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Innovations in Managing Catastrophe Risk

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The 1980s and 1990s have ushered in impressive changes in the property-liability insurance market. Among these have been a withdrawal of commercial business into alternative risk management vehicles and strategies; crises and coverage changes in liability insurance; the integration of insurer asset and liability management; the emergence of innovative reinsurance instruments such as financial reinsurance; experiments with radical regulation; and various forms of corporate reorganization and reassembly, the most recent being the merger activity among brokers leading to increased concentration. Perhaps the most dramatic changes lie in the securitization of catastrophe risk. Experiments have occurred with new instruments such as catastrophe (CAT) bonds, exchange traded catastrophe options, insurer issued catastrophe put options, as well as bartered risk exchanges. Although the volume of business yet traded is small, interest is growing both among insurers and investors.

PRECONDITIONS FOR SECURITIZATION

The emergence of these new instruments at this time is not accidental; the preconditions are well defined (see Santomero and Babbel, 1997). On an intellectual level, corporate risk managers, treasurers, and CFOs of both insurance and noninsurance firms have questioned why risk is important when shareholders can diversify their investment holdings. Out of this climate, a more focused rationale for risk management has emerged that combines hedging strategy with corporate financial management. Hedging can add value because of tax nonlinearities. Moreover, since much of the cost of risk arises from perverse interplays between risk and leverage, leverage management now stands alongside hedging as an appropriate strategy for offsetting the costs of risk. This new intellectual climate stresses the financial economic benefits of managing risk, and its proponents—being familiar with financial institutions and financial instruments—have naturally looked to the financial markets to address risk management problems. Moreover, this process has diminished (though perhaps not removed) distinctions between insurable and noninsurable risk; risk management has become more "holistic."

The second and closely related precondition is that there has been an explosive growth in derivatives markets. In part, the evolution of this market has been fueled by speculative demand; but it has partly been stimulated by the need for

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new hedging instruments. This market has provided instruments to hedge positions in particular firms and industries, to hedge interest rate and foreign exchange risk, and to hedge positions in commodities. In this climate, it is not surprising that risk managers and CFOs have come to view insurance as another type of option. CFOs of industrial firms, used to hedging commodity risk and foreign exchange risk with options, are now starting to see the firm's liability policy as an option. Similarly, insurance companies' CFOs who currently use options as part of the asset liability management program will start to think of reinsurance as an option.

Other preconditions for catastrophe risk securitization are internal to the insurance market. The traditional instrument for insurers to hedge catastrophe risk is reinsurance. Recent evidence has shown catastrophe risk to be unusually expensive compared with other forms of hedges. Evidence of catastrophe reinsurance contracts presented by Froot and O'Connell (1996) suggests that, over the past decade, the ratio of price minus expected losses to expected losses has been in the order of 60 to 70 percent and can be much higher on high level coverages. These costs seem to reflect inefficiencies inherent in traditional reinsurance contracts. The presence of a hedge clearly creates moral hazard costs. *Ex ante,* the hedge will tend to relax incentives for prudent underwriting. *Ex post,* reinsurance will tend to make insurers sloppy in their claim settlement practices; an especially serious issue for catastrophe losses, where the loss itself is of sufficient scale that it overwhelms the insurers' capacity to settle claims in an orderly fashion. Anecdotal evidence for extremely generous settlements after the Northridge earthquake and Hurricane Andrew is pervasive. Of course, there are controls to redress such problems. Reinsurance is usually implicitly a long-term relationship that is brokered by specialized intermediaries. This arrangement locks the parties into a relationship and thus increases the reputational costs of adverse behavior. While insurers may not always behave perversely when they are reinsured, the costs of preventing them from doing so are high. Moral hazard costs may not come in the form of increased claims but in the expensive contractual relationships that are necessary to offset the inherently perverse incentives of reinsurance.

A second transaction cost arises from default risk. Both Andrew and Northridge gave rise to insurer and reinsurer insolvencies. As the scale of potential catastrophes increases, one might expect insolvencies to increase disproportionately. The problem is that the risk-to-premium ratio is very high for catastrophe reinsurers who cover the tails of loss distributions. The potential for insolvency causes various transaction costs. First, potential insolvency limits the effectiveness of the reinsurance hedge and may cause the insurer to supplement its reinsurance with other adaptive strategies aimed at addressing reinsurance failure. Second, the potential for insolvency can lead to expropriatory behavior, and this calls for costly contractual constraints. Third, and most directly, insolvency has a set of direct transaction costs in reallocating the resources of a defaulting insurer among competing claimants. These costs will be anticipated and priced in an efficient market.

