

INTRODUCTION

Sensing the potentials inherent in the mortgage finance and insurance industries for establishing a sound earthquake insurance program within the private sector, but recognizing the possible impediment that antitrust laws impose, the Federal Emergency Management Agency (FEMA) commissioned an exploratory study of the problem in 1980 (Brown and Weston, 1980). The main purpose of the study was to identify and illustrate, within involvements and activities identified as possessing earthquake damage mitigation potential, those which might provoke or be vulnerable to antitrust or restraint of trade challenges. Where such vulnerabilities were identified, they were analyzed to determine whether, how, and with what consequences they might be avoided. The study also noted that few property owners appeared willing to buy earthquake insurance, and it examined the reluctance of both the insurance and the mortgage finance industries to promote such a market.

After 1980, a number of events, developments, and changes occurred which suggested that the 1980 assessment needed to be updated. For example:

- During the last few years, major changes have occurred in the mortgage finance industry, as well as in the general economy. The changes in the general economy have also imposed some significant disruptions within the insurance industry.
- Much has been learned about designing new buildings and renovating existing buildings to better withstand seismic stresses.
- Significant decisions have been handed down by the courts in the field of antitrust law. Some federal and state anti-

trust policies have been subjected to a broad re-examination, and specific legislative attention is being given to the scope of exemption from federal antitrust laws which the insurance industry has enjoyed.

- A particularized override has been judicially upheld with respect to the so-called "grandfathered" status traditionally accorded to existing construction completed under earlier building and safety codes, where a clear, present, and remediable threat to public safety is recognized.
- There has been an expansion of potential liability of municipal governments, with respect to negligence in the exercise of police power responsibilities, though that subject is outside the scope of this study.
- Recent California court decisions have interpreted the doctrine of concurrent causation in such a manner as to extend the scope of coverage of existing property damage insurance policies to include indemnification against loss occasioned by earthquake or earth movement, even where a particular hazard insurance policy expressly excluded such coverage.
- Legislative response to the decisions mentioned above resulted in a compromise dictating that any company writing property damage in California tender to its policy holders a one-time offer to provide, for a stated premium, an earthquake coverage endorsement. This mandate produced a doubling (to about 15%) of the number of one-to-four-family residential properties presently covered by earthquake insurance.
- Also in California, studies designed to find ways to improve land-use regulatory processes for the purpose of mitigating earthquake damage stimulated passage of the Alquist-Priolo Act which requires sellers of housing located in close proximity to known active surface fault lines to make adequate disclosure of that fact.
- A fundamental question has been raised with respect to the capacity of the insurance industry to meet its contractual obligations if a major earthquake should impact a large urban area such as Los Angeles or San Francisco; that issue is at present undergoing active study and evaluation.
- Predictability of major earthquakes has not yet achieved the degree of reliability hoped for a decade ago. Nonetheless, a consensus exists among seismologists and other professionals working in the field that before the year 2000 California probably will experience an earthquake similar in magnitude to the 1906 San Francisco quake.

- Much knowledge has been acquired regarding the vulnerability of sectors of the nation outside of the far west to major earthquakes of an intensity similar to those experienced by New Madrid, Missouri, in 1811 and 1812. Some 37 states now have been identified as sharing the risks of major earthquake damage.

The significance of these developments is considered in this paper.'

GENERAL ATTITUDE TOWARD EARTHQUAKE INSURANCE

In this section we summarize, from the 1980 study, some then apparent intraindustry differences in attitude regarding the underwriting of earthquake insurance; highlight uncertainties which contributed to those differences; recognize some post-1980 developments that have affected those attitudes; and remark on efforts being pursued to reduce the differences and to attain an industry consensus on how best to handle the earthquake peril. We also recognize recent federal and state legislative efforts to narrow the area of industry exemption from application of federal and state antitrust laws. We take note of some practices within the industry that may prove vulnerable to antitrust challenge. We attempt to illustrate why the industry believes that, as matters now stand, it could find itself in a precarious economic state if it were obliged to comprehensively underwrite earthquake damage. And we conclude with a description of some conceptual approaches being analyzed by industry leaders seeking to develop an economically sound program under which all needs for earthquake insurance could be satisfied.

