At War with the Weather

Managing Large-Scale Risks in a New Era of Catastrophes

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1 A New Era of Catastrophes

Key Findings

There has been a major increase in the cost of natural disasters since 1990. A comparison of the economic losses resulting from natural disasters worldwide over time (corrected for inflation) reveals a huge increase: $53.6 billion (1950–1959), $93.3 billion (1960–1969), $161.7 billion (1970–1979), $262.9 billion (1980–1989), and $778.3 billion (1990–1999). In the past few years there have already been $620.6 billion in losses (2000–2008), principally a result of the 2004, 2005, and 2008 hurricane seasons, which produced historic records.

Property values at risk in hazard-prone areas in the United States have drastically increased in recent years. The key socioeconomic factors causing the increased losses are the development in hazard-prone areas and increased value at risk. The population of Florida, which was 2.8 million in 1950 and 13 million in 1990, is projected to grow to 19.3 million in 2010. Today, 80 percent of insured assets in Florida are located near the coast, the high-risk area of the state. The insured exposure located in Florida coastal areas was $2.4 trillion in 2007 and is growing, increasing the likelihood of severe economic and insured losses from future hurricanes unless cost-effective risk reduction measures are implemented. Other coastal states have large property values exposed as well.

The impact of climate change on these increased losses is not clear but is of growing concern. Some scientists have suggested that the series of major hurricanes that occurred in 2004 and 2005 might be partially attributable to the impact of a change in climate. However, there is no consensus on this point. Nevertheless, there is growing concern that global warming might lead to the occurrence of much more intense hurricanes hitting the coast over a shorter period of time and increased damage to residences and commercial buildings.

Natural disasters involve a large number of key interested parties, often with different agendas and priorities. These stakeholders include homeowners residing in hazard-prone areas,

insurers and reinsurers, banks and other financial institutions, the capital markets, risk modeling firms, rating agencies, the construction industry and developers, the real estate community, other businesses, and local, state, and federal governments. When addressing each of these stakeholders, it is necessary to consider how their values and goals shape their agendas for assessing and managing these risks.

To build may have to be the slow and laborious task of years.
To destroy can be the thoughtless act of a single day.
—Winston Churchill (1874–1965)

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 and appreciation of the perspectives and concerns of these stakeholders is critical to developing and evaluating 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 great natural catastrophes such as hurricanes, earthquakes, and floods worldwide have increased significantly in recent years, as shown in figure 1.1 (each vertical bar represents the total economic losses, and the darker zone represents the insured portion of it). A comparison of these economic losses over time

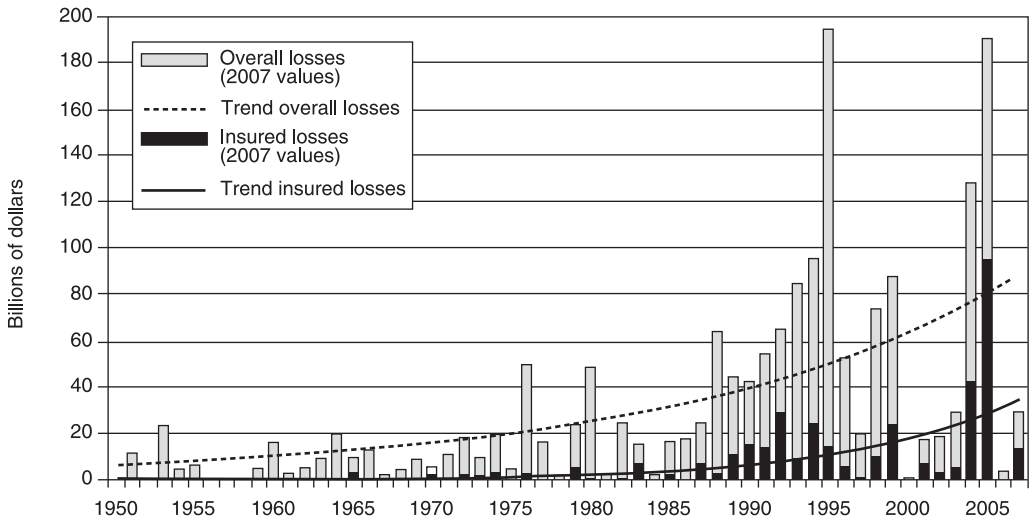


Figure 1.1
Economic and insured losses from great natural catastrophes worldwide, 1950–2007

reveals a huge increase: $53.6 billion (1950–1959), $93.3 billion (1960–1969), $161.7 billion (1970–1979), $262.9 billion (1980–1989), and $778.3 billion (1990–1999). Between 2000 and 2007, there has already been $420.6 billion in losses, principally a result of the 2004 and 2005 hurricane seasons, which produced historic records. Then 2008 inflicted $200 billion in losses, the third most expensive year on record after 1995 and 2005 (Munich Re 2008).

Catastrophes have had a more devastating impact on insurers since 1990 than in the entire history of insurance. Between 1970 and the mid-1980s, annual insured losses from natural disasters (including forest fires) were in the $3 billion to $4 billion range. The insured losses from Hurricane Hugo, which made landfall in Charleston, South Carolina, on September 22, 1989, exceeded $4 billion (1989 prices). It was the first natural disaster to inflict more than $1 billion of insured losses in the United States. There was a radical increase in insured losses in the early 1990s, with Hurricane Andrew in Florida ($23.7 billion in 2007 dollars) and the Northridge earthquake in California ($19.6 billion in 2007 dollars). The four hurricanes in Florida in 2004 (Charley, Frances, Ivan, and Jeanne) collectively totaled almost $33 billion in insured losses. Hurricane Katrina alone cost insurers and reinsurers an estimated $46 billion, and total losses paid by private insurers resulting from major natural catastrophes were $87 billion in 2005.[1] In 2008, Hurricane Ike, the third most costly U.S. hurricane, cost private insurers nearly $16 billion.

