“On Shaky Ground?”

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by Howard Kunreuther, Neil Doherty and Anne Kleffner

DATELINE: NORTHERN CALIFORNIA.
At 2:00 p.m., a massive earthquake measuring 8.3 on the Richter scale – roughly the same magnitude as the catastrophic 1906 San Francisco earthquake – rocked this northern California region. The quake, whose epicenter was located on the North San Andreas fault line, jolted office workers from their workstations and sent schoolchildren scurrying for safety.

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EARTHQUAKES AND THE INSURANCE INDUSTRY
In California, coverage for shake damage is usually subject to a 10 percent deductible so that only serious structural damage would impact insurers.

Given this scenario of a midday, midweek catastrophic earthquake, would insurance firms be able to meet their financial obligations to settle claims in full? Would there still be a sufficient number of financially healthy firms selling high-quality insurance products following such an event? What impact would the decrease in the insurers' surplus, as caused by the earthquake, have on their future operations?

Several responses from the insurance industry are possible. For example, insurers may not be able to replace surplus in the short-run, but they could choose to maintain their pre-earthquake volume of business. Since the surplus determines the capacity of the insurer to write business, the lower the surplus, the smaller the volume the insurer can sell while still offering financial security to policyholders. By maintaining the same premium volume without replacing surplus, the probability of future insolvencies increases. For a large reduction in surplus, insurers will probably be forbidden by regulators to maintain current levels of supply.

Another possibility is that insurers can't replace their surplus, but do reduce volume to a level that provides similar financial security to the pre-earthquake period. While the quality of insurance will be maintained, there will be a problem of insurance availability. It would also be conceivable that insurers are able to replace surplus and maintain volume, where neither quality nor availability will be long-standing problems. However, even in this case, raising new capital takes time, and consumers will be exposed to some mixture of quality and availability problems in the immediate post-earthquake phase.

In the normal course of their business, insurers do not have to sell off financial assets in order to pay their claims. Normal loss experience is fairly predictable and can be met from the natural maturing and turnover of longer term financial assets and by holding some assets in near cash form. However, catastrophic losses require that the insurer liquidate substantial quantities of financial instruments. Nonetheless, the release of large blocks of assets by insurers in order to pay earthquake claims is not expected to significantly depress prices.

Under the above set of conditions, the insurance industry can expect an estimated $40.3 billion in total losses (based on aggregates in 1987 dollar values). It should be noted that some recent estimates predict losses upwards of $43.9 billion (1991 dollars) for shaking damage and "fire following" losses alone. To the extent that there is inflation and/or an increase in property values, this figure will underestimate the total cost of a catastrophic earthquake. The considerable uncertainty associated with the magnitude of the earthquake, its epicenter and the time of occurrence suggest that the range of possible damage is very wide. Hence, the estimate should be viewed as an illustrative example to examine relative impacts.

To put the $40.3 billion estimate into some perspective, this figure may be set against the total surplus of the insurance industry, estimated to have been $165 billion in 1992. It must be further noted that this $165 billion figure overstates the actual surplus available to pay losses since some carriers do not operate in California and some surplus must be available to pay other losses. Furthermore, the actual surplus may be overstated due to an overestimation of capital assets or understated reserves given the long-tail nature of liability claims. In other words, at least one third of the industry's surplus is at risk in a catastrophe of the magnitude depicted above.

On the surface, however, it would appear as if the industry as a whole would have sufficient resources to cover such an unusual loss. However, this assumes that the earthquake does not coincide with other abnormal loss experience for the insurance industry, nor does the industry suffer other major catastrophes.
In the event of a major earthquake, business interruption losses are likely to be severe due to the long lead time in rebuilding.

such as windstorms, hurricanes or cleanup losses in the current time frame. Furthermore, losses will not be the same across firms, nor are they proportionate to the insurers’ ability to pay them.

As the results of a survey conducted by the authors to determine the effects of a catastrophic earthquake upon the insurance industry conclude, a catastrophic earthquake would significantly deplete the surplus of most insurers and cause some of the smaller insurers to become insolvent and default. Furthermore, catastrophe reinsurance will have only a limited impact in helping primary insurers to maintain their financial strength – most firms will still have a significant percentage of their surplus at risk from a catastrophic earthquake, and reinsurance would save few, if any, primary insurers from insolvency.

THE HIDDEN COSTS
Out of the estimated $40.3 billion insured loss figure, approximately $23.7 billion arose from sources other than shake damage. This can occur because even if the home or business is not protected by earthquake insurance, it is likely to be covered for consequential losses by other insurance such as fire, theft, additional living expense, ordinance or law, and business interruption losses.

