measures is to require that banks and other lenders 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 recognized inspector that the structure meets or exceeds building code standards. This requirement either could be legislated or imposed by the existing housing GSEs (Fannie Mae, Freddie Mac, and Ginnie Mae). Existing 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 in the interest of homeowners: the 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 1241 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 follow building codes, and 85 percent considered it very important that local building departments conduct inspection of new residential construction.

The inspection required to establish a seal of approval could be undertaken by certified contractors. For new properties, the contractor would 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 (provided the GSEs guarantee such loans) (Kunreuther and Michel-Kerjan, 2006)\textsuperscript{205}.

\textbf{Local, State and Federal Tax Incentives}

One 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 mitigation measure, then this taxpayer 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. A property owner who improves a home by making it safer is likely to have the property reassessed at a higher value and, hence, have 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 homebuyers 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 Berkeley program has been a great success. According to Arrietta Chakos, the assistant city manager, about 40 percent of Berkeley’s homes have been improved using this tax incentive\textsuperscript{206}.

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,


\textsuperscript{206} Personal communication.
then the general community gains much larger savings 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 even federal level. To the extent that the savings in disaster costs accrue to these units of government, tax rebates are most appropriate.

**Better Zoning Ordinances**

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 something: that these locations are naturally 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.

Ideally, local authorities would realize this and adopt zoning policies of not permitting rebuilding in such locations. But this is unlikely, since much of the pressure to permit, if not encourage, such rebuilding exists at the local level. This pressure is unlikely to be as intense at the state level, and thus one way of addressing the problem is for states to adopt policies that prevent or discourage localities from allowing rebuilding in areas that have been the subject of multiple natural catastrophes (at least three 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. Alternatively the federal government could use penalties to accomplish the same objective – withholding federal highway monies, as one example, unless the states adopted this zoning policy.

**11.7. Application to Florida**

Florida has several insurance mandates regarding mitigation measures and rating that make it an interesting test case. First, rating on mitigation measures, such as adherence to latest building code, are mandatory in Florida. Florida also has a permit and inspection system that allows insurers to verify that mitigation measures are in place without the expense of independent verification. A qualified inspector is defined as a Florida Licensed building inspector, building contractor, general contractor, residential contractor, structural engineer or architect.

In order to quantify the mitigation discounts that insurers give to their policyholders, we examined the rate manuals for four major homeowners insurance companies in Florida: Allstate, State Farm, St. Paul Travelers and Citizen’s Property Insurance Corporation. What we present is therefore a sample of, rather than a complete listing of, mitigation discounts.
The Building Code Effectiveness Grading System

As discussion above, the Building Code Effectiveness Grading System (BCEGS) is a community level mitigation level that ISO administers. Figure 11.1 below shows, in stark detail, how the stringency of building code can translate into vastly different levels of damage (upper west side versus lower east side). It is a photo taken in South Florida after hurricane Andrew which “…shows homes on one side of a street completely destroyed, while homes on the other side were still standing. Later inspection determined that, in many cases, construction of the destroyed buildings was well below the standard required by the building code in effect.” The companies we surveyed all gave the same discounts: 11-14% premium discounts for those with the best BCEGS score (1) dropping to 0% for those with the worst BCEGS score (10), and 0% or even a 1% surcharge for those policyholders who live in a community not graded by ISO.

Figure 11.1. Effectiveness of Mitigation Measures in Place in Florida
Source: National Oceanic and Atmospheric Administration/Department of Commerce

Florida Building Code 2001

The latest building code in Florida is the Florida Building Code, 2001 edition (FBC 2001). As with any building codes, properties constructed before the new building code are grandfathered in until the next improvement to the home. Therefore, homes come in three types with respect to building code compliance: non-FBC (grandfathered structures), existing homes FBC compliant (pre-2001 constructions that are retrofitted to the latest building standard) and FBC new construction (homes built after adoption of the new building code). All four companies have two types of mitigation discount plans: one for FBC compliant (whether existing or new construction) and one for non-FBC compliant homes with verified mitigation measures. Measures that garner discounts include roof covering, roof deck attachment, roof-wall connection, roof opening protection and secondary water resistance measures. This discount generally applies to the hurricane portion of the premium (premium structures are generally split between non-hurricane and hurricane premium).

Rewarding Superior Construction through Insurance Premium Rebates

One other mitigation measure of interest is superior construction, or structures that are built with mitigation features above and beyond those required by building codes. One example of this is the Fortified Home® seal of approval offered by IBHS. Of the four companies, only one explicitly makes use of this mitigation seal, awarding policyholders a 10 percent discount on total premiums (i.e. hurricane and non-hurricane premiums), while another defines a “superior construction” measure (i.e. which can encompass other types of well designed structures), and awards policyholders a 15 percent discount on total premiums\(^{208}\).

Sidebar 11.1. Best Practices in Florida

The C-4 Project: Moving Water to Prevent Flooding

The Miami/Dade Flood Control Project, or C-4 Basin Project (2002), built on the existing canal system, was created to address the county’s extensive flooding problem and to relocate excess water from one area to another so it could be absorbed into the groundwater or held in reserve. At the heart of the C-4 basin is the Tamiami Canal, which begins in the Everglades National Park and traverses the Miccosukee Indian reservation, the critical Pensuco Wetlands, and several municipalities before flowing into the environmentally-sensitive Biscayne Bay. The driving force of the C-4 Project is the forward pump station at the mouth of the canal, which is designed to push water flow downstream against the tide. A second station, at the mouth of the Miami River Canal in the C-6 basin, was built to offset the flow from the C-4 canal and prevent flooding upriver. There are three pumps in each station that can process approximately 4,500 gallons of water per second.

For occasions when the canals cannot handle the water volume necessary to prevent flooding, an emergency detention basin, comprised of two reservoirs, was created to receive and store the excess water. In addition, a separate supply canal was built to divert excess water from the C-4 canal to and from the detention basin which allows water to be shifted from area to area, not only in times of heavy rainfall or potential flooding, but also during instances when a need for water in other areas arises, such as when droughts occur.

The cost of the project totaled $70 million. The State of Florida was awarded $52.5 million from FEMA’s Hazard Mitigation Grant Program. The Quality Neighborhood Improvement Program, along with the South Florida Water Management District and Miami/Dade County, contributed remaining funds.

Miami Children’s Hospital

Beginning in 2001, the Miami Children’s Hospital (MCH) underwent a state-of-the-art retrofit to enable it to withstand a Category 4 hurricane. The hospital serves seven counties in southern Florida, including populous Miami/Dade County, and is the region’s only specialty hospital for children. The 268-bed medical facility has expertise in all aspects of pediatric medicine and is an important community resource. An assessment of the facility’s exterior construction, built in the mid-1980s, found that it was unsafe at wind speeds associated with a Category 2 hurricane, which is a common occurrence in southern Florida. Hospital administrators had to solve a two-fold problem: how to fund the renovation project, and how to conduct the retrofit and renovations without disrupting medical services.

MCH received $5 million through FEMA’s Hazard Mitigation Grant Program, administered by the Florida Department of Community Affairs, to help pay for the $11.3 million project. The retrofit involved strengthening the building by encapsulating the three-story structure in pre-molded panels of concrete reinforced with glass fibers. The panel system, anchored into the building’s existing support structure, forms a protective cocoon around the hospital and, along with impact-resistant windows and a strengthened roof, enables the building to withstand winds of up to 200 miles per hour.

