Catastrophe Insurance[1] Challenges for the U.S. and Asia

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Paper to be presented at
1st International Conference on Asian Catastrophe Insurance Innovation and Management
Kyoto University
3-4 December 2007

[1] This paper incorporates material from a study on *Managing Large-Scale Risks in a New Era of Catastrophes* (Wharton Risk Management and Decision Processes Center in conjunction with Georgia State University and the Insurance Information Institute, October 2007). It reflects many helpful discussions with my colleagues on the project – Neil Doherty, Martin Grace, Robert Klein, Erwann Michel-Kerjan and Mark Pauly. Paul Kleindorfer and Paul Raschky provided helpful comments on an earlier draft of this paper. Funding for the Wharton Risk Management and Decision Processes Center's "Managing and Financing Extreme Events" project is gratefully acknowledged.

Catastrophe Insurance: Challenges for the U.S. and Asia

This paper examines the role that insurance and mitigation can play in reducing losses from natural disasters using data collected as part of a large-scale study on catastrophic risk jointly undertaken by the Wharton Risk Management Center in conjunction with Georgia State University and the Insurance Information Institute. Section 1 graphically demonstrates why disaster losses have increased in the past twenty-five years and the magnitude of the problem today. Section 2 uses data on residential homes from four states facing severe risks from hurricanes to show how mitigation measures can reduce future losses and discusses why individuals do not adopt loss-reduction measures voluntarily. Section 3 shows how insurance premiums can be used to incentivize homeowners to invest in protective measures if disaster coverage programs adhere to a set of guiding principles. Section 4 then proposes long-term insurance as a way of reducing losses from future disasters and addressing concerns facing insurers and homeowners in hazard-prone areas. I then examine the question as to whether policies should include all-hazards (Section 5) and briefly discusses lessons form the earthquake insurance market in Japan. (Section 6). The paper concludes with a summary of the key points in the paper and proposes a set of open questions for future research in this area.

1. Recent Changes in the Impacts of Extreme Events

Increases in Economic and Insured Losses

The economic and insured losses from natural disasters have increased significantly in recent years as shown in Figure 1 (each vertical bar represents the total economic losses, the darker zone represents 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 three years of the 21st century (2001-2003) were less severe than previous years, 2004 and 2005 produced historical records.

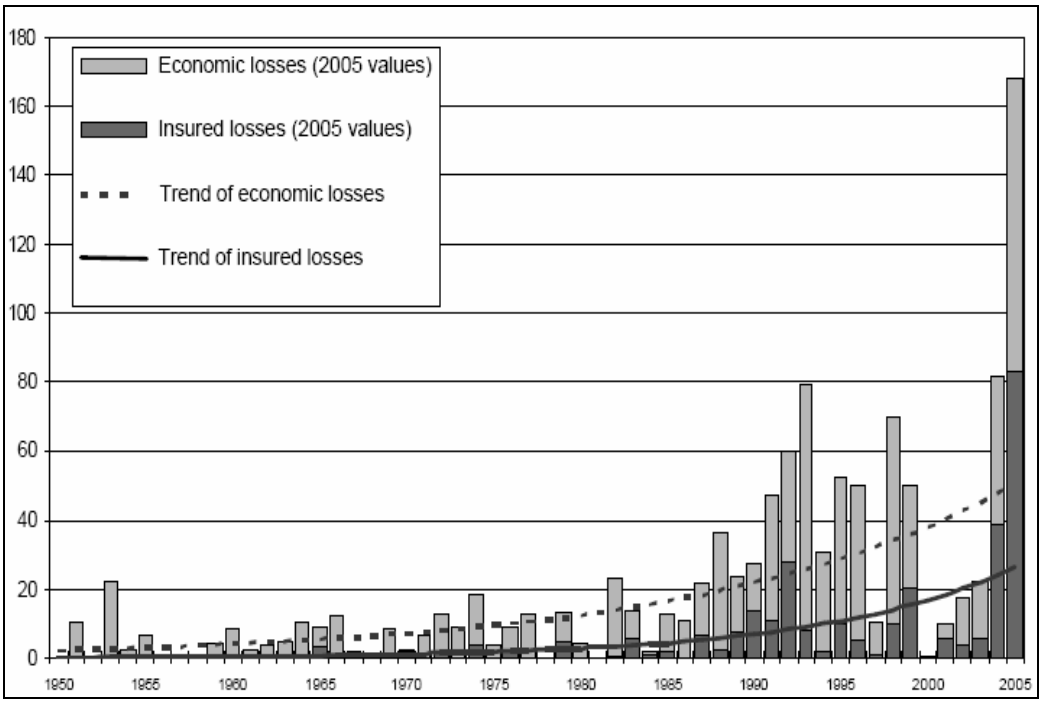

FIGURE 1. EVOLUTION OF "GREAT NATURAL CATASTROPHES" 1960-2005. ECONOMIC VERSUS INSURED IMPACT

Sources: Data from Munich Re, 2005 Geo Risks Research –- in U.S. $ billon indexed to 2005

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 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 were $83 billion in 2005.[2] Figure 2 depicts the upward trend in worldwide *insured* losses from catastrophes between 1970 and 2006 (in 2006 indexed prices).

[2] This figure thus excludes payment by the National Flood Insurance Program (NFIP) for damage due to 2005 flooding (over $20 billion in claims).

