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Mitigating Disaster Losses through Insurance

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Abstract

Losses from natural disasters have increased in recent years due to growth of population in hazard-prone areas and inadequate enforcement of building codes. This article first examines why homeowners have not voluntarily adopted cost-effective protective measures and have limited interest in purchasing insurance. It then proposes a disaster-management program which utilizes insurance coupled with well-enforced building codes to reduce future damage. Banks and financial institutions play a key role in this program by requiring inspections of homes as a condition for a mortgage. New forms of reinsurance coverage against catastrophic losses from natural disasters are necessary to protect insurers against potential insolvency from the next mega-disaster.

Key words: natural hazards protective behavior, insurance, building codes

1. The natural disaster syndrome

The challenges associated with reducing losses from hurricanes and other natural hazards can be attributed to what I shall call the natural disaster syndrome. It consists of two interrelated components: limited interest in protection prior to a disaster, and high costs to insurers and the federal government following a catastrophic event.

Before a disaster, most homeowners, private businesses, and the public sector do not voluntarily adopt cost-effective measures to reduce their potential losses from future storms. Futhermore, building codes designed to protect the structure against hurricanes are not well enforced. A significant amount of the damage could have been averted had building codes been enforced and individuals taken protective measures in advance of the disaster.

The lack of interest in and enforcement of protective measures, coupled with the substantial growth of population in coastal areas, has increased the probability that when a disaster occurs, the losses will be severe. In most cases the insurance industry and federal government have borne the lion's share of the recovery costs. For example, the total economic damages from Hurricane Andrew, which swept ashore along the southern Florida coastline just south of Miami on August 24, 1992, are estimated to be over $25 billion. Total private insurance claims payments to victims of the storm are estimated at $15.5 billion.[1] Given the large increase in the magnitude of losses from recent disasters, insurers and reinsurers are concerned about their financial ability to cover insured damage from future catastrophic disasters.

1.1. Lack of concern and enforcement of codes

The evidence supporting the natural disaster syndrome is rather convincing. With respect to the lack of interest in adoption of loss reduction measures, a 1974 survey of more than 1,400 homeowners in hurricane-prone areas in the United States revealed that only 22% of the respondents had voluntarily adopted any protective measures, with the average investment totaling $1600 (Kunreuther et al. 1978).

Even after Hurricane Andrew, most residents in hurricane-prone areas along the Atlantic and Gulf Coasts appear not to have invested in loss reduction measures. A July 1994 telephone survey of 1241 residents in six cities revealed that 37% of those interviewed had made some improvement to their residence. (Insurance Institute for Property Loss Reduction 1995).[2] Studies of the added costs of materials and labor for hurricane-resistant designs indicate that it will add no more than 4–5% to the cost of a new home and that this additional expense is not substantial relative to the added benefits of safety and security (Unnewehr, 1994).

Building codes are often *not* enforced in hazard-prone areas. According to the Insurance Information Institute, 25% of the insured losses from Hurricane Andrew could have been prevented through better building code compliance and enforcement (Insurance Services Office, 1995). Many communities have inadequate staffing and training to enforce these codes in a quality fashion. In Dade County, there were only 60 building inspectors who were required to conduct *multiple* inspections on an average of 20,000 new buildings each year, a nearly impossible task when driving time, report writing, and other administrative tasks are taken into account (Insurance Research Council and Insurance Institute for Property Loss Reduction, 1995).

1.2. Increasing losses

Recent U.S. Census data show that over one-half of the U.S. population now lives along one of the ocean or inland coastlines. More than 36 million of these people reside in the most hurricane-prone counties in the United States today and this number is expected to double by 2010. The trends are also striking. From 1970 to 1990, the southeastern Atlantic coastal areas had an increase in population density of 75%, far exceeding the national average of 20%.

From 1988 to 1993, the total insured coastal property in the United States increased 69% from $1.86 trillion to $3.15 trillion. In Florida, the state most vulnerable to hurricanes, insured exposures increased from $565.8 billion to $871.7 billion during this five-year period (Insurance Research Council and Insurance Institute for Property Loss Reduction, 1995).

Thus, it is not surprising that the losses from hurricanes and other natural disasters are on the rise. In the past several years, we have had a series of disasters within close proximity of each other which have caused billions of dollars in damage to different

regions of the country and created large losses to the insurance industry. The insurance industry's catastrophic losses from 1989 to 1992 were over $39.5 billion in 1992 dollars, more than the $38.6 billion for the previous 26 years combined (Insurance Services Office, 1994).