The project was completed in the spring of 2004 and proved to be effective in the following months: Young patients and their families did not need to evacuate from the hospital when Hurricanes Frances and Jeanne struck. In addition, MCH welcomed over 60 children who live at home but depend on ventilators or other powered medical equipment.

During Hurricane Frances, MCH was the refuge for nearly 1,000 staff members and their families. The hospital hosted medical evacuees and families during Hurricanes Katrina and Wilma (2005). MCH has proven to be a safe haven for sheltering sick children and those who care for them.

Sources: FEMA. A more detailed description of these two examples can be found on FEMA’s website.
11.8. Conclusions

The 2005 hurricane season has provided additional empirical evidence supporting that many victims suffered severe losses from flooding because they had not mitigated their home and did not have flood insurance to cover the resulting damage. As a result there is an unprecedented level of federal disaster assistance promised to aid these victims. But the amount of disaster relief will never cover all the losses that could have been avoided by the implementation of effective protection measures.

There are many reasons why those in harm’s way have not protected themselves against natural disasters. The principal reason is that many individuals believe that the event will not happen to them. This belief coupled with subsidized insurance rates in high risk areas has led to increased development in areas subject to natural disasters. In addition, budget constraints and short time horizons may limit people’s interest and ability to invest in hazard mitigation measures and their desire to purchase insurance.

At a local level, government representatives might also prefer allocate taxpayers’ money where they can gain more political capital in the short term; investing in mitigation might not be their first priority until a disaster occurs.

If we as a society are to commit ourselves to reducing future losses from natural disasters and limit government assistance after the event, then we have to engage the private and public sectors in a creative partnership. This requires well-enforced building codes and land-use regulations coupled with insurance protection. Economic incentives, making these actions financially palatable to property owners, need to be provided in the form of long-term mitigation loans and subsidies to low income residents of high hazard areas. The rationale for taking these measures before the next disaster is to avoid the large-scale disaster relief that will otherwise follow. In addition, if structures are well-designed and appropriate land-use regulations are in place there will be a reduction in injuries and fatalities and the need to relocate large number of victims that could have enormous psychological and sociological implications.
Chapter 11 – Summary

This chapter analyzes mitigation measures for reducing the physical consequences of specific types of catastrophes (wind, flood, and earthquake), many of which have proven to be cost-effective. However, the lack of mitigation measures in place has been illustrated again in the aftermath of the 2005 hurricane season.

We also discuss how risk perception affects people and firms in their decisions as to whether or not to invest in protective measures and the importance of social norms and interdependencies on their decision processes. Given the reluctance of individuals to invest in cost-effective mitigation measures voluntarily, there is a need to develop innovative strategies that involve public-private sector partnerships. Well-enforced building codes coupled with insurance incentives and long-term mitigation loans could be important in this regard. One can also utilize seals of approval and tax incentives as a way of encouraging homeowners to adopt loss reduction measures. The chapter concludes with illustrative examples as to how Florida has encouraged investment in mitigation measures.

Chapter 11 - Key Questions

1. What are the current impediments facing insurers for financially rewarding individuals who adopt mitigation measures?
2. What steps need to be taken to reduce these impediments?
3. What role can other interested parties in the private sector (e.g. financial institutions, real estate agents, developers) play in encouraging adoption of cost-effective mitigation measures?
4. What role can the public sector play in encouraging and/or forcing adoption of cost-effective mitigation measures?
CHAPTER 12

IMPACT OF INSURANCE STATUS ON ECONOMIC WELFARE OF HOMEOWNERS IN HAZARD-PRONE AREAS

In determining the future of insurance mechanisms as a policy instrument in financing recovery from natural disasters and enhancing the adoption of adequate mitigation measures we need to have a clearer understanding of what proportion of homeowners in hazard-prone areas actually currently have protection. The first portion of this chapter tackles this issue by looking at special runs provided to us by the U.S. Census and comparing them with American Housing Survey data.

We then turn to the question as to what impact increases in the cost of insurance would have on housing values so that we can better appreciate the economic implications of setting risk-based premiums. We conclude the chapter by turning to the issue of tax relief for uninsureds. We study the impact of a homeowner deciding not to purchase insurance knowing that he can write off his uninsured losses on his taxes. If enough residents pursue this option coupled with the uninsured population, there may be increased pressure for disaster relief after the next catastrophe.

12.1. Estimating the Number of Uninsured Homeowners

The most serious policy problems occur when a substantial fraction of homeowners suffering losses do not have private insurance protection. If this fraction is large there will be considerable pressure for special legislation to provide them with disaster assistance. In the United States most homes are covered by some type of homeowners insurance, but a sizeable minority is not. It is these victims’ financial plight that raises the loudest calls for public assistance following natural and man-made catastrophes. When a disaster strikes, either uninsured homeowners are impoverished or public policy must step in, commonly in delayed, incomplete, inefficient and arbitrary ways. Getting a clear idea of what kinds of homeowners currently have or lack insurance coverage is a key to designing or evaluating public policy.

To help fill this gap, we assembled data on the proportion of homeowners without insurance. We used two different data sources: the 2002 American Housing Survey (AHS) and a special run provided to us by the U.S. Census—based on their one-in-six 2000 survey. Both are large sample random surveys; our analysis is limited to those households with an owner-occupied home. The AHS data provides detailed information on insurance, housing and homeowner characteristics, but was collected only in large metropolitan areas. The Census data covers the entire country, but the information it collected on coverage and homeowner characteristics was less extensive.
**Hypotheses Regarding the Uninsured Population**

We want to explore the existence and magnitude of the association between having or not having homeowners insurance of any kind and (a) whether or not the home carried a mortgage and (b) the income of the homeowner (relative to the poverty line).

Homeowners without mortgages were more likely to be uninsured. Indeed, the most important reason that homeowners have protection against property losses is because lenders require them to have coverage so as to protect the lender’s assets. Proof of insurance is almost always a condition for issuing or continuing a mortgage. If the mortgage balance slips to a low level relative to the value of the property, rational lenders may be less concerned about continuing insurance protection, expecting that any remaining exposure might be coverage by the salvage and/or land value of the property.

Household income or wealth has a less obvious relationship to insurance coverage. For a given asset value at risk, the theory of insurance would generally suggest that lower-income households would be more likely to be insured, since a loss would be a larger proportion of their wealth and therefore more devastating. However, it is often said that lower income homeowners are “less able to afford” insurance (as part of housing costs). As discussed in Chapter 6, budget constraints may prevent some of these homeowners from taking coverage unless they were required to do so. Although there is no precise (or even imprecise) definition of “affordability” that is generally accepted, it is surely true that a given household would see much deeper cuts in other consumption from a given insurance premium if their income were substantially lower.

For lower-income households without a mortgage who find the insurance premium on their current home to be too burdensome, there is an economically more attractive option to being uninsured: sell the house, use the proceeds to buy a less expensive home and use the savings to cover the insurance premium on their new residence. This strategy works well on paper. In reality, however, sentimental attachment to a given home, the desire to live in a bigger home or in a nicer area, inertia and the high transaction costs associated with selling and buying a new home (including the time and expenses associated with moving), lagged responses to insurance premium increases due to the appreciation in house value and higher replacement cost, and/or just poor planning may make this strategy unattractive.

**Analyses of American Housing Survey (AHS) Data**

The AHS data indicates how these conflicting motives for purchasing insurance play out. The specific wording of the question in the AHS questionnaire was “Does this household have homeowners’ insurance (household property insurance)?” and might be somewhat broad. Indeed, some people may have interpreted “homeowners’ insurance” to mean more comprehensive fire and hazard protection than what they currently have. So the fraction of people who say “no” may be an upward biased measure of those with no protection whatsoever. The AHS may therefore yield imprecise estimates of population means for the percentage of uninsured individuals. However, the relationship of these measures to different socio-economic variables should still be valid as long as such a bias is unrelated to the household characteristics in question.