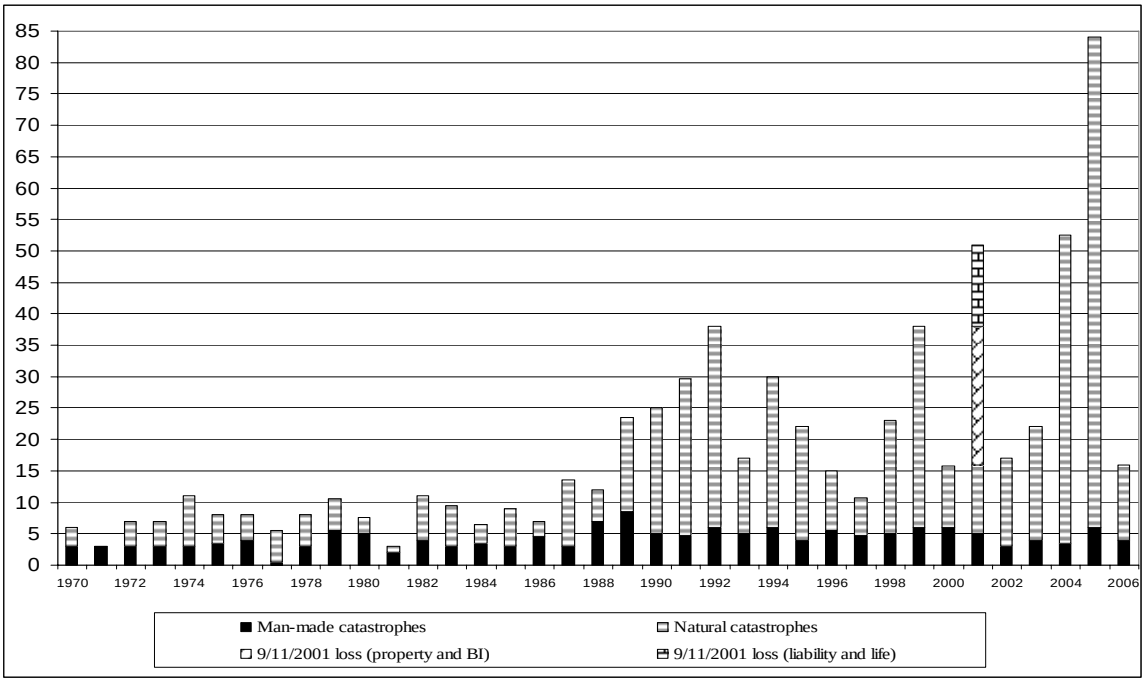

FIGURE 2. WORLDWIDE EVOLUTION OF CATASTROPHE INSURED LOSSES, 1970-2006
(9/11: all lines, including property and business interruption (BI); in U.S.$ billon indexed to 2006)
Sources: Wharton Risk Center with data from Swiss Re and Insurance Information Institute

Table 1 reveals the 20 most costly catastrophes for the insurance sector over the past 35 years (in 2006 dollars). Several observations are relevant 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 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.

Losses due to natural catastrophes and man-made disasters were far below the long-term trend in 2006. Of the $48 billion in catastrophe-related economic losses, $16 billion was covered by insurance ($11 billion for natural disasters; $5 billion for man-made). Over the past 20 years, only two had insured losses lower than in 2006 (1988 and 1997) (Swiss Re, 2007).

TABLE 1. THE 20 MOST COSTLY INSURED CATASTROPHES IN THE WORLD, 1970-2006

U.S.$ billion (indexed to 2006)	Event	Victims (Dead or missing)	Year	Area of primary damage
66.3[3]	**Hurricane Katrina**	**1,326**	**2005**	**USA, Gulf of Mexico et al.**
35.5	**9/11 Attacks**	**3,025**	**2001**	**USA**
22.9	Hurricane Andrew	43	1992	USA, Bahamas
19.0	Northridge Quake	61	1994	USA
13.6	**Hurricane Ivan**	**124**	**2004**	**USA, Caribbean et al.**
12.9	**Hurricane Wilma**	**35**	**2005**	**USA, Gulf of Mexico et al.**
10.4	**Hurricane Rita**	**34**	**2005**	**USA, Gulf of Mexico et al.**
8.6	**Hurricane Charley**	**24**	**2004**	**USA, Caribbean et al.**
8.4	Typhoon Mireille	51	1991	Japan
7.4	Hurricane Hugo	71	1989	Puerto Rico, USA et al.
7.2	Winterstorm Daria	95	1990	France, UK et al.
7.0	Winterstorm Lothar	110	1999	France, Switzerland et al.
5.5	**Hurricane Frances**	**38**	**2004**	**USA, Bahamas**
5.5	Storms and floods	22	1987	France, UK et al.
4.9	Winterstorm Vivian	64	1990	Western/Central Europe
4.9	Typhoon Bart	26	1999	Japan
4.4	Hurricane Georges	600	1998	USA, Caribbean
4.1	**Tropical Storm Alison**	**41**	**2001**	**USA**
4.1	**Hurricane Jeanne**	**3,034**	**2004**	**USA, Caribbean et al.**
3.8	**Typhoon Songda**	**45**	**2004**	**Japan, South Korea**

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

Increased Development in Hazard-Prone Areas [4]

During 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 North America, *typhoons* in Asia and *windstorms* in Europe) contribute 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 (ABI, 2005). In 2005, 99.7 percent of all catastrophic losses worldwide were due to weather-related events (Mills and Lecomte, 2006).

[3] Including the $20 billion paid for flood coverage by the NFIP.

[4] This subsection is based on H. Kunreuther and E. Michel-Kerjan (2007).

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.

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. According to the U.S. Bureau of the Census, 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), 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 U.S. National Flood Insurance Program (NFIP),[5] according to a study undertaken by Munich Re (2000). 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 3). This represents $1.9 trillion of insured exposure located in coastal areas ($1.4 trillion of commercial exposure and $900 billion of residential exposure) (Figure 4). Insurance density is thus another critical socio-economic factor to consider when evaluating the evolution of insured loss due to weather-related catastrophes.[6]

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, if another hurricane like Katrina were to hit the Gulf Coast, it would likely inflict significant direct losses (property damage) and indirect losses (business interruption) unless strong mitigation measures are put in place.

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[5] 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.

[6] For additional data on the economic impact of future catastrophic hurricanes see The Financial Services Roundtable (2007).