Hurricane Andrew was the single most costly natural disaster to the insurance industry in its history. Insurers such as State Farm and Allstate suffered financial losses from Andrew of $3.5 and $2.5 billion, respectively (Snyder, 1993). A computer simulation model indicated that if this same hurricane had hit Miami the losses could have exceeded $40 billion and led to many more than the nine insurer insolvencies that resulted from the actual disaster (Insurance Services Office, 1994).

Hurricane Hugo, which hit South Carolina in September 1989, cost the insurance industry over $4.9 billion in damage. Thirteen of the 24 largest catastrophes in terms of real insured losses since 1970 were from hurricanes or storms resulting in total insured damage of over $41 billion (Swiss Re, 1994).

Those who suffer losses to property and contents from hurricanes are uncertain as to whether their losses will be covered by insurance until the cause of damage is determined. A standard homeowners' and business insurance policy, normally required by banks and financial institutions as a condition for a mortgage, provides protection against wind but *not* water damage.[3] Insurance firms have experimented in the past with providing coverage against water damage from floods, hurricanes, and other storms, but have concluded that the risk was uninsurable.

As a result, Congress passed the National Flood Insurance Program (NFIP) in 1968, whereby owners of homes and businesses can purchase coverage for water damage if the community in which they are located agrees to enforce hazard mitigation requirements and land-use regulations. Flood insurance is marketed by private insurers, but premiums are deposited in a federally operated Flood Insurance Fund, which then pays all claims. By design, the Flood Insurance Fund is not actuarially sound. Subsidized rates are available for structures built before rate maps were prepared for the areas in which they are located. As of 1993, rates for about 41% of the 2.5 million flood insurance policies were subsidized and averaged only one-third of what the actuarial rates for those policies would be (U.S. Congress, 1995, p. 63).[4]

Most individuals subject to water damage do not purchase flood insurance voluntarily. According to the Federal Insurance Administration, which administers the NFIP, approximately 2.5 million of the nearly 10 million households in flood- and hurricane-prone areas of the United States, had purchased flood insurance at the end of 1995. As a specific example, consider the seven Midwest states affected by the Mississippi floods of August 1993. Less than 42,000 households out of the 803,000 residing in special flood-hazard areas had purchased flood insurance at the time of these floods. (Karr 1993)

Following catastrophic disasters, such as Hurricane Andrew or the 1993 Mississippi floods, the government will provide some type of disaster assistance to help cover uninsured losses to victims. Although the programs are more stringent than they were 20 years ago, when forgiveness grants of up to $5000 and low interest loans of 1% had been provided,[5] the Small Business Administration still offers low-interest (subsidized) loans for up to 30 years to individuals and businesses. The annual interest rate may not exceed

4 or 8%, depending on whether the applicant has credit available elsewhere (U.S. Congress, 1995, p. 156). In addition, the federal government normally covers 75% of the costs of damage to public sector structures and infrastructure, but this percentage was increased to 100% following Hurricane Andrew and 90% for areas affected by the 1993 Mississippi floods. It is thus not surprising that Burby (1992) found that most local governments have not adopted hazard mitigation measures or purchased insurance against future disasters.

1.3. Outline of article

This article focuses on understanding the causes of the "natural disaster syndrome" and suggests a program for alleviating its impacts. The next two sections explore why there is a reluctance by residents of hazard-prone areas to invest in protective measures and voluntarily purchase insurance against losses from natural disasters. Section 4 examines why the insurance industry is *not* interested in promoting or offering coverage against these events.

To cope with the constraints on both the demand and supply side, a program is proposed in section 5 which advocates *private* insurance, coupled with well-enforced building codes and government reinsurance for catastrophic losses. The concluding section summarizes the principal points of the article.

2. Why individuals have limited interest in protective measures

A decision by a homeowner on whether to adopt a protective measure involves comparing the upfront investment cost (C) with the reduction in property losses from future hurricanes. A key question that needs to be addressed is: "What is the maximum amount that a person would be willing to pay (WTP) for this protection?" If the property owners focus on the expected benefits from the mitigation measure during the time they plan to live in the structure, then the WTP depends on the magnitude of the loss reduction and the family's anticipated length of stay in the home.[6]

Consider the following hypothetical example. Suppose that scientific experts have estimated that there is an annual probability of .04, or 1 in 25, that a severe hurricane will cause damage to homes in Miami, Florida. The Gale family has a one-story home in the area. If they reinforced the walls and foundations at a cost of C = $1200, it would reduce the losses from severe hurricanes by $10,000. In other words, the expected *annual* benefit from investing in such a measure would be $400 (.04 × $10,000).