The cost of catastrophe insurance and reinsurance reflects the burning costs (expected losses) as well as transaction costs. In addition to high transaction costs,

actual losses and expectations of future losses have increased in recent years. Various articles have noted the unprecedented level of insured catastrophe losses in the past decade compared with earlier periods (Lewis and Murdock, 1996; D'Arcy and France, 1992; Cummins, Lewis, and Phillips, 1998). Explanations include the accumulation of insured capital in high-risk areas and the more controversial claim that there has been a shift in the level of weather-related catastrophe events due to cyclical factors or to underlying climate shifts. These distributional shifts do not, by themselves, shift the balance from insurance to other risk management instruments. But they do underscore the apparently high and increasing cost of catastrophe exposure which has, in turn, raised its visibility as a risk management topic. Accordingly, financial institutions have seen this area as a target of opportunity.

A final precondition relates to the quality and distribution of information. The increasing cost of catastrophe exposure has been an important factor in the emergence of new catastrophe modeling companies such as RMS, Eqecat, and AIR. These companies model many potential catastrophe events, and, by combining scientific knowledge on storms and seismic events with data on building and capital stocks (including engineering data on building structures), they are able to estimate damage patterns. Further combination with financial and insurance data enables these models to estimate dollar losses and allocate these losses to insurers. These models, together with insurers' own models, have improved the quality of forecasts of catastrophe losses. In turn, improved estimates of expected losses have no doubt fostered trade in reinsurance and new instruments.

But even more importantly, the emergence of these new modeling firms has leveled the information playing field. Perhaps one of the major barriers to trade is asymmetry of information between parties to a potential contract. In the traditional reinsurance market, insurers and reinsurers undoubtedly had a comparative advantage over insureds and investors in estimating catastrophe losses; moreover, many professional reinsurers probably modeled and understood this risk better than many insurers. An information advantage of this sort gives the endowed party opportunities to profit at the expense of the uninformed. Recognizing this, the uninformed party is less likely to engage in trade. The new modeling companies have leveled this field by providing loss estimation services not only to insurers and reinsurers but to banks, consulting companies, brokers, and investors. That all parties can be equally informed has been a factor in arousing the interest of investors in new instruments.

THREE INNOVATIONS

Nonindemnity Hedges—Basis Risk versus Moral Hazard

The case for securitization of catastrophe exposure that is often heard rests on two arguments. The first is that the industry faces losses that are abnormally large relative to the financial capacity of the insurance market but modest relative to the much larger financial markets. Therefore, it is argued, even very large catastrophes can be absorbed by capital markets without serious dislocation. For example,

a quite feasible $100 million loss would wipe out about 40 percent of the total surplus of the U.S. property-liability industry. But the same loss is less than the average variation in value traded in the capital markets. The second argument is that catastrophe losses are uncorrelated with major capital market indices and thus represent a zero beta instrument that offers great diversification potential to investors. While not inaccurate, these arguments miss what I believe to be the essential issue. The point is that neither of these arguments addresses the inefficiencies of reinsurance that lie at the heart of the demand for securitization. In principle, catastrophe losses can be spread throughout the capital market while retaining the current reinsurance structure.

Reinsurance is normally a long-term and costly relationship. It is conducted in a market in which reputation is of great importance and parties are bound together in good faith. Reputation, once lost, becomes a serious constraint on doing business. In short, the reinsurance market is the polar opposite of a spot market in which many financial assets are traded. This costly and cumbersome set of relationships can be explained by the underlying moral hazard in reinsurance. The ceding firm determines its underwriting practices and the settlement of claims, both of which can be adversely affected by the presence of reinsurance; respectively, there is *ex ante* and *ex post* moral hazard. For catastrophe insurance, the *ex ante* moral hazard is particularly worrying since the accumulation of claims under a large catastrophe loss is likely to overwhelm the loss settlement facilities of ceding insurers. Monitoring, reputation, and the desire to secure long-term relationships to secure future coverage thus become instruments to prevent the primary insurer from abusing its reinsurer by relaxing loss settlement practices. The first major innovation of securitization has been to offer an alternative, and possibly cheaper, way to address the moral hazard cost.

