Catastrophe Securities and the Market Sharing of Deposit Insurance Risk

*by Kevin P. Sheehan**

Over the past two decades, the U.S. banking industry has experienced an unprecedented wave of consolidation. Today the 100 largest banking organizations hold nearly three-quarters of all industry assets. With the industry now dominated by a small number of institutions, any banking crisis could involve the failure of one or more of these large banks. Thus, although the history of the Federal Deposit Insurance Corporation (FDIC) is primarily a record of small-bank failures, the consolidation of the industry suggests a future of possible large-bank failures that might expose the Corporation to unprecedented deposit insurance losses.

This outlook is comparable to the one projected by recent trends in property/casualty insurance. Catastrophic insurance losses from earthquakes, hurricanes, and other natural disasters have already reached unparalleled levels, and property/casualty insurers are anticipating even larger losses in the future.

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The disasters of hurricane Andrew and the Northridge earthquake alone cost the insurance industry more than the cumulative insured losses from catastrophes in the decade before those events. Losses from the two disasters totaled over $45 billion in 1997 dollars, with insured losses running about $30 billion. These insured losses compare with cumulative insured losses from natural catastrophes in the previous decade of only about $25 billion.[1] Yet, although the Atlantic and Gulf coastal regions of Florida are exposed to hurricanes and much of California is vulnerable to earthquakes, the population in these states has grown at two or three times the national average for the last three decades. Given this population growth, scenarios constructed by catastrophe modelers now suggest the possibility of a $76 billion hurricane in Florida, a $72 billion earthquake in California, and even a $21 billion hurricane in the Northeast.[2]

Faced with this increased exposure and seeking an alternative to traditional methods of managing their risk load, property/casualty insurance compa-

[1] *See* Froot (1997).

[2] *See* Cummins, Doherty, and Lo (2002).

nies have turned to capital markets. The securities market appears to offer insurance companies an avenue for diversifying their natural disaster risk.

This type of diversification requires securitizing property catastrophe risk. Such securities transfer property catastrophe risk to investors. One example is a catastrophe bond that offers an insurance company some degree of debt forgiveness in the event of a hurricane or some other predefined natural disaster. Another innovative instrument is a catastrophe equity put that allows an insurance company to recapitalize after a catastrophe by exercising a put option on its own stock. Other insurance-based financial instruments include exchange-traded property catastrophe options and property catastrophe swaps.

Property/casualty insurers have recently begun to issue these catastrophe securities. Surprisingly, property/casualty insurers use little reinsurance. These insurers overwhelmingly retain, rather than share, their large-event risks; and even with the introduction of catastrophe securities, the amount of risk sharing has not increased. The limited risk sharing in private insurance markets can be partly attributed to the presence of moral-hazard problems. Froot (1997) presents a number of other explanations for the limited sharing of catastrophe risk. These include behavioral explanations, market power on the part of reinsurers, and price regulation at the state level. Like property/casualty insurers, the FDIC is exposed to large-event risk: a large-bank failure does not happen often, but such an event could result in huge deposit insurance losses. If the FDIC attempted to shift its risk, the Corporation might find itself limited by many of the same factors.

This article investigates issues that property/casualty insurance companies are facing and that the FDIC should consider if it, too, decides to address its increased exposure by securitizing the risk it faces—in the case of the FDIC, the risk of large-bank failure. Specifically, the article details how the insurance companies and the FDIC might reduce their exposure either by entering the reinsurance market directly or by issuing their own catastrophe securities. The article concludes that both kinds of risk shifting are likely to be limited by a number of factors. The one this article focuses on is the moral-hazard problem, because such a focus leads to a number of interesting implications for the market sharing of deposit insurance risk.