Table 1 depicts the expected benefit-cost ratio of such an investment as a function of the time horizon, annual discount rate (d), and probability of a disaster (p). For example if d=.10 and p=1/25, the Gale family would want to invest in these protective measures, if they planned to live in their home for more than four years. There are two principal reasons why individuals have *not* invested in cost effective loss reduction measures (LRMs).

Table 1 Expected benefit/cost ratio of investing in loss reduction measure as a function of time horizon, discount rate and perceived probability (p) of a disaster

Time horizon (in years)	Discount rate (10%) $p=1/25$	$p=1/75$	Discount rate (20%) $p=1/25$	$p=1/75$
1	.30	.10	.28	.09
2	.58	.19	.51	.17
3	.83	.28	.70	.23
4	**1.06**	.35	.86	.29
5	1.26	.42	**1.00**	.33
10	2.05	.68	1.40	.47
15	2.54	.84	1.56	.52
20	2.83	.94	1.62	.54
25	3.03	**1.01**	1.65	.55

2.1. *Underestimation of probability*

Individuals may perceive the probability of a disaster causing damage to their home as being sufficiently low that the investment in the protective measure will not be justified. Suppose that the Gale family perceived the chances of a severe hurricane damaging their home to be 1 in 75, rather than the scientists' estimate of 1 in 25. As shown in column 3 of table 1, the Gales would have to expect to live in their home for at least the next 25 years in order to want to invest in this LRM.

Some individuals may relate their perceived probability of a disaster (p) to a threshold level (p^*), which they may unconsciously set, below which they do not worry about the consequences at all. A decision to ignore events where $p < p^*$ may be justified by claiming that there is a limited amount of time available to worry about protecting oneself against hazards. Such a rule is also easy to explain and justify to others because of its simplicity.[7]

The contingent weighting model proposed by Tversky, Sattath, and Slovic (1988) provides a useful framework for characterizing individual choice processes with respect to this lack of interest in adopting protective measures. In this descriptive model, individuals make tradeoffs between the dimensions associated with alternatives, such as probability and outcomes. The weights which they put on these dimensions are contingent, because they may vary depending on the problem context and the way information is presented. People often weight these dimensions differently than would be suggested by normative models of choice such as expected utility theory.

It is easy to see why the "it will not happen to me" strategy violates the tenets of expected utility theory or benefit-cost analysis. Instead of weighting the outcome from an event by its perceived probability of occurrence, individuals who utilize a threshold model treat events with $p<p^*$ as having a zero chance of occurrence. Homeowners who follow this decision process may have no interest in adopting cost-effective loss reduction measures, because they do *not* consider the consequences of certain disasters.

2.2. High discount rates

Persons may have a very high discount rate so that future benefits are not given much weight when evaluating the protective measure. As shown in table 1 (columns 4 and 5) if the Gale family's annual discount rate is doubled to $d=.20$ and the family accepts the scientists' estimate of $p=1/25$, then the Gales must expect to live in their house for a least five years before investing in the measure. If $p=1/75$, then there is no value of T where the expected benefit/cost ratio is greater than 1.

Evidence for high annual discount rates has been observed in studies evaluating the reluctance of consumers to invest in energy-saving equipment. (Hausman, 1979; Gately, 1980; Kempton and Neiman, 1987). A set of experiments by Lowenstein (1987) on willingness to pay for items whose receipt was delayed or speeded up revealed that the implied discount rates are considerably higher than market rates, particularly in situations where the expected savings over time are small relative to the upfront expenditure.

3. Limited interest in voluntary insurance purchase

The decision on whether to purchase insurance requires a different comparison of benefits and costs than does investing in protective activities. A premium is paid to cover damage from a disaster only for a prespecified period of time (e.g., six months, one year). In other words, the expected benefits from this form of protection are restricted to the same time period for which the insurance contract is valid rather than over the projected life of the structure. Despite this difference, the factors influencing the decision on whether or not to voluntarily purchase an insurance policy appear to be very similar to the rationale for not investing in cost-effective loss-reduction measures.

3.1. Importance of perceived risk

Those who do not want coverage, perceive the risk to be sufficiently low such that they are not worried about the consequences. If the risk is perceived to be relatively high, then there is increased interest in purchasing a policy. The occurrence of a disaster causing damage to one's home is likely to have a significant impact on the demand for insurance. These conclusions, which were based on in-person interviews of homeowners in flood-, hurricane-, and earthquake-prone areas undertaken over 20 years ago (Kunreuther et al., 1978), are also, supported by four recent surveys since 1989 of homeowners in earthquake-prone areas of California (Palm et al, 1990; Palm, 1995).