In 1980, California residential and small business property owners represented a very quiescent market for earthquake insurance, with only 7% of property insurance policies carrying an earthquake endorsement. In other states the percentage was even lower. Property/casualty insurers had not actively promoted the sale of this coverage, but they generally made it available to requesting clients at premiums the industry considered reasonable. The industry was well aware, however, that the federal government, in several pieces of proposed legislation and in the National Earthquake Hazards Reduction Act, had shown a continuing interest in expanding private earthquake insurance coverage (see Brown and Schiller, 1979; Cheney, 1987).

The lack of enthusiasm among property/casualty insurers stemmed from a general recognition that it was not sound business to underwrite earthquake protection extensively. This judgment was based on several factors, the foremost being the inability to predict earthquake incidence or to estimate dependably the probable maximum loss (PML) that the industry would sustain. The PML uncertainty resulted from lack of sufficient data within the industry regarding earthquake incidence, coverage, and related matters. (To produce information making it possible to ascertain how much earthquake insurance is in place in California, with respect to buildings of up to eight stories [taller buildings being less susceptible to the type of ground motion that has caused most damage in major earthquakes], the commissioner of insurance issued a "data call" in 1979. Yearly submissions have

been received, summarized, and published subsequently. See Department of Insurance, 1980-1986, for the information for a given year). Another reason for the industry's avoidance of substantial earthquake exposure was its fear of strong "adverse selection"--the tendency of poorer risks to seek or continue insurance to a greater extent than do better ones (Anderson et al., 1981; see also, Winter, 1988). Furthermore, the existing projections for an R8.25 earthquake impacting San Francisco or Los Angeles produced PML damage figures in the multibillion dollar range, causing considerable apprehension concerning the re-insurance market's ability to absorb such losses.

Several studies conducted in the modern period of heightened earthquake awareness (here defined as originating with the 1964 Alaskan earthquake) have probed for reasons why, even in California, such a small percentage of homeowners has purchased earthquake insurance (Kunreuther et al., 1978; see also, Cheney 1987, p. 32). They found that even in California there was a widespread public perception that unless one's property was on or in close proximity to a known surface fault, it was not at significant risk from an earthquake (this perception may be supported by California's Alquist-Priolo Special Studies Zone Act of 1972 which requires disclosure to prospective buyers of close proximity to a known active fault). There also was a commonly held belief that premium costs were relatively high (the rate has typically ranged between \$1.50 and \$2.00 per \$1000 of insured value) particularly when subjected to a deductible clause,

usually pegged in California at 5% of insured value prior to the passage of Assembly Bill 2865 , and at 10% thereafter. (Assembly Bill 2865, described in greater detail below, was a significant earthquake mitigation measure in California. It prescribed that "no policy of residential insurance may be issued or delivered or, with respect to policies in effect on the effective date of this chapter, initially renewed in this state by any insurer unless the named insured is offered coverage for loss or damage caused by the peril of earthquake as provided in this chapter.") Other identified reasons for the low level of consumer interest included a widespread public attitude of complacency or fatalism. Particularly in the eastern and central U.S. there was very little public awareness of the region's significant earthquake history. Not surprisingly, the perception held by many members of the public has been that the probability of a damaging earthquake is remote. Consequently, earthquake insurance is most often seen as a not very attractive investment, instead of as an indemnity type of protection.

During the last eight years, there has been considerable broadening of public awareness of and constructive concern over the peril of earthquakes, especially in California where the relative imminence of a major event is being accorded serious official recognition, and (thanks in large part to the efforts of the Central United States Earthquake Consortium [CUSEC]) in the seven states surrounding the New Madrid, Missouri, fault zone. In general, however, there has not been any notable public demand

for earthquake insurance. Only in the near aftermath of an earthquake of attention getting intensity, such as the Long Beach (1933), the Kern County (1952), the Alaska (1964) and the San Fernando (1971) earthquakes and, more recently, the Coalinga (1983), the Morgan Hill (1984), and the Mexico City (1985) events, has a surge of interest occurred. Historically, a substantial amount of the protection procured in such cases lapsed at an early premium renewal date.