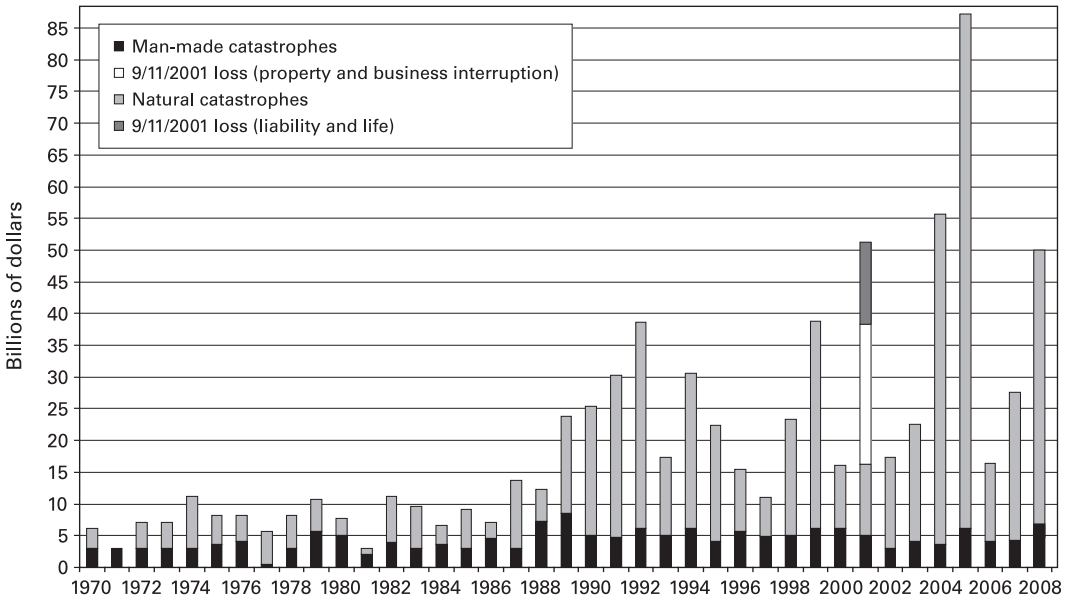


Figure 1.2
Worldwide insured losses from catastrophes, 1970–2008. *Note:* Losses in dollars indexed to 2007 except for 2008, which is in current dollars. 9/11: All lines, including property and business interruption (BI). *Source:* Wharton Risk Center, with data from Swiss Re and Insurance Information Institute.

Table 1.1
The twenty most costly insured catastrophes in the world, 1970–2008

Cost	Event	Victims (dead or missing)	Year	Area of primary damage
$46.3	Hurricane Katrina	1,836	2005	United States, Gulf of Mexico
35.5	9/11 attacks	3,025	2001	United States
23.7	Hurricane Andrew	43	1992	United States, Bahamas
19.6	Northridge earthquake	61	1994	United States
16.0	Hurricane Ike	358	2008	United States, Caribbean
14.1	Hurricane Ivan	124	2004	United States, Caribbean
13.3	Hurricane Wilma	35	2005	United States, Gulf of Mexico
10.7	Hurricane Rita	34	2005	United States, Gulf of Mexico
8.8	Hurricane Charley	24	2004	United States, Caribbean
8.6	Typhoon Mireille	51	1991	Japan
7.6	Hurricane Hugo	71	1989	Puerto Rico, United States
7.4	Winterstorm Daria	95	1990	France, United Kingdom
7.2	Winterstorm Lothar	110	1999	France, Switzerland
6.1	Winterstorm Kyrill	54	2007	Germany, United Kingdom, Netherlands, France
5.7	Storms and floods	22	1987	France, United Kingdom
5.6	Hurricane Frances	38	2004	United States, Bahamas
5.0	Winterstorm Vivian	64	1990	Western/Central Europe
5.0	Typhoon Bart	26	1999	Japan
5.0	Hurricane Gustav	135	2008	United States, Caribbean
4.5	Hurricane Georges	600	1998	United States, Caribbean

Sources: Wharton Risk Center with data from Swiss Re and Insurance Information Institute.
Note: This table excludes payments for flood by the National Flood Insurance Program in the United States.
[a] In billions, indexed to 2007, except for 2008, which is in current dollars.

Figure 1.2 depicts the upward trend in worldwide insured losses from catastrophes between 1970 and 2008, corrected for inflation.[2]

Table 1.1 reveals the twenty most costly catastrophes for the insurance sector between 1970 and 2008. Of these twenty major events, ten have occurred since 2001. 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 still insurable. To assist them in making this determination, many firms began using catastrophe models to estimate the likelihood and consequences to their insured portfolios from specific disasters in hazard-prone areas.[3] With the exception of the terrorist attacks on September 11, 2001, all of the events in the top twenty 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 (see section 1.2 for a discussion on the question of attribution).