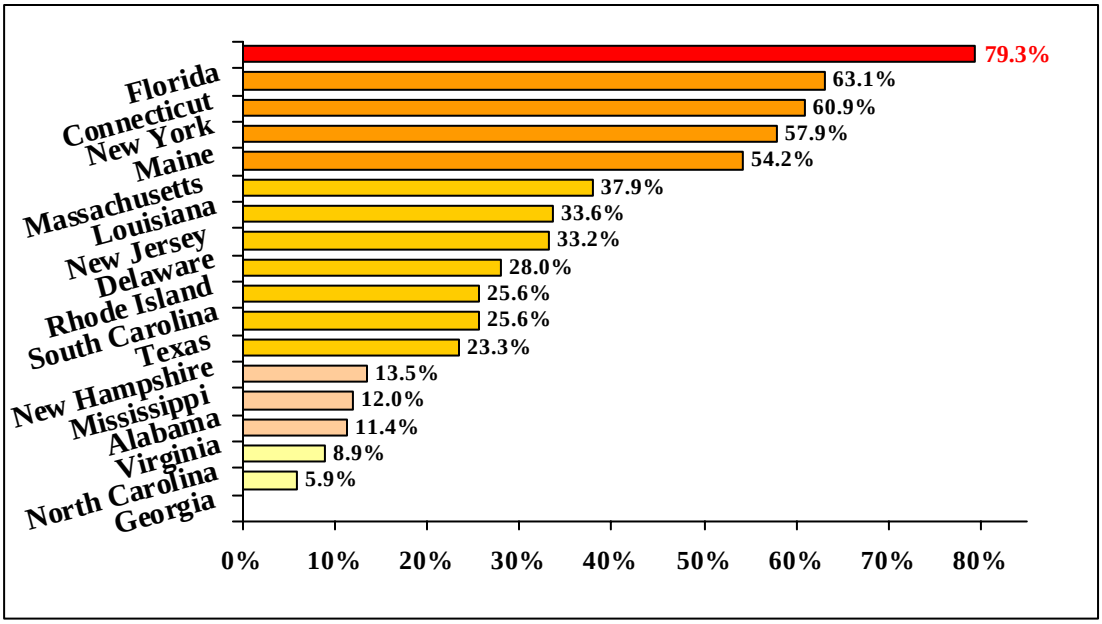

FIGURE 3. INSURED COASTAL EXPOSURE AS A PERCENTAGE OF STATEWIDE INSURED EXPOSURE (RESIDENTIAL AND COMMERCIAL PROPERTIES) (DEC. 2004)

Source: Data from Applied Insurance Research (AIR) Worldwide

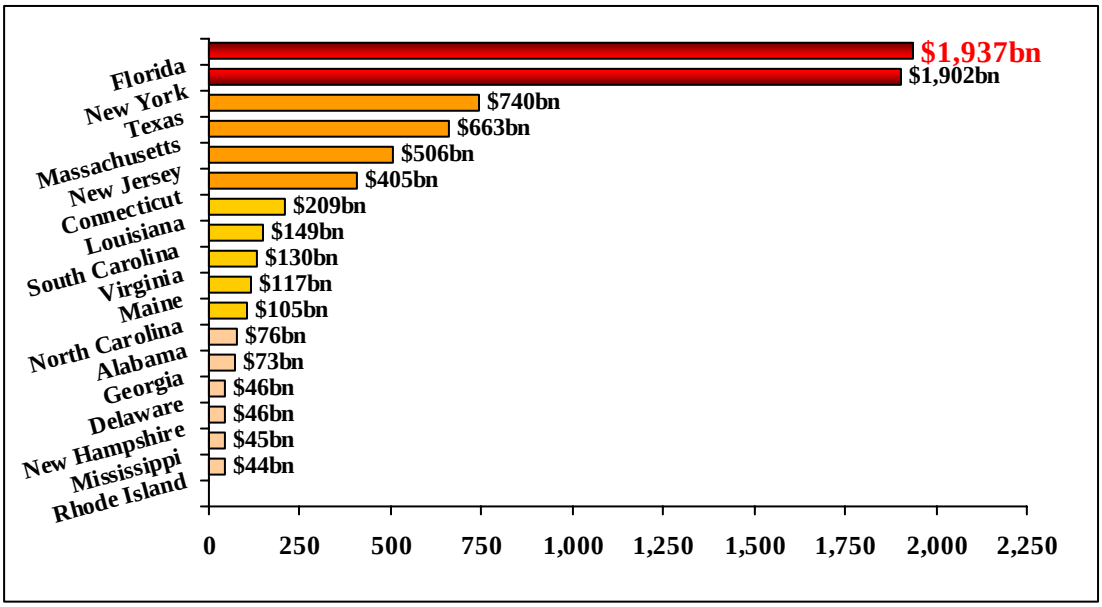

FIGURE 4. TOTAL VALUE OF INSURED COASTAL EXPOSURE AS OF DECEMBER 2004 (IN $ BILLION; RESIDENTIAL AND COMMERCIAL PROPERTIES)

Source: Data from Applied Insurance Research (AIR) Worldwide

2. Challenges in Utilizing Mitigation to Reduce Future Losses

We undertook an analysis of four states (Florida, New York, South Carolina and Texas) to determine the impact of mitigation on reducing losses from hurricanes of different intensities to residential homes. Data on each state's residential-only exposure to hurricane risk was provided by *Risk Management Solutions* (RMS). Losses are comprised of damage caused by the wind to buildings, contents, as well as victims' additional living expenses (ALE). Our analyses in New York, South Carolina and Texas were performed looking at both the wind and storm surge peril using the RMS' hurricane Industry Exposure Database. The RMS analyses in Florida did *not* include storm surge damage from hurricanes due to wind, so the Florida figures underestimate the damages relative to the other three states.

RMS also provided data on the losses assuming full mitigation of the structures without determining whether each of the measures was cost effective. In New York, South Carolina and Texas, we assumed that **all** houses and buildings were built to the latest standard. In Florida, we assumed that the relevant homes met the building codes for the *Fortified…for Safer Living* program.[7] These building codes are directed only at wood frame or masonry dwellings, which comprise 80 percent of the residential structures in the state, and include mitigation measures such as roof anchors.