The problem considered here is pervasive in contract design: how to secure an efficient tradeoff between risk sharing and efficiency. The alternative solution is to design a hedge contract in which the payout is tied to an instrument that is correlated with the insurer's loss but over which the insurer has little control. Such instruments can be

an index of all industry catastrophe losses by region;
an index of catastrophe losses of a subset of insurers by region;
an index of all insurers excluding the hedging firm;
an index of insurers with a liability portfolio similar to the hedging firm;
a modeled estimate of losses of the hedging firm from a given event; or
a schedule of preset payouts, each assigned to a prespecified event.

Indices are used in CBOT option contracts and in the contracts projected for the upcoming Bermuda exchange. Moreover, indexed catastrophe bonds have been designed. But the most visible recent catastrophe bond issues did not use indexing to redress moral hazard. The recent $400 million USAA catastrophe bond was not indexed but tied to USAA's own losses. Accordingly, it retained a 20 percent coinsurance provision and specified claim auditing procedures to prevent insurer moral hazard. Thus, in controlling moral hazard, it really looks quite like

conventional reinsurance. In contrast, a Swiss Re–First Boston $100 million catastrophe bond was indexed. But this was issued by a reinsurer, apparently to expand capacity to offer conventional reinsurance. Thus, conventional reinsurance and its associated moral hazard is preserved. Any potential efficiency gains require that the primary insurer accept a tradeoff between basis risk and moral hazard.

Contingent Refinancing

The second innovation is an alternative specification of the insurer's risk management problem. Following a catastrophe event, the insurer will find its surplus, and its capacity to continue offering direct insurance, depleted. The firm will thus lose income from the displaced future business. A hedge replaces the lost surplus, but it can be replaced directly through a post-loss equity issue. Post-loss equity financing is a substitute for hedging.

A problem with equity refinancing is that the loss itself will probably cause share value to fall. Thus, refinancing will, at best, involve serious dilution and, at worst, be unattainable. Only if the post-loss equity value (surplus plus franchise value) is positive, is refinancing feasible. A mixed strategy is contingent refinancing in which the insurer issues a put option on its own stock. Aon has structured such catastrophe put options. Following a predefined event (a catastrophe loss of given size), the firm can issue new equity to a counter-party at a fixed exercise price. If the option is "in the money," the insurer is recapitalized and the counterparty has provided a partial hedge. The dilution effect is smaller than with a simple post-loss equity issue, and the value of the original shares is partly protected. Since there is a partial hedge in the catastrophe put, there are incentive problems. But these can be alleviated by coordination of the catastrophe trigger and the exercise price of the option (see Doherty, 1997).

Debt Forgivenes—Liability Hedges

Like the other two innovations, debt forgiveness is not entirely new; it dates back to the origins of insurance in contracts such as bottomry. The idea is to compensate the party suffering a loss not by making a payment but by forgiving a debt. What is novel in catastrophe bonds is that the debt is created specifically as collateral for a hedge instrument. Stripped of all legal and regulatory features, catastrophe bonds are simply debt instruments issued by an insurer to a counterparty, which will be forgiven (interest, principle, or both) if the defined event occurs. The proceeds are usually held in trust, and the debt is repaid if no loss occurs.

The main advantage of debt forgiveness is that it avoids default risk for the insurer. This contrasts with reinsurance, where the reinsurer's solvency may be at issue after a major catastrophe loss. Herein lies the strength and weakness of catastrophe bonds. The possibility for designing out the credit risk is a useful feature. But the way these instruments have been used by insurers has sacrificed the benefits of diversification. In recent catastrophe bond issues, capital has been tied up to collateralize the maximum hedged loss in single client–single peril deals.

Constraining capital usage in this way has an opportunity cost. Thus, one can imagine the emergence of multiclient-multiperil deals, where, because losses are not perfectly correlated, they can be secured against credit risk with smaller capital than is required by separate transactions.

Conclusion

The three innovations described here have been used in catastrophe risk management to address specific needs that have arisen in a specific market setting. But the innovations are unlikely to be confined to a single line of risk. Liability risk presents similar challenges to insurers as catastrophe risk, and, while the intertemporal features of liability exposure can be different, there are also moral hazard credit and risk problems that may be amenable to different forms of incentive contracting than traditional hedges. The three innovations—nonindemnity contracts, contingent refinancing, and debt forgiveness—present contract design features that may well be applied also to liability. Another area—the management of noninsurer corporate risk, that is, the direct business of insurers—already has seen considerable innovation, much of it resembling that for insurer catastrophe risk. For example, the recasting of the corporate risk management problem as one of refinancing and seeking capital structure (as opposed to hedging) solutions is well established. These are just two innovations. The point is that, while innovation is dramatic and visible in catastrophe risk, it is quietly proceeding elsewhere.

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