Particularly in California, one might expect loan-originating finance institutions to require mortgagors to purchase earthquake insurance for any earthquake-vulnerable property encumbered by a security interest favoring the mortgagee. However, almost no such pressure was evident in 1980, nor is it today in California, much less in any of the other high-earthquake-risk sectors of the United States (see Palm, 1985a, 1985b). The secondary mortgage market, in 1980, seemed to be equally complacent. The Federal Home Loan Mortgage Corporation (FHLMC) commissioned a study examining its exposure incidental to a major earthquake (Kaplan, Smith and Associates, 1981), but that study did not disclose any intolerable risk for the sponsor, and nothing was done, at least publicly, that showed concern over possible financial disruption to the secondary market as the consequence of a major earthquake. At most, there was a general clause in the standard mortgage documents promulgated by Federal National Mortgage Association (FNMA) and the FHLMC which specified the minimum property insurance coverage a security interest must carry to be

routinely acceptable to the secondary market. That clause did not even mention earthquakes, though a window was left open for individual lenders to add the requirement of an earthquake endorsement or other additional coverage where such additions would reflect common practice within their area of operations.

Paradoxically, the FHLMC requires earthquake insurance coverage for loans originated in Puerto Rico and the Virgin Islands. As far as we could learn, the rates charged in those territories apparently are not prohibitive. Puerto Rico has traditionally been a capital-short jurisdiction with respect to mortgage money and thus has been sensitive to matters that would dissuade investors. Although California has always been in a similar capital-deficit position, eastern lenders apparently have not found the general absence of earthquake insurance dissuasive to mortgage investments there. Perhaps the difference is attributable to bargaining leverage inherent in the vast California market and to the fact that, thanks to branch banking, loan originations in California are largely under the control of a few very large financial institutions.

Differences Within the Industry

In 1980, to a greater extent than today, there were differences of opinion among insurance industry leaders regarding the industry capacity to reinsure earthquake coverage written on a comprehensive scale. Among those feeling that the reinsurance capacity was insufficient, there were further differences of opinion regarding the wisdom of designing a program to cure such

a deficiency through the active participation of the federal government. Alerted in the early 1970s by attempted federal legislation which, had the bills not been defeated in committee, could have mandated widespread private coverage for earthquake damage, many industry leaders were openly antagonistic during that decade and on into the 1980s to any insurance industry/federal government relationship similar to the early National Flood Insurance Program.

Reasons for the Differences

There were a number of reasons for industry leaders differing on the capacity of the industry to deal with a catastrophic earthquake and on the strategy of forming a government alliance of some sort to cope with such an event. One reason was that industry potential for handling an earthquake PML was somewhat dependent upon the marketing strategy that the industry might adopt. If it continued to maintain its low-profile marketing posture, so that it did not subject itself to a level of financial risk for earthquake losses that was disproportionate to its other obligations, the industry capacity was presumed to be adequate. Alternatively, if it should become established federal policy to assume the bulk of the burden of postearthquake private sector rehabilitation and restoration, the industry capacity should be adequate. But these two complementary strategies represented an edging away from the risk-taking function of the insurance business, forfeited a share of the market that might be lucrative, and suggested, whether or not correctly, that the

insurance industry could not handle this peril (and perhaps others).

That the risk was not yet quantified did not mean that it was not quantifiable. There were some who speculated that it might be possible, through various methods of selecting markets, distributing the highest exposures on some sort of a tolerable "FAIR SHARE"² program, combining the earthquake peril with other risks, and managing the deductible clause effectively, to handle all the earthquake business that the market could generate without exhausting or jeopardizing industry capacity. Others speculated that the industry could manage earthquake coverage by developing a program involving the federal government in a limited way to handle any portion of the financial burden imposed by a truly devastating earthquake that was demonstrably beyond industry capacity.