Perceived risk was a major predictor of earthquake insurance purchase. Respondents in all four surveys were asked to estimate the probability of a major earthquake damaging their community or their home. The responses to this question consistently discriminated the insured from the uninsured. Those with higher perceived vulnerability to future earthquakes are more likely to adopt earthquake insurance than those who believe that an

earthquake is unlikely to affect their home or their community. Insurance purchase was unrelated to any measure of seismic risk that is likely to be familiar to homeowners.

Consider the Loma Prieta earthquake of 1989, which caused substantial damage to property in Santa Clara County, and, to a lesser extent, in Contra Costa county in California. In these counties, there are major differences in responses to the 1989 and 1990 survey. In 1989, about 34% of the uninsured respondents in both counties felt that earthquake insurance was *unnecessary*. By 1990, only about 5% in these counties gave this response. In Santa Clara County, 11% of the uninsured households decided to purchase coverage between 1989 and 1990.[8]

3.2. Role of disaster assistance

One of the arguments that had been advanced as to why individuals do not adopt protective measures is that they assume liberal aid from the government will be forthcoming should they suffer losses from a disaster. Under the current system of disaster assistance, the Governor of the State(s) can request that the President declare a "major disaster" and offer special assistance if the damage is severe enough.

There does *not* appear to be any evidence suggesting that individuals refuse to purchase *property* insurance because they feel that they will be bailed out by the government should they suffer damage.[9] The only empirical data examining this question were surveys undertaken more than 20 years ago. The findings suggest just the opposite pattern. Although most uninsured homeowners were aware that the Small Business Administration (SBA) provided aid to victims, these respondents had little knowledge of the terms of the loans and most did not anticipate turning to the federal government for relief should they suffer damage from a disaster. In fact, most homeowners expect to rely on their own resources or bank loans to finance their recovery. Their decision not to purchase insurance was primarily due to other factors, such as not perceiving the hazard to be a serious problem (Kunreuther et al., 1978).

3.3. Cancellation of policies

Those who do purchase insurance are likely to cancel policies if they have not made a claim after a few years. For example, approximately one in five policyholders under the National Flood Insurance Program (NFIP) cancel their coverage each year.[10] This lack of interest in continuing to purchase insurance may explain the rather startling finding of a report by the U.S. General Accounting Office (GAO) on flood victims with insurance protection. A survey conducted in Texas following a major flood in 1989 revealed that 79% of the owners of damaged properties required to purchase flood coverage were *uninsured* at the time of the disaster (U.S. General Accounting Office, 1990). It would not be surprising to learn that many of these individuals purchased a policy at the time that

they took out a mortgage but failed to renew their policy the next year or several years later after *not* experiencing any flood losses. The financial institutions issuing the mortgage would have had to have looked the other way.

4. Why insurers do not promote coverage?

The two principal reasons why private insurers do not offer policies to cover water damage from hurricanes and floods or actively promote earthquake coverage are the uncertainty of the risk and a fear of the severe financial cost of a catastrophic disaster if they had widespread coverage.

4.1. Uncertainty of risk

Frequently occurring disasters, such as fire, make it possible to estimate such risks rather precisely. Low probability–high consequence events, such as hurricanes, floods, and earthquakes, present more challenging problems because of the relatively limited past data available. Here one has to rely on risk assessments undertaken by meteorologists, hydrologists, and seismologists. The studies to date indicate that there is considerable uncertainty and ambiguity with respect to estimating the chances of a particular disaster occurring in a specific area.[11]

On the empirical side, a recent survey of underwriters illustrates that they will charge higher premiums than for more well-specified risks (Kunreuther, Hogarth, Spranca, and Meszaros, 1995). A questionnaire was mailed to underwriters employed by primary insurance companies and reinsurance firms, asking them to specify the prices which they would charge to insure a factory against property damage from a severe earthquake under the following four different cases: **Case 1:** well-specified probabilities (p) and known losses (L); **Case 2:** ambiguous probabilities (Ap) and known losses; **Case 3:** well-specified probabilities and uncertain losses (UL), and **Case 4:** ambiguous probabilities and uncertainty losses.[12]

For the nonambiguous case, the probability of the earthquake (p) was set at either .01 or .001, and the loss, should the event occur (L), was specified at either $1 million or $10 million, yielding four different scenarios.[13] If one standardizes the premium set by the underwriter at 1 for the nonambiguous case, then one can examine how ambiguity affects pricing decisions. Table 2 depicts the ratio of the other three cases relative to the nonambiguous case (p, L) for the four different scenarios which were distributed randomly to underwriters in primary insurance companies.