Table 3 details the differences in losses for hurricanes with return periods of 100, 250 and 500 years for each of the four states we are studying when these loss-reduction measures are in place. For example, all wood frame or masonry homes in Florida met the building codes for the *Fortified …for Safer Living* program the property damage to residential structures from a 100-year hurricane would be reduced from $84 billion to $33 billion, a 61 percent savings. Note that these savings do not include the additional expenses of building to the more stringent code. The justification of specific measures for a piece of property would need to compare the upfront cost of mitigation with the expected discounted benefits of the measure over the project life of the structure.

TABLE 3. MONEY SAVED FROM FULL MITIGATION FOR DIFFERENT RETURN PERIODS (IN $(BILLIONS)

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

[7] Information on this program is available on the website of the Institute for Business and Home Safety at http://www.ibhs.org/property_protection/default.asp?id=8.

The Natural Disaster Syndrome

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

One of the reasons for the natural disaster syndrome is due to the decision makin*g processes of individuals with respect to events such as a Category 3 or 4 hurricane or a major earthquake. Prior to a disaster, many individuals perceive its likelihood as sufficiently low that they argue, "It will not happen to me." As a result, they do not feel the need to invest voluntarily in protective measures, such as strengthening their house or buying insurance. It is only after the disaster occurs that these same individuals express remorse that they didn't undertake protective measures.

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

There is extensive evidence that residents in hazard-prone areas do not undertake loss-prevention measures voluntarily. A 1974 survey of more than 1,000 California homeowners in earthquake-prone areas revealed that only 12 percent of the respondents had adopted any protective measures (Kunreuther et al. 1978). Fifteen years later, there was little change despite the increased public awareness of the earthquake hazard. In a 1989 survey of 3,500 homeowners in four California counties at risk from earthquakes, only

5 to 9 percent of the respondents in these areas reported adopting any loss reduction measures. Palm et al. (1990), Burby et al. (1988) and Laska (1991) have found a similar reluctance by residents in flood-prone areas to invest in mitigation measures.

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

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

3. The Role of Insurance in Encouraging Mitigation

Given the significant increase in damage from hurricanes and other natural disasters during the past fifteen years due to the growing population and assets in high-risk areas, we need a new approach to encourage property owners to undertake effective mitigation measures. In addition to well-enforced building codes there is a role that insurance can play to encourage the adoption of these measures and overcome the "*it cannot happen to me"* and *hyberbolic discount rate* biases discussed in the previous section. Two principles, which appear to conflict with each other, should guide the development of insurance programs for reducing future losses and allocating the costs of disasters in an efficient and equitable manner.

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

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

Principle 1 is important because its application would provide a clear signal of relative damage to those currently residing in areas subject to natural disasters and those who are considering moving into these regions. Risk-based premiums also enable insurers to provide discounts to homeowners and businesses who invest in cost-effective loss-reduction mitigation measures. If the premiums are not risk-based, insurers have **no** economic incentive to offer these discounts. In fact, they prefer not to offer coverage to these property owners because it is a losing proposition in the long-run.

Principle 2 reflects a concern for some residents who are now living in hazard-prone areas who will be faced with large premium increases if insurers are permitted to adhere to Principle 1. Today, regulations imposed by State Insurance Commissioners keep premiums artificially lower than the risk-based level in many regions subject to hurricane damage. If insurers are permitted to charge risk-based premiums, homeowners residing in hurricane-prone areas would pay considerably more for coverage than they currently do.

Note: Principle 2 applies only to those individuals who are now residing in hazard-prone areas. Those who locate in the area in the future should be charged premiums that reflect the risk. If they were provided with subsidies from public subsidies one would be encouraging the development of hazard-prone areas and exacerbate the potential for catastrophic losses from future disasters documented above.

Premiums Reflecting Risk

The first step in developing an insurance program that would adhere to *Principle 1* is to estimate the rates reflecting risk that would apply to different regions of the country. Catastrophe models have been developed which evaluate the expected losses from hurricanes, earthquakes and floods, utilizing data from experts to estimate the likelihood of damages resulting from disasters of different magnitudes and intensities. Although there is uncertainty surrounding the estimates from these catastrophe models, they have been widely used by insurers and reinsurers to price the risk. The premiums charged by insurers and reinsurers would reflect the expected claims from the insured events, the loading factor to cover administrative, marketing and claims processing costs and the cost of capital for covering catastrophic losses and the uncertainty surrounding the likelihood of these large-scale disasters.[8]

To enable insurers to charge risk-based premiums, regulators should stay out of the rate-setting business. If one allows a truly competitive market to operate, then insurers would not engage in price-gouging since they would be undercut by another company who profitably markets policies at a

[8] For more details on the role of capital costs and ambiguity of the risk in the pricing of insurance and reinsurance see Wharton Risk Center (2007) Chapter 6.

lower price. Regulators would still have an important role to play in other aspects of the insurance operation by making certain that insurers have sufficient surplus to protect unsuspecting consumers against the possibility of their becoming insolvent following the next severe disaster.

Affordability of Coverage

The second step in the process relates to the affordability and equity issues indicated in *Principle 2.* To begin with, it would be critical to measure where and for whom affordability is truly a challenge and whether other individuals residing in these areas (e.g., those providing valuable goods and services to other parts of the country) deserve a subsidy.

To assist these individuals currently residing in disaster-prone areas, we recommend that some type of insurance voucher be provided by the state or federal government. This type of in-kind assistance (rather than an unrestricted grant) assures that the recipients use the funds for obtaining insurance. If this system were applied to a family in a hazard-prone area, it would pay an insurance premium that reflects risk, and then be reimbursed by the state for a portion of the increased cost of insurance over the prior year's policy. The amount of reimbursement could be determined by their income and the risk-based insurance premium that they are charged. If these individuals adopted mitigation measures then they would receive a reduction in their insurance premium (in addition to the amount of the voucher) to reflect the reduction in their future expected claims from insurance.