Among the considerations in assessing industry exposure was an impressive and growing body of engineering knowledge concerning earthquake damage mitigation. Remaining to be answered were legal questions regarding such matters as whether earthquake-resistant renovations could be required for existing buildings constructed in full compliance with subsequently outmoded building codes (for a discussion of this issue, see Miller, 1985).

The differences of opinion within the industry over how to deal with the earthquake insurance problem were, and are, rooted in the fact that insufficient statistical data exist to structure a dependable risk management program, and industry committees

continue to struggle with the questions of whether and how earthquake risks can be handled effectively.

Writing Earthquake Insurance: Actuarially Unsound?

In risk management, once the extent of a loss can be reasonably determined, it is possible to pursue various quantitative means for tolerably distributing that anticipated loss. An earthquake is recognized as a "fundamental" or "group" risk. Such risks are

caused by conditions more or less beyond the control of the individuals who suffer the losses, and since they are not the fault of anyone in particular, it is held that society, rather than the individual, has a responsibility to deal with them. Although some fundamental risks are dealt with through private insurance, it is an inappropriate tool for dealing with most fundamental risks, and some form of social insurance or other transfer program may be necessary. (Vaughan and Elliott, 1978, p. 10).

The peril of earthquake has long been considered uninsurable because, of the various methods of handling risk (avoidance, transfer, sharing, reduction, and retention), the processes of transfer and sharing of losses, upon which the business of insurance is based, require a capacity to predict probabilities within the law of large numbers. Again, the problem is that history has not yet provided a "sufficiently large sample" nor has it been possible to dependably identify a "sufficiently large number of exposure units" to permit effective application of probability theory (Vaughan and Elliott, 1978). Thus it has been widely accepted within the industry that in the absence of further data, earthquakes were not insurable within traditional insurance concepts.

Reinsurance capacity limits. In 1980, interviews with some industry leaders and published reports indicated there were some who were convinced that the worldwide reinsurance market was incapable of covering a PML of the magnitude that was then being projected for the San Francisco Bay area or the Los Angeles basin. There seemed to be no dependable projections regarding the PML for a repeat of the great earthquakes that occurred near New Madrid, Missouri; Charleston, South Carolina; and Boston, Massachusetts; but it was speculated that even greater losses might be inflicted by a major earthquake in certain high-risk east coast or midwest sectors than were being projected for California.

In 1980, the California PML projections were based on studies such as those done by Algermissen and others in 1972 (U.S. Department of Commerce, 1972; see also, Steinbrugge, 1978a, p. 203) and 1973 (U.S. Department of Commerce, 1973; see also, Rinehart et al., 1976 [summarized in Steinbrugge, 1978b]). It was expected that the results of the data call in 1978 by the California insurance commissioner (discussed above) would produce more dependable figures, the first set of which would be available during 1980, (but not before the 1980 Brown-Weston study was completed). The Algermissen studies, and those by Rinehart et al., Steinbrugge, and others had produced impressive, detailed estimates which were considered to represent the "state of the art" with respect to projecting the extent of property damage that would be incurred in Los Angeles or in San Francisco as a

consequence of an R8.25 earthquake (approximately the intensity of the San Francisco earthquake of 1906). The 1976 Rinehart study estimated single-family residential property losses at \$2.2 billion for an R8.25 quake along the San Andreas fault in the San Francisco Bay area. Steinbrugge's working group estimated that at 1978 prices, this figure would amount to \$4.1 billion. Similarly, Rinehart estimated single-family residential damage losses of \$4.0 billion for an R8.25 earthquake on the Newport-Inglewood fault in the Los Angeles basin, and Steinbrugge's 1978 update increased the figure to \$7.5 billion (Steinbrugge, 1978b, pp. 50-51). It is important to note that these studies were intentionally limited to "shake" damage and excluded secondary or tertiary consequences.