Property Catastrophe Risk and Conventional Reinsurance

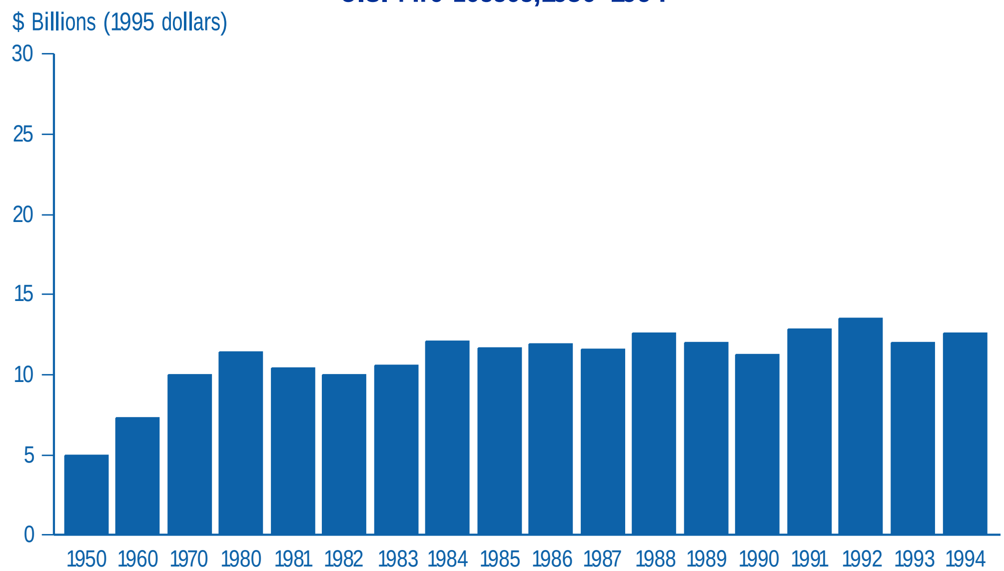
Figure 1 illustrates that losses are highly predictable for some large pools of insurance risk. For a noncatastrophic event such as fire loss, an insurance company diversifies its risk by creating a large portfolio of independent risks so that (by the law of large numbers) the average loss approaches the mean of the loss distribution (that is, the expected value of losses). Risk-averse individuals are willing to pay something for fire insurance, and one can show that this amount is greater than the expected value of losses.[3] Given the willingness to pay this amount, an insurer holding a large portfolio of fire insurance policies can provide coverage by simply charging policyholders a premium approximately equal to its average loss (per dollar of insurance).

Figure 2 illustrates that property/casualty insurers cannot effectively reduce the variance of cost from natural disasters by creating large pools. Unlike other lines of insurance, losses from earthquakes, hurricanes, and other natural disasters are highly

[3] To see this, consider a risk-averse individual whose wealth, W, is subject to a random loss, L. Risk aversion can be represented by a concave utility function, $U()$. Given the concavity of $U()$, one can show that $EU(W - L) < U(W - \bar{L})$, where E is an expectation operator and $\bar{L}$ is the expected value of losses. This result lends itself to the interpretation that follows. First note that the expression $EU(W - L)$ defines the expected utility of random wealth while the expression $U(W - \bar{L})$ defines the utility for a specific amount of certain wealth. Certain wealth can be obtained by purchasing complete insurance, and the amount of this wealth equals the initial wealth less an insurance payment. Now, if a risk-averse individual acquires complete insurance by paying a premium equal to the expected value of losses, the utility from insured (i.e., certain) wealth, $U(W - \bar{L})$, is greater than the expected utility from uninsured (i.e., random) wealth, $EU(W - L)$. Such an individual is therefore better off purchasing insurance, and this would be true even if the premium were slightly larger than $\bar{L}$.