Table 12.1 shows the proportion uninsured homeowners in the metropolitan area in two of the target states of this study, Florida and Texas, by household income relative to the
Federal Poverty Line\textsuperscript{210} and to mortgage status. Not having a mortgage predicts the absence of homeowners (HO) insurance as shown by the second and third rows of each of the three subtables based on income relative to the poverty line. We focus on 6 cities: Miami (MIA), Houston (HOU), San Antonio (SAT), Dallas (DAL), Tampa (TPA) and Fort Worth—Arlington (FWA).

Table 12.1. Sample Data on Owner-Occupied Housing, Six Cities

\begin{tabular}{|c|c|c|c|c|c|c|}
\hline
 & \textbf{MIA} & \textbf{HOU} & \textbf{SAT} & \textbf{DAL} & \textbf{TPA} & \textbf{FWA} \\
\hline
\% Houses with Mortgages & 51\% & 37\% & 37.0\% & 51.0\% & 42.0\% & 34.0\% \\
\hline
\% Houses with Mortgages & 16.2\% & 9.0\% & 8.4\% & 9.3\% & 6.1\% & 14.9\% \\
with no HO insurance & & & & & & \\
\hline
\% Houses without & 26.1\% & 31.6\% & 31.7\% & 19.6\% & 11.1\% & 27.2\% \\
Mortgages with no HO & & & & & & \\
insurance & & & & & & \\
\hline
\textbf{Income > 200 > 400\% of Poverty} & & & & & & \\
\% Houses with Mortgages & 67.0\% & 56.0\% & 49.0\% & 63.0\% & 57.0\% & 56.0\% \\
\hline
\% Houses with Mortgages & 12.8\% & 5.7\% & 4.1\% & 3.7\% & 3.7\% & 5.4\% \\
with no HO insurance & & & & & & \\
\hline
\% Houses without & 18.9\% & 18.7\% & 15.4\% & 10.3\% & 14.2\% & 15.1\% \\
Mortgages with no HO & & & & & & \\
insurance & & & & & & \\
\hline
\textbf{Income > 400\% of Poverty} & & & & & & \\
\% Houses with Mortgages & 74.0\% & 73.0\% & 63.0\% & 77.0\% & 69.0\% & 69.0\% \\
\hline
\% Houses with Mortgages & 5.5\% & 2.1\% & 0.1\% & 1.6\% & 1.6\% & 1.0\% \\
with no HO insurance & & & & & & \\
\hline
\% Houses without & 10.8\% & 9.6\% & 5.4\% & 3.8\% & 5.2\% & 4.3\% \\
Mortgages with no HO & & & & & & \\
insurance & & & & & & \\
\hline
\end{tabular}

Source: American Housing Survey

The other influence was household income relative to the poverty line. It is interesting that as income increases a homeowner is more likely to have a mortgage and hence purchase insurance. The percentage of individuals who have insurance increases with income level whether or not one has a mortgage. For example in the Miami area the percentage of uninsured homeowners with (without) mortgages was 16 percent (26 percent) for those below the

\textsuperscript{210} The Federal Poverty Line ranges from $9,800 for a single person and increases by $3,400 for each additional person in the household within the 48 contiguous states.
poverty line compared with 13 percent (19 percent) and 5 percent (11 percent) respectively for those in the two higher income brackets.

We also used logit regression methods to examine the influence of income, mortgage status, and some other characteristics of the property on the probability of being insured. As indicated in Table 12.2, in all of the cities household income was positively related to having insurance, as was mortgage status in all cities but Miami where it had no significant statistical effect. Newer properties were also associated with a greater likelihood of having insurance. Condos were less likely to be insured compared to single-family homes, but larger multiple-unit dwellings were more likely to be insured than smaller ones in some of the areas but not in others.

Table 12.2. Impact Income and Housing Characteristics on Insurance Status
*Signs of significant regression coefficients; zero means coefficient is not significant logit regressions predicting having insurance.

<table>
<thead>
<tr>
<th></th>
<th>HOU</th>
<th>TPA</th>
<th>DAL</th>
<th>FWA</th>
<th>MIA</th>
<th>SAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>INCOME</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>MORTG</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>VALUE</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>+</td>
<td>0</td>
<td>+</td>
</tr>
<tr>
<td>YRBLT</td>
<td>0</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>YRMOVE</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>+</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>UNITS</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>0</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>CONDO</td>
<td>-</td>
<td>-</td>
<td>0</td>
<td>0</td>
<td>-</td>
<td>0</td>
</tr>
</tbody>
</table>

The proportion of uninsured homeowners is especially large at lower income levels. But even at income levels high enough that coverage should leave enough income left for consumption, a non-trivial fraction reports being uninsured. There is also some variation across metropolitan areas that is hard to understand.

Analysis of U.S. Census Data

Insurance premiums for a given house may vary little with metropolitan areas. For this reason, we use the Census data to give us greater geographical diversity, generating measures for almost all ZIP code areas in the study states. Here we focus on the survey for Florida only.

The Census requested one household in six (the so-called one-in-six survey) to fill out a larger survey than the normal one. One of the questions is “How much was paid last year for fire, hazard, and flood insurance on this property?” We obtained data on the proportion of owner-occupied housing that reported spending zero or less than $100 annually on this insurance. We utilized data provided by Risk Management Solutions to specify the risk of damage to a home by location and compared this measure to the estimated loss cost for each ZIP code area in Florida. Table 12.3 shows the relative risk of not spending on homeowners insurance, for all ZIP codes in Florida, by household income and comparative risk.
Table 12.3. Likelihood of Homeowner Being Uninsured a Function of Risk of Windstorm Damage from Hurricanes and Income Level Relative to Federal Policy Line (FPL) in Florida (by ZIP code)

<table>
<thead>
<tr>
<th>Income</th>
<th>Storm Risk</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 200% FPL</td>
<td>Low</td>
<td>1.00</td>
<td>0.83</td>
<td>0.83</td>
</tr>
<tr>
<td>200-400% of FPL</td>
<td>Medium</td>
<td>0.53</td>
<td>0.58</td>
<td>0.53</td>
</tr>
<tr>
<td>&gt; 400% of FPL</td>
<td>High</td>
<td>0.67</td>
<td>0.58</td>
<td>0.36</td>
</tr>
</tbody>
</table>

Sources: Data from Risk Management Solutions, Homeowners Insurance Policies from Sponsors, and U.S. Census Data on Income

The data is normalized relative to the lowest income bracket (less than 200% below the Federal Poverty Line (FPL) and the lowest storm damage ZIP codes). In these areas the premiums are high relative to the modeled storm risk because they are not subsidized as they are in medium and high-hazard areas. Approximately 4 percent of residents in these areas were uninsured. Even though this figure is very low (for reasons we do not fully understand) it was nearly three times greater than the uninsured percentage of homeowners as in the lowest cell—households with incomes greater than 400 percent FPL in high risk areas.

Conclusions

Most homes are covered by at least some insurance that pays benefits in the case of property damage. The AHS and U.S. Census data sets differ on the size of the uninsured population. For the most vulnerable group—low income households with no mortgage—the estimated proportion of uninsured varies between 4 and about 20 percent. The different data sets do agree on what predicts not having insurance: low income and not having a mortgage. The Census data also suggest that the ratio of insurance premiums relative to modeled risk may influence this decision. Homeowners in lower risk areas are more likely to be uninsured presumably because their premiums were high relative to the risk of loss but there may be other reasons as well.