At the other end of the scale, a 1975 Report of the Special Earthquake Study Committee of the National Committee on Property Insurance (NCPI) recognized the "staggering proportions of the capacity problem that could be created by mandated coverage of one-to-four-family dwelling units in areas of high seismicity, and referenced estimates for California alone as showing an exposure of approximately 200 billion dollars" (Special Earthquake Study Committee, 1975). (Since it was first published, the \$200 billion figure has not been seriously advanced. More recent industry projections, taking into consideration all losses proximately related to the shaking event, such as worker's compensation, business interruption, fire, directors' and officers' and other professional liability lines, etc., range in the neighbor-

hood of \$60 billion. Estimates of the death toll range from 3,000 to 23,000, depending on the time of day, day of the week, and other critical factors.) If there was a justifiable concern over reinsurance capacity under existing market coverage, when that coverage was considered in the context of the inherent obligation to remain solvent with respect to all the other risk exposures underwritten by the industry, then there was little question at the time that mandated coverage for earthquake would clearly exceed industry capacity. Recently, a concerted effort has been initiated to ascertain with reasonable precision what the peripheral, or nonshaking, damages might be. One result has been the publication of a highly regarded study by Dames and Moore, regarding earthquake-caused fire losses (Scawthorn, 1987).

Reserves authorized under tax code. The anticipation of a PML of a magnitude in the neighborhood of \$60 billion intensified industry concerns over the limits imposed by IRS rules on the accumulation of reserves. Under the existing tax code and under the accounting principles traditional within the industry, the reserves needed to establish a fund sufficiently large to permit industry underwriting of major earthquake losses would be treated as taxable profits. Furthermore, the unique nature of insurance accounting practices poses for some observers the question of whether a functional reserve account could be established even if the IRS rules did not impose such an impediment (see, for example, Anderson et al., 1981).

Flood insurance experience. A precedent-setting "non-insurable" or "fundamental" risk is the peril posed by flood, primarily because "adverse selection" is so clearly applicable in flood situations. Experience, augmented by statistical data broadly disseminated, will assure that most people who have real property in a floodplain will be interested in affordable flood insurance, while those who do not reside or own property in a floodplain will be uninterested in purchasing flood insurance. The National Flood Insurance Act of 1968, provided for federal administration of the Flood Insurance Program. The act separated the flood insurance rate-making process into two distinct categories: chargeable premium (subsidized) rates and estimated risk premium (actuarial) rates. The insurance industry, permitted by the act to originate coverages and to service policies and claims, and to receive appropriate premiums for doing so, had become increasingly disenchanted over its relationships with the Flood Insurance Administration, primarily because the administration insisted on the need to participate in decisions regarding rate making and other business matters of the insurance industry. This experience caused many industry leaders to resist any efforts to structure a similar program for earthquake coverage. Others believed, however, that given the need for catastrophic reinsurance, the federal government was the only place to turn if the industry was going to be persuaded and/or directed to write substantial amounts of flood insurance.

Recently, the Federal Insurance Administration (FIA) instituted its "Write Your Own" program, a process in which private insurers sell and service flood insurance under their own names with the federal government as a guarantor against losses. The program has been well received by the industry and has assuaged many of the objections held earlier by the insurers.

Practices of investment versus premium charges. During the period when the first figures in response to the California insurance commissioner's data call were being accumulated, the property/casualty industry was in the midst of the "soft market" phase of what had been identified as a cyclical financial pattern (Cheney, 1987, pp. 25-27, 31). Because of the high interest rates then in force, the industry recognized an opportunity to earn attractive profits by investing funds to the greatest extent possible. This opportunity prompted some firms to lower premiums in order to generate additional investment capital, in turn causing other companies to reduce premiums to be competitive. More recently, that pattern changed dramatically when interest rates declined rather precipitously in the early 1980s, with the efforts to adjust to an abruptly different marketplace producing some uncommon responses, discussed below, which might have anti-trust implications (see Strumwasser, 1986).