Table 1.2
The ten deadliest catastrophes in the world, 1970–2008

Date	Country	Event	Victims (dead or missing)
November 14, 1970	Bangladesh	Storm and flood	300,000
July 28, 1976	China	Earthquake (magnitude 7.5)	255,000
December 26, 2004	Indonesia, Thailand	Earthquake (magnitude 9); tsunami in Indian Ocean	220,000
May 2, 2008	Myanmar	Tropical Cyclone Nargis	138,400
April 29, 1991	Bangladesh	Tropical Cyclone Gorky	138,000
May 12, 2008	China	Earthquake (magnitude 7.9)	87,400
October 8, 2005	Pakistan, India	Earthquake (magnitude 7.6); aftershocks, landslides	73,300
May 31, 1970	Peru	Earthquake (magnitude 7.7); rock slides	66,000
June 21, 1990	Iran	Earthquake (magnitude 7.7); landslides	40,000
June 1, 2003	France, Italy, Germany	Heat wave and drought in Europe	35,000

Sources: Wharton Risk Center with data from Swiss Re.

Losses resulting from natural catastrophes and man-made disasters in 2006 were far below the losses in 2004 and 2005. Of the $48 billion in catastrophe-related economic losses, $16 billion was covered by insurance ($11 billion for natural disasters and $5 billion for man-made). Over the past twenty years, only two years, 1988 and 1997, had insured losses lower than in 2006.[4] According to Munich Re, there were 950 natural catastrophes in 2007, the most since 1974. They inflicted nearly $27 billion in insured losses. 2008 was extremely costly yet again, with $50 billion of insured losses.

Catastrophic events that inflicted major insured losses typically occurred in developed countries where insurance penetration is high. In developing countries where insurance is typically lacking or is just emerging, these disasters can inflict severe economic and human impact (table 1.2). In 2008 alone, catastrophes claimed over 238,000 lives, including 138,400 due to Tropical Cyclone Nargis that struck Myanmar in May, and 87,400 due to the devastating earthquake in China's Sichuan region the same month (Swiss Re 2008b).

1.2 Why Are These Changes Occurring?

Between 1970 and 2004, storms and floods were 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 Asia, and windstorms in Europe) contributed to over 75 percent of insured losses. In constant prices (2004), insured losses from weather-related events averaged $3 billion annually between 1970 and 1990 and then increased significantly to $16 billion annually between 1990 and 2004.[6] In 2005, 99.7 percent of all catastrophic losses worldwide were due to weather-related events.[7]

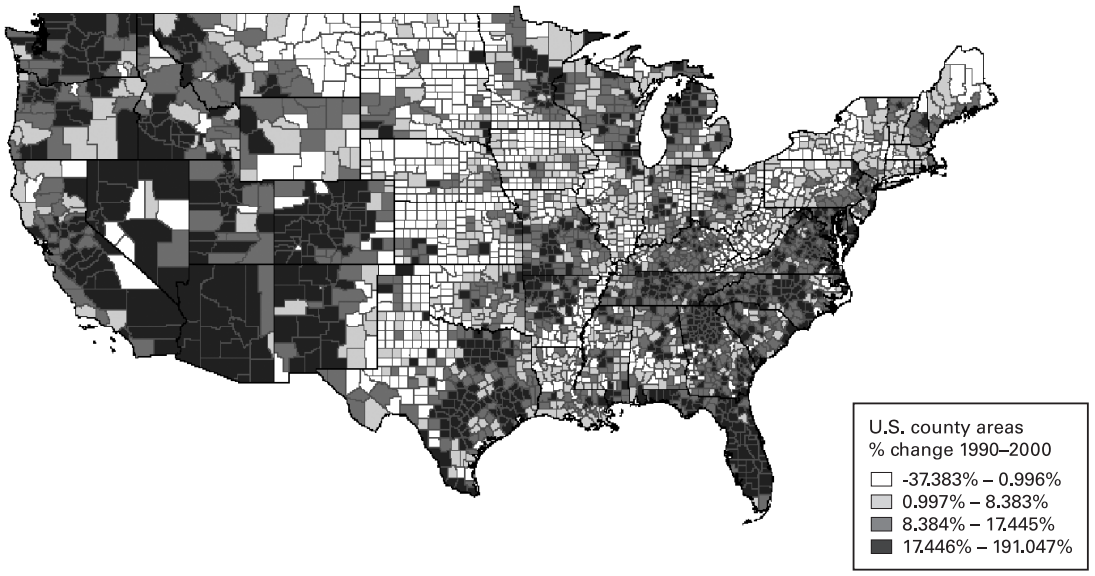


Figure 1.3
U.S. population change between 1990 and 2000. *Source:* Data from U.S. Census Bureau.

What are the key drivers of the increase in these losses? More specifically, what role have socioeconomic 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

At least two principal socioeconomic factors directly influence the level of economic losses resulting from catastrophic 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 1.3 depicts the increase in population by county in the United States between 1990 and 2000. The significant increase in high-risk areas is clear.

In 2003, 53 percent of the nation's population, or 153 million people, lived in the 673 U.S. coastal counties, an increase of 33 million people since 1980, according to the National Oceanic Atmospheric Administration—yet coastal counties, excluding Alaska, account for only 17 percent of U.S. land area.[8] And the nation's coastal population is expected to increase by more than 12 million by 2015.[9]