A rationale for this type of government transfer program is provided by Coate (1995). He points out that if the government makes in-kind transfers of insurance to the poor they will not have to rely on disaster relief in the event of a loss. He shows that reliance on private charity produces adverse efficiency effects which can be avoided if the government makes in-kind transfers of insurance as would be the case with a voucher system.[9]

There are several existing programs that could serve as models for developing such a voucher system that we now briefly discuss.

Food Stamp Program. Under the Food Stamp Program, a family is given vouchers to purchase food based on their annual income and size of the family. The idea for the program was born in the late 1930s, revived as a pilot program in 1961 and extended nationwide in 1974. The current program structure was implemented in 1977 with a goal of alleviating hunger and malnutrition by permitting low-income households to obtain a more nutritious diet through normal purchasing of food from grocery stores. Food stamps are

[9] See Litan, Nutter and Racicot (2007) for a rationale for in-kind subsidies based on economic need and geographic location.

available to most low-income households with limited resources regardless of age, disability status or family structure.[10] The program is funded entirely by the federal government. Federal and state governments share administrative costs (with the federal government contributing nearly 50 percent). In 2003, total federal food stamp costs were nearly $24 billion. As of June 2007, more than 26 million individuals benefit from this program. (Food Research and Action Center, 2007).[11]

Low Income Home Energy Assistance Program (LIHEAP). The mission of this program is to assist low income households that pay a high proportion of their income for home energy in meeting their immediate energy needs. The funding is provided by the federal government but is administered by the states and federally recognized tribes or insular areas (e.g., Guam, Puerto Rico, Virgin Islands) to help eligible low-income homeowners and renters meet their heating or cooling needs (eligibility based on similar criteria than the food stamp program).[12] The federal government became involved in awarding energy assistance funds to low-income households program as a result of the increase in oil prices resulting from the Organization of Petroleum Exporting Countries (OPEC) oil embargo in 1973. Over the past few years, the annual appropriation of this program has averaged $2 billion.[13]

Universal Service Fund (USF).[14] The USF was created by the Federal Communications Commission in 1997 to ensure that consumers in all regions of the nation have access to, and expense rates for telecommunications services that are reasonably comparable to those in urban areas. To achieve this goal, the USF provides discounts to residents in high-cost rural areas, to low-income individuals and other special groups (e.g., rural health care providers, schools and libraries in low-income areas). All telecommunication carriers that provide service internationally and between states pay contributions into the USF. The carriers may build this factor into their billing systems if they choose to recoup this amount from their customers. The USF provides discounts that make basic, local telephone service affordable for more than 7 million low-income consumers. From 1998 to 2006, over $50 billion has been disbursed by this fund.

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[10] More details on this program as of September 2007 can be found at http://www.frac.org/html/federal_food_programs/programs/fsp.html.

[11] Source: *Food Research and Action Center*. Data available at http://www.frac.org/data/FSPparticipation/2007_06.pdf, as of September 2007.

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

[13] For more details on this program, see *U.S. Department of Health and Human Services at* http://www.acf.hhs.gov/programs/liheap/

[14] For more details on this program see http://www.usac.org/about/universal-service as of September 2007.

Who Should Subsidize Insurance?

The above programs use different methods to subsidize low-income families for specific goods and services. With respect to homeowners' insurance, there are several different ways that vouchers could be provided which mirror these programs.

General taxpayer. If one takes the position that everyone in society is responsible for assisting those who reside in hazard-prone areas, then one could utilize general taxpayer revenue from the federal government to cover the costs of insurance vouchers. This is what is currently done by the Food Stamp Program and the Low Income Home Energy Assistance Program.

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

Insurance policyholders. A special tax could be levied on all insurance policyholders for covering the costs of these vouchers. The rationale for this type of tax would be that all homeowners (as opposed to all taxpayers) should be responsible for helping to protect those who cannot afford protection or should be subsidized for other reasons. The justification for such a program would be similar to the rationale for establishing the USF for telecommunication service: providing affordable telephone service to all residents in the country.

4. Long-term Homeowners Insurance

Nature of the Program

Based on the principle of risk-based rates, insurers should consider marketing long-term insurance contracts on residential property as a way of providing stability to homeowners and encouraging adoption of cost-effective mitigation measures. There is precedent for long-term contracts in insurance – Benjamin Franklin created the *Philadelphia Contributionship for the Insuring of Houses from Fire* in 1752. It eventually became the *Green Tree Mutual Assurance Company,* which closed its doors in 2004.[15]

[15] The Philadelphia Contributionship and other perpetual insurance companies require a large fixed payment at the time that one purchases insurance. The interest earned on this "insurance investment" covers the annual premiums on the property. We thank Felix Kloman for calling attention to this type of long-term insurance relationship.

One might also consider whether insurance should be required on all residential property. In the United States this would not be a radical change from the current situation – homeowners who have a mortgage are normally required by the bank which finances the loan to purchase coverage against wind damage for the length of the mortgage. Similarly, those in flood-prone areas are required to purchase flood insurance under the National Flood Insurance Program if they have a federally insured mortgage. Insurance coverage is required today for other consumer purchases. Today in all states, motorists must show proof of financial responsibility on their automobile insurance policy, or bodily injury and property damage liability in order to register their car.

For a long-term insurance policy to be feasible (say, 10 or 25 years), insurers would have to be able to charge a premium that reflects their best estimate of the risk over that time period, a loading factor, capital costs and the ambiguity associated with catastrophic losses. (*Principle1*). The uncertainty surrounding these estimates could be reflected in the premium as a function of the length of the insurance contract, in much the same way that the interest rate on fixed-rate mortgages varies between 15, 25 and 30 year loans. Insurance vouchers could be provided to homeowners who cannot afford coverage at risk-based rates. (*Principle 2)*

The obvious advantage of a long-term insurance contract from the point of view of policyholders is that it provides them with stability and an assurance that their property is protected for as long as they own it. This has been a major concern in hazard-prone areas where insurers have cancelled policies following severe disasters such as those that occurred during the 2005 hurricane season. By establishing mandatory insurance, all homeowners in hazard-prone areas would be protected following the next disaster, thus providing them with financial resources for recovery and reducing the need for liberal disaster assistance.