For the highly ambiguous case (Ap, UL), the premiums were between 1.43 to 1.77 times higher than if underwriters priced a nonambiguous risk. The ratios for the other two cases were always above 1, but less than the (Ap, UL) case (Kunreuther, Hogarth, and Meszaros, 1993).

Table 2. Ratios* of underwriters premiums for ambiguous and/or uncertain earthquake risks relative to well-specified risks

Scenario	Cases				
	1	2	3	4	
	p,L	*Ap,L*	*p,UL*	*Ap,UL*	*N*
$p = 005$ $L = \$1$ million	1	1.28	1.19	1.77	17
$p = 005$ $L = \$10$ million	1	1.31	1.29	1.59	8
$p = 01$ $L = \$1$ million	1	1.19	1.21	1.50	23
$p = 01$ $L = \$10$ million	1	1.38	1.15	1.43	6

N = Number of respondents

*Ratios based on mean premiums across number of respondents for each scenario

4.2. *Fear of catastrophic losses*

Hurricanes, where there is significant damage from the *wind*, will have a severe impact on the surplus of insurers who have provided standard homeowners' or commercial coverage to a significant number of residents and businesses in the impacted areas. Nine property-casualty insurance companies became insolvent as a result of losses from Hurricane Andrew, forcing other insurers to cover their claims using the industry's guarantee fund. Property insurance became more difficult to obtain as many insurers reduced concentrations of insured property in coastal areas, due to a concern with future catastrophic losses from hurricanes (Insurance Research Council and Insurance Institute for Property Loss Reduction, 1995).

With respect to earthquakes, a recent study suggests that a catastrophic earthquake would have severe consequences on the surplus of private insurers in the United States (Kunreuther et al., 1992). Data were collected from 18 insurance firms providing earthquake coverage in California, to determine the financial impact to them should there be a reoccurrence of a disaster of the same magnitude and geographic location as the 1906 San Francisco earthquake.

The study found that if such a catastrophic earthquake (CE) occurred, five out of the 11 firms with surpluses less than $2 billion would suffer losses that would exceed their surplus and cause them to be insolvent. The seven larger firms in the survey with surpluses exceeding $2 billion would be less severely affected by the catastrophic earthquake. Though none of these large firms would be insolvent, three of them would have to curtail their current business or raise new capital, because their surplus would be sufficiently depleted from the CE such that they could not meet current regulatory guidelines.

At a theoretical level, Winter (1988, 1991) and Doherty and Posey (1992) have shown that a particular severe flood, earthquake, or hurricane could have a very negative impact on the availability of insurance throughout the country. Doherty, Posey and Kleffner (1992) examine how insurers have responded to a variety of surplus shocks in the past. Their analysis suggests that only 50% of the lost surplus is likely to be replaced following a catastrophic loss, so that the availability of coverage in many different lines of insurance would have to be reduced.

5. A proposed disaster management program

The above evidence suggests that individuals residing in hazard-prone areas and insurers are reluctant to deal with natural disasters for very different reasons. Many homeowners at risk do not take protective action, because they feel that the disaster will not happen to them; others who have compared costs with potential benefits may feel that insurance and loss reduction measures (LRMs) are not good investments.

Private insurers have been reluctant to promote coverage against hurricanes, floods, and earthquakes because of the uncertainty regarding the risk and a concern with the financial consequences to them in the aftermath of a catastrophic disaster. Hence, they want to limit their exposure.

5.1. Key role of insurance

The challenge which society faces today is how to promote investments in cost-effective loss reduction mechanisms, while at the same time placing the burden of recovery on those who suffer losses from natural disasters. *In theory*, insurance is one of the most effective policy tools for achieving both objectives, because it rewards investments in cost-effective mitigation with lower premiums and provides indemnification should a disaster occur.[14]

In practice insurers generally do not charge premiums which encourage loss prevention measures. They feel that few people would voluntarily adopt these measures based on the small *annual* premium reduction, as compared to the upfront cost (C) of investing in these measures. As discussed in section 2, if individuals have short time horizons, then there will be little interest in investing C=$1200 in return for a reduction in annual premiums of $400.

Insurance is a highly regulated industry, with rate changes and new policies generally requiring the approval of state insurance commissioners. The development of premium schedules which provide rate reductions for adoption of certain mitigation measures requires administrative time and energy, both to develop and make a case to the state insurance commissioners. If mitigation measures are not viewed as attractive investments by potential policyholders, then insurers who have incurred costs in developing these premium reduction programs would be at a competitive disadvantage relative to those firms who had not.