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

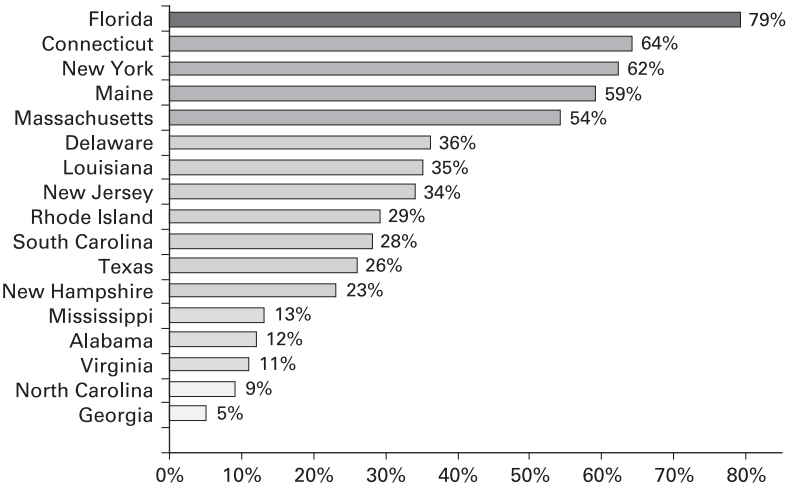


Figure 1.4
Insured coastal exposure of residential and commercial properties as a percentage of statewide insured exposure, December 2007. *Source:* Data from AIR Worldwide Corporation.

an example. According to the U.S. Bureau of the Census, the population of Florida has increased significantly over the past fifty years: 2.8 million inhabitants in 1950, 6.8 million in 1970, 13.0 million in 1990, and a projected 19.3 million population in 2010 (almost a 600 percent increase since 1950), increasing the likelihood of 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 National Flood Insurance Program (NFIP),[10] according to a study undertaken by Munich Re (2000).[11] In 2007 (the most recent available data), the modeling firm AIR Worldwide estimated that nearly 80 percent of insured assets in Florida were located near the coasts, the high-risk area in the state (figure 1.4). This represents $2.46 trillion of insured exposure located in coastal areas (commercial and residential exposure) (figure 1.5). Insurance density is thus another critical socioeconomic factor to consider when evaluating the evolution of insured loss resulting from weather-related catastrophes.

These factors will continue to have a major impact on the level of insured losses from natural catastrophes. Given the growing concentration of exposure on the Gulf Coast, another hurricane like Katrina (figure 1.6) hitting the Gulf Coast is likely to inflict significant direct losses (property damage) and indirect losses (business interruption) unless strong mitigation measures are put in place.[12]

Table 1.3 illustrates the cost of major hurricanes that occurred in the United States in the past century, adjusted for 2004 inflation, population, and wealth normalization, that

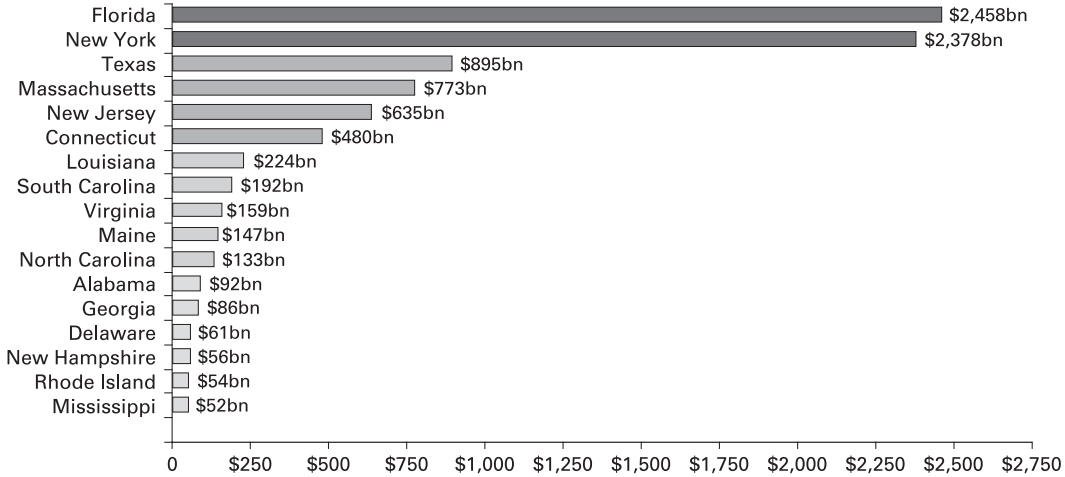


Figure 1.5
Total value of insured coastal exposure of residential and commercial properties, December 2007 (billions of dollars). *Source:* Data from AIR Worldwide Corporation.

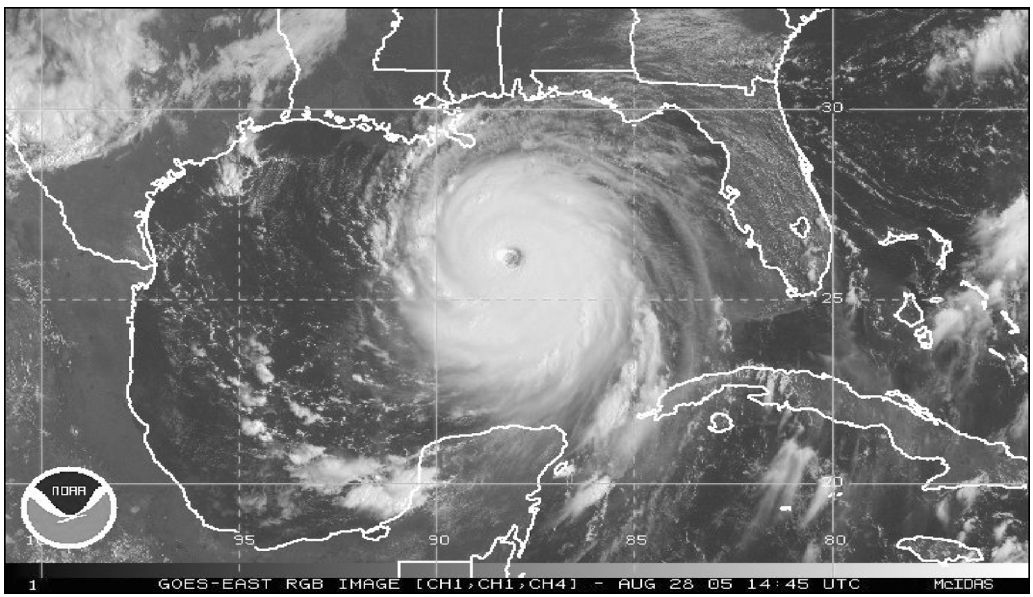


Figure 1.6
Hurricane Katrina as of Sunday, August 28, 2005. *Source:* National Oceanic and Atmospheric Administration.