Insurers offer coverage for the effects of shaking on structures, both residential and commercial, as a consequence of an earthquake under various types of policies and for various classes of clients. For residential coverage this is normally in the form of an endorse-

ment on homeowners coverage to include shake damage. In California, coverage is usually subject to a 10 percent deductible so that only serious structural damage would impact insurers. Today approximately 25 percent of the homes in California are covered for shake damage.

For commercial structures there is no typical pattern of insurance coverage. According to a 1989 All-Industry Research Advisory Council survey, an estimated 50 percent of large businesses are thought to have some shake coverage, but protection for smaller businesses is unusual. There is also no standard deductible on commercial policies; it varies from 2 percent to 10 percent, depending on the class of building, and it is expected that many commercial losses would exceed their deductibles. Additionally, many commercial earthquake insurance policies are for limited amounts on a “first loss” basis excess of the deductible.

But apart from shake damage, insurers are exposed to other possible liabilities that may be covered by standard insurance policies even if the policyholder has not considered the earthquake risk. The most obvious of these is damage caused by fire following an earthquake, as was dramatically illustrated by the 1906 earthquake. Losses from fire following an earthquake are routinely covered under standard property and business interruption insurance coverage. Furthermore, life and health insurance policies will be invoked to pay for deaths, injuries and medical expenses incurred. An earthquake during working hours can cause injuries to employees, thereby giving rise to workers’ compensation claims.

Various types of liability policies cover the inevitable flurry of lawsuits that follow such incidence. Thus, even though the damage might be thought of as an “Act of God,” architects, engineers, contractors, etc., are inevitable targets, as plaintiffs assert that damage resulted from a design defect or poor construction (Association of Bay Area Governments, 1984). Other normal claims that the insurance industry is likely to incur include marine insurance losses (from tsunamis) and automobile losses.

As buildings and plants are damaged or destroyed, their owners are denied productive use of these assets and consequent loss of earnings. In the event of a major earthquake, these losses are likely to be severe due to the long lead time in rebuilding, since the
construction and related industries will be stretched beyond their normal capacity to do repairs and rebuild. In addition, from the experience of Hurricane Andrew, the likelihood of significant cost increases of materials and labor (perhaps 30 percent to 40 percent) over and above more normal conditions must also be recognized.

These indirect costs to the insurance industry can be extensive. For example, practically all homes and businesses are protected against fire losses, so policyholders will be able to make claims for any damage caused by fire following any earthquake. Health and life insurance policies provide coverage for the costs of injuries and fatalities from a quake. Workers' compensation insurance will cover these earthquake-induced losses to businesses. Similarly, business interruption policies will cover losses that are earthquake-induced if the proximate cause of the loss is an insured peril (e.g., fire following an earthquake). Thus, even if insurers do not sell any earthquake policies, they have a massive exposure from a catastrophic shake. These indirect losses or hidden exposures, are rarely recognized outside the insurance industry.

After examining the effect of a catastrophic earthquake on a sample of 18 insurance firms—seven large (surplus greater than $2 billion), five medium (surplus between $1 billion and $2 billion), and six small (surplus less than $1 billion)—the authors conclude that such a catastrophe would create a wide-ranging financial impact across the industry.

Excluding for the moment any consideration of reinsurance policies bought from, or sold to, other firms, the projected earthquake would have a relatively minor impact on the loss-to-surplus ratios of three of the largest insurers. On the other hand, five out of the 11 small and medium-size firms would suffer losses that exceeded their surplus—indeed, these firms would become insolvent. All of the firms would have losses that were 10 percent or more of their surplus. Although the sample is small, the fact that these insurers write over 40 percent of the U.S. property/casualty business makes it reasonable to draw conclusions regarding the condition of the industry after a catastrophic earthquake.
ROLE OF REINSURANCE

Primary insurers who sell directly to individuals and firms frequently insure part of their liability against catastrophic risk with reinsurers. Thus, primary insurers can recover from their reinsurers should claims be excessive, thereby mitigating the depletion in surplus. (It should be noted, however, that a number of large primary insurers accept back, often unknowingly, reinsurance that the primary insurer had originally ceded.) Furthermore, the availability of reinsurance permits primary insurers to offer both more insurance coverage and coverage on bigger risks.

Unfortunately, this practice is not as clean as the principle. Paradoxically, a major catastrophe will impact reinsurers more severely than primary firms since the premiums private reinsurers collect for covering highly unlikely losses will be small relative to the magnitude of the claims for which they are responsible from a major disaster. Consequently, in the face of a catastrophic earthquake, primary insurers will have considerably more premium income to meet this liability than the reinsurers who thus face a greater likelihood of insolvency.