Encouraging Adoption of Mitigation Measures

Long-term insurance also provides economic incentives for investing in mitigation where current annual insurance policies (even if they are risk-based) are unlikely to do the trick due to the behavioral considerations discussed in the previous section. To highlight this point, consider the following simple example. Suppose a family could invest $1,500 to strengthen the roof of its house so as to reduce the damage by $30,000 from a future hurricane with an annual probability of 1/100. An insurer charging a risk-

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Kloman has favored long-term commitments and partnerships between the insurer and insured for many years, having written columns on the topic in his publication, *Risk Management Reports* in September 1994 and October 1995.

based premium would be willing to reduce the annual charge by $300 (i.e. 1/100 x $30,000) to reflect the lower expected losses that would occur if a hurricane hit the area in which the policyholder was residing. If the house was expected to last for 10 or more years, the net present value of the expected benefit of investing in this measure would exceed the upfront cost at an annual discount rate as high as 15 percent.

Under current annual insurance contracts, many property owners would be reluctant to incur the $1,500 because they would get only $300 back next year. If they underweight the future, the expected discounted benefits would likely be less than their $1,500 upfront costs., In addition, budget constraints could discourage them from investing in the mitigation measure. Other considerations would also play a role in a family's decision not to invest in these measures: The family may be uncertain as to how long they will reside in the area and/or whether their insurer would reward them again when their policy is renewed.

A 20-year required insurance policy ties the contract to the property rather than to the individual. In fact, the homeowner could obtain a $1,500 home improvement loan tied to the mortgage at an annual interest rate of 10 percent, resulting in payments of $145 per year. If the insurance premium were reduced by $300, the savings to the homeowner each year would be $155. Alternatively, this loan could be incorporated as part of the mortgage at a lower interest rate.

A bank would have a financial incentive to provide this type of loan. By linking the mitigation expenditures to the structure rather than to the current property owner, the annual payments would be lower and this would be a selling point to mortgagees. The bank would be more fully protected against a catastrophic loss to the property, and the insurer's potential loss from a major disaster would be 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 for disaster relief. A win-win-win-win situation for all! (Kunreuther 2006).

There is an additional benefit to insurers in having banks encourage individuals to invest in cost-effective mitigation measures. The costs of reinsurance, which protects insurers 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 insurer 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, and each one would have a claims payment of $40,000 following a hurricane if homes had not strengthened their roofs. The insurer's loss from such a disaster would be $40 million.

Suppose that the insurer wants to have $25 million in coverage from a reinsurer to protect its surplus. 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 fortified 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 by the insurer in the form of a lower premium.

5. Should Long-term Insurance Include All Hazards?[16]

Currently, insurance programs for residents in hazard-prone areas are segmented across perils. Standard homeowners' and commercial insurance policies (normally required as a condition for a mortgage), protect against damage from fire, wind, hail, lightning, winter storms and volcanic eruption. Earthquake insurance can be purchased at an additional cost. Flood insurance is offered through the National Flood Insurance program.

Features of the Program

An all-hazards insurance policy, if developed, should adhere to the two principles of premiums reflecting risk and affordability. Insurance programs where all natural disasters are covered by a single policy have been adopted in other countries. In 1954, Spain formed a public corporation, the Consorcio de Compensation de Seguros, that today provides mandatory insurance for so-called "extraordinary risks," including natural disasters and political and social events such as terrorism, riots and civil commotion. Such coverage is an add-on to property insurance policies that are marketed by the private sector. The Consorcio pays claims only if the loss is not covered by private insurance, if low-income families did not buy insurance and/or the insurance company fails to pay because it becomes insolvent. The government collects the premiums and private insurers market the policies and handle claims settlements (Freeman and Scott 2005).[17]

In France, a mandatory homeowners' policy covers a number of different natural disasters, along with terrorism risk. The main difference comes at the reinsurance level, which is partially provided by a publicly-owned reinsurer, the Caisse Centrale de Reassurance, for flood, earthquakes, and droughts, and by an insurance pool, Gareat, with unlimited government guarantee for terrorism. There is no public reinsurance for storms (Michel-Kerjan and de Marcellis, 2006).

[16] This section draws heavily on Kunreuther, H. (2007).

Switzerland has a mandatory insurance insurance system where policies cover both damage from fire as well as natural disasters (except for earthquakes). According to von Ungern-Sternberg (2004) property owners in 19 of the 26 cantons in the country are legally obligated to purchase this coverage from a cantonal insurance monopoly. Inhabitants of the remaining seven cantons can obtain property insurance only from private companies.

Advantages of All-Hazards Insurance

Consider an insurer who wishes to market homeowners' coverage in different parts of the country. With risk-based rates it will collect premiums that reflect the earthquake risk in California, hurricane risk on the Gulf Coast, tornado damage in the Great Plains states, and flood risk in the Mississippi Valley. Each of these disaster risks is independent of the others. This higher premium base and the diversification of risk across many hazards reduce the likelihood that such an insurer will suffer a loss that exceeds its surplus in any given year for a given book of business.

An all-hazards homeowners' policy should also be attractive to both insurers and policyholders in hurricane-prone areas, because it avoids the costly process of having an adjuster determine whether the damage was caused by wind or water. The problem of differentiating wind damage from water damage was a particularly challenging one following Hurricane Katrina. Across large portions of the coast, all that remained of demolished buildings were foundations, making it difficult to determine the cause of damage. In these cases, insurers may decide to pay the coverage limits rather than incurring litigation costs to determine whether the damage came from water or wind. For a house still standing, this process is somewhat easier since one knows, for example, that roof destruction is likely to be caused by the wind, and water marks in the living room are signs of flooding (Towers Perrin 2005).