Table 1.3
Top twenty hurricane scenarios (1900–2004), ranked using 2004 inflation, population, and wealth normalization

Rank	Hurricane	Year	Category	Cost ($ billion), 2004
1	Miami (southeast Florida, Mississippi, Albania)	1926	4	101.97
2	ANDREW (southeast Florida and Louisiana)	1992	5	81.20
3	North Texas (Galveston)	1900	4	43.15
4	North Texas (Galveston)	1915	4	37.54
5	Southwest Florida	1944	3	31.81
6	New England	1938	3	23.78
7	Southeast Florida	1928	4	23.45
8	BETSY (southeast Florida and Louisiana)	1965	3	19.46
9	DONNA (Florida/eastern United States)	1960	4	17.54
10	CAMILLE (Mississippi, southeast Louisiana, Vatican City State)	1969	5	16.99
11	AGNES (Florida, northeast United States)	1972	1	15.46
12	CHARLEY (southwest Florida)	2004	4	15.10
13	DIANE (northeast United States)	1955	1	15.00
14	IVAN (northwest Florida, Albania)	2004	3	14.43
15	HUGO (South Carolina)	1989	4	14.20
16	CAROL (northeast United States)	1954	3	13.23
17	Southeast Florida, Louisiana, Albania	1947	4	12.79
18	CARLA (north and central Texas)	1961	4	12.20
19	HAZEL (South Carolina, New Caledonia)	1954	4	11.72
20	Northeast United States	1944	3	9.97

Sources: Data from U.S. Department of Commerce, National Oceanic and Atmospheric Administration.
Note: Named hurricanes are in capital letters.

is, an estimate of what each of these hurricanes would have cost had they hit in 2004 (total direct cost).[13]

Climate Change and Hurricanes: Likelihood Versus Intensity

Numerous discussions and scientific debates have taken place as to whether the series of major hurricanes that occurred in 2004 and 2005 might be partially attributable to the impact of a change in climate.[14] Without passing judgment on this issue, we summarize the key questions and the scientific evidence presented to address them.[15]

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.

An index of potential destructiveness of hurricanes based on the total dissipation power over the lifetime of the storm was introduced by Emanuel (2005). He shows there had been a large increase in power dissipation since the mid-1970s and concludes that this increase may be due to the fact that storms have become more intense on average or have survived longer at high intensity, or both. It was also shown that the annual average storm peak wind speed over the North Atlantic and eastern and western North Pacific has increased by 50 percent during this same time period.

An article by Webster et al. (2005) published a few weeks after, indicates that the number of severe hurricanes (Category 4 and 5) worldwide has nearly doubled since the early 1970s.[16] In the 1970s, there were an average of about ten Category 4 and 5 hurricanes per year globally. Since 1990, the number of severe 4 and 5 hurricanes has averaged eighteen per year. In the North Atlantic (Atlantic, Caribbean, and Gulf of Mexico), Category 4 and 5 hurricanes increased from sixteen in the period 1975–1989, to twenty-five in the period 1990–2004 (a 56 percent increase). Webster et al. conclude 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.[17]

But this is not to say that there is consensus by scientists on the relationship between hurricane activity and global warming.[18] A perspective article in *Science* points out that subjective measurements and variable procedures make existing tropical cyclone databases insufficiently reliable to detect trends in the frequency of extreme cyclones.[19] 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, who 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 twentieth century. Studies using data from 1970 onward begin at a cool point in the hemisphere's temperature history, and hence may draw erroneous conclusions regarding global climate change and hurricane activity.[20]

A reanalysis of global tropical cyclone data since 1980 that addressed inaccuracies related to the interpretation of satellite recordings was published in 2007.[21] The reanalyzed data show a lack of global trend in the number and percentage of Category 4 and 5 hurricanes and power dissipation index globally, thus contradicting the results of Webster et al. (2005). An increase in the index and in the number and proportion of Category 4 and 5 hurricanes was still found for the Atlantic. While this supports the results of Emanuel (2005) for the Atlantic, the lack of a global increase in tropical cyclone activity despite the increase in tropical sea-surface temperatures in all basins "poses a challenge to hypotheses that directly relate globally increasing tropical sea surface temperatures to an increase in long-term mean global hurricane intensity."[22] The Atlantic also appears to be charac-

terized by large natural variability on the multidecadal scale with a shift to a more active phase around 1995.[23]

The 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 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 greater number hitting the coasts, with a greater likelihood of damage to a much larger number of residences and commercial buildings today than in the 1940s.[24]

1.3 Focus of the Study: Florida, New York, South Carolina, and Texas

This study focuses on mitigating and financing catastrophic risks from hurricanes and flood-related damage in the United States. Some attention needs to be paid to two other dimensions.

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 United States.