Many fault lines remain unidentified, making earthquake risk in some areas of the country unknown

Since default by reinsurers does not absolve primary insurers from discharging their contracts, primary firms will be left holding the bag. Moreover, there is likely to be very little reinsurance available following such a catastrophic event, thus restricting availability.
A large portion of the United States is at risk for earthquakes. An important policy issue is how much of and to what extent the country is exposed to this hazard. If it were just California, for example, many would question federal involvement in terms of a federal earthquake insurance program since it is a state problem. It is becoming ever more clear, however, that the earthquake hazard threatens many states besides California. In fact, in 1977, the U.S. Congress declared that “all 50 states are vulnerable to the hazards of earthquakes and at least 39 of them are subject to major or moderate seismic risk.” But even though the whole country is at risk, the risk differs substantially across it.

One way to describe the earthquake hazard in different areas is by using a contour map as shown above. The map delineates seismic zones, with zone 4 having the highest seismicity. The map shows that areas of California and Alaska are in zone 4 and parts of Missouri, Washington, Montana and Utah are in zone 3.

Four regions outside of California and Alaska are most likely to be shaken by a destructive earthquake at some time in the future. These are: the Central states, where four quakes of up to 6.6 in magnitude on the Richter scale ruptured the New Madrid, Missouri, seismic zone in 1811-1812; the East Coast, where a quake measuring 7.0 on the Richter scale occurred near Charleston, South Carolina, in 1886; the Pacific Northwest, where in the last 135 years there have been more than 1,000 earthquakes felt and a number of shocks have been of moderate to large magnitude; and the Nevada-Utah-Montana seismic zone, where a quake in Hebgen Lake, Montana, in 1959 killed an estimated two dozen people from landslides.

The presence of active fault lines is another way to differentiate the earthquake hazard in different states. But although scientists are able to identify many faults, there still remain others that are unidentified, making the earthquake risk in some areas of the country unknown.

Another important factor in describing the earthquake hazard in different regions of the country is preparedness. The Central and Eastern states do not have earthquake resistant construction practices like in California, so a similar quake in these areas could be a much worse disaster. Eastern quakes are also potentially more damaging because of the high population density in this part of the country. Finally, Eastern earthquakes can damage a much wider area because of the nature of the earth itself. In California, for example, the terrain is generally rocky and the ripple effect of the seismic activity is captured by the rock, thereby limiting it. By contrast, the East has generally sandy soil that permits earthquake shocks to travel much farther, thereby potentially devastating an area 100 times greater in the East than in the West.
To determine the role reinsurance plays, a survey was conducted on the amount of reinsurance coverage 18 primary insurers—14 responded—had against catastrophic earthquake-related losses. Even assuming all reinsurance to be collectible, most small and medium-size firms, and two large firms, would still have a significant percentage of their surplus at risk from a catastrophic earthquake. Moreover, these insurers predicted to become insolvent without reinsurance would still become insolvent even with reinsurance.

The ratios of the amount of catastrophic reinsurance to total loss for the 14 primary insurers indicate that their total loss was much greater than the amount of catastrophic reinsurance protection held. This suggests that the private reinsurance market does not by itself remedy the effects of a catastrophic loss on primary insurers. Furthermore, the reinsurers are highly vulnerable to large losses. Given that many self-insured reinsure their exposures (a factor rarely taken into consideration) and that virtually all primary insurers in the sample will require full payment from their reinsurers, it is inevitable that the reinsurance sector will experience difficulties in meeting payments and offering coverage after the catastrophe.

To be sure, the insolventcies identified here will not leave policyholders out in the cold. They may receive partial payment from the insolvent company and are likely to obtain the remaining portion from the California insurance guarantee fund. Thus, theoretically, all defaults could be covered.

However, the extent of such protection is limited. First, given the magnitude of the event, the levies required to fully compensate for all defaults would be substantial and could even lead to further insolventcies among insurers surviving the initial financial impact of the earthquake. Second, the guarantees provide only limited protection. Large residential claims would be only partly compensated, and large commercial claims would receive only limited compensation from such programs.

CONFIDENCE ABOUT MITIGATION
Mitigation is recognized as an important policy tool for reducing earthquake losses. For example, the liberal government disaster assistance programs and the possible bankruptcy of businesses and homeowners impose costs on the general taxpayer that can be reduced by adoption of certain building codes. Also, a building’s collapse as a result of an earthquake can produce economic dislocations and other social costs above the replacement value of the buildings. These too could be lowered by adopting stringent building codes, particularly in areas such as Memphis, Tennessee, that have not suffered any recent earthquakes yet are located in a particularly vulnerable area.

Since catastrophic earthquakes occur so infrequently it is difficult to determine how effective certain loss mitigation measures will be. Judging from the Loma Prieta earthquake that hit northern California in October 1989, however, the various structural designs performed about as well as engineers expected. According to a 1989 EQE Engineering Inc. report, “Except for buildings near the epicenter, most cases of severe damage occurred in older buildings with little seismic capacity and in areas of extremely weak soils.”