Risk Assessments, Premium Categories, Ratings Standards

The present system used in California establishes earthquake insurance rates primarily on a county-by-county basis, the entire state being divided into eight multicounty letter-designated segments, with segments A (San Francisco area) and B (Los Angeles area) being subdivided into three subcategories each. In addition, residential buildings are classified into seven basic categories, some having from two to five subcategories, representing different types of construction. Single-family wood-frame structures are assigned a low risk factor; unreinforced solid masonry structures with brick and sand-lime mortar have one of the highest. Within a given county zone, all buildings of a particular type or class are assigned the same rate, even though local building codes may have dictated differing qualities of construction from one municipal jurisdiction to another. The rating is of the hazard; insurance industry rating practice would not differentiate between a building that had been "rehabilitated" and one that had not. In theory, perhaps, an individual property should be entitled to a premium reduction to reflect an improvement to reduce earthquake damage, but for rate incentives to encourage code modifications or construction practices leading to damage mitigation, the rating process in California would have to be substantially modified. Furthermore, the industry would have to speak and act in concert to avoid geographical fragmentation, and the process might be very unwieldy and expensive to operate. Even if the process was uniformly applied, the prospect

of doing business competitively would seem to be jeopardized, and antitrust considerations might be raised, even if the state was one where prior approval of rates was necessary.

The California Data Call Program

The role of the department of insurance varies from state to state. Under California's "[n]o-file or open competition laws," which have been in effect since 1947, "companies are not required to file their rates for approval of the commissioner of insurance. Insurance companies and rating bureaus may adopt rates and make them effective immediately without this prior approval. . . . The California law makes it clear that competition, not government authority, is the preferred governor of rates, and that barring the existence of an anti-competitive situation or practice, the insurance commissioner is not to regulate rates as such" (Vaughan and Elliott, 1978, p. 140). The responsibility of the commissioner is to assure, within reason, the continued financial ability of each insurer or reinsurer to handle covered losses (Department of Insurance, 1984, p.7).

Reasons. As mentioned previously, in order to make "it possible to estimate the aggregate industry exposure to a great earthquake" and to "have quantified information when developing specific plans of action for dealing with the earthquake threat" (Department of Insurance, 1984, pp. 7-8) the California insurance commissioner issued a data call regulation setting out reporting requirements designed to produce, within a reasonable period of time, the necessary statistical data. General publication of the

data by the commissioner's office would enable the industry to make pertinent business judgments in a sound manner.

Specifics and progression. The data call was issued on August 8, 1978, and has been the source of each annual California Earthquake Zoning and Probable Maximum Loss Evaluation Program Report since 1980 (Department of Insurance, 1980-1988). In 1980 a significant segment of the industry failed to file timely returns, but subsequent reporting has been considerably more diligent. Some deficiencies were identified in the initial data requirements, and subsequent modifications produced data that were more functional. The sixth yearly report, California Earthquake Zoning and Probable Maximum Loss Evaluation Program, based on the data requested, was published in June, 1986 (Department of Insurance, 1986).

Changes Since 1980

In the period since 1980, a number of significant changes and developments have occurred. Specifically, as mentioned above, most credible scientists now believe that California will experience an earthquake of R8.2 or greater either before or soon after the turn of the century. Additionally, contrary to optimistic expectations of a few years ago, it is now generally conceded that accurate, short-term earthquake prediction will not be possible in the near future. A number of more specific changes are addressed below.

Changes Reflected in the Annual Department of Insurance Reports

With respect to the risks related to earthquakes, there are, on the one hand, a number of factors, including recent judicial decisions applying the doctrine of concurrent causation (discussed in detail below, see Department of Insurance, 1986, pp. 15-16), inflation, the effect of Assembly Bill 2865, inclusion of earthquake-related costs of such matters as business interruption, unemployment, and similar socioeconomic disruptions, which, when taken into consideration, generate a much greater PML due to a major earthquake than did the earlier, admittedly limited, assessments.