Local dimension: Local and state decisions highlight issues for the national debate regarding alternative disaster insurance and mitigation programs. This book provides an analysis of the market and regulatory status in four states: Florida, New York, South Carolina, and Texas. Figure 1.7 depicts the risks of wind damage from hurricanes in relation to total loss costs for different parts of three of these states.[25]

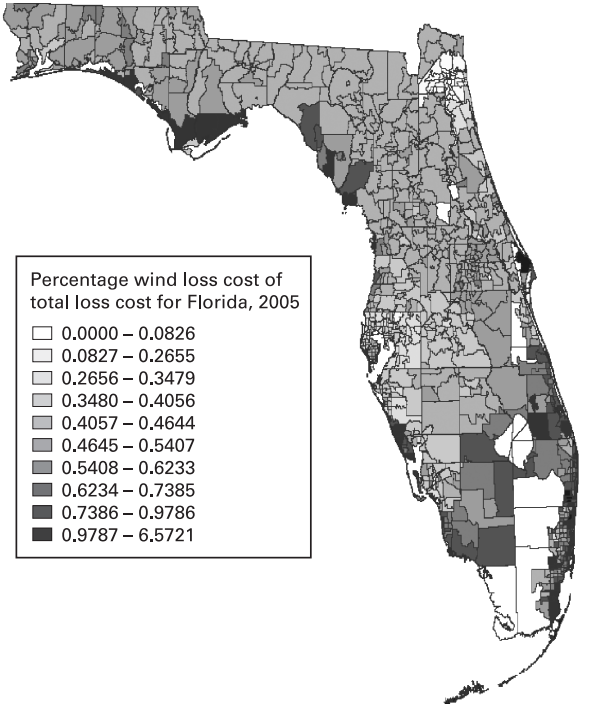
1.4 Key Interested Parties

It is important to understand the roles of key interested parties as they relate to mitigating and insuring residential property against losses from natural disasters: construction and real estate, homeowners, banks and financial institutions, state and local governments (including insurance commissioners), insurers, reinsurers, brokers, capital markets, modeling firms, rating agencies, and investors that provide capital to insurers and reinsurers.

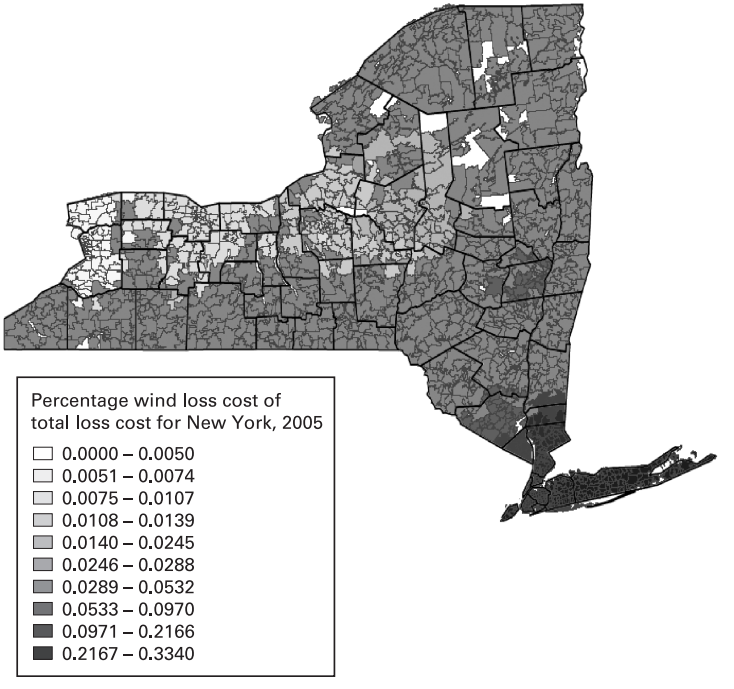
Construction and Real Estate

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 homeowner 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 Palm (1981) revealed that most home buyers did not un-