Figure 1

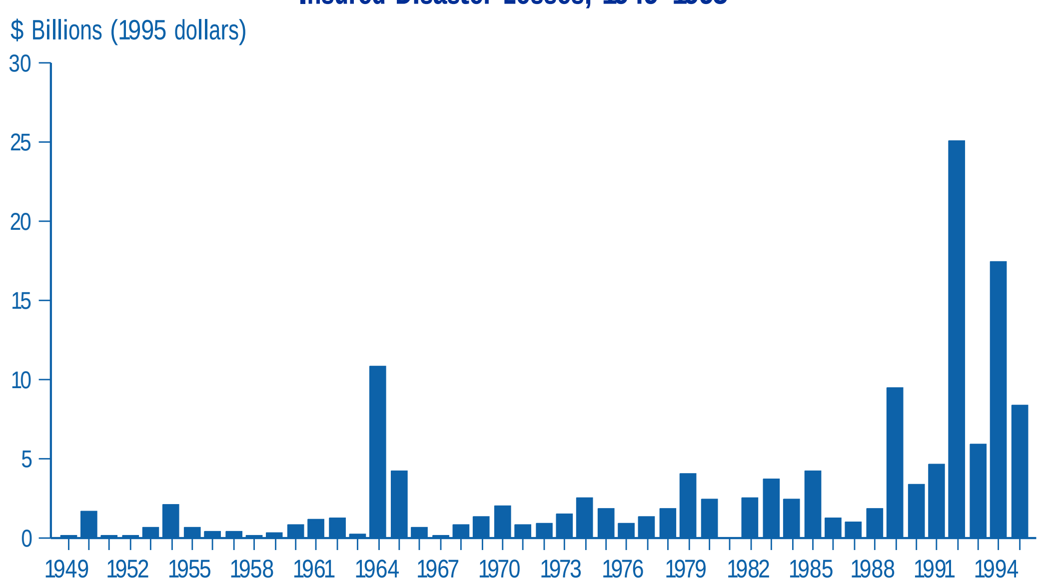
U.S. Fire Losses,1950–1994



Source: Lewis and Murdock (1996).

Figure 2

Insured Disaster Losses, 1949–1995



Source: Lewis and Murdock (1996).

correlated. When a hurricane hits the coast of Florida, for example, most homes in the region incur some damage. Insurance companies typically reduce the variance of their cost by pooling risk across policyholders, but given the highly correlated nature of natural disaster risk, property/casualty insurers cannot fully diversify by using traditional insurance methods.

In the case of independent risk (such as fire loss), an insurer can plan to pay losses out of premium income.[4] Because costs are relatively certain, an insurance company provides coverage by charging a premium approximately equal to its average loss (per dollar of insurance). For catastrophe risk, in contrast, the annual pattern of losses is highly variable, and large amounts of capital are required to cover potentially huge losses. In this case, an insurer provides coverage by holding enough capital to cover potentially huge insurance losses.[5] This capital finances the purchase of liquid securities, and in the case of a natural catastrophe, the insurance company liquidates these securities to pay policy claims.

Reinsurance allows an insurer to provide catastrophe coverage while holding only a limited amount of capital. When broadly used, reinsurance can be interpreted as a pooling arrangement that mutualizes the industry's risk. Under this risk-sharing arrangement, individual insurance companies hold only limited amounts of capital, and each insurer is accountable for a proportion of total industry losses. That is, each insurer pays a proportion of total losses, and the pooling of industry resources through reinsurance contracts ensures that adequate capital is in place to provide this catastrophe coverage.

Thus a major objective of reinsurance is to share or distribute the risk of loss.[6] The primary insurance market is characterized by the sale of insurance policies from a primary insurer to the insured, and primary insurers may then cede or pass on some or all of their insurance risk to a reinsurer. Through reinsurance transactions, primary (or direct) insurers share the risk of loss with reinsurers (and/or other primary insurers). In return for a premium payment, an insurer transfers some of its loss exposure to a reinsurer, and the reinsurer agrees to indemnify the insurer for losses falling within the reinsurance agreement.

Reinsurance contracts take the form of either *facultative agreements* or *treaties*. With facultative reinsurance, the primary insurer negotiates a separate contract for each policy that it reinsures. Treaties are agreements whereby the reinsurer agrees to accept all policies of a particular type—property/casualty policies, for example. In both cases, reinsurers charge a premium for assuming this risk. In addition, this reinsurance can be broadly categorized as either *pro rata* coverage or *excess-of-loss* protection. A pro rata policy provides the primary insurer with coverage against a fixed percentage of losses, whereas an excess-of-loss policy provides protection for a fixed amount of losses above a specified threshold, or attachment point.