12.2. Impact on Housing Values under Different Insurance Schemes

In Florida, recent changes in risk perception and increases in insurance premiums may affect home prices and cause concerns by homeowners about the impact this will have on their equity. It is thus important to understand the effect of changes in insurance premiums on home values, as well as the impact of possible regulatory change aimed at minimizing shifts in home values.

The “cost” of a home is not merely its price but includes ownership costs, such as maintenance, depreciation, and insurance as well as losses borne by the property owner should
a disaster occur. For ease of exposition we will assume that all ownership costs other than insurance are zero so we can focus on the impact that changes in premiums will have on housing values.

Assume that all individuals purchase insurance, no matter how expensive it is, and that there are only two costs of a home, its initial price and all future insurance premiums. In this model, the total discounted cost of a home is equal to:

\[
P + \sum_{t=1}^{T} \delta^{t}I_{t} = P + \left( \frac{\delta t - \delta^{T+1}I_{T+1}}{1 - \delta} \right)
\]

(12.1)

where:

- \(P\) is price of the home,
- \(I_{t}\) is the insurance costs in period \(t\),
- \(\delta\) is the discount factor,
- \(t\) is the year,
- \(T\) is the life of the property.

Thus, an increase in insurance premiums of \(X\) in each period increases the total cost by:

\[
\left( \frac{\delta - \delta^{T+1}}{1 - \delta} \right) \times X
\]

Based on equation (12.1) individuals should not be willing to pay as much for the home after seeing the increase in insurance premiums. While little research has been done to assess whether higher insurance costs do indeed depress home prices, this idea has permeated the real estate community in Florida following recent large insurance premium increases. The University of Florida Survey of Emerging Market Conditions (3rd Quarter 2006) found that, in many areas, insurance premiums now are often the largest cost of owning a home\(^{211}\). The survey also revealed that, based on the opinions of over 300 respondents, the cost of insurance became the top concern in the real estate profession\(^{212}\). Sixty-nine percent of those surveyed believed condo prices will fall overall or at least fall relative to inflation, and 47 percent made the same prediction for single family homes\(^{213}\).

These survey results provide evidence that real estate professionals are concerned about home prices decreasing as result of higher insurance premiums. It would be reasonable to assume that homeowners have even greater concerns, since they potentially have a lot more at stake. Individuals could lose a large fraction of their personal wealth from sudden shifts in the price of their homes. According to the 2004 Survey of Consumer Finances, homeowners have


\(^{212}\) Ibid.

39.5 percent of their personal wealth invested in their primary residence\(^{214}\). Thus, on average, a 20 percent decrease in the value of an individual’s primary residence will translate into a 7.9 percent decrease in their personal wealth.

Despite these concerns, the Florida real estate market has been booming. In 2004, the price index of homes rose by about 19 percent, ranking 5\(^{th}\) nationally\(^{215}\). In 2005, home price appreciation hastened to 26.83 percent, ranking 2\(^{nd}\) nationally\(^{216}\). It is perplexing that home prices rose by so much despite increasing hurricane frequency and rising insurance premiums. It is possible that home prices would have increased by a greater amount, had risk and insurance premiums remained constant.

Researchers have studied the effect that changes in perceived risk have on home values\(^{217}\). We are only aware of one study, by Charles Nyce, that looked specifically at the effect of changes in insurance prices on home values\(^{218}\). Nyce’s study, while interesting, used highly aggregated data and thus does not shed light on effects within a single state. One reason for the lack of research in this area may be that previous researchers did not have a dataset with insurance premiums and estimated risk over time for small geographic areas.

Understanding the effect of insurance premium increases is not a simple task. The following shows some of the concerns and questions that need to be answered before predictions can be made regarding the effect of future changes in insurance premiums on home prices. At any one time, there could be a change in risk or premiums, or it is possible that both could change simultaneously. It is also possible that neither could change. To be clear, when we refer to changes, we are referring to unanticipated changes. Anticipated changes would already be capitalized into home values.

There are four possible cases to consider:

<table>
<thead>
<tr>
<th>Risk Change</th>
<th>Insurance Premium Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Case 4</td>
</tr>
<tr>
<td>No</td>
<td>Case 2</td>
</tr>
</tbody>
</table>

The effect on home prices in cases 1 and 4 is easy to predict, while the effect in Cases 2 and 3 depends on a variety of factors. The predictions and determining factors are explained


\(^{215}\) Office of Federal Housing Enterprise Oversight (OFHEO) House Price Indexes.

\(^{216}\) Ibid.


below. Note, we assume in the following that change in risk equals change in the perceived risk of individuals, since perceived (not statistically-based estimates) influences their decisions.

**Case 1 – No Change in Risk or Insurance Premiums**

No changes in home prices are predicted from the previous period.

**Case 2 – Change in Risk but No Change in Insurance Premiums**

There are several factors that determine whether or not changes in risk alone will affect the total costs of owning a home, and hence home prices.

- **Insurance Status**: Generally, most homeowners are insured because it is mandated in most mortgage contracts. For those who are not insured, increases in risk raise the expected cost of self-insuring and thus affect the expected costs of ownership to these homeowners. If all homeowners are uninsured, the value of homes should decrease as a result. It is not clear what the effect will be if a fraction of homeowners are insured.

- **Impact of Risk on Future Insurance Premiums**: Changes in risk might affect future insurance premiums, but not those in the current period. Increases in future insurance premiums should lower home prices. However, it is possible that increased risk may not be reflected in future premiums if regulators do not allow rate increases.

**Case 3 – Change in Insurance Premiums but No Change in Risk**

- **Insurance Status**: Changes in premiums alone should change home prices if all (or close to all) individuals insure. As in Case 2, it is not clear what the effect will be if only a fraction of individuals insure.

- **Why Insurance Premiums Can Increase Without Changes in Risk**:
  - Greater ambiguity with respect to the risk leads insurers to want to raise their prices;
  - Depletion of surplus after a disaster leads insurers to raise premiums in order to rebuild capital;
  - Insurance commissioners relax rate restrictions and allow insurers to raise their premiums on rates which have been subsidized.

**Case 4 – Change in Both Insurance Premiums and Risk**

The (expected) costs of owning a home will surely rise whether or not the majority of individuals insure, and thus home prices should fall relative to the market.

**Can Regulators Control Home Price Movements?**

Any intervention that keeps the current and expected future costs of owning a home constant should keep home prices constant relative to the market. The most obvious method to prevent large increases in home ownership costs in high-risk areas is to keep insurance
premiums from rising there. Regulators can accomplish this permanently by allowing higher than risk-based premiums in some areas and restriction insurance premiums in high-risk areas. An insurer will only be willing to provide coverage in both these areas if required to do so. Otherwise, it will not want to offer insurance in the high-hazard region since it knows it will be losing money in the long run in these areas.

Regulators can also control risk by requiring more mitigation measures through stricter building codes. To the extent that insurance premiums reflect the risk, property owners should benefit from these codes by having to pay lower insurance premiums. The two examples of how regulators can attempt to control rising insurance premiums are discussed in more detail in Chapter 5.

**Example of a Plan to Control Risk**

Suppose modeling companies indicate that the hurricane risk has increased significantly in certain regions of Florida. Insurers will then want to raise their premiums to reflect the change in risk and/or the increased cost of reinsurance. Insurers must send their proposed rate increases to the Florida Office of Insurance Regulation (OIR), which has the authority to deny them. Suppose that the OIR decides to reject any proposal that does not increase rates evenly across Florida, thus mandating cross-subsidies to high-risk areas.