Hunter (1994) suggests that until recently insurers may not have promoted loss control measures because they felt it had a negative financial incentive on their profits. He points out that for many years insurers viewed their role as a pass-through mechanism rather than as a promoter of safety. They saw their profitability related to the level of rates. If they promoted mitigation measures and were able to reduce losses, then this would prevent them from raising premiums and increasing their profits. At the same time, if they promoted loss control through stricter code enforcement, then they would be fighting trade associations representing builders and real estate agents. They viewed the choice between promoting loss control or taking a more passive position as an obvious one.

Today the situation is changing. Following Hurricane Andrew, the insurance industry has taken a new view toward mitigation measures because of the severe losses which they incurred due to lack of enforcement of building codes. One of the purposes of the newly established Insurance Institute for Property Loss Reduction (IIPLR) is to explore with scientific experts ways in which structures can be better designed so that they will withstand hurricane and wind damage. In addition, IIPLR is encouraging building code inspection and enforcement. As part of this activity, IIPLR has initiated a Code Effectiveness Grading Schedule which is designed to encourage a community's code adoption and code enforcement effectiveness, using the Fire Suppression Rating Program as a prototype.[15]

5.2. Key linkages with other interested parties

For insurance to serve as a useful policy tool for helping to reduce future property losses from natural hazards and provide compensation to victims, it needs to be linked to well-enforced building codes. In addition, other interested parties from the private and public sectors have to play a supporting role. The elements of a disaster management program are outlined below:

Improving risk estimates. The occurrences of Hurricane Andrew and the Northridge Earthquake have stimulated the insurance industry to develop computer-generated simulation models, indicating what could happen in hurricane- and earthquake-prone areas over periods of ten years, 100 years, or even 1,000 or 10,000 years. These models suggest rates for specific types of property, by incorporating estimates of the disaster probabilities and engineering studies of damage. Based on different disaster scenarios associated with a specific hurricane or earthquake, they provide a range of estimates of insured losses that are likely to occur (U.S. Congress, 1995).[16]

Use seals of approval on structures meeting codes. One way to encourage the adoption of cost-effective loss reduction measures is to have states incorporate them into their building codes and give each building that meets or exceeds these standards a seal of approval. To institutionalize such a procedure, financial institutions could require an inspection and certification of the facility as a condition for obtaining a mortgage. This inspection, which would be a form of buyer protection, is similar in concept to the termite

and radon inspections normally required today when property is financed. The success of such a proposed program requires a group of well-qualified inspectors who would provide accurate information as to whether existing building codes and standards were being met.

Evidence from a July 1994 telephone survey of 1241 residents in six hurricane-prone areas on the Atlantic and Gulf Coasts[17] provides supporting evidence for some type of seal of approval. Over 90% of the respondents felt that local home builders should be required to follow building codes, and 85% considered it very important that local building departments conduct inspection of new residential construction (Insurance Institute for Property Loss Reduction, 1995a).

Use insurance to encourage hazard mitigation. To reduce their losses from disasters, insurers may want to limit coverage to structures that are given a seal of approval. If banks require insurance as a condition for a mortgage, then financial institutions together with the insurer can help enforce building codes. Well-designed buildings should be rewarded with lower premiums, lower deductibles, and/or higher coverage limits on their insurance policy.

Consider comprehensive disaster insurance. The insurance industry should explore the feasibility of property insurance which includes protection against earthquake, flood, and hurricane damage. Rates would be based on risk, with the potential losses diversified throughout the country.

Such a comprehensive policy has several advantages over the current system where property owners normally have to buy separate policies to cover flood and earthquake damage. It is likely to reduce the chances that an insurer will become insolvent over the current program, due to the larger premium base to cover losses from any *single* disaster and the diversification of risks across a wider area.[18] In the case of hurricanes, the insured losses from a single disaster will be larger than under the current system, since the insurer will be responsible for both wind and water damage. The impact on any specific insurer's surplus, and hence their chances of insolvency, will depend upon the total number of policies written and the degree of diversification of the risk.

An all-hazards program may 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. It also averts disputes between the insured and insurer. These are likely to arise today if the adjuster rules that the losses were uninsured, because they were caused by water, while the policyholder believes it was due to wind. Consider the following situation which occurred after Hurricane Carla in 1962. One contractor built his home with the best available materials so that it withstood the winds from Carla, but later was flooded and almost totally destroyed. His damage claim under a homeowners' policy was disallowed. Nearby, another house built of cheap materials had its shingle roof disintegrated by the wind early in the storm. The insurance claim for total loss was paid (Moore, 1964, p. 188).