As mentioned above, however, primary property/casualty insurers use reinsurance to cover only a relatively small amount of their catastrophic exposures.[7] Swiss Re (1997) reports that only a fraction of the exposure in United States' hazard-

[4] Even so, an insurance fund is necessary to cover unexpected losses. However, little capital is needed when insurance losses are relatively constant through time.

[5] In theory this capital should be readily available. Modern portfolio theory tells us that a security should be priced in terms of its correlation with the market portfolio. The return on Treasury securities is not correlated with the returns on stocks and bonds. Given that catastrophe exposures are not correlated with the returns on a market portfolio, an insurance company could attract capital by promising to pay an expected return equal to the return on Treasury securities. To generate this required return, holders of these zero-beta assets would receive the interest earnings from the insurer's portfolio of liquid securities as well as additional compensation for expected insurance losses. The insurance company would fund this risk premium by charging policyholders an amount equal to the expected value of the losses. However, since risk-averse individuals are willing to pay amounts greater than the expected value of losses, the insurer could fund an even larger premium and offer investors excess returns for the use of this risk-taking capital. Of course, capital constraints may exist, and possible sources of this market friction are identified below.

[6] Geographical diversification is another important objective of reinsurance. *See* Cummins and Weiss (2000) for a general discussion of reinsurance.

[7] This article argues that such limited coverage can be explained to some degree by the presence of moral-hazard and adverse-selection problems. Again, see Froot (1997) for additional explanations for the limited use of catastrophe reinsurance coverage.

prone states is covered by catastrophe reinsurance. In fact, an analysis by Froot of a large sample of reinsurance contracts finds that "reinsurance coverage as a fraction of exposure is high at first (after some small retention) and declines markedly with the size of the event, falling to a level of less than 30 percent for events of only $8 billion."[8]

The reason property/casualty insurers use relatively little reinsurance is that it is available only in limited quantities and at very high prices. Limited quantities are evidenced by the fact that reinsurance coverage typically involves deductibles and insurance limits. The high cost of reinsurance is illustrated by a reinsurance transaction involving the California Earthquake Authority (CEA). In late 1996 CEA purchased reinsurance from National Indemnity, a subsidiary of Berkshire Hathaway. According to Froot, "[u]nder the structure of the reinsurance contract with National Indemnity the actuarially expected loss was 1.7 percent and the [insurance] limit was $1.05 billion. In return for bearing the earthquake risk National Indemnity received an annual premium of $113 million—or 6.3 times the actuarially expected losses of $18 million."[9]

Industry-wide prices on reinsurance contracts seem to match almost exactly the pricing of the CEA contract. However, further analysis shows that much of the high premium-to-expected-loss ratio (which is averaged across all layers) comes from coverage for the highest layers of losses—that is, coverage for low-frequency, high-severity events. Around the time of the CEA transaction, reinsurance coverage for these low-frequency, high-severity events required premiums greater than 25 times expected losses, as Figure 3 indicates. The figure shows the premium-to-expected-loss ratios (by year) for different layers of reinsurance coverage. The axis labeled "exceedence decile" identifies the likelihood (from high to low) that insurance losses will exceed the deductible on a reinsurance contract. On this axis, a value of 10 corresponds to the small probability that insurance losses will exceed a very large deductible. Since reinsurance coverage for the highest layers of losses involves contracts with very large deductibles, the back row of the figure identifies the spread over expected losses for catastrophic coverage.

The evidence of high prices provided by Figure 3 is consistent with a limited demand for reinsurance services. High prices are inferred from the observation that insurance premiums are significantly greater than expected losses. Such large spreads can explain the limited demand for reinsurance; however, expected losses may be underestimated because we are dealing with extremely rare events. If expected losses are underestimated, the actual spreads are somewhat smaller than those appearing in the figure. Nevertheless, even if one were to revise expected losses substantially upward, the magnitude of the spreads would remain large, and the revised spreads would still indicate the high cost of reinsurance coverage.