On the other hand there is also room for optimism. The 1984 report of the insurance commissioner, though noting that "large earthquakes do occur frequently and could occur along the California coast at any time," also adds, "The hopeful aspect . . . is that a large earthquake need not be as great a disaster as it could have been in the past. Significant advances have been made in the design and construction of earthquake resistive structures, and the building codes have been updated to reflect these advances." Further, it advises that "great efforts are being made by government and private industry in earthquake preparedness and in measures to protect computer records, communications, and other essential equipment and functions." Finally, however, it cautions that "the older buildings still remain vulnerable" (Department of Insurance, 1984, p. 7).

As mentioned earlier, Miller has published an important study which helps to dispel a long-held premise regarding "grandfathered" buildings. It had been generally accepted that a building constructed in compliance with building code requirements in effect at the time of construction could not later be subjected to governmentally ordered upgrading to bring it into compliance with newer, more demanding code prescriptions unless the contemplated renovations required replacement of components or systems which were by then regulated by newer codes (Miller, 1985). Miller's study demonstrated that when public safety and health are directly involved, the police powers of state and municipal governments suffice to require essential upgrading or razing, whether other renovations are contemplated or not.

Even before 1980, California had experimented with the opposite side of this coin by permitting seismic-stress-resisting structural changes to be made even to the extent of substantial renovation—without having to replace existing "mechanical systems" (i.e., electrical, plumbing, heating, systems, etc.) which did not fully comply with currently applicable code requirements—if to do so would enhance the public safety (Brown and Weston, 1980, endnotes 11-12).

Department of insurance questionnaire: results to date.

The "main purpose" of the reporting requirement "is to make an effort to quantify each insurance company's exposure to a large earthquake" (Department of Insurance, 1986, p. 4). The 1986 report itemizes several "important benefits" that have already

been "realized from these reporting requirements." It states that the questionnaire "gives a simple methodology for estimating the probable maximum loss on an insurance company's business in each zone. Thus an insurance company can estimate its earthquake exposure in each zone and determine its concentration of risk." It continues, "[The] relative risk between construction classes" is also given, thus enabling a company to "limit its earthquake exposure" by allocating its exposure among the classes. It notes that some companies, after working with the questionnaire, have "decided to extend and refine their analysis of the earthquake risk. This is usually done by taking into consideration proximity to known active faults and soil conditions." It adds, "Reinsurers often use the questionnaire to monitor the earthquake exposures of their primary companies. . . . The Department of Insurance uses the reports to monitor each company's exposure in relation to the company's surplus. . . . The questionnaire makes it possible to estimate the aggregate industry exposure to vibration damage from a great earthquake." The Department believes that a "better insurance product will develop in terms of price and coverage" and that "it can be shown that certain types of homes, because of construction and location, have a very limited risk from damage from earthquakes" thus making it possible for such homes to "have earthquake coverage at nominal cost" (Department of Insurance, 1986, pp. 4-5). This last concept should be evaluated under the caution set forth in Steinbrugge's "micro-zonation" perceptions (see Steinbrugge, 1978a, p. 208).

One fact that the questionnaires have helped to clarify is that large commercial establishments and municipal governments, to a surprisingly large extent, have provided themselves with earthquake insurance (possibly because of the in-house availability or the retention of trained risk managers). Because each business is unique in needs, finances, risk judgment, and other factors affecting their decisions, it is not possible to detail the process generally, but Vaughan and Elliott (1978, p. 500) note that DIC (Difference In Conditions) coverage is often written (DIC is a special form of all-risk coverage written in conjunction with basic fire coverage and designed to provide protection against losses not reimbursed under the standard fire forms, including flood and earthquake), there is often an excess of loss element in the package, and often a number of locations are included within the package negotiated by a given firm. Often there will be a strong, but carefully defined, self-insurance component, with either municipal governments or large industries. It has been suggested that as much as 50% of all large industry and commercial entities have some program of earthquake insurance (see Cheney, 1987, p. 232).