Subsidized property insurance premiums result in costs of ownership that are below the true costs. When cross-subsidies exist for high-risk areas, some individuals who would otherwise not live in high-risk areas if they were forced to pay actuarially fair insurance premiums will now feel it is affordable and move into the area. More generally, more individuals will reside in high-risk areas if insurance rates are subsidized than if they are risk-based.

To illustrate the impact of subsidized insurance premiums on homeowners prices consider an area in Florida where the annual likelihood of windstorm losses (total destruction of home) from hurricanes was 1 in 50 so that the risk-based rate would be 2 percent of insured value. Suppose that because of regulation rates are capped at 1% of insured value. For simplicity, assume that the insured value always equals the price of a home, and that insurers have no loading costs. The relative costs for homeowners who are subsidized due to regulation and those who would pay risk-based premiums are shown in the table on the next page.
### Questions to Be Answered in Future Research

- Do increases in risk, but constant insurance premiums, affect home prices and if so by how much?
- Do increases in insurance premiums, but constant risk, affect home prices and if so by how much?
- How much do increases in risk, and equivalent increases in insurance premiums, affect home prices?
- Does the level of current subsidy matter in the three above questions?
- Should regulators be concerned with, and try to correct, sharp changes in housing prices resulting from increased risk or rising insurance premiums? How should they do this?
- Regardless of whether it is advisable to correct for sharp price changes, will regulators in practice try to avoid/soften sharp changes for political reasons?
- How would/do regulations designed to limit insurance premiums in high risk areas affect:
  - Insurers’ earnings?
  - Availability of insurance?
  - Location of new development?

---

<table>
<thead>
<tr>
<th></th>
<th>Insurance Subsidized</th>
<th>Insurance Not Subsidized</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of a Home</td>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td>Insurance Premium (I)</td>
<td>0.01P</td>
<td>0.02P</td>
</tr>
<tr>
<td>Sum of Discounted Future Insurance Premiums</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$ \frac{I}{1 - \delta} = I(0.95 - 0.95^{30}) \approx 15I$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.15P</td>
<td>0.3P</td>
</tr>
<tr>
<td>Total Cost</td>
<td>1.15P</td>
<td>1.3P</td>
</tr>
</tbody>
</table>

where:

- $P$ is the price of a home
- $I$ is the insurance rate
- $\delta$ is the discount factor

And $T$, the life of the property, is assumed to be 30 years

(See equation 12.1)

If a home is valued at $200,000, then a homeowner’s discounted cost of insurance would be $30,000 if the rate was subsidized by the regulator and $60,000 if it was risk-based.
12.3. Tax Write-offs and Demand for Insurance

The casualty and theft loss federal tax deduction allows individuals to deduct a portion of uninsured property damage or theft losses resulting from unexpected events, such as hurricanes and earthquakes, from income when calculating federal taxes. In effect, it serves as a free form of insurance that, benefits individuals who do not purchase insurance at the expense of taxpayers.

While many items have limitations on the amount that can be deducted, casualty and theft loss deductions have no such restrictions. Rather, the casualty and theft loss deduction always reduces taxes by the full amount of the above calculation. Additionally, as will be explained later, if the casualty or theft loss deduction exceeds income, the excess of the deduction over income can be deducted from past (i.e. result in a tax refund for previous years’ taxes) as well as future federal taxes.

In this section, going bare refers to purchasing no insurance. The benefit received by those who go bare is progressive (in income); the rich benefit more than the poor from a hurricane that causes severe damage to their homes. Higher income individuals are likely to have larger losses due to more expensive homes and have a higher marginal tax rate.

Calculation of the Casualty and Theft Loss Deduction

We now explain how this tax benefit works and its potential effect on people’s decision to purchase insurance against natural disasters. An individual must calculate the allowed deduction for casualty and theft losses by first determining which value is lower; the adjusted basis\(^{219}\) or the loss in fair market value. They then must subtract from this the amount of insurance compensation and $100 for each separate casualty or theft loss (for example: damage from separate hurricanes). Finally, 10 percent of adjusted gross income is subtracted. The remaining amount can then be included as an itemized deduction for the tax year in which the loss occurred (referred to as the loss year).

An Illustrative Example

John purchased a home in 1995 for $800,000, and has not renovated or expanded it over time. During the next 9 years the market treated him well; his home appreciated to $1,200,100. He had a steady income; he earned exactly $300,000 a year for the last few years, and had no investment earnings (thus we assume that $300,000 was his adjusted gross income). John never purchased property insurance. In 2004, a hurricane significantly damaged his home, reducing the fair market value from $1,200,100 to $500,000. Table 12.4 below shows how the deductible amount is calculated.

<table>
<thead>
<tr>
<th>Table 12.4</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Basis</td>
<td>$800,000</td>
</tr>
<tr>
<td>Loss in Fair Market Value</td>
<td>$700,100</td>
</tr>
<tr>
<td>Smaller of the Two Above</td>
<td>$700,100</td>
</tr>
<tr>
<td>Subtract $100</td>
<td>-$100</td>
</tr>
<tr>
<td>Amount After Deduction $100</td>
<td>$700,000</td>
</tr>
<tr>
<td>Subtract 10% of AGI</td>
<td>-$30,000</td>
</tr>
<tr>
<td>Amount Eligible For Deduction</td>
<td>$670,000</td>
</tr>
</tbody>
</table>

\(^{219}\) The adjusted basis is the amount the home was purchased for (price + taxes) plus any repairs, additions, or improvements minus any previously taken casualty loss deductions. Note that, while the casualty loss deduction will lower the adjusted basis, subsequent repairs will raise it.
Since there is no limit on the casualty and theft loss deduction as an itemized deduction, he pays no taxes in 2004. If married with no children, he would have paid approximately $76,000 in federal taxes that year had he purchased property insurance. Thus, in the loss year alone, the casualty and theft loss deduction saved him $76,000. Next, it will be shown that he will actually recover more of the loss because he can carry the excess loss to other tax years.

**Explanation of the Net Operating Loss Deduction**

The net operating loss (NOL) deduction allows an individual to deduct from past and future taxes the excess of the casualty and theft loss deduction over income. If the net operating loss (excess of casualty and theft loss deduction over the loss year’s adjusted gross income) is greater than the income in the year to which it was carried, then this second excess can be carried over again to another year.

In total, one casualty or theft loss deduction can be carried back 3 years, and forward 20 years, meaning that a large enough casualty or theft loss deduction could result in an individual paying no income taxes over a 24-year-period (3 years back, 20 years forward, plus the loss year). The individual can, when filing taxes for the loss year, adjust federal taxes in the carryback years and receive a refund from the government.

There are only a few items which can be included in a net operating loss. Excluded deductions will provide the individual no benefit in years when the net operating loss exceeds income. Thus, while the net operating loss allows an individual to carry the loss forward and backward, the casualty and theft loss and net operating loss deductions may be of less value to people who have high itemized deductions that do not qualify for the net operating loss deduction.

*Continuation of Earlier Example* Recall, John earned $300,000 a year, and could deduct from taxes $670,000 for the casualty loss. He pays no taxes in 2004. But, he also had a net operating loss, meaning that he can carry over part of the casualty loss, thus reducing taxable income for previous years and receiving a refund. Recall that the NOL is first carried back 3 years, and then carried forward to the next eligible year. Table 12.5 shows the amount that can be carried back to each year, the resulting taxable income, and the amount that he saves each year and in total.