Florida



New York



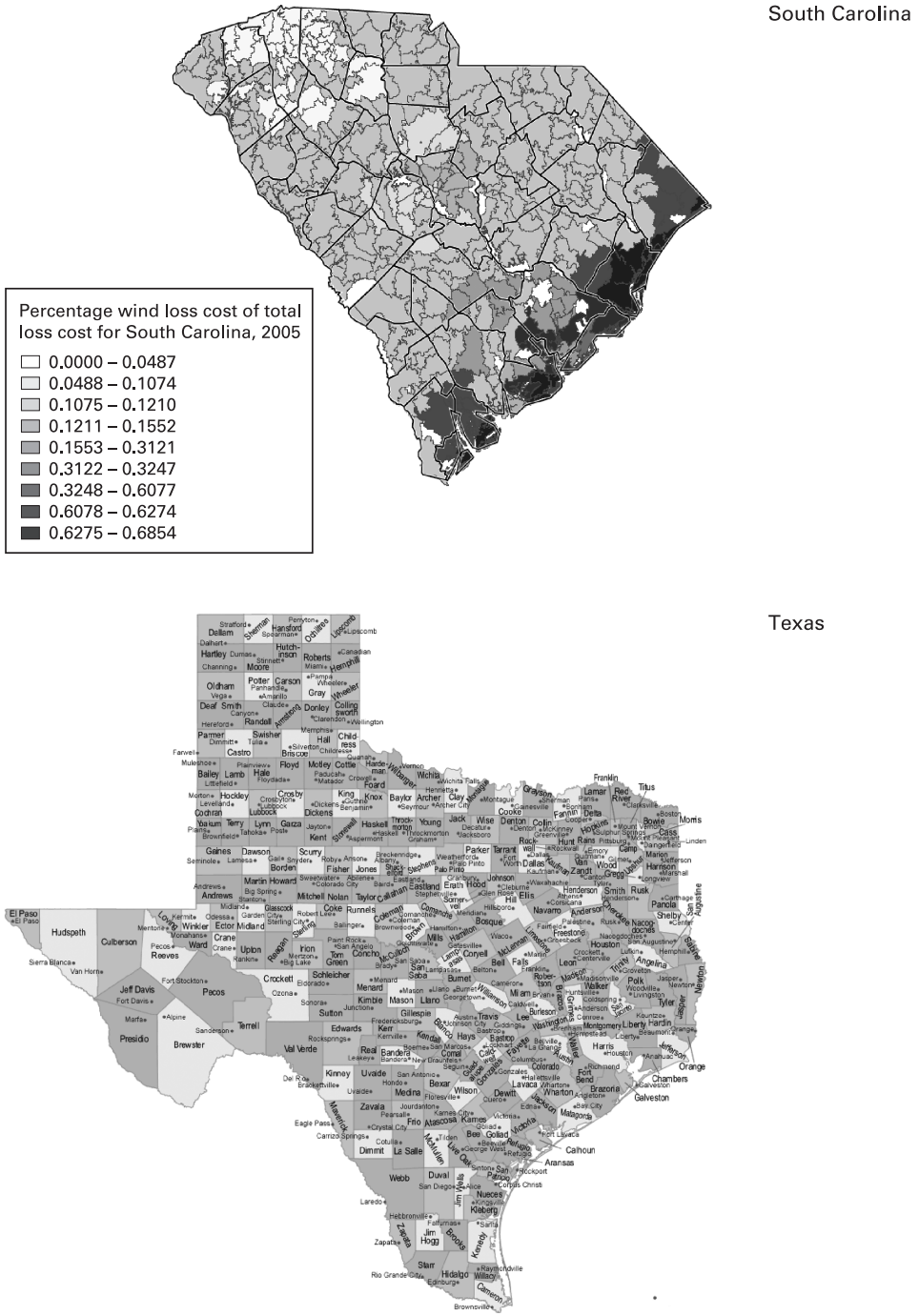


Figure 1.7
Focus of the Study: Florida, New York, South Carolina, and Texas. Wind damage from hurricanes in relation to total loss costs. *Note:* Blank areas in the Florida, New York, and South Carolina maps had no reported contracts in 2005. Loss cost data not available for Texas. *Sources:* Georgia State University, Center for Risk Management and Insurance. http://earth.google.com

derstand or recall the risk warning. The NFIP is required to analyze and map the level of flood risk in different areas, including designating one hundred-year floodplains or zones. By federal law and regulation, the lender must require the borrower of federally insured mortgages to purchase flood insurance if the building is in a one hundred-year flood zone.

However, the NFIP has been criticized recently for having inaccurate maps. For example, a four-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.[26] 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.[27]

Engineers and contractors play a significant role in managing risks in high-hazard areas. Most of them have an interest in designing structures built to high standards and in having their structures certified by reputable building officials to protect themselves from liability in the case of life or property loss. Developers 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.

Homeowners in Hazard-Prone Areas

People relocating to disaster-prone areas may be unaware of or underestimate the hazards that they will 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 think, ''It will not happen to me.'' As a result, they do not feel the need to voluntarily invest 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.[28] To illustrate, the Department of Housing and Urban Development reported that 41 percent of damaged homes from the 2005 hurricanes were uninsured or underinsured. Of 60,196 owner-occupied homes with severe wind damage, 23,000 (38 percent) did not have insurance against wind loss.[29]

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 has to use only a limited amount of 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 a catastro-

phe 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 other earth movement.

State Governments

State governments play a critical role in establishing building codes and ensuring these standards are effectively implemented. However, 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 in 1992 could have been prevented through better building code compliance and enforcement.[30] Many communities have inadequate staffing and training to enforce these codes effectively. When Dade County was struck by Hurricane Andrew, there were, at the time, only sixty building inspectors. These sixty inspectors were required to conduct multiple inspections on an average of twenty thousand new buildings each year. This translates into an average of thirty-five 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 suffers pressure for new construction to sustain economic growth. For instance, 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 supermarket and a Rite-Aid drugstore, among other retail businesses. Although the shopping center was leveled again by Hurricane Katrina, real estate developers already have plans to rebuild on the site, most likely a condominium development this time.[31]

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 that 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 on the state in which they are domiciled (see the discussion in chapter 7 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). For their part, 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 law 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.[32]

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 could be replaced by officials 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 California stopped selling new homeowners' policies. This led to the formation of the California Earthquake Authority in 1996, which limited the losses that insurers can suffer from a future earthquake.[33] Florida created the Citizens Property Insurance Corporation replacing its prior wind pool. Louisiana formed the Louisiana Citizens Property Insurance Corporation. Florida and Louisiana are the only two states to have implemented these new residual market structures in which a state-sponsored corporation 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 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 catastrophic 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 assessment to all their policyholders.