The attractiveness of insurance that guarantees that the policyholder will have coverage against *all* future losses has been demonstrated experimentally by Kahneman and Tversky (1979). They showed that 80% of their subjects preferred such coverage to what they termed *probabilistic insurance*.[19] It has also been observed in other contexts, even when

standard benefit-cost analysis has argued for maintaining a partial risk (Baron et al., 1993).[20]

Expand protection to insurers against catastrophic losses. New forms of coverage against catastrophic losses from natural disasters are now being explored to supplement traditional private reinsurance. One new development by reinsurers is the creation of *finite risk products* which involve transfers of underwriting and investment risk that are designed to smooth the ceding insurer's losses over a number of years by establishing a special fund to meet future insured disaster losses. Each year, the fund grows by a defined portion of the reinsurance premium. At the end of the reinsurance program, the fund is returned to the ceding insurer if it has not been used to cover losses. If the fund balance is negative, the reinsurer would require some degree of deficit repayment by the insurer.[21] Other instruments are catastrophic insurance futures contracts and call spreads, introduced by the Chicago Board of Trade, which enable an insurer to hedge against their underwriting risk.[22]

Legislatures in risk-prone states have recently begun to provide some security and stability for financing catastrophic losses experienced by insurers. Following Hurricane Andrew, the Florida hurricane catastrophe trust fund was created to reimburse insurance companies when disaster-related losses exceed certain levels. Each insurer writing covered policies must pay a premium and contract with the fund for reimbursement of a portion of its losses. An insurer is reimbursed for 75% of its losses beyond a level that is twice the insurer's gross instate written premiums for the prior year.[23] Private reinsurance can be received simultaneously, provided total recoveries do not exceed the insurer's total losses (Paragon Viewpoint, 1994).

Another option, which complements traditional reinsurance and new sources of funds from the capital markets is a proposed initiative referred to as *excess of loss (XOL)* contracts. (Lewis and Murdoch 1996). Under such an arrangement the federal government would directly write and sell contingent claims against the upper layers of catastrophic disaster losses on a per risk and per occurrence basis. These contracts would cover insurance industry losses from a disaster in the $25–$50 billion layer of coverage, currently not available in the private market.[24]

The advantage of all these programs is that it reduces uncertainty to private insurers about the consequences of a catastrophic disaster, so that they should be able to lower their premiums for disaster coverage. This catastrophic protection also greatly reduces the likelihood that insurers will cut back on the availability of coverage in the future, as they did following Hurricane Andrew.

Subsidize low income families. Many poorly constructed homes are owned by low-income families. Many cannot afford the costs of mitigation measures on their existing structure or the costs of reconstruction should their house suffer damage from a natural disaster. Equity considerations argue for providing this group with low-interest loans and grants for the purpose of adopting cost-effective loss reduction measures (LRMs) or for enabling them to relocate their home to a safer area. Since low-income victims are likely to receive federal assistance after a disaster, subsidizing these mitigation measures can also be justified on efficiency grounds.

6. Conclusions

The principal message of this article is that insurance is a potentially valuable tool for encouraging loss reduction measures against natural hazards and for providing recovery funds to disaster victims. However, it needs to be coupled with other policy tools, such as building codes, and requires the active involvement of other parties such as banks and financial institutions, builders and contractors, and government agencies.

Incentives such as premium reductions, lower deductibles, and higher limits of coverage should be given to individuals in hazard-prone areas to encourage them to adopt cost-effective measures voluntarily. Private insurers should consider offering an all-hazards policy backed by the private reinsurance market and new initiatives for covering catastrophic losses.

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Notes

1. For more details on the impact that Hurricane Andrew had on the insurance industry, see Insurance Research Council and Insurance Institute for Property Loss Reduction (1995).
2. An even greater reluctance to adopt mitigation measures has been found in earthquake-prone areas. In a 1989 survey of 3,500 homeowners in four California counties, only between 5 and 9% of the respondents in each of these four areas reported adopting any LRMs (Palm et al., 1990).
3. The standard Homeowners Policy and Commercial Program will not pay for loss or damage caused directly or indirectly by earthquakes or water. There can be exceptions to the exclusions listed below through special deluxe policies offered by some companies.
4. A more detailed history of flood insurance and how it influenced the development of the NFIP can be found in Kunreuther et al., 1978, pp. 24–26. A discussion of the current status of the NFIP and of its potential role in reducing future flood-related losses appears in the Interagency Floodplain Management Review Committee's *Sharing the Challenge: Floodplain Management into the 21st Century* (1994), chap. 9.
5. These were the provisions for disaster assistance following Tropical Storm Agnes, which produced $2 billion in damage to the Northeast in June 1972.
6. In theory, the value of the investment would be reflected in the resale price of the house. Hence, restricting the expected benefits of the measure to the current owner is a conservative one.
7. Camerer and Kunreuther (1989) provide a number of examples of where threshold rules have been used by individuals, firms, and government agencies.
8. The data from the survey reveal that people in Santa Clara County who lived closer to the San Andreas Fault and whose houses tended to be damaged or were located close to damaged homes were more likely to buy earthquake insurance in the 15 months following the Loma Prieta earthquake than the others in the sample. However, distance from the San Andreas Fault had no impact on the decision to purchase insurance prior to the Loma Prieta earthquake. (Palm et al., 1990, pp. 98-101).
9. The General Accounting Office (GAO) reported that participation in the federal program would be higher if farmers did not expect federal disaster payments following widespread catastrophes. GAO felt that such an expectation was a secondary reason in a decision not to purchase insurance (U.S. Congress, 1995, p. 66)

10. Congressional Hearings on the National Flood Insurance Program in May 1989 (Committee on Banking, Finance and Urban Affairs, 1989) provided the following testimony for determining this cancellation rate. There were 2.1 million policies in force at the time (p. 14). Nearly 400,000 new flood insurance policies are added each year, but these are offset by approximately the same number of people dropping their policies (p. 29).
11. For more detail on the challenges in predicting hurricanes and earthquakes for purposes of rating making, see Insurance Services Office, 1994, Appendices B and C.
12. An ambiguous probability refers to the case where "there is wide disagreement about the estimate of p and a high degree of uncertainty among the experts." A well-specified loss (L) means that all experts agree that, if a specific event occurs, the loss will equal L. An uncertain loss refers to the situation where the experts' best estimate of a loss is L, with estimates ranging from L_{min} to L_{max}.
13. These well-specified scenarios were $p = .005$, $L = \$1$ million; $p = .005$, $L = \$10$ million; $p = .01$, $L = \$1$ million; and $p = .01$, $L = \$10$ million.
14. This presumes that both homeowners and insurers are aware of state-of-the-art technologies and can determine what impact they will have on reducing expected losses from future disasters.
15. The Fire Suppression Rating Program grades cities and towns from one to ten, based on their water supply and quality of fire-fighting facilities. Fire insurance rates for structures in the community are partially based on this rating (Rejda, 1982).
16. See Dong et al. (in press) and Insurance Service Office, (1994), pp. 24–27 for more detailed descriptions of these procedures.
17. The six areas were Corpus Christi, Texas; Biloxi, Mississippi; Myrtle Beach, South Carolina; and Tampa, Miami, and Jacksonville, Florida.
18. Of course a comprehensive policy increases the number of risks which an insurer is exposed to, and hence will increase aggregate losses over the policy period.
19. Kahneman and Tversky's definition of probabilistic insurance is a policy whereby you pay half the regular premium, but only receive coverage half the time. More specifically, in case of damage, there is a 50% chance that you pay the other half of the premium and the insurance company pays all the losses, and there is a 50% chance that you get back your insurance payment and suffer all the losses.
20. For example, many persons prefer cleaning up one site, so that there is zero risk, rather than investing the same funds in partially cleaning up several sites, where the reduction in risks (e.g., cancer deaths) is much greater. For more details see Baron et al. (1993).
21. Nationwide Insurance successfully negotiated such an arrangement with J.P. Morgan and Salomon Brothers in 1995. Under this arrangement Nationwide borrows $400 million from the two investment bankers which is placed in a trust fund composed of U.S. Treasury securities. In the event of a catastrophe these Treasury Bonds would be liquidated and Nationwide will substitute its own surplus notes. A similar financial arrangement but one with more extreme consequences are Act of God bonds whereby investors provide capital to be used by the insurer if a catastrophe occurs. For more details on the potential role of these instruments to cover catastrophic losses see Russell and Jaffee (1995).
22. See Cummins and Geman (1995) and Culp (1996) for a more detailed discussion on these hedging mechanisms and the challenges in pricing them.
23. Companies with a surplus of $15 million or less can collect once losses equal one-and-one-half times the premium.
24. Under the proposal, the Treasury would auction a limited number of XOL contracts. Insurers, reinsurers and state and national reinsurance pools would be eligible purchasers. Contracts would be sold to the highest bidder above a base reserve price which is risk-based. For more details see Lewis and Murdoch (1996).

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