<table>
<thead>
<tr>
<th>Year</th>
<th>Income</th>
<th>Casualty Loss Deduction</th>
<th>Net Operating Loss Carried to Next Year</th>
<th>Taxable Income</th>
<th>Total Taxes With Deduction Benefit</th>
<th>Total Taxes Without Deduction Benefit</th>
<th>Tax Savings(^1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>$300</td>
<td>$670</td>
<td>$370</td>
<td>$0</td>
<td>$0</td>
<td>$76</td>
<td>$76</td>
</tr>
<tr>
<td>2001</td>
<td>$300</td>
<td>$0</td>
<td>$70</td>
<td>$0</td>
<td>$0</td>
<td>$86</td>
<td>$86</td>
</tr>
<tr>
<td>2002</td>
<td>$300</td>
<td>$0</td>
<td>$230</td>
<td>$58</td>
<td>$84</td>
<td>$26</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>$58</td>
<td>$245</td>
<td>$187</td>
<td></td>
</tr>
</tbody>
</table>

\(^1\)Tax savings is defined as the difference between the total taxes from going bare as opposed to purchasing full insurance.
Table 12.5 shows that John paid no taxes in 2004, was refunded all taxes for 2001 (the first year that the NOL is carried to), and a partial refund on his 2002 taxes. In 2003, he pays taxes as normal because the NOL was completely used up in 2001 and 2002.

Clearly, in this example, John lost a lot of money. His home dropped in value by $700,100, but he only received $187,408 in compensation. But, this compensation was provided at no cost to him. He did not have to pay in advance for it as he would if he had purchased insurance.

**Special Law Changes for Losses Resulting From Hurricanes Rita, Wilma, or Katrina**

Some tax laws relating to casualty and theft loss deduction and subsequent net operating loss deductions were changed for casualty losses that occurred in qualified regions due to hurricanes Wilma, Rita, or Katrina. The changes were:

- Casualty losses did not have to be reduced either by $100 or by 10 percent of adjusted gross income. Thus, the full amount could be deducted from taxes.
- The carryback for net operating losses was 5 years, rather than 3. Thus, the number of years to which the casualty loss could be deducted from taxes increased to 26, and the 5-year-carryback allowed individuals to receive more of the casualty loss back that year (in the form of a refund for past taxes paid), as opposed to having to wait to receive compensation until filing taxes in later years.
- Instead of deducting the loss from 2005 taxes, one could redo 2004 taxes as if the casualty loss occurred in 2004. Thus, this allowed individuals to choose the loss year (from 2004 or 2005), which could potentially make them better off.

It is interesting to note that these special benefits were added for 2005 taxes due to Katrina, but not for 2004 taxes following the four severe Florida hurricanes. It is not clear why there were special rules in one year but not the other, or whether consumers should expect special tax rule changes for hurricane losses in future years.

**Analysis of the Decision to Go Bare**

Under the current tax law, individuals are not choosing between purchasing insurance and bearing the full risk. Rather, they are choosing between purchasing insurance and bearing some of the risk while the government/other taxpayers bear the rest through the casualty and theft loss deduction.

*Basic Theory* Assume that the insurance premium is actuarially fair with a loading rate of 10 percent, and that there is a 1 percent chance of having a loss of size L (and zero chance of any other sized loss) over a year. The insurance rate will thus be 0.011L. Also assume that the percent of a casualty loss that will be recovered through the tax deduction, if the individual does not insure at all, is 25 percent (which seems reasonable as shown in tables 5 and 7). Therefore, with the casualty and theft loss deduction, an individual who does not insure will only lose 0.75L if the loss occurs.
Table 12.6 shows, for this example, the expected loss and variance for the cases of full insurance and no insurance, both in the scenarios where the casualty and theft loss deduction exists and where it does not.

<table>
<thead>
<tr>
<th>Table 12.6</th>
<th>With Casualty and Theft Loss Deduction</th>
<th>Without Casualty and Theft Loss Deduction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Insured</td>
<td>Not Insured</td>
</tr>
<tr>
<td>Expected Loss</td>
<td>0.011L</td>
<td>0.0075L</td>
</tr>
<tr>
<td>Variance</td>
<td>0</td>
<td><strong>0.005575L</strong>²</td>
</tr>
</tbody>
</table>

Notice that both the expected loss and the variance are lower when the tax benefit exists. Therefore, individuals will view going bare to be more attractive in the case where the casualty loss deduction exists. Thus, this tax benefit may be inducing individuals who would fully insure without this free benefit to not insure at all.

**Income Dynamics**  This section explains how income affects the percent of the casualty loss that is recovered through the casualty and theft loss deduction. Assume throughout this discussion that the individual does *not* purchase any insurance.

There are two factors that determine what percent of a casualty loss is recovered through the casualty and theft loss deduction. The first factor raises the percent recovered, and the second lowers it. With regards to the first factor, increases in income can raise the percent recovered by increasing the proportion of *otherwise* taxable income that falls in higher marginal tax brackets; because this income will now not be taxed, the higher tax rate will not be paid. With regard to the second factor, increases in income can lower the percent recovered because the stipulation that one subtracts 10 percent of adjusted gross income from the loss results in a larger figure being subtracted from the casualty loss before it can be taken as a deduction. Thus, increases in income can either raise or lower the percent of the casualty loss that is recovered through the tax benefit, depending on the size of both the casualty loss and income.

The first factor, involving the marginal tax bracket effect, appears to dominate for large losses, and thus increases in income will generally raise the percent of the casualty loss that is recovered. Table 12.7 provides detailed information regarding the calculation of taxes paid, including aggregate taxes, savings in taxes, and the percent of the casualty loss which is recovered from the tax benefit, and the average marginal tax rate saved as a function of income and casualty loss. Table 12.8 adds more detail, showing the difference in the amount that would be paid in taxes each year. These tables confirm that the percent of a casualty loss recovered tends to increase with income.

---

220 Otherwise taxable income refers to income that would be taxed if no loss occurred and is no longer taxed after filing the casualty loss.
Managing Large-scale Risks in a New Era of Catastrophes

Chapter 12

Report on Phase I of the Study

Table 12.7 (all dollar amounts are in thousands)

<table>
<thead>
<tr>
<th>Yearly Income</th>
<th>Total Casualty Loss</th>
<th>Total Taxes With Deduction Benefit</th>
<th>Total Taxes Without Deduction Benefit</th>
<th>Tax Savings¹</th>
<th>Average Marginal Tax Rate for Income That Is Not Taxed Because of the Casualty and Theft Loss Deduction</th>
<th>Reduction in Casualty Loss for Eligible Deduction: 10%*(AGI)</th>
<th>Tax Savings as Percent of Casualty Loss: Total Casualty Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>$200</td>
<td>$1,500</td>
<td>$103</td>
<td>$418</td>
<td>$315</td>
<td>$20</td>
<td>21.3%</td>
</tr>
<tr>
<td>B</td>
<td>$300</td>
<td>$1,500</td>
<td>$382</td>
<td>$762</td>
<td>$380</td>
<td>$30</td>
<td>25.8%</td>
</tr>
<tr>
<td>C</td>
<td>$400</td>
<td>$1,500</td>
<td>$692</td>
<td>$1,112</td>
<td>$420</td>
<td>$40</td>
<td>28.8%</td>
</tr>
<tr>
<td>D</td>
<td>$500</td>
<td>$1,500</td>
<td>$1,028</td>
<td>$1,462</td>
<td>$434</td>
<td>$50</td>
<td>30.0%</td>
</tr>
<tr>
<td>E</td>
<td>$700</td>
<td>$1,500</td>
<td>$1,720</td>
<td>$2,162</td>
<td>$420</td>
<td>$70</td>
<td>28.0%</td>
</tr>
<tr>
<td>F</td>
<td>$1,000</td>
<td>$1,500</td>
<td>$2,751</td>
<td>$3,212</td>
<td>$461</td>
<td>$100</td>
<td>30.7%</td>
</tr>
</tbody>
</table>

¹ Tax savings is defined as the difference between the total taxes from going bare as opposed to purchasing full insurance.