The potential damage from an earthquake cannot be reduced by warning immediately before the event because no one is able to predict when an earthquake will occur. By contrast, advanced warnings of hurricanes or floods allow areas about to be hit to be evacuated or measures taken to reduce property damage. The inability to give advanced warning to a quake-prone area, thus increasing the potential for death and injury, makes mitigation before the event even more important.

As mentioned above, one problem regarding earthquake mitigation is that areas of the country besides California that have a seismic risk are not prepared for it in terms of building codes. As for hurricanes, the damage is predictable, but most building codes do not require architects and engineers to design hurricane-resistant buildings. Contrast these two cases with the flood risk. In order for a community to be eligible for flood insurance it must agree to adopt and enforce floodplain management regulations, such as restricting land use and imposing building codes.

POLICY OPTIONS
The advantages of maintaining the supply of earthquake insurance through the private insurance sector for smaller disasters are that it provides a distribution system for compensation in the event of a major catastrophe; the industry is largely competitive; and it provides a mechanism for providing appropriate incentives for mitigation (risk-based premiums) — arguably, this mechanism has so far been underutilized.

There are, however, several problems associated with providing earthquake coverage entirely through the private sector. First, the industry has a massive hidden exposure from earthquakes from non-dedicated policies that cover non-shake damage. These exposures are difficult, if not impossible, to rate for the earthquake risk, since this peril does not meet the accepted standards of insurability.
The unique characteristics of earthquakes make them difficult to insure as compared to other natural hazards—flooding, tornadoes, hurricanes, and severe wind.

**Probability:** Catastrophic earthquakes occur infrequently, and the low probability of such an event causes significant problems from an insurance rate-making standpoint. The infrequency of major earthquakes and the lack of information mean that the statistical analysis and actuarial techniques typically utilized by insurers do not work very well.

Tax policy further prohibits insurers from reserving for catastrophic losses. Since reserves for contingencies can be accumulated only out of after-tax income, earthquake insurance premiums set aside for future losses would be taxed first as profits. Even if insurers wanted to accumulate after-tax funds, competition would discourage them from doing so because any insurers that chose to raise prices to reflect the earthquake risk would be at a disadvantage.

**Catastrophic Potential/Severity:** The major factor contributing to the potential severity of losses from an earthquake is that regions outside California are not prepared from a structural point of view. Most buildings in the East and Midwest are not constructed to withstand a large quake and this implies very large losses should a major quake occur.

**Insurance Coverage:** Only 25 percent of homeowners in California purchase it. This is up from a few years ago when only about 7 percent purchased coverage, an increase due mostly to a 1985 state law requiring insurance companies to indicate to homeowners that this coverage is available. Countrywide, the percentage is only about 5 percent.

A second problem associated with providing earthquake coverage is that the regulatory environment in some states and for some lines of business is one in which investors perceive that current premium rates deny insurers a fair rate of return. Should a catastrophic earthquake occur, there would be limited interest in new capital investment to replenish surplus, creating serious availability problems for other lines of coverage. A third problem is that private reinsurers will not be able to provide sufficient reinsurance relief to cover the losses to most insurers should a catastrophic earthquake occur.

The authors support the creation of a federal reinsurance program that would act as a reinsurer of last resort, collecting premiums from private insurers while protecting against severe losses. Under such a plan, the federal government could avoid paying for large amounts of disaster assistance that would otherwise be expected. It also would have the authority to require earthquake insurance on all federally insured mortgages. The federal government could additionally withhold disaster assistance and funds to high-risk earthquake communities unless they introduced specific building codes and regulations. In 1973, the National Flood Insurance Program set a precedent for this type of federal involvement specifying these types of “incentive” measures.

In the absence of a major catastrophe, a federal reinsurance agency would accumulate a base of reserves over the first few years to cover future losses. Should a catastrophe occur before the buildup of reserves, the agency would have government authorization to cover the losses. A similar proposal that is self-financing has been advanced by the Natural Disaster Coalition in Washington, D.C., an alliance of private insurance companies. Both proposals require that appropriate incentives be given to property owners to adopt cost-effective mitigation measures and for primary insurers to engage in prudent underwriting.

An alternative route is to rely on disaster assistance to either supplement current insurance claims in the case of a catastrophic earthquake or to replace earthquake insurance entirely. There are tremendous practical problems should private insurers exit from the earthquake market, for this would entail canceling existing policies and inserting clauses in all other policies denying coverage for all losses caused by an earthquake. State insurance regulators (particularly in earthquake-prone areas such as California) will be unlikely to permit such actions. Moreover, such action would undoubtedly trigger liberal federal relief following both major and minor earthquakes. Not only would disaster relief discourage mitigation, but it would also raise questions of equity regarding who should pay for disaster losses—the victim or the general taxpayer.