An all-hazards policy would also deal with the problem that insurers currently face with respect to fire damage caused by earthquakes. Even if a homeowner has not purchased an earthquake insurance policy, she will be able to collect damages from a fire due to earthquake. In the case of the 1906 San Francisco earthquake, most of the damage was caused by fire, and insurers were obligated to cover these losses. In this sense, homeowners' insurance actually covers a portion of earthquake losses even though this coverage is excluded from the policy

Another reason for having an all-hazards insurance policy is that it will reduce a homeowner's confusion as to whether or not she has coverage. Many people residing in the Gulf Coast believed they were covered for water damage from hurricanes when purchasing their homeowners' policies. The attractiveness of insurance that guarantees that the policyholder will have coverage against all losses from disasters independent of cause has also been demonstrated experimentally by Kahneman and Tversky (1979).

They showed that 80 percent of their subjects preferred such coverage to what they termed "probabilistic insurance," where there was some chance that a loss was not covered. What matters to an individual is the knowledge that she will be covered if her property is damaged or destroyed, not the cause of the loss. Such a policy has added benefits to the extent that individuals are unaware that they are not covered against rising water or earthquake damage in their current homeowners' policy.

Another advantage of all-hazards homeowners' insurance is that it may address some of the issues that currently plague the National Flood Insurance Program. As noted recently by the U.S. Government Accountability Office, only half of the properties eligible for flood insurance are covered by it. Furthermore, a number of properties that suffered water damage from Hurricane Katrina were not eligible to purchase flood insurance under the NFIP. Those who did have flood insurance and suffered large losses from the rising waters were only able to cover a portion of their losses because the maximum coverage limit for flood insurance under the NFIP is $250,000 on building property and $100,000 on personal property.[18]

Naturally, an all-hazards insurance policy will be more expensive than the standard homeowners' policy because it is more comprehensive. If premiums are based on risk, however, policyholders would be charged only for hazards that they face. Thus, a homeowner in the Gulf Coast would theoretically be covered for earthquake damage but would not be charged anything for this additional protection if the area in which she resides is not a seismically active area. In promoting this all-risk coverage, one needs to highlight this point to the general public, who may otherwise feel that they are paying for risks that they do not face.

Challenges in Implementing All-Hazards Insurance

The principal challenge in companies providing all-hazard insurance relates to the whether the risk is ***insurable.*** Many insurers are likely to resist all-hazards insurance because they may fear the possibility of even larger losses than they have suffered to date. Some note that if both wind and water damage were to be included in a homeowners' policies, the losses from Hurricane Katrina to private insurers would be considerably higher. In order for insurers to feel comfortable with such a program, they would have to be able to protect themselves against catastrophic losses either through private risk transfer instruments (e.g., reinsurance, catastrophe bonds), state funds or federal reinsurance.

There will also be special needs facing small insurers operating in a single state who have smaller surplus than larger firms and are limited in their

[18] For more details on the current status of the National Flood Insurance Program see Michel-Kerjan, E. and Kousky, C. (2007).

ability to diversify their risk. These insurers may find that the variance in their losses increases by incorporating the flood and earthquake risks as part of a homeowners' policy. For example, a Louisiana insurance company providing protection against hurricane damage might find the variance in losses to be higher than it is today if both wind and water damage were covered under a homeowners' policy. For these companies to compete with larger firms, they would have to be able to protect themselves against catastrophic losses through either private- or public-based risk transfer instruments that would not price them out of the market.

Insurers who market an all-hazards insurance policy face an additional challenge in trying to convince homeowners that they will pay only for risks that they actually face. One way for insurance companies to do this is to itemize the cost of different types of coverage on the policy itself, in much the way current homeowners' or automobile insurance delineates the cost of different types of protection. If a family living on the Gulf Coast knew that it would be paying $3,000 for wind coverage, $1,500 for water coverage. $500 for fire coverage and $0 for earthquake coverage, it would not complain about covering damage from seismic risk facing California homeowners. Such an itemized list of coverage would also highlight the magnitude of risks that the family faces by living in their region, another role that insurance can play – a signal as to how hazardous a particular place is likely to be.

6. Lessons from Japan re Earthquake Insurance[19]

Today, in Japan there is a functioning public/private partnership between the Japanese property insurance industry, offering policies, and the Japanese government, providing a form of reinsurance backstop. The system was revised in 1980 to further encourage participation by mandating that earthquake insurance be included on residential policies on a mandatory offer basis. although, the consumer may decline coverage.

The most recent revision to the earthquake insurance system came as a result of the Hyogoken-Nanbu earthquake (Kobe, Japan) in 1995. In the aftermath of this disaster, the earthquake insurance program was modified to provide economic incentives to encourage the building of earthquake resistant residences. This was done by introducing discounted premium rates based on a building's earthquake resistance with discounts based on a housing performance indication system under Japan's Housing Quality Guarantee Law.

[19] This subsection is based on National Association of Insurance Commissioners (2007) "Natural Catastrophe Risk: Creating a Comprehensive National Plan."

7. Conclusions and Suggestions for Future Research

Conclusions

We can summarize the conclusions that emerge from this paper with the following points:

- The losses from natural disasters has increased significantly in the past 15 years, and we as a society are more vulnerable to catastrophic losses in future years than we have been in the past.
- A principal reason for these increased losses is the continuing economic development in hazard-prone areas. The development of Florida highlights this point: the projected population in Florida in 2010 will be 19.3 million -- a 700 percent increase over the 2.8 million inhabitants residing in the state in 1950.
- By mitigating existing and new homes with structural measures (e.g., better designed roofs) one could reduce future disaster losses significantly. If all residential homes in Florida were fully mitigated, the damage from a 100-year hurricane would be reduced from $84 billion to $33 billion, a decrease of 61 percent.
- Individuals are reluctant to invest in cost-effective mitigation for many reasons including an underestimation of the risk, a focus on short-term returns and budget constraints.
- Insurance provides an opportunity to reward individuals who undertake mitigation measures by offering discounts on insurance premiums. For insurers to want to provide these premium reductions they need to be able to charge risk-based rates. If one wants to subsidize some homeowners in hazard-prone areas (e.g., low income residents) vouchers should come from sources outside of insurance using models such as the Food Stamp program.
- Long-term insurance tied to the property rather than to the individual provides financial stability to individuals residing in hazard-prone areas and should lead to the adoption of cost-effective mitigation measures which would normally not be adopted under annual insurance policies. Such a program raises a number of questions including whether all-hazards should be incorporated in a homeowners policy.