Table 12.8 (all dollar amounts in thousands)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>$200</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$20</td>
</tr>
<tr>
<td>B</td>
<td>$300</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$1</td>
<td>$76</td>
<td>$76</td>
<td>$76</td>
<td>$76</td>
<td>$30</td>
</tr>
<tr>
<td>C</td>
<td>$400</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$25</td>
<td>$111</td>
<td>$111</td>
<td>$111</td>
<td>$111</td>
<td>$40</td>
</tr>
<tr>
<td>D</td>
<td>$500</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$4</td>
<td>$146</td>
<td>$146</td>
<td>$146</td>
<td>$146</td>
<td>$146</td>
<td>$50</td>
</tr>
<tr>
<td>E</td>
<td>$700</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$266</td>
<td>$216</td>
<td>$216</td>
<td>$216</td>
<td>$216</td>
<td>$216</td>
<td>$70</td>
</tr>
<tr>
<td>F</td>
<td>$1,000</td>
<td>$0</td>
<td>$181</td>
<td>$321</td>
<td>$321</td>
<td>$321</td>
<td>$321</td>
<td>$321</td>
<td>$321</td>
<td>$321</td>
<td>$100</td>
</tr>
</tbody>
</table>

*For simplicity, yearly income is assumed to remain exactly constant across years for each individual. Also for simplicity, tax rules for 2004 are used for all years in the table.

Casualty Loss Size Dynamics: Increases in the size of casualty losses, for a given income, do not greatly affect the percent of the casualty loss that is recovered by reductions in taxes for losses that are large relative to income. Table 12.9 shows the amount an individual will save in taxes for various-sized casualty losses, and the tax savings as a percent of the casualty loss. Table 12.10 adds more detail, showing the amount that would be paid in taxes each year.

Table 12.9 (all dollar amounts in thousands)

<table>
<thead>
<tr>
<th>Casualty Loss</th>
<th>Yearly Income</th>
<th>Tax Savings¹</th>
<th>Tax Savings as Percent of Casualty Loss: Total Casualty Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>$500</td>
<td>$300</td>
<td>$130</td>
</tr>
<tr>
<td>B</td>
<td>$750</td>
<td>$300</td>
<td>$193</td>
</tr>
<tr>
<td>C</td>
<td>$1,000</td>
<td>$300</td>
<td>$253</td>
</tr>
<tr>
<td>E</td>
<td>$1,500</td>
<td>$300</td>
<td>$380</td>
</tr>
<tr>
<td>G</td>
<td>$2,000</td>
<td>$300</td>
<td>$511</td>
</tr>
</tbody>
</table>

¹ Tax savings is defined as the difference between the total taxes from going bare as opposed to purchasing full insurance.

*For simplicity, yearly income is assumed to remain exactly constant across years for each individual. Also for simplicity, tax rules for 2004 are used for all years in the table.
Chapter 12

Managing Large-scale Risks in a New Era of Catastrophes

Report on Phase I of the Study

Table 12.10 (all dollar amounts in thousands)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A $500</td>
<td>$300</td>
<td>$0</td>
<td>$22</td>
<td>$76</td>
<td>$76</td>
<td>$76</td>
<td>$76</td>
<td>$76</td>
<td>$76</td>
<td>$479</td>
</tr>
<tr>
<td>B $750</td>
<td>$300</td>
<td>$0</td>
<td>$0</td>
<td>$36</td>
<td>$76</td>
<td>$76</td>
<td>$76</td>
<td>$76</td>
<td>$76</td>
<td>$417</td>
</tr>
<tr>
<td>C $1,000</td>
<td>$300</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$76</td>
<td>$76</td>
<td>$76</td>
<td>$76</td>
<td>$76</td>
<td>$357</td>
</tr>
<tr>
<td>E $1,500</td>
<td>$300</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$76</td>
<td>$76</td>
<td>$76</td>
<td>$76</td>
<td>$230</td>
</tr>
<tr>
<td>G $2,000</td>
<td>$300</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$22</td>
<td>$76</td>
<td>$76</td>
<td>$98</td>
</tr>
</tbody>
</table>

*For simplicity, yearly income is assumed to remain exactly constant across years for each individual. Also for simplicity, tax rules for 2004 are used for all years in the table.

Analysis of the Decision to Partially Insure

Theoretically, an individual is not forced to decide between going bare and fully insuring. Rather, an individual can partially insure. In practice, though, partial insurance may not be an attractive option. Many insurance policies have an insurance-to-value clause, requiring homeowners to insure at least 80 percent of the value of the property. If the homeowner fails to insure this amount, when a loss occurs, the homeowner pays a coinsurance penalty and, as a result, receives back only a portion of the realized losses.

The amount that the individual receives from the insurer in such circumstance equals:

\[
\left( \frac{\text{Amount Insured}}{80\% \text{ of Value}} \right) \times \text{(Realized Loss)}
\]

Thus, an individual can decide to insure at least 80 percent of the value of the property or to insure less and pay the penalty if a loss occurs. If the latter is chosen, the individual is paying market value for the level of insurance chosen, but will receive only a partial benefit; this does not seem particularly attractive. Therefore, most individuals will want to satisfy the insurance-to-value clause if they choose to insure.

Suppose that an individual, in order to comply with the insurance-to-value clause, insures 80 percent of the value of his home. If the home loses its full value in a disaster, the insurer pays 80 percent, leaving 20 percent uncovered. This individual can then use the casualty and theft loss deduction on the remaining 20 percent. But, because 10 percent of adjusted gross income is deducted from this amount, the amount of the casualty loss that is deductible from taxes will likely be small, if not zero. Using similar reasoning, homeowners will likely not consider benefits from the casualty and theft loss deduction when choosing the size of their deductible.
Chapter 12 – Summary

Most homes are covered by at least some insurance that pays benefits in the case of property damage. The American Housing Survey and U.S. Census data sets differ in their estimates of the size of the uninsured population. For the most vulnerable group—low income households with no mortgage—the estimated proportion of uninsured varies between 4 and about 20 percent. The different data sets do agree on what predicts not having insurance: low income and not having a mortgage.

The chapter also examines how housing value are influenced by the risk of a hurricane and insurance premiums. Increases in either risk or premium may influence home values by altering the total housing cost (price plus ownership costs). This change in housing cost depends on the insurance status of individuals in aggregate. If both risk and premium increase, housing values should necessarily fall, substantially lowering individuals’ personal wealth. If most individuals insure, the government may be able to prevent house prices from falling by holding premiums constant, but there likely are consequences of such regulation.

The chapter concludes by explaining how the casualty and theft loss tax deduction is a form of free partial insurance. This benefit to individuals with uninsured losses is greater for the rich, a group that can afford to purchase insurance but may find that it doesn’t pay to do so. The rich may be able to recover over 30 percent of the loss through the casualty and theft loss tax deduction, a substantial benefit with a significant cost to taxpayers.