Technical evolution. The 1983 Coalinga R6.7 earthquake; the 1984 Morgan Hill R6.2 earthquake; and the 1985 Michoacan ("Mexico City") R8.1 earthquake combined to increase public awareness of continuing seismic risk, and also provided testing grounds for engineered mitigation efforts. There has been encouraging progress in developing an understanding of seismic forces and in

engineering mitigative measures which can dependably reduce damage and personal injury. Indeed, buildings constructed in compliance with modern "earthquake codes" which subsequently experienced substantial seismic shocks have generally performed close to design expectations (see, for example, Department of Insurance, 1984, pp. 16-18). Land use controls have been less impressive in application and in demonstrated performance, possibly because the area of exposure is usually fairly large; because ground motions created by an earthquake vary in nature and effect with the geologic formations involved; because, in contrast with floodplain designations, there is no "earthquake plain" readily identifiable and quantifiable; and because the laws regulating land use are less certain in application since their functions and purposes are far more comprehensive and interrelated than are those regulating construction practices and materials. California's unique Alquist-Priolo Special Studies Zone Act, mentioned above, demonstrates the limited effectiveness of land-use legislation, as well as its susceptibility to abuse or misapplication (see Palm, 1981, p. 94).

Economics and Need to Make Premium Charges Sound

As mentioned above, the late 1970s and early 1980s were considered a "soft market" with respect to property/casualty insurance. The trend, with respect to earthquake insurance, was toward lower premium costs. In California, the premium rate ranged in the neighborhood of \$1.50 to \$2.00 per \$1000 of insured value, with a 5% deductible clause (Department of Insurance,

1986, p. 17). As noted, there was a considerable tendency within the industry to generate business by price cutting which was sometimes not actuarially sound. The nonallocated funds so produced were channelled to interest-bearing investments.

When interest rates began dropping significantly and rapidly in 1984, a number of companies found that their premium structure was not satisfactory and began to remedy the situation. One obvious strategy was to increase premiums; another was to diminish risk. One means of diminishing risk was to limit doing business in, or to withdraw from, high-risk market sectors; insurers became reluctant to write coverage in areas where large claims had been awarded. It was similarly logical to avoid or diminish the amount of business in areas where insufficient historical data precluded the application of the principle of large numbers—in other words, in fields such as earthquake insurance. Counterpressure arose, however, due to the decision in the 1982 Garvey case (discussed in greater detail below) which, by invoking a broadened concept of "concurrent causation," threatened to incorporate earthquake coverage into every "all risk" policy, in spite of any clause expressly excluding earthquake or earth movement.

In late 1984 and early 1985, when interest rates had leveled off substantially below the levels of previous peak years, one noticeable consequence in California was that a number of insurance firms began requiring a 10% deductible with earthquake coverage.

At the time of the 1980 study, earthquake insurance was available to anyone who requested it, but the coverage was not pushed in the marketplace (Brown and Weston, 1980, p. 15). There were several reasons for this caution. First, agents did not find that commissions earned adequately reflected the effort needed to promote the coverage (this, in turn, perhaps being a reflection of the general industry reluctance, noted above, to push earthquake insurance). Again, there was general industry acceptance of the premise that a major earthquake impacting a metropolitan area could inflict an awesome amount of property damage. Even worse, from an economic perspective, the industry recognized that the peril, by its nature, should stimulate "adverse selection" on a regional and/or type-of-construction basis. Moreover, the major residential market (wood-frame buildings) was (and is) structurally less vulnerable to severe damage than almost any other construction class, thus lessening the attractiveness of any endorsement carrying a deductible clause (even though such a clause was necessary to establish economically tolerable, if not actuarially sound, rates).

The Garvey Case and the Concurrent Causation Complication

The decision of the Superior Court, City and County of San Francisco, in Garvey v. State Farm Fire & Casualty Co.³ startled the property/casualty insurance industry by finding applicable the California doctrine of "concurrent causation" (see Department of Insurance, 1984, pp. 22-25; 1985, pp. 5-17; and 1986, pp. 15-16). Under this doctrine, the court said, an insurer could be