Future Research[20]

There are a number of issues associated with the development of a long-term insurance policy which have a direct impact on insurers and

[20] Portions of this subsection are based on interchanges with Dwight Jaffee at UC Berkeley on the challenges in implementing a long-term insurance policy tied to a mortgage (Personal correspondence, Sept. 3, 2007 and Sept. 27, 2007).

homeowners, and indirect effects on other stakeholders that require further research and analysis. Some of the issues that need to be resolved include:

Nature of the Contract. Long-term insurance could be offered by insurers in the form of a fixed-price contract (FPC) for the full term of the policy (e.g., 20 years) or an adjustable premium contract (APC) at a variable premium with guaranteed renewal for the term of the policy. The annual premium would be reset based on an index that would have to be simple and transparent. Policyholders will want the option to terminate the contract – mortgage markets provide examples of both good and bad practices. On FPCs, formal arrangements to make the insurer whole through provisions such as yield maintenance and defeasance (the two most common methods for dealing with prepayment costs on commercial mortgages) may be necessary.[21] On APCs, the borrower would want the right to terminate the contract without cost within a certain time period of a premium increase notification. (e.g., 3 months).[22]

Protection Against Catastrophic Losses. One would need to know how the rating agencies will view long-term FPC commitments, since the insurer is now locked into the premium even if the expected losses rise. To protect itself against possible increases in the probability of catastrophic losses over time, insurers marketing FPCs would have to be able to invest in cat bonds or other forms of securitized risks. Some type of government guarantee might be necessary to deal with both insurers and policyholders' concerns with respect to the ability to pay claims in the future following a catastrophic loss. As for the pricing of the product, FPC premiums would likely be somewhat higher than APC premiums to protect insurers against an increase in the risk during the contract period. This behavior would be similar to the pricing of fixed-rate mortgages relative to adjustable rate mortgages.

One of the central issues will be how high will the price of a long-term contract be given the ambiguities associated with the risk and the capital costs for covering catastrophic losses. Without some type of protection against large losses either through long-term risk transfer instruments (which currently do not exist) and/or a government reinsurance program at the state or federal level, the premiums for FPC's are likely to be extremely high so that there would be little demand for this type of coverage. [23]

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[21] See http://www.rivkinradler.com/rivkinradler/Publications/newformat/200302weissman.shtml for more details on these two contractual arrangements. For a fuller discussion of the defeasance option see Dierker, M., Quan, D. and Torus, W. (2004).

[22] Failure to require this condition has created major problems for subprime mortgages.

[23] A relate question is whether long-term contracts are immune to renegotiation when there are changes in the level of the perceived risks. What protection does the insurance and reinsurance industry have if one discovers that the dikes in New Orleans are not built to specification and companies have a large book of business in the area with rates fixed for the next 10 years? I appreciate Paul Kleindorfer raising this point. (Personal communication November 21 2007)..

Understanding the Contract. Those who purchase insurance policies often have a difficult time understanding the terms of the contract, what risks are covered, and the basis for being charged a specific rate. The problem is likely to be compounded for a long-term insurance contract. There is an opportunity for insurers to educate consumers as to the basis for the premiums they charge by providing more detail on the types of risks that are covered and the amount charged for different levels of protection. More specifically, insurers could break down the premium into coverage against fire, theft, wind damage and other losses included in a homeowners' policy, and how the premium varied with the length of the long-term contract.

If the insurance policy included all hazards, then a premium breakdown will enable homeowners to understand the nature of the risks that they face and help them recognize that they are not cross-subsidizing other policyholders who live in more hazardous areas. Those residing in states such as Illinois where damaging hurricanes and earthquakes are highly unlikely, will learn that they will not pay much (if anything) for damages from these two hazards. On the other hand, homeowners residing in coastal areas of Florida and Texas will learn that their premium for wind damage from hurricanes will be very high. Those who adopted mitigation measures will also learn how large a premium reduction they will receive each year for taking this action.

It would be very useful for insurers to reveal this information so that homeowners will be able to make better decisions by understanding the nature of the contract and what alternative options cost them. They will then be able to make tradeoffs between costs and expected benefits – impossible for them to do today. Thaler and Sunstein (in press) argue for this type of information disclosure by proposing a form of government regulation termed RECAP (Record, Evaluate and Compare Alternative Prices). They recommend that the government not regulate prices but require disclosure practices, not in a long, unintelligible document, but in a spread-sheet-like format that includes all relevant formulas.

Institutional Details. Some of the open questions regarding institutional details which require further analysis and discussion with key stakeholders are:

- Under what circumstances could a property owner change his insurance policy over time?
- What role would the modeling companies and the scientific community studying climate science play in providing estimates for developing risk-based premiums and suggesting a rationale for changes over time as new information becomes available from the scientific community?
- What types of risk transfer instruments would have to emerge from the reinsurance market as well as from the capital markets to protect insurers against catastrophic losses?

- What role would the public sector play in providing protection against catastrophic losses or significant changes in estimates of the risk over time?
- How will the rating agencies view long-term insurance contracts?
- How concerned will consumers be at possible insolvency of insurers providing long-term contracts, and what steps should be taken to protect homeowners should this occur?

Whether long-term insurance will be viewed as attractive by insurers, homeowners, regulators and other relevant stakeholders is uncertain. What is clear today is that we need innovative programs for reducing future losses from disasters that involve the public and private sectors. For insurance to play an important role in this regard, one needs to understand what a policy can and cannot do as a function of the nature of the risk, the type of coverage provided by the insurer and the premium structure. Japan may offer some guidance with respect to the development of such a program since there have been efforts following the 1995 Kobe earthquake to tie the insurance contract to the mortgage.

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