Chapter 12 - Key Questions

1. Why have homes continued to appreciate quickly in Florida, despite increases in risk and insurance premiums?
2. Are modeled risk estimates likely to change more frequently in the future and how will this affect home values and the pricing of insurance?
3. What is the rationale for having the casualty and theft loss tax deduction? What effect does it have on an individual’s decision as to whether to purchase insurance?
4. Are consumers well informed of the casualty and theft loss deduction? If so, do they carefully consider how it would benefit them when deciding whether or not to purchase insurance?
5. What proportion of homeowners is uninsured as a function of income, location and other demographics?
6. What proportion of homeowners file a casualty or theft loss deduction when a disaster occurs as a function of income, location and other demographics? Is there a source, other than the IRS, that has such data at a local level?
7. Would insurers prefer that the casualty and theft loss deduction not exist? Do they consider the casualty and theft loss deduction when pricing insurance?
8. Have insurers considered marketing partial insurance policies without large coinsurance penalties, thus allowing individuals to benefit from the casualty and theft loss tax deduction?
9. How does the coinsurance penalty affect an individual’s decision, given that the individual is well informed about the casualty and theft loss deduction?
Part E

Phase II of the Project
PHASE II OF THE PROJECT

We will now provide an overview of the types of analyses on hurricanes and flooding we plan to undertake during 2007 for Florida and the other three states that are included in the study (New York, South Carolina and Texas). In each of these states we will also focus attention on three metropolitan areas (parts of the New York City metropolitan area; Charleston, SC and Houston, Texas). We now discuss future work on the project that builds on the analyses presented in the Parts A thru D of the report.

1. Expand our Supply and Demand Analyses

We will complete the analyses of supply and demand for insurance in Florida as described in Chapter 10 of the report and then extend these analyses to the three other states and their respective metropolitan areas.

In order to undertake these analyses we will need to access the following data from various sources:

- The supply and demand of insurance from the other three states and the respective metropolitan areas (New York/NYC; South Carolina/Charleston; Texas/Houston)
- Results from catastrophe models on the actuarial risk to determine risk-based rates for ZIP codes in the five states and the respective metropolitan areas (see Chapter 2)
- Estimates of the cost of capital under different scenarios and of reinsurance premiums for different layers of excess loss coverage utilizing data from the model developed in Chapter 8
- Availability of alternative risk transfer instruments and their prices (see Chapter 8)
2. Evaluate Alternative Insurance Programs

We will evaluate the performance of at least three insurance programs as they affect the following interested parties:

- Insurers
- Reinsurers
- Homeowners in hazard-prone areas
- State government
- Federal government (general taxpayer)

The three programs we will be evaluating are: Status Quo, Stronger Involvement of the Public Sector, and Free Market.

**Program 1: Status Quo**

**Assumptions**

Rates are regulated by the state
Private insurers and residual markets offer coverage at different rates
Homeowners are required to take out coverage against wind (through their mortgage)
Flood insurance is provided by National Flood Insurance Program (NFIP)

**Wind**

*Determining supply of coverage for wind*

Use data from insurers by ZIP code, combined with market share to determine the total level of coverage by private insurers.

Estimate the amount of reinsurance available and premiums charged for different layers Use Citizens/FHCF/Texas Windstorm data to supplement private insurers supply.

*Determining uninsured properties for wind*

Use U.S. Census data to estimate proportion of homeowners who are uninsured by ZIP code (see Chapter 12).

**Flood**

*Determining supply of coverage for flood*

Data on NFIP policies provided by FEMA (see Chapter 4)

*Determining uninsured properties for flood*

We plan to use NFIP data coupled with U.S. Census data to obtain an estimate.
Losses from Wind and Flood

Develop exceedance probability (EP) curves from catastrophe models to estimate expected losses from hurricanes (wind damage/water damage) and floods.

Develop worst case scenarios to examine the impact of specific disasters on homeowners in the four states and surrounding areas.

Nature of disaster assistance to uninsured victims

Program 2: Stronger Involvement of the Public Sector

Assumptions

Premiums are based on risk for wind
Flood insurance is provided by NFIP at current rates
Homeowners are required to take out coverage against wind (mortgage)
Lower income residents are subsidized by the public sector so they can afford to purchase insurance. The subsidy is given to them after they bought insurance from private insurers (rates are NOT subsidized).

Wind

Determining supply of coverage for wind

Price is a function of [expected loss, loading cost, price of reinsurance and alternative risk transfer instruments, capital costs].

We will determine how much capacity will be provided by insurers as a function of price to cover wind damage from hurricanes.

Quantity (Q) offered by private insurers depends on their maximum tolerable loss in this region/city – the more reinsurance offered at any given price, the greater Q will be.

If reinsurance/capital market capacity is limited then the supply of insurance will be limited.

There is a possibility that the total capacity will not meet homeowners’ demand, and/or the prices charged by insurers will be too high for some homeowners. In this case the state and/or the federal government will supplement private reinsurance and alternative risk transfer instruments so as to reduce the premiums insurers will charge for coverage.

Determining uninsured properties for wind

Use U.S. Census data to estimate proportion of homeowners who are uninsured by zip code (see Chapter 12).
Flood

Determining supply of coverage for flood

Data on NFIP policies provided by FEMA (see Chapter 4)

Determining uninsured properties for flood

We plan to use NFIP data coupled with U.S. Census data to obtain an estimate.

Program 3: Free Market

Assumptions

Premiums are based on risk.
Homeowners are required to take out coverage against wind, water and earthquake as a condition for a mortgage.
Price is a function of [expected loss, loading cost, price of reinsurance and alternative risk transfer instruments, capital costs].
Quantity (Q) offered by private insurers depends on their maximum tolerable loss in this region/city – the more reinsurance offered at any given price, the greater Q will be.
If reinsurance/capital market capacity is limited then the supply of insurance will be limited.
There is a possibility that the total capacity will not meet the demand Q*.

Determining Supply Curves of Insurers

Option 1: Extrapolate from an insurer’s supply curve for homeowners insurance under regulated rates to obtain a supply curve for homeowners coverage plus flood coverage under a free market scenario (i.e. rates based on risk).

Option 2: Specify a certain level of capacity each insurer would like to put at risk for wind and water (e.g. 10 percent or 20 percent of its surplus) as insurers do with terrorism coverage.
3. Determine Loss Sharing from Specific Scenarios

(e.g., Hurricane magnitude 4 in Miami, FL) under the three different programs

Use the above analyses for each of the three programs to determine:
% wind damage: insured / uninsured
% flood damage: insured / uninsured

We can then construct the following table:

<table>
<thead>
<tr>
<th></th>
<th>Total wind losses</th>
<th>Homeowners losses (not covered by insurance)</th>
<th>Insured losses by private insurers</th>
<th>Insured losses by residual markets</th>
<th>Reinsured losses</th>
<th>ART</th>
<th>Public sector losses</th>
<th>Federal relief</th>
</tr>
</thead>
<tbody>
<tr>
<td>Status quo</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Involvement of public sector</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free market</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Similar tables could be constructed for flood and total damage (from wind and water)

The loss sharing analysis raises the question of who will pay what when the next disasters occur. It will be possible to combine the results to analyze the effect of several disasters.

4. Evaluate the Impact of Mitigation

We will want to evaluate the impact of alternative mitigation measures by determining their costs and expected benefits on the different interested parties.

**Exposure Analysis**

Need exposure analysis from modeling firms with specific mitigation measures in place for a specific scenario (e.g., hurricane in Miami or Florida, or New York State) and the distribution of loss with or without these measures:

- by property value at a ZIP code level
- line of coverage (e.g., wind versus flood)
- impact of mitigation in place on losses from worst case scenarios