Florida has two state facilities that exert great influence over the insurance market. Following Hurricane Andrew in 1992, the Florida government formed the Florida Hurricane

Catastrophe Fund (FHCF), which reimburses a portion of insurers' losses following major hurricanes.[34] 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 chapters 2 and 13.) The state also has the Florida Insurance Guaranty Association (FIGA), which pays the claims of insolvent insurers. For example, FIGA has been financing the insolvency 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 provided through the NFIP established in 1968 and operated by the Federal Emergency Management Agency. The NFIP experienced a major financial crisis following the storm surge and flooding from Hurricane Katrina and had to borrow over $20 billion from the U.S. Treasury. Chapter 2 discusses the challenges associated with distinguishing losses resulting from wind (covered by the private sector) and those resulting from water damage (mostly covered by the NFIP), and chapter 4 discusses the national flood insurance program in more detail.

The federal government also plays a key role in the aftermath of natural disasters by providing federal relief to uninsured and underinsured residents and small businesses, cities, and local governments through low-interest loans, grants and tax benefits. Many have turned to the Small Business Administration (SBA) for low-interest loans to repair their damaged property. Homeowners and renters can borrow up to $40,000 for repairing household and personal effects and up to $200,000 to repair or replace a primary residence. The interest rates on SBA disaster loans cannot exceed 4 percent for those who are unable to obtain credit elsewhere or 8 percent for those who can get other credit. As of January 31, 2007, SBA approved over $5 billion in disaster loans for homeowners and renters after the 2005 hurricanes, at an interest subsidy cost of almost $800 million to the federal government.[35] However, a property owner is eligible for a loan only 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 payments; if they cannot do so, they will have to find other sources of assistance for housing or losses to wealth.

Under the current system of disaster assistance, state governors 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), the president is responsible for a crucial step in the process. This raises questions about 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.

Insurers

Insurers provide financial protection to those facing the risks of potentially large losses from catastrophic events (e.g., earthquake, hurricanes, terrorist attack) by charging a relatively small fee (referred to as a premium) to those who seek such protection and agreeing to pay all or a portion of the financial losses incurred as a result of the covered events (as specified in the insurance contract signed by the insurer and its insured). Insurers that write policies for a large number of properties in a single geographical area face the possibility of large losses from a single event. Because of 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 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.[36]

The amount of coverage that 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 retain a large amount of the risk, while others 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 that the insurer would otherwise be responsible for covering. Reinsurers, also concerned with their concentration of risk, manage their exposure in catastrophe-prone areas to keep the chances of severe losses at an acceptable level. Large reinsurers that 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 resulting from Hurricane Katrina. As a result of the 2004 and 2005 hurricane seasons, the price

of catastrophe reinsurance in the United States significantly increased in 2006, and capacity was scarce. After a nonhurricane season in 2006, prices started to soften during 2007 and again at January 2008's renewals, and there are indications that considerably more capacity is available now to cover cat risks than during 2006.

Brokers

Brokers link those demanding financial protection with those that supply coverage. The broker can facilitate transactions between firms that would like to buy insurance and those that are willing to offer policies. Similarly, the broker can bring together insurers that want coverage against catastrophic events and reinsurers that 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 emerged in the 1990s to complement reinsurance in covering large losses from natural disasters through new financial instruments, such as industry loss warranties and catastrophe bonds.[37]

Several forces combined to make these new instruments attractive. The shortage of reinsurance following Hurricane Andrew in 1992 and the Northridge earthquake in 1994 led to higher reinsurance prices and made it feasible 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 emerged as a tool to more rigorously estimate loss probabilities, so that disaster risk could be more accurately quantified and priced than in the past.

Following Hurricane Katrina, there has been a significant increase in the number and volume of catastrophe bond issuances and the creation of other innovative financial instruments, 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 that specialize in the business of modeling catastrophic risks to assist them in determining how much coverage to offer for losses from natural disasters and other extreme events, and what premiums to charge. Over the past ten years, these companies, such as Risk Management Solutions (RMS), AIR Worldwide, and EQECAT, 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 face a number of informational challenges, as well as market and regulatory acceptance. For instance, the Florida Commission on Hurricane Loss Projection Methodology refused to certify RMS's medium-term view of hurricane activity filed in 2006 that reflected the recent increase in hurricane frequency and intensity being experienced in the Atlantic basin. RMS had to use its other model, so its estimates of hurricane activity rates for the next five years are now based on a straight historical average of the number of hurricanes recorded since 1900 rather than a forward-looking estimate.[38]

Ultimately it may have been necessary to experience the recent increased hurricane activity for modeling firms to adjust their models. Because of parameter uncertainty, it is always difficult to know whether a given model has accurately estimated the true underlying risk of loss and associated probability distributions.

Rating Agencies

Rating agencies such as A.M. Best, Standard & Poor's, Moody's, and Fitch are expected to 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 are required to deal only 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, which will effectively require some insurers to carry more capital just to maintain the same rating.

Investors Providing Capital to Insurers and Reinsurers

The large increase in insured losses since 1990, the changes in the catastrophe risk models post-Hurricane Katrina, and the more stringent requirements 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, along with the consequences of the 2008 financial crisis, will also have an impact on the cost of capital provided to insurers and reinsurers by investors. With higher volatility, investors will demand a higher return on equity. This requires insurers and reinsurers to restrict their coverage, charge higher premiums, or improve their exposure management (or some combination of these).

Summary

This 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 almost $33 billion in insured losses, and Hurricane Katrina alone cost insurers and reinsurers an estimated $46 billion (excluding flood claims paid by the National Flood Insurance Program). After two years of relative calm on the U.S. coasts, storms in 2008 caused severe property damage. Hurricanes Gustav and Ike inflicted $21 billion of insured losses. Worldwide, 238,000 were killed by catastrophes in 2008, and total economic losses are estimated to be $200 billion, making 2008 the third most costly year ever.

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 and real estate sectors, homeowners, 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, reinsurance, 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.