

## Insurability Conditions and the Supply of Coverage

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**A**S POINTED OUT IN CHAPTER 1, insurance has the potential to help reduce future losses as well as provide compensation following a disaster. However, in order for companies to be willing to supply coverage against specific risks, they must view them as being insurable. This chapter focuses on the insurance world and what it means for a risk to be insurable. It explores the challenges the insurer faces when dealing with catastrophic losses, such as those from natural disasters.

We first give a brief history of hazard insurance, paying special attention to losses from fire and natural hazards. This will make it clearer why catastrophic risks present a set of special problems for both insurers and reinsurers. We then focus on the process for determining when a risk is insurable and what premium to charge for coverage against ambiguous risks with catastrophic potential. The next section summarizes the types of insurance available for protecting residential and commercial property against types of

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<sup>1</sup>James Arment, Robert Klein, Eugene Lecomte, Frank Nutter, Richard Roth, Jr., and Richard Roth, Sr., provided contributions to this chapter.

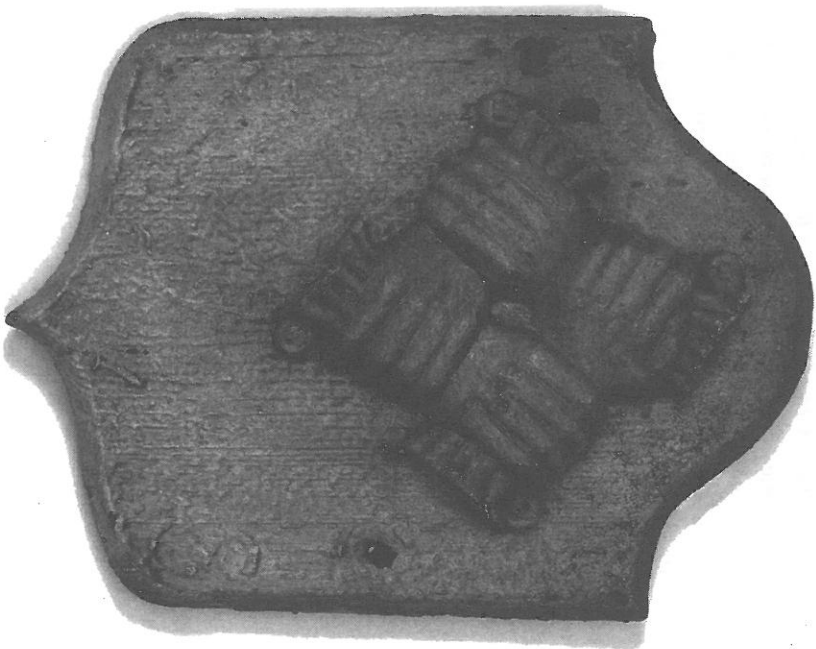
natural disasters. The chapter concludes with a discussion of how catastrophic losses have affected the insurance and reinsurance industry. In particular, we discuss residual market mechanisms, which have been created by some states to offer insurance in high-hazard areas when the voluntary market refuses to meet the demand at the regulated rates.

### A BRIEF HISTORY OF HAZARD INSURANCE

Long before the development of insurance as such, early civilizations evolved various kinds of insurance-like devices for transferring or sharing risk. For example, early trading merchants are believed to have adopted the practice of distributing their goods among various boats, camels, and caravans, so each merchant would sustain only a partial loss of his goods if some of the boats were sunk or some of the camels and caravans were plundered. This concept survives today in the common insurance practice of avoiding over-concentration of properties in any one area, and by spreading risk through reinsurance arrangements.

We can trace to the Code of Hammurabi in 1950 B.C., the practice of bottomry, whereby the owner of a ship binds the ship as security for the repayment of money advanced or lent for the journey. If the ship is lost at sea the lender loses the money, but if the ship arrives safely, he receives with the loan repayment the premium specified in advance, which is higher than the legal rate of interest. Bottomry, one of the oldest forms of insurance, was used throughout the ancient world (Covello and Mumpower, 1985).

By 750 B.C. the practice of bottomry was highly developed, particularly in ancient Greece, with risk premiums reflecting the danger of the venture. Mutual insurance also developed at this time, whereby all parties to the contract shared in any loss suffered by one of the traders who paid a premium. The decay and disintegration of the Roman Empire in the fifth century A.D. was followed by the development of small, isolated, self-sufficient, and self-contained communities. Since international commerce practically ceased, there was little need for sophisticated risk-sharing devices such as insurance. However, with the revival of international commerce in the thirteenth and fourteenth centuries, the use of insurance-type mechanisms resumed (Pfeffer, 1966). In England, the establishment of Lloyd's Coffee House in 1688 (the beginnings of "Lloyd's of London") provided a gathering place for individual marine underwriters (Covello and Mumpower, 1985). London then became the center of the global marine insurance market.



*Fire mark, ca. 1800, of the Philadelphia Contributionship for the Insurance of Houses from Loss by Fire, the oldest fire insurance company in America. The company was founded by Benjamin Franklin and his colleagues in 1752. This plaque on a building indicated that the property had fire insurance coverage provided by The Contributionship (Courtesy of The Philadelphia Contributionship for the Insurance of Houses from Loss by Fire; Will Brown).*

### Fire and Windstorm Insurance

Modern fire insurance was developed after the Great Fire of London in 1666, which destroyed over three-fourths of the buildings in the city. In the early eighteenth century Philadelphia took the first steps toward the protection of property from the fire peril; the city possessed seven fire-extinguishing companies. Philadelphia also passed regulations concerning the nature and location of buildings in the city. Led by Benjamin Franklin, Philadelphians organized the first fire insurance company in

America, the Philadelphia Contributionship for the Insurance of Houses from Loss by Fire. It was followed by the creation of four more insurance companies before the end of the eighteenth century, and by an increasing number of fire insurance companies in other cities in the first half of the nineteenth century. The financial problems associated with catastrophic losses are well illustrated by the great New York fire of 1835, which swept most of the New York fire insurance companies out of existence (Oviatt, 1905).

Until recent years, attention to the fire peril has predominated over attention to other natural hazards. Insurers over the decades have studied the peril of fire intensively. Conflagrations such as the great New York fire of 1835 and the Chicago fire of 1871 focused attention on fire prevention. The National Board of Underwriters, established in 1866 in New York City, concentrated on protecting the interests of fire insurance companies. It established safety standards in building construction and worked to repress incendiarism and arson. In 1894, fire insurance companies created the Underwriters Laboratories as a not-for-profit organization to test materials for public safety. The National Fire Protection Association was founded two years later in 1896 and, by encouraging proper construction, still plays a major role in lessening the number of fires. Today's engineering and technical schools conduct research and educate and train fire safety personnel.

The nineteenth century saw the rise of the two principal types of insurance organizations in business today: mutual and stock insurance companies. A mutual company is an insurance company that is owned and operated by its policyholders and run for their benefit. The policyholders elect a board of directors, who in turn elect officers to manage the company. Because a mutual company is owned by the policyholders, any excess income is either returned to the policyholders as dividends, used to reduce premiums, or retained to finance future growth. A stock insurance company is a corporation owned by stockholders who participate in the profits and losses of the company.

The concept of insurance as an important means of risk spreading and risk reduction is best exemplified by the factory mutual insurance companies founded in the early nineteenth century in New England (Bainbridge, 1952). Factory mutual companies offered factories an opportunity to pay a small premium in exchange for protection against potentially large losses from fire, thus illustrating the risk-spreading function of insurance. One of the first mutual insurance companies providing fire insurance coverage to textile mills was Boston Manufacturers.

Following a mill inspection in 1865, Edward Manton, president of Boston Manufacturers, noted "Renew at same if an additional force pump is added. If not, renew for \$10,000 at 1 1/4" (Bainbridge, 1952, p. 112). That is, the mill would have to pay an additional 1 1/4 cents per \$100 without the additional force pump.

Regarding risk reduction, the mutuals required inspections of factories both prior to issuing a policy and after one was in force. Poor risks had their policies canceled; premiums were reduced for factories that instituted loss prevention measures. The Boston Manufacturers also worked with lantern manufacturers to encourage them to develop safer designs and then advised their policyholders that they had to purchase lanterns from those companies whose products met their specifications. The Manufacturers Mutual in Providence, Rhode Island, developed specifications for fire hoses and advised mills to buy only from companies that met these standards. In many cases, factory mutual insurance companies would only provide coverage to companies that adopted specific loss prevention methods. For example one company, the Spinners Mutual, only insured risks where automatic sprinkler systems were installed.

Insurance against wind damage was first written in the second half of the nineteenth century, but only by a limited number of companies. In its earliest form, the policy contract provided for insurance against loss by fire or storm. Until 1880 this type of insurance was sold by local or farmers' mutual insurance companies on rural risks, rather than city risks, and was confined to the East. The first insurance covering windstorm by itself was initiated in the Midwest in the latter part of the nineteenth century and was called "tornado insurance." It continued as a separate policy until 1930.

Windstorm insurance began to evolve in its present form in 1930 when the stock fire insurance companies filed an "Additional Hazards Supplemental Contract" in conjunction with the standard fire policy. This new contract provided a single rate for coverages that had traditionally been offered as separate policies for tornado, explosion, riot and civil commotion, and aircraft damage insurance. Incorporating this array of coverage in one contract was seen as a radical step in a generally conservative industry. In October of that same year, the contract was expanded even further when the New England Insurance Exchange revised it to include the perils of hail and motor vehicles, as well as all types of windstorms, not just tornadoes. In 1938, the Additional Hazards Supplemental Contract was re-named "Extended Coverage," and smoke damage was added to the coverage.

When first introduced in the East, the Extended Coverage (EC) endorsement was purchased by few individuals, and was even viewed as a luxury. A striking demonstration of this was the fact that comparatively little of this insurance was sold in Massachusetts until after the 1938 hurricane, the first to hit New England in a century. This event stimulated sale of the EC endorsement in part because many banks now required that it be added to fire insurance on mortgaged property. Although there were some changes in the perils covered during the 1930s and 1940s, the basic package has been retained and continues to be used today.

### Property-Casualty Insurance Today

The insurance industry today is divided into two broad areas: property-casualty insurance companies, and life and health insurance companies. Property-casualty companies predominate numerically, with almost 4,000 property-casualty companies and about 2,000 life insurers operating in 1997 (telephone conversation, Customer Service Department, A. M. Best and Co., 1998). Property-casualty and life and health are really two different worlds, and the insurance laws of the various states recognize the sharp distinction between them. The property-casualty companies are the main source of coverage against natural hazards in the United States and hence bear the lion's share of the insured losses from disasters.

There is a significant difference between the property lines and the casualty lines, both of which are written by property-casualty companies. Property insurance reimburses policyholders directly for their insured losses, and thus is labeled as first-party coverage. Casualty insurance, for the most part, protects its policyholders against financial losses involving third parties, and consequently is called third-party insurance. For example, an automobile liability policy pays for damage caused by negligent action on the part of its insured when a vehicle owned by a third party is involved. An exception to this is automobile physical damage insurance, which is first-party insurance. It is more efficient for insurers to write this in conjunction with automobile liability coverages. General liability and workers' compensation are other important casualty lines of insurance.

Most of the financial losses caused by natural disasters are due to property damage. A homeowner's multiperil policy provides coverage against damage to one's property from fire, windstorm, and hail, as well as other perils, except for earthquake (which can be attached as a special rider to the homeowner's policy), and flood (which can be purchased

from the federal government's National Flood Insurance Program by homeowners facing this risk). A commercial multiperil policy, which covers business risks, is similar to a homeowner's policy except that it often includes earthquake and flood coverage.

Agents or brokers sell most insurance policies. An agent is someone who legally represents the insurer and has the authority to act on the company's behalf. In property insurance there are two types of agents: independent agents, who can represent several companies, and exclusive agents, who represent only a single company. Brokers legally represent the insured, normally a corporation. They are extremely important in commercial property insurance today, providing risk management and loss control services to companies as well as arranging their insurance contracts. Insurance is also marketed by direct writers, who are employees of the insurer, and by mail-order companies. With the emergence of electronic commerce, the World Wide Web is likely to be an increasingly important source for marketing insurance in the future.

### BASIC CONCEPTS OF INSURANCE

Insurance is an economic institution that allows the transfer of financial risk from an individual to a pooled group of risks by means of a two-party contract. The insured party obtains a specified amount of coverage against an uncertain event (e.g., an earthquake or flood) for a smaller but certain payment (the premium). Insurers may offer fixed, specified coverage or replacement coverage, which will take into account the increased cost of putting the structure back into its original condition. Law and ordinance insurance covers the additional cost required by changes in building codes and other legal requirements.

Most insurance policies have some form of deductible, which means that the insured party must cover the first portion of their loss. For example, a 10 percent deductible on a \$100,000 earthquake policy means that the insurance company is only responsible for property damage that exceeds \$10,000 up to some prespecified maximum amount, the coverage limit.

### Losses and Claims

The insurance business, like any other business, has its own vocabulary. A *policyholder* is a person who has purchased insurance. The term *loss* is used to denote the payment that the insurer makes to the policyholder for the damage covered under the policy. It is also used to mean

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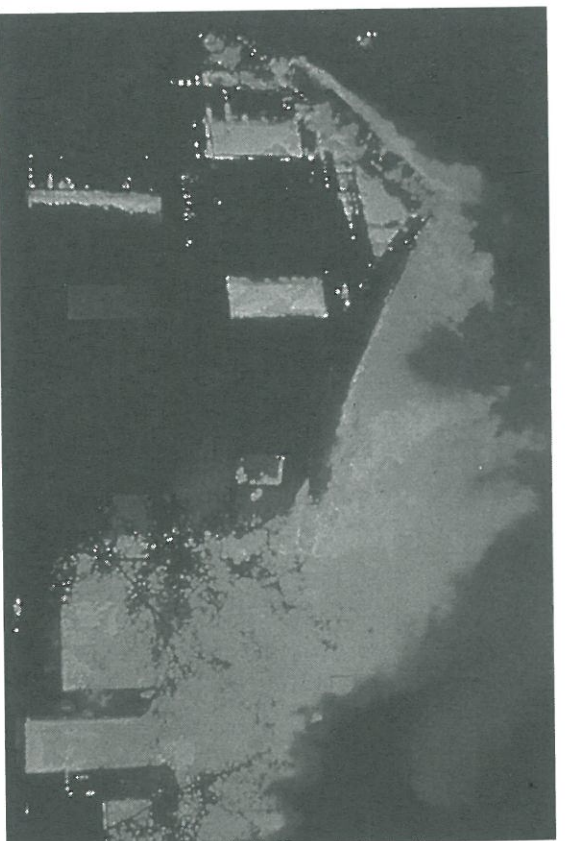
the aggregate of all payments in one event. Thus, we can say that there was a "loss" under the policy, meaning that the policyholder received a payment from the insurer. We may also say that the industry "lost" \$12.5 billion dollars in the Northridge earthquake.

A *claim* means that the policyholder is seeking to recover payments from the insurer for damage under the policy. A claim will not result in a loss if the amount of damage is below the deductible, or subject to a policy exclusion, but there will still be expenses in investigating the claim. Even though there is a distinction between a claim and a loss, the terms are often used interchangeably to mean that an insured event occurred, or in reference to the prospect of having to pay out money.

### The Law of Large Numbers

Insurance markets can exist because of *the law of large numbers*, which states that for a series of independent and identically distributed random variables (such as automobile insurance claims), the variance of the average amount of a claim payment decreases as the number of claims increases. Consider the following gambling example. If you go to Las Vegas and place a bet on roulette, you are expected to lose a little more than 5 cents every time you bet \$1. But each time you bet you will either win or lose whole dollars. If you bet ten times, your average return is your net winnings and losses divided by ten. According to the law of large numbers, the average return will converge to a loss of 5 cents per bet. The larger the number of bets, the closer the average loss per bet will be to 5 cents.

Fire is an example of a risk that satisfies the law of large numbers since its losses are normally independent of one another. (In some cases, however, losses caused by fire are not independent of each other: the Oakland fire of 1991 destroyed 1,941 single-unit dwellings and damaged 2,069 others.) To illustrate this law's application, suppose that an insurer wants to determine the accuracy of the probability of fire loss for a group of identical homes valued at \$100,000, each of which has a 1/1,000 annual chance of being completely destroyed by fire. If only one fire occurs in each home, the expected annual loss for each home would be \$100 (i.e.,  $1/1000 \times \$100,000$ ). If the insurer issued only a single policy, then a variance of approximately \$100 would be associated with its expected annual loss. (The variance for a single loss  $L$  with probability  $p$  is  $Lp(1-p)$ . If  $L = \$100,000$  and  $p = 1/1,000$ , then  $Lp(1-p) = \$100,000(1/1,000)(999/1,000)$ , or \$99,900.)



A single-family house fire (FEMA).

As the number of policies issued,  $n$ , increases, the variance of the expected annual loss or mean will decrease in proportion to  $n$ . Thus, if  $n = 10$ , the variance of the mean will be approximately \$10. When  $n = 100$  the variance decreases to \$1, and with  $n = 1,000$  the variance is \$0.10. It should thus be clear that it is not necessary to issue a large number of policies to reduce the variability of expected annual losses to a very small number if the risks are independent.

However, natural hazards—such as earthquakes, floods, hurricanes, and conflagrations such as the 1991 Oakland fire—create problems for insurers because the risks affected by these events are not independent. They are thus classified as *catastrophe risks*. If a severe earthquake occurs in Los Angeles, there is a high probability that many structures will be damaged or destroyed at the same time. Therefore, the variance associated with an individual loss is actually the variance of all of the losses that occur from the specific disaster. Due to this high variance it takes an extraordinarily long history of past disasters to estimate the average loss with any degree of predictability. This is why seismologists and risk assessors would like to have databases of earthquakes, hurricanes, or other similar disasters over 100- to 500-year periods. With the relatively short period of recorded history, the average loss cannot be estimated with any reasonable degree of accuracy.

One way that insurers reduce the magnitude of their catastrophic losses is by employing high deductibles, where the policyholder pays a fixed amount of the loss (e.g., the first \$1,000) or a percentage of the total coverage (e.g., the first 10 percent of a \$100,000 policy). The use of coinsurance, whereby the insurer pays a fraction of any loss that occurs, produces an effect similar to a deductible. Another way of limiting potential losses is for the insurer to place caps on the maximum amount of coverage on any given piece of property.

An additional option is for the insurer to buy reinsurance. For example, a company might purchase a reinsurance contract that will cover any aggregate insured losses from a single disaster that exceeds \$50 million up to a maximum of \$100 million. Such an excess-of-loss contract could be translated as follows: the insurer would pay for the first \$50 million of losses, the reinsurer the next \$50 million, and the insurer the remaining amount if total insured losses exceeded \$100 million. An alternative contract would be for the insurer and reinsurer to share the loss above \$50 million, prorated according to some predetermined percentage.

#### Probable Maximum Loss and Capacity

Because their financial resources are limited, insurance companies need to quantify their potential loss from a catastrophic event. In other words, insurers need an estimate of what the actual total damage might be from their current portfolio of policies and how it would affect their ability to pay claims.

For many years, fire insurance managers used the concept of a *probable maximum loss* (PML) to estimate what percentage of a particular building would likely be damaged in the event of a fire. The California Insurance Department carried this concept over to earthquake insurance when it devised its *Earthquake Questionnaire* in the 1970s (California Insurance Department, 1975). In the questionnaire the replacement cost of the insured homes is multiplied by a “PML percentage factor” to give a dollar estimate of the expected average damage to all of the insured homes in a defined earthquake zone. A similar concept is now used for defining PML in hurricane-prone areas of the country. An insurer’s *capacity* is the maximum amount of PML exposure on all building risks that an insurer is willing to insure in any one region or zone. For example, when a limit is placed on a certain earthquake zone, such as \$250 million, this is called a capacity limit of \$250 million for that zone. Sometimes it is expressed in terms of the state as a whole. In other words,

capacity is the maximum amount of aggregate loss that the insurer is willing to accept from one specific disaster event. The insurer determines its capacity based on the amount of surplus it has, its cash flow and profits from other lines of insurance it writes, and the amount of its reinsurance to cover catastrophic losses from specific disasters. Thus “capacity” refers to how much of the insurer’s resources its management is willing to risk on one major disaster.

#### INSURABILITY CONDITIONS?

What does it mean to say that a particular risk is insurable? This question must be addressed from the vantage point of the potential supplier of insurance who offers coverage against a specific risk at a stated premium. The policyholder is protected against a prespecified set of losses defined in the contract.

Two conditions must be met before insurance providers are willing to offer coverage against an uncertain event. Condition 1 is the ability, when providing different levels of coverage, to identify and quantify, or estimate, the chances of the event occurring and the extent of losses likely to be incurred. Condition 2 is the ability to set premiums for each potential customer or class of customers. This requires some knowledge of the customer’s risk in relation to others in the population of potential policyholders. If Conditions 1 and 2 are both satisfied, a risk is considered to be insurable. But it still may not be profitable. In other words, it may be impossible to specify a rate for which there is sufficient demand and incoming revenue to cover the development, marketing, and claims costs of the insurance and still yield a net positive profit. In such cases the insurer will opt *not* to offer coverage against this risk.

#### Condition 1: Identifying the Risk

To satisfy this condition, estimates must be made of the frequency at which specific events occur and the magnitude of loss they are likely to cause. Such estimates can use data from previous events, or scientific analyses of what is likely to occur in the future. We will first illustrate the use of historical data, with the peril of fire as an example, and then discuss scientific prediction, with the earthquake peril as an example.

<sup>2</sup>This section is based on Chapter 4 in Freeman and Kunreuther, 1997.

We will then show how new developments in catastrophe risk modeling have made it easier to estimate the risk facing insurers when they are considering how much coverage to provide in hazard-prone areas.

### Collecting Historical Data on the Risk of Fire

Rating agencies typically collect data on all the losses incurred over a period of time for particular risks and exposure units. Suppose the hazard is fire and the exposure unit is a well-defined entity, such as a \$300,000 wood frame home to be insured for one year in California. The typical measurement is the pure premium (PP), which is the basis for setting an actual premium for potential customers. The PP is defined as:

$$PP = \text{Total Losses} / \text{Total Number of Exposure Units. (1)}$$

(The pure premium normally considers loss adjustment expenses for setting a claim. We will assume that this component is part of total losses. For more details on calculating pure premiums, see Launie et al., 1986.) Assume that the rating agency has collected data on 100,000 wood frame homes in that state and has determined that the total annual loss from fires to these structures over the past year is \$20 million. If these data are representative of the expected loss to this class of wood frame homes in California next year, then, using (1), PP is given by:

$$PP = \$20,000,000 / 100,000 = \$200.$$

This figure is simply an average. It does not differentiate between wood frame homes of different values, their locations in the state, the distance of each home from a fire hydrant, or the quality of the fire department serving different communities. All of these factors are often taken into consideration by underwriters and actuaries who specify a premium that reflects their estimate of the risk to particular structures.

### Using Scientific Data to Estimate the Risk of Earthquakes

If there were comparable long-term data available on annual damage to wood frame homes in California from earthquakes of different magnitudes, then a method similar to the one described above could be used to determine the probability and magnitude of loss from earthquakes. However, due to the infrequency of these disasters and the relatively small number of homes that have been insured against them, this type of analysis is not feasible. Insurance providers instead have turned

to scientific studies by seismologists, geologists, and structural engineers to estimate the frequency of earthquakes of different magnitudes, as well as the damage that is likely to occur to different structures from such earthquakes.

Figure 2-1 depicts the type of information required to determine the pure premium for a wood frame house subject to earthquake damage in California. The x-axis (magnitude of loss) is the amount of damage an earthquake might cause to a wood frame home of a given value. The y-axis (probability) is the estimated annual probability that a wood frame home in a specific region of California would suffer a specified amount of loss from an earthquake. If these data are available from scientific studies, the pure premium in this case would be equivalent to the expected loss, which is given by the area under the curve in Figure 2-1.

Scientists have been working to reduce the ambiguity and uncertainty in predicting the location, severity, frequency of occurrence, and physical effects of earthquakes. Over the past 20 years seismologists have discovered factors that influence the probability of an earthquake

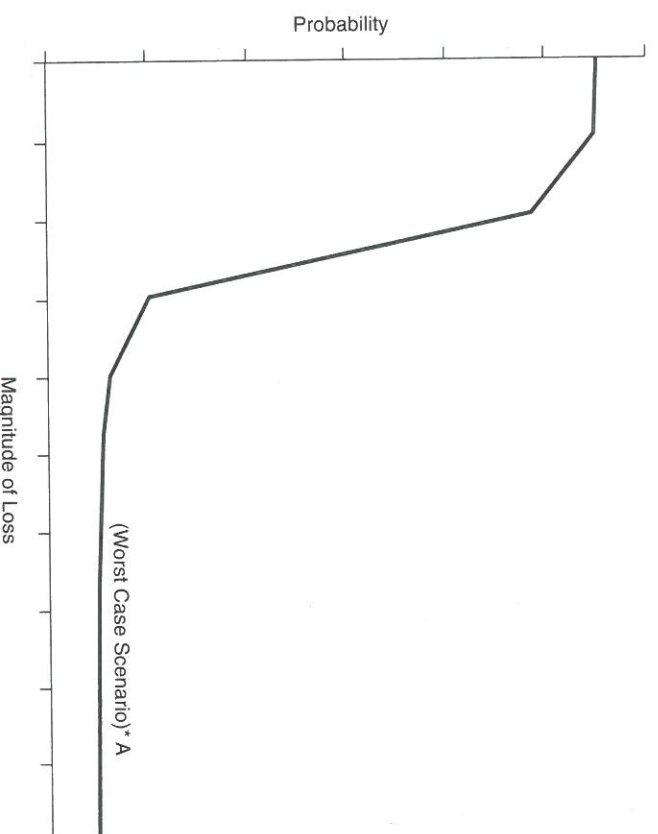


FIGURE 2-1 Determining expected loss to a wood frame house from an earthquake in California.

in a specific area, by examining geologic records, looking at actual events, and conducting experiments on how the ground responds to earthquake processes. Scientists are still uncertain as to how different factors interact with each other and what their relative importance is (Hanks and Cornell, 1994).

Engineers have focused on the nature, distribution, and level of damage from earthquakes. Congress mandated the continued improvement of worldwide post-earthquake investigations by authorizing the National Earthquake Hazard Reduction Program in 1976, and re-authorizing it in 1990 (P.L. 101-614). Such investigations have increased our understanding of the performance of various types of buildings and structures in earthquakes of different magnitudes. However, there is still considerable uncertainty about the damage earthquakes are likely to cause to different structures. Hazard risk maps have been drawn for earthquakes, but they only provide rough guidelines as to the likelihood and potential damage from specific events. For the medium-intensity Northridge earthquake, for example, the predicted damage was considerably less than the actual losses (Scawthorn, 1995). (For a detailed discussion of new advances in seismology and earthquake engineering, see FEMA, 1994, and Office of Technology Assessment, 1995.)

The recent use of geographic information systems (GIS) for incorporating geologic and structural information for a region has enabled scientists to estimate potential damage and losses from different earthquake scenarios. The data for the region are stored in the form of GIS maps of ground shaking estimation; maps of secondary seismic hazards such as liquefaction, landslide, and fault rupture; and maps of damage to structures in the region (King and Kiremidjian, in press).

While seismologists and geologists cannot predict with any certainty the probability of earthquakes of different magnitudes occurring in specific regions of California and the resulting damage to structures, they are often asked to predict worst-case scenarios for a particular structure as a result of an earthquake of a given magnitude. For example, they are asked to estimate the maximum credible probability ( $p^*$ ) from an earthquake of intensity ( $i$ ) in the vicinity of a wood frame house in an earthquake-prone area. The engineers then provide their best estimates of the probable maximum loss to the house ( $L^*$ ) from such an earthquake. (The use of PML for determining earthquake premiums is described in Chapter 4.) The resulting worst-case scenario for the wood frame house is shown as point A in Figure 2-1.

### *Development of Catastrophe Models*

New advances in information technology have led to the development of catastrophe models, which have proven very useful for quantifying risks based on estimated probabilities and expected damage. The development of faster and more powerful computers now makes it possible to examine extremely complex phenomena in ways that were impossible even five years ago. Large databases can now be stored and manipulated so that large-scale simulations of different disaster scenarios under various policy alternatives can be easily undertaken.

A catastrophe model is the set of databases and computer programs designed to analyze the impact of different scenarios on hazard-prone areas. A catastrophe model combines scientific risk assessments of the hazard with historical records to estimate the probabilities of disasters of different magnitudes and the resulting damage to affected structures and infrastructure (U.S. Congress, 1995). The information can be presented in the form of expected annual losses and/or the probability that in a given year the claims will exceed a certain amount. Catastrophe models can also be used to calculate estimated insured losses from specific hypothesized events (e.g., a Hurricane Andrew hitting downtown Miami and Miami Beach).

Specifically, catastrophe models combine the characteristics of the disaster with characteristics of the property in the affected region to determine a damageability matrix. This matrix provides information on the potential losses from disasters of different magnitudes to the structures at risk. Depending on the type of insurance coverage available, one can then estimate the insured loss per property (see Insurance Services Office, 1996). Figure 2-2 illustrates the interaction between these different components of the catastrophe model for earthquake hazards. A more detailed discussion on how one creates and utilizes catastrophe models appears in Appendix B.

The occurrence of Hurricane Andrew and the Northridge earthquake stimulated the insurance industry to pay more attention to output from these catastrophe models that indicate what could happen in hurricane- and earthquake-prone areas over periods of 10 years, 100 years, or even 1,000 or 10,000 years. Catastrophe models provide the insurer with an opportunity to determine how much coverage it should provide, what premiums it should charge, and where it should offer policies to reduce its probability of severe financial losses to an acceptable level.

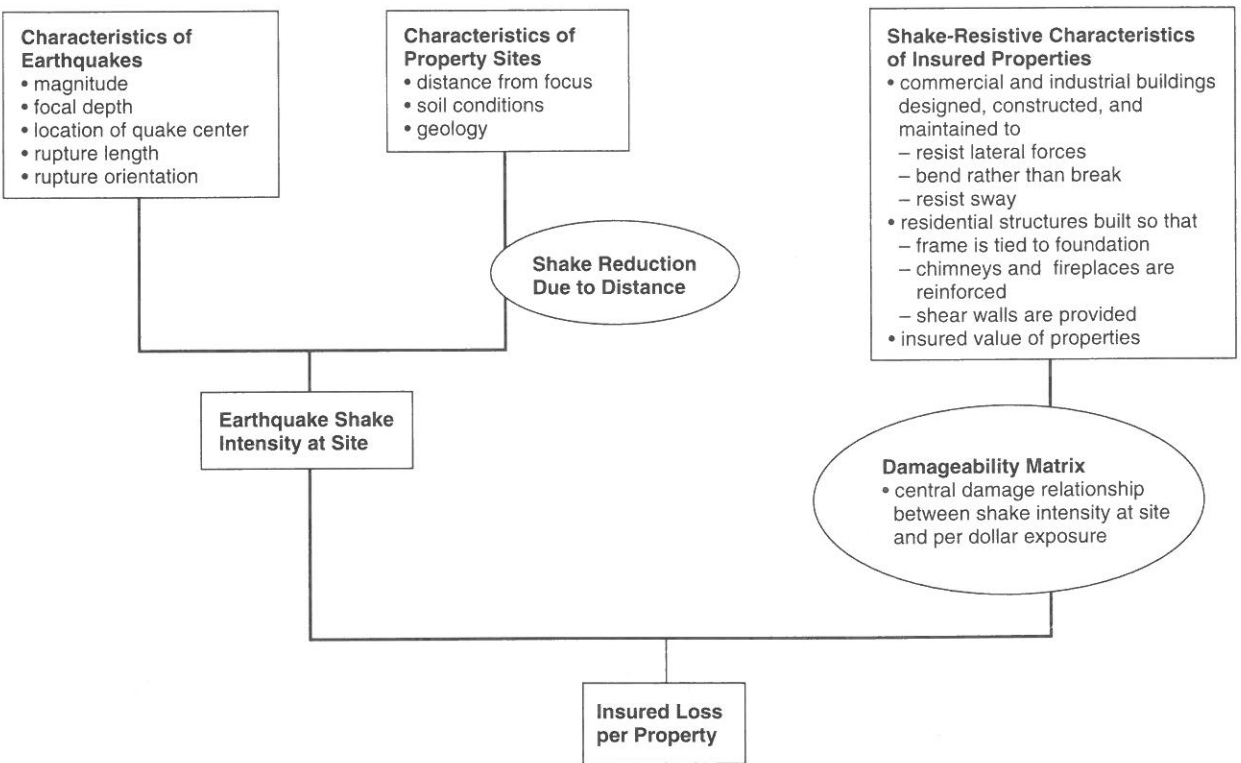


FIGURE 2-2 Modeling the effects of earthquake shake damage on insured losses. Source: Insurance Services Office, 1996.

### Condition 2: Setting Premiums for Specific Risks

Once the risk has been identified, the insurer needs to determine what premium it can charge to make a profit, while not subjecting itself to an unacceptably high chance of a catastrophic loss. There are a number of factors that play a role in determining what prices companies would like to charge. In the discussion that follows we are assuming that insurers are free to set premiums at any level they wish. In reality, state regulations often limit insurers in their rate-setting process.

#### *Ambiguity of Risk*

Not surprisingly, the higher the uncertainty regarding the probability of a specific loss and its magnitude, the higher the premium will be. As shown by a series of empirical studies, actuaries and underwriters are so averse to ambiguity and risk that they tend to charge much higher premiums than if the risk were well specified.

Kunreuther et al. (1995) conducted a survey of 896 underwriters in 190 randomly chosen insurance companies to determine what premiums would be required to insure a factory against property damage from a severe earthquake. The survey results examine changes in pricing strategy as a function of the degree of uncertainty in probability and/or loss. A probability is considered to be well specified where there is enough historical information on an event that all experts can agree that the probability of a loss is  $p$ . When there is wide disagreement about the estimate of  $p$  among the experts, this ambiguous probability is referred to as  $Ap$ .  $L$  represents a known loss—that is, there is a general consensus about what the loss will be if a specific event occurs. When a loss is uncertain, and the experts' estimates range between  $L_{min}$  and  $L_{max}$ , this uncertain loss is denoted as  $UL$ . Combining the degree of probability and loss uncertainty leads to four cases which are shown in the columns of Table 2-1.

To see how underwriters reacted to different situations, four scenarios were constructed, as shown by the rows in Table 2-1. Where the risk is well specified, the probability of the earthquake is either .01 or .005; the loss, should the event occur, is either \$1 million or \$10 million. The premium set by the underwriter is standardized at 1 for the non-ambiguous case; one can then examine how ambiguity affects pricing decisions.

Table 2-1 shows the ratio of the other three cases relative to the

**TABLE 2-1** Ratios of Underwriters' Premiums for Ambiguous or Uncertain Earthquake Risks Relative to Well-Specified Risks<sup>a</sup>

Scenario	Cases				
	1 <i>p, L</i>	2 <i>Ap, L</i>	3 <i>p, UL</i>	4 <i>Ap, UL</i>	5 <i>N<sup>b</sup></i>
<i>p</i> = .005 <i>L</i> = \$1 million	1	1.28	1.19	1.77	17
<i>p</i> = .005 <i>L</i> = \$10 million	1	1.31	1.29	1.59	8
<i>p</i> = .01 <i>L</i> = \$1 million	1	1.19	1.21	1.50	23
<i>p</i> = .01 <i>L</i> = \$10 million	1	1.38	1.15	1.43	6

<sup>a</sup>Ratios are based on mean premiums across number of respondents for each scenario.  
<sup>b</sup>*N* = number of respondents.

Source: Kunreuther et al., 1995.

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.

#### *Adverse Selection*

If the insurer sets a premium based on the average probability of a loss, using the entire population as a basis for this estimate, those at the highest risk for a certain hazard will be the most likely to purchase coverage for that hazard. In an extreme case, the poor risks will be the only purchasers of coverage, and the insurer will lose money on each policy sold. This situation, referred to as *adverse selection*, occurs when the insurer cannot distinguish between the probability of a loss for good- and poor-risk categories.

The assumption underlying adverse selection is that purchasers of insurance have an informational advantage by knowing their *risk type*. Insurers, on the other hand, must invest considerable expense to collect

information to distinguish between risks. For example, suppose some homes have a low probability of suffering damage (the good risks) and others have a higher probability (the poor risks). The good risks stand a 1 in 10 probability of loss and the poor risks, a 3 in 10 probability. For simplicity, assume that the loss is \$100 for both groups and that there are an equal number of potentially insurable individuals in each risk class.

Since there is an equal number in both risk classes, the expected loss for a random individual in the population is \$20. (This expected loss is calculated as follows:  $[50(.1 \times \$100) + 50(.3 \times \$100)]/100 = \$20$ .) If the insurer charges the same premium across the entire population, only the poor-risk class would normally purchase coverage, since their expected loss is \$30 ( $.3 \times \$100$ ), and they would be pleased to pay only \$20 for the insurance. The good risks have an expected loss of \$10 ( $.1 \times \$100$ ), so they would have to be extremely risk averse to be interested in paying \$20 for coverage. If only the poor risks purchase coverage, the insurer will suffer an expected loss of \$10 (i.e.,  $\$30 - \$20$ ) on every policy it sells.

There are two principal ways that insurers can deal with this problem. If the company knows the probabilities associated with good and bad risks but does not know the characteristics of the property, the insurer can raise the premium to at least \$30 so that it will not lose money on any individual purchasing coverage. In reality, where there is a spectrum of risks, the insurer may only be able to offer coverage to the worst-risk class in order to make a profit. Hence, raising premiums is likely to produce a market failure in that very few of the individuals who are interested in purchasing coverage to cover their risk will actually do so at the going rate.

A second way for the insurer to deal with adverse selection was proposed by Rothschild and Stiglitz (1976). The insurer could offer two different price-coverage contracts. For example, Contract 1 could be offered at price = \$30 and coverage = \$100, while Contract 2 might be price = \$10 and coverage = \$40. If the poor risks preferred Contract 1 over 2, and the good risks preferred Contract 2 over 1, this would be one way for the insurers to market coverage to both groups while still breaking even.

A third approach is for the insurer to require some type of audit or examination to determine the nature of the risk more precisely. However, inspections and audits are expensive and will raise the premium charged unless the potential policyholder pays for the audit.

It is important to remember that the problem of adverse selection only emerges if the persons considering the purchase of insurance have more accurate information on the probability of a loss than the firms selling coverage. If the policyholders have no better data than the insurers, both sides are on an equal footing. Coverage will be offered at a single premium based on the average risk, and both good and poor risks will want to purchase policies.

### *Moral Hazard*

Providing insurance protection to an individual may lead that person to behave more carelessly than before he or she had coverage. If the insurer cannot predict this behavior and relies on past loss data from uninsured individuals to estimate rates, the resulting premium is likely to be too low to cover losses.

Moral hazard refers to an increase in the probability of loss caused by the behavior of the policyholder. Obviously, it is extremely difficult to monitor and control behavior once a person is insured. How do you monitor carelessness? Is it possible to determine if a person will decide to collect more on a policy than he or she deserves by making false claims?

The numerical example used above to illustrate adverse selection can also demonstrate moral hazard. With adverse selection the insurer cannot distinguish between good and bad risks, but the probability of a loss for each group is assumed not to change after a policy is sold. With moral hazard the actual probability of a loss becomes higher after a person becomes insured. For example, suppose the probability of a loss increases from  $p = .1$  before insurance to  $p = .3$  after coverage has been purchased. If the insurance company does not know that moral hazard exists, it will sell policies at a price of \$10 to reflect the estimated actuarial loss ( $.1 \times \$100$ ). The actual loss will be \$30 since  $p$  increases to .3. Therefore, the firm will lose \$20 (i.e.,  $\$30 - \$10$ ) on each policy it sells.

One way to avoid the problem of moral hazard is to raise the premium to \$30 to reflect the known increase in the probability,  $p$ , that occurs once a policy has been purchased. In this case there will *not* be a decrease in coverage as there was in the adverse selection example. Those individuals willing to buy coverage at a price of \$10 will still want to buy a policy at \$30 because they know that their probability of a loss with insurance will be .3.

Another way to avoid moral hazard is to introduce *deductibles* and

*coinsurance* as part of the insurance contract. A sufficiently large deductible can act as an incentive for the insureds to continue to behave carefully after purchasing coverage because they will be forced to cover a significant portion of their loss themselves. With coinsurance the insurer and the insured share the loss together. An 80 percent coinsurance clause in an insurance policy means that the insurer pays 80 percent of the loss (above a deductible), and the insured pays the other 20 percent. As with a deductible, this type of risk-sharing arrangement encourages safer behavior because those insured want to avoid having to pay for some of the losses. (For more details on deductibles and coinsurance in relation to moral hazard, see Pauly, 1968.)

Another way of encouraging safer behavior is to place upper limits on the amount of coverage an individual or enterprise can purchase. If the insurer will only provide \$500,000 worth of coverage on a structure and contents worth \$1 million, then the insured knows he or she will have to incur any residual costs of losses above \$500,000. This assumes that the insured will not be able to purchase a second insurance policy for \$500,000 to supplement the first one and hence be fully protected against a loss of \$1 million, except for deductibles and insurance clauses. Even with these clauses in an insurance contract, the insureds may still behave more carelessly with coverage than without it simply because they are protected against a large portion of the loss. For example, insureds may decide not to take precautionary measures that they would have adopted had they been uninsured. The cost of adopting mitigation may now be viewed as too high relative to the dollar benefits that the insured would receive from this investment. If the insurer knows in advance that an individual will be less interested in loss reduction activity after purchasing a policy, then it can charge a higher insurance premium to reflect this increased risk, or it can require specific mitigation measures as a condition of insurance. In either case this aspect of the moral hazard problem will have been overcome.

### *Correlated Risk*

Correlated risk refers to the simultaneous occurrence of many losses from a single event. As pointed out earlier, natural disasters such as earthquakes, floods, and hurricanes produce highly correlated losses: many homes in the affected area are damaged and destroyed by a single event.

If a risk-averse insurer faces highly correlated losses from one event,

it may want to set a high enough premium not only to cover its expected losses, but also to protect itself against the possibility of experiencing catastrophic losses. An insurer will face this problem if it has many eggs in one basket—if, for example, the insurer provides earthquake coverage mainly to homes in Los Angeles County rather than across the entire state of California.

To illustrate the impact of correlated risks on the distribution of losses, assume that there are two policies sold against a risk, where  $p = .1$ , and  $L = \$100$ . The actuarial loss for each policy is \$10. If the losses are perfectly correlated, then there will be either two losses with probability of .1, or no losses with a probability of .9. On the other hand, if the losses are independent of each other, then the chance of two losses decreases to .01 (i.e.,  $.1 \times .1$ ), with the probability of no losses being .81 (i.e.,  $.9 \times .9$ ). There is also a .18 chance that there will be only 1 loss (i.e.,  $.9 \times .1 + .1 \times .9$ ).

The expected loss for both the correlated and uncorrelated risks is \$20. [For the correlated risk the expected loss is  $.9 \times \$0 + .1 \times \$200 = \$20$ . For the independent risk the expected loss is  $(.81 \times \$0) + (.18 \times \$100) + (.01 \times \$200) = \$20$ .] However, the variance will always be higher for correlated than uncorrelated risks if each has the same expected loss. Thus, risk-averse insurers will always want to charge a higher premium for the correlated risk.

#### Insurability Conditions and Demand for Coverage

The above discussion suggests that in theory insurers can offer protection against any risk that they can identify, and for which they can obtain information to estimate the frequency and magnitude of potential losses, as long as they have the freedom to set premiums at any level. However, due to problems of ambiguity, adverse selection, moral hazard, and highly correlated losses, they may want to charge premiums that considerably exceed the expected loss. For some risks the desired premium may be so high that there would be very little demand for coverage at that rate. In such cases, even though an insurer determines that a particular risk meets the two insurability conditions discussed above, it will not invest the time and money to develop the product.

More specifically, the insurer must be convinced that there is sufficient demand to cover the development and marketing costs of the coverage through future premiums received. If there are regulatory restrictions that limit the price insurers can charge for certain types of coverage,

then companies will not want to provide protection against these risks. In addition, if an insurer's portfolio leaves the insurer vulnerable to the possibility of extremely large losses from a given disaster due to adverse selection, moral hazard, and/or high correlation of risks, then the insurer will want to reduce the number of policies in force for these hazards.

The case studies of California and Florida discussed in Chapters 4 and 5 reveal a number of concerns by insurers with respect to providing coverage against earthquake and hurricane. Given rate and coverage restrictions imposed on them in each of these states, insurers claim that insurance for these two perils *cannot* be profitably marketed today. (It should be noted that most insurance companies made large profits prior to the early 1990s by marketing hurricane insurance in Florida and earthquake coverage in California. However, all of these profits, and more, disappeared with the occurrence of Hurricane Andrew and the Northridge earthquake.) Insurers had reached a similar conclusion a number of years ago with respect to flood hazards. This led to the development of the National Flood Insurance Program in 1968.

#### AVAILABLE RESIDENTIAL COVERAGE FOR NATURAL DISASTERS

We now turn to the types of coverage that are currently available in the United States for protection against property damage from different types of natural disasters.

##### Earthquakes

As pointed out in Chapter 1, insurance coverage for earthquake shake damage can be included, but is not automatically included, in homeowners' insurance policies for an additional premium, except in California. Today in California, one normally purchases a residential earthquake policy through the California Earthquake Authority, a state-run earthquake insurance company. A more detailed analysis of earthquake insurance in California appears in Chapter 4. For states including California, earthquake coverage is often included in a commercial policy for structures in hazard-prone areas, or it can also be purchased as a separate policy. Protection against loss by fire which might follow an earthquake is included in the basic fire peril coverage in all property insurance contracts. Business interruption (BI) from an earthquake is covered by a separate BI policy.

### Floods

Flood insurance was first offered by private companies in the late 1890s and again in the mid-1920s (Manes, 1938). However, the loss experienced by those insurers providing coverage was so large that they left the market and discouraged others from entering. Insurance companies viewed the flood risk as unmarketable because problems of adverse selection and high correlation of risks necessitated rates so high that few individuals would want to purchase coverage. The 1952 *Report on Floods and Flood Damage* explicitly makes this point by noting that because of the "impossibility of making this line of insurance self-supporting due to the refusal of the public to purchase such insurance at the rates which would have to be charged to pay annual losses, companies generally could not prudently engage in this field of underwriting" (Insurance Executive Association, 1952).

In 1968 Congress created the National Flood Insurance Program (NFIP) as a means of offering coverage on a nationwide basis through the cooperation of the federal government and the private insurance industry. A more detailed discussion of the NFIP, and its opportunities and challenges in comparison with a private insurance program, is discussed in Chapter 6.

### Hailstorms

Hail is a product of thunderstorms, and is usually associated with strong winds. Since damage is caused by both wind and hail, it is difficult to allocate the dollar loss to each cause separately. Thus, insurance loss payment data is combined for the two perils. Insurance coverage for hailstorms is nearly universal. It is part of the basic coverage in virtually all residential and commercial property insurance policies sold in the United States. Anyone purchasing a property insurance policy in this country probably has the coverage.

Although hailstorms can produce widespread structural damage, it is unusual for them to render a dwelling uninhabitable or a business structure unusable. Hail is the second leading cause of damage covered by property insurance in the United States, after fire, and the variance in the aggregate level of losses from year to year is relatively small in contrast to other natural hazards.

Hailstorm damage can occur virtually anywhere in the country, although some areas are considerably more susceptible to these storms. Because hailstorms are widespread and quite random, it is possible to

forecast expected loss costs with a reasonable degree of certainty. This, in turn, allows property insurers and reinsurers to price this coverage and allocate capital with sufficient accuracy to fund expected loss costs.

### Hurricanes

Hurricanes are large storms that originate over tropical ocean waters; they are characterized by high winds and extensive flooding. Hurricane wind damage and windblown water damage are included as part of the basic wind coverage in most property insurance policies. Flood damage resulting from hurricanes is *not* included in property insurance policies but can be purchased as separate coverage under the National Flood Insurance Program.

Although relatively infrequent in the United States, when hurricanes do occur they are capable of causing tremendous destruction and damage to structures over a large area. Property exposures to hurricanes in all coastal states (with the exception of Louisiana) more than doubled from 1980-1993. During this period the value of insured residential exposures increased by 166 percent, and commercial exposures went up 193 percent. (Insurance Research Council and Insurance Institute for Property Loss Reduction, 1995). Since these storms are events of low frequency but high financial impact, considerable uncertainty surrounds loss projections for the future. Chapter 5 presents a detailed discussion of the challenges that insurers face in providing hurricane coverage in Florida.

In recent years increased attention has been given to hurricane prediction. Historical data for the twentieth century suggest that hurricanes follow cyclical patterns. After a relatively quiescent period from 1960 to 1987, the picture changed when Hurricane Gilbert hit the Caribbean and Mexico in 1988, and Hurricane Hugo struck the South Carolina coast in 1989. In 1992 Hurricane Andrew devastated south Florida, and Hurricane Iniki hit Hawaii. In 1995, Hurricane Erin and Hurricane Opal caused significant damage in Florida.

### Landslides

Landslides are normally not considered an insurable peril by private insurers. Insurance programs cover landslides only to the extent that the damage is caused by an insured earthquake, or is associated with flood damage covered by policies sold under the National Flood Insurance Program.

### Lightning

While lightning is not usually considered a disaster peril, it is a natural cause of loss that results in a number of damage events in the United States. Lightning damage is covered by the basic fire peril and, as such, is included in standard property insurance policies.

Most lightning damage is relatively minor, consisting of damage to electrical components caused by a lightning surge traveling through a structure's electrical system. Occasionally, fire will result from a lightning strike. Lightning storms seldom produce a large number of serious damage claims in a single event. Like tornadoes and hailstorms, these events are sufficiently random that they seldom result in market disruptions.

### Tornadoes

Like hailstorms, insurance coverage for tornado damage is nearly universal. Coverage for tornado damage is part of the basic wind coverage in all residential and commercial property insurance policies. The pricing and marketing characteristics of tornado coverage are similar to those of hailstorms.

Tornadoes are possible throughout the United States, but historical data indicate that some states are more tornado-prone than others. Tornado alley stretches from west Texas to Kansas, Oklahoma, and the rest of the midwestern United States. Most of the 900 tornadoes recorded annually in the United States occur in this vicinity. Texas has the greatest number, with almost 100 touching down each year (Harris et al., 1992). Since the national weather service began tracking tornadoes in 1953, the three states with the most tornado sightings have been Texas, Oklahoma, and Florida, in descending order (Grazulis, 1993).

Tornadoes often cause severe damage or destruction to structures directly in their paths, and less serious damage to structures on their periphery. Typical tornadoes involve relatively small areas of damage, although there are notable exceptions such as the ones hitting Lubbock, Texas (1970), and Xenia, Ohio (1974), each of which caused damage in the hundreds of millions of dollars. Since tornadoes result from the same kinds of meteorological conditions that produce hailstorms, they are often accompanied by hail damage.

### Tsunamis

The public often calls tsunamis (or seismic sea waves) "tidal waves." This implied relationship to ocean tides is incorrect, as tsunamis are directly related to earthquakes; tides are the result of gravitational forces of the moon. One of the most disastrous tsunamis of the last century occurred on June 15, 1896, in the Sankriku region on the northeast coast of Japan. About 20 minutes after feeling a slow gentle motion of long duration (the indicators of a large distant shock), the sea receded to return as a wall of water tens of feet high, killing 27,122 people.

### Wildfires

Wildfires can best be defined as fires fed by natural vegetation that cause damage to structures and other property in their path. Included in that definition are forest fires, prairie fires, and brush fires (more frequently referred to as urban wildfires in recent years).

Wildfires are sufficiently random to permit the private insurance mechanism to include this coverage in most property insurance contracts. There are, however, instances where the probability of loss is so great that insurance coverage is not readily available through private carriers. Examples include remote areas that are susceptible to wildfires but have minimal firefighting services, and areas with particularly hazardous physical surroundings such as the brush areas of southern California. In some of these regions, state governments have mandated insurance pools to insure these properties. Any losses incurred by these pools in excess of premiums paid are assessed to private carriers marketing insurance in the state.

### Winter Storms

Severe winter storms produce structural damage and destruction. Typical damages are caused by high winds, weight of ice and snow, freezing damage to plumbing systems, and fires resulting from heating units operating beyond their designed capacity. In many instances, this damage results from storms in areas that do not normally experience severe winter weather. While seldom resulting in total damage to individual structures, these events can produce widespread moderate damage with large aggregate costs.

Damage caused by winter storms is included in most property insurance policies because losses from these events are sufficiently random to permit the private insurance mechanism to operate effectively.

## Volcanic Eruption

Damage directly caused by volcanic eruption is included in most property insurance policies. Not much property in the United States is exposed to this type of hazard.

ALTERNATIVE MECHANISMS FOR  
FINANCING CATASTROPHIC LOSSES

The worst catastrophe-related insured losses in the United States, by a wide margin, occurred during the period from 1989 to 1997, as shown in Table 2-2. The realization that potential damage is as much as five to six times greater than had been previously assumed greatly impacts the amount of capital considered at risk by an insurer. In the extreme case, an insurer that had intended to limit its catastrophe exposure to the amount of its retained capital (net worth) would now find that its exposure is several times greater than anticipated. This insurer would have no choice but to reduce that exposure.

The more likely circumstance is a multiline, multistate insurer that sets its disaster risk "appetite" at a relatively small fraction of retained capital. When that insurer learns that its real exposure significantly exceeds that amount, it must also adjust. Basically, that adjustment can be accomplished in three ways: the amount of exposure can be reduced, the amount of capital can be increased, or some type of protection can be provided to the insurer against catastrophic losses from specific disasters. This section focuses on the third method of providing financial relief, showing how private reinsurance and state residual market arrangements have offered insurers added protection against catastrophic losses.

## The Role of Reinsurance

Reinsurance does for the insurance company what primary insurance does for the policyholder or property owner: it provides a way to protect against unforeseen or extraordinary losses. For all but the largest insurance companies, reinsurance is almost a prerequisite for offering insurance against hazards where there is the potential for catastrophic damage. In a reinsurance contract, one insurance company (the reinsurer, or assuming insurer) charges a premium to indemnify another insurance company (the ceding insurer) against all or part of the loss it may sustain under its policy or policies of insurance.

TABLE 2-2 Annual Catastrophe Losses, 1949-1997

Year	Number of Catastrophes	Estimated Loss Payments
1949	4	\$ 22,300,000
1950	12	231,150,000
1951	5	17,450,000
1952	9	24,050,000
1953	16	88,650,000
1954	10	298,600,000
1955	12	94,900,000
1956	11	72,400,000
1957	11	73,350,000
1958	7	25,300,000
1959	7	48,200,000
1960	8	129,400,000
1961	15	183,500,000
1962	20	197,000,000
1963	9	33,700,000
1964	21	196,150,000
1965	13	694,100,000
1966	16	110,800,000
1967	37	327,222,000
1968	22	134,509,000
1969	20	256,408,000
1970	21	450,162,000
1971	35	173,458,000
1972	30	214,704,000
1973	41	376,076,000
1974	31	696,040,000
1975	32	513,492,000
1976	27	270,745,000
1977	44	422,653,000
1978	41	645,563,000
1979	54	1,702,554,000
1980	51	1,177,023,000
1981	33	713,831,000
1982	33	1,528,670,000
1983	33	2,254,765,000
1984	26	1,548,258,000
1985	34	2,816,035,000
1986	26	871,516,000
1987	24	946,000,000
1988	32	1,409,000,000
1989	34	7,642,000,000
1990	32	2,825,000,000
1991	36	4,723,000,000
1992	36	22,970,000,000

continued

TABLE 2-2 *Continued*

Year	Number of Catastrophes	Estimated Loss Payments
1993	36	\$ 5,620,000,000
1994	38	17,010,000,000
1995	34	8,325,000,000
1996	41	7,375,000,000
1997	25	2,600,000,000
Total 1949-1988	933	\$21,989,684,000
Total 1989-1997	312	\$79,090,000,000

Note: Figures not adjusted for inflation.

Source: Property Claims Service.

The most common type of reinsurance contract is a *treaty*, a broad agreement covering some portion of a particular class of business. (A less common form of reinsurance is a facultative contract, which covers a specific risk of a ceding insurer and is often written for a business where there is a significant potential for loss, such as airlines.) There are several types of treaties, each of which involves different sharing arrangements between the insurer and reinsurer. To illustrate these differences, consider the hypothetical case where a large fire causes \$10 million in damages to a policyholder of the Accord Insurance Company. Under the terms of a *quota share treaty* arranged with the Binder Reinsurance Company, the two companies would agree to share losses according to some fixed percentage. If the two companies share losses equally, Accord and Binder Reinsurance would each pay \$5 million in claims.

Under a *pro rata treaty* Accord would pay the entire claim and be reimbursed for a set percentage of the claims by Binder Re in exchange for an annual premium. If Binder Re had agreed to pay 30 percent of the loss, then Accord initially pays the entire \$10 million and receives \$3 million back from the reinsurer.

If the arrangement between the companies had been an *excess of loss treaty*, Accord would be responsible for all losses up to a specified amount, and Binder Re would reimburse Accord for a layer of losses up to some prespecified maximum dollar figure. For example, if the reinsurance contract specified \$5 million in excess of \$1 million, then Accord

would pay the \$10 million in losses, and Binder Re would reimburse Accord for \$5 million of this amount. If the insured loss was below \$1 million, then Accord would be responsible for all of it.

Reinsurance is a global business. Its international nature reflects a desire to spread risk and access domestic and foreign capital markets to help cover losses. About two-thirds of all property catastrophe reinsurance placed on risks occurring in the United States is held by foreign reinsurance companies.

The property catastrophe reinsurance market has reacted quickly to major catastrophe losses. The increase in those losses over the past few years has alerted reinsurers to the magnitude of accumulated exposures. Worldwide reinsurance capacity suffered at the end of 1992 into 1993, not only from retrenchment by U.S. reinsurers following hurricanes Andrew and Iniki, but also because of shrinkage in the London market—a vital player in the global reinsurance business. In 1993, reinsurers significantly renegotiated contract terms in light of the reevaluation of catastrophe exposures. Today, the outlook has brightened and the market has rebounded. The Lloyd's market is coming back with new cash commitments from corporate entities and better management of aggregate exposures. In addition, market opportunity for new capital resulted in the establishment of the "Bermuda Market" for property catastrophe reinsurance. Eight new property catastrophe reinsurance companies were formed between June 1993 and January 1, 1994, with combined capital of \$4.8 billion.

The recent trend of consolidation among reinsurers, which has developed over the past few years, bodes well for the property catastrophe reinsurance market. As of the end of 1997, catastrophe reinsurance capacity remained abundant. Extrapolating from the maximum lines offered by reinsurers from different worldwide markets, Guy Carpenter and Company has estimated that the amount of traditional capacity available for any single insurance program is realistically around \$500 million. An additional \$500 million can be obtained from nontraditional sources (Guy Carpenter and Company, 1997).

A major factor behind market consolidation has been a "flight to quality"—that is, a demand by ceding companies for greater reinsurance security, which has translated into higher capitalization for reinsurers in general. Further, property catastrophe reinsurers that maintain financial strength through sufficient capitalization and have a geographically diversified book of business will be well positioned to respond to market demands for catastrophe reinsurance.

### Residual Market Mechanisms

Residual markets mechanisms (RMMs) are designed to allow persons who are unable to obtain insurance through normal channels to purchase insurance coverage. RMMs are established in most instances by state legislation and are run by all insurance companies doing property insurance business in the state. RMMs have played an important role in enabling insurers to continue to offer coverage against losses from natural disasters, notably hurricanes. Despite the availability of some reinsurance, there is concern among the insurance companies that their current exposure to hurricanes is much too large and that they must reduce the number of policies in hazard-prone areas. Because of strict regulation of insurers by the various state insurance departments, it is not possible to cancel policies wholesale. Hence the need for RMMs.

### FAIR Plans

The Fair Access to Insurance Requirements, or FAIR, plans were born as a result of the civil disorders, riots, and conflagrations that erupted in the mid- and late 1960s. These disturbances resulted in a severe shortage of fire insurance in the urban areas affected. It became apparent that without the availability of insurance, the damaged and destroyed cities would not be rebuilt. In 1968 Congress passed the Urban Property Protection and Reinsurance Act, which enabled urban property owners to have fair access to insurance as a prerequisite for obtaining building rehabilitation loans vital to the preservation of the cities.

The states, which regulate insurers and insurance, enacted laws creating FAIR plans and mandating all licensed property-casualty insurers to participate. Insurers, in turn, were protected against catastrophic losses from riots through reinsurance made available by, and purchased from, the federal government (Lecomte and Demerjian, 1997). The federal reinsurance facility never was accessed, and ceased to exist when the 1968 act finally expired in 1983. It did, however, establish a precedent for the use of FAIR plans with respect to natural hazards perils.

### Beach and Wind Plans

Beach and wind plans were developed at about the same time as FAIR plans. The numerous hurricanes which ravaged the Atlantic and Gulf Coasts during the 25-year interval between 1941 and 1965 had

resulted in limited availability of windstorm insurance in these hazard-prone areas. This availability problem prompted legislatures in the affected states to enact laws requiring insurers providing homeowners' coverage to make insurance against loss by windstorm available to those who otherwise would not be able to purchase a policy. Thus, beach and windstorm plans, similar to FAIR plans, evolved in most states along the Atlantic coast (Lecomte and Demerjian, 1997).

### Evaluation of RMMs

In theory, RMMs are intended to serve only as a secondary source of coverage for insurable risks that cannot obtain coverage through the voluntary market. This implies that the plans charge adequate rates (i.e., do not run a deficit) and remain relatively small. However, depending on how they are structured and regulated, RMMs can significantly exacerbate market problems. These mechanisms have the potential of mushrooming and even swallowing the voluntary market if their rates are competitive, or if other factors significantly restrict the supply of voluntary coverage. High assessments to fund residual market deficits can also hasten an insurer's exit from the voluntary market and discourage entry. Cost containment incentives can be undermined if residual markets rates are inadequate, and/or servicing carriers are not induced to control claim costs.

RMMs cannot be used effectively to replace the voluntary market or substantially subsidize high-risk areas. At best, they can provide only a short-term safety valve for temporary decreases in the supply of insurance, and a long-term source of coverage for a small number of high-risk properties. The creation of these mechanisms, however, does not provide a solution for the solvency of the insurance companies because the sponsoring companies are responsible for the losses that arise from them. The net result is that the losses are merely redistributed among the companies depending upon how the assessment procedure is fashioned for the particular residual markets organization.

### SUMMARY AND CONCLUSIONS

The insurance industry today is concerned with the magnitude of losses from catastrophic events because most firms perceive that another major disaster could affect their financial stability. Many insurers in the

United States would like to reduce the amount of coverage they offer and charge premiums more in line with their risk experience.

These concerns raise a question as to what the future role of the private market will be in providing financial protection against losses from catastrophic events. Many insurers feel that the premiums they are forced to charge are too low, and the number of policies they are required to provide in hazard-prone areas places them in a precarious financial position should another catastrophic disaster occur in these areas.

Because future earthquakes and hurricanes pose a threat to the solvency of insurers, new approaches are required for dealing with catastrophic risks. It is, however, essential that both insurance and non-insurance participants recognize that by far the greater amount of insurance claim payments continues to be made for non-catastrophic losses. While totals vary considerably from year to year and from company to company, over the past 35 years only about 20 percent of insurance claim payments have gone to catastrophe-related losses. This figure includes the financial impact of both Hurricane Andrew and the Northridge earthquake. The remaining 80 percent of payments have been made for routine fire, theft, liability, and other losses which occur one at a time.

However, if a disaster does occur, it may cause such a financial drain on the insurers' surplus that it may restrict their ability to provide other types of coverage. To prevent this situation, it is necessary to explore arrangements for dealing with the risks of large losses from natural disasters. The next two chapters discuss how California and Florida have addressed these issues with respect to the earthquake and hurricane risks, respectively.

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## CHAPTER THREE

### Demand for Disaster Insurance: Residential Coverage

RISA PALMI<sup>1</sup>

**W**HY IS THERE LIMITED DEMAND for disaster insurance? If people understood that they can protect themselves from catastrophic losses with a small investment in insurance, would they purchase coverage? Several studies on how people make decisions when faced with unlikely, but possibly disastrous events provide considerable insight into why many residents in hazard-prone areas do not purchase insurance voluntarily to protect themselves against losses from future disasters (Camerer and Kunreuther, 1989). Despite the intuitive appeal of the axioms associated with normative models of choice, the plain fact is that few individuals behave according to expected utility theory—that is, most individuals do not select the strategy that maximizes expected utility. Instead, it appears that the weights on probability and outcomes in judging different alternatives are contingent on the problem context or the framing of different options (Tversky and Kahneman, 1981). What are the factors that affect the decision to purchase disaster insurance? And, more generally, how do human beings adjust to risks in their environments?

<sup>1</sup>Edward Pasterick provided contributions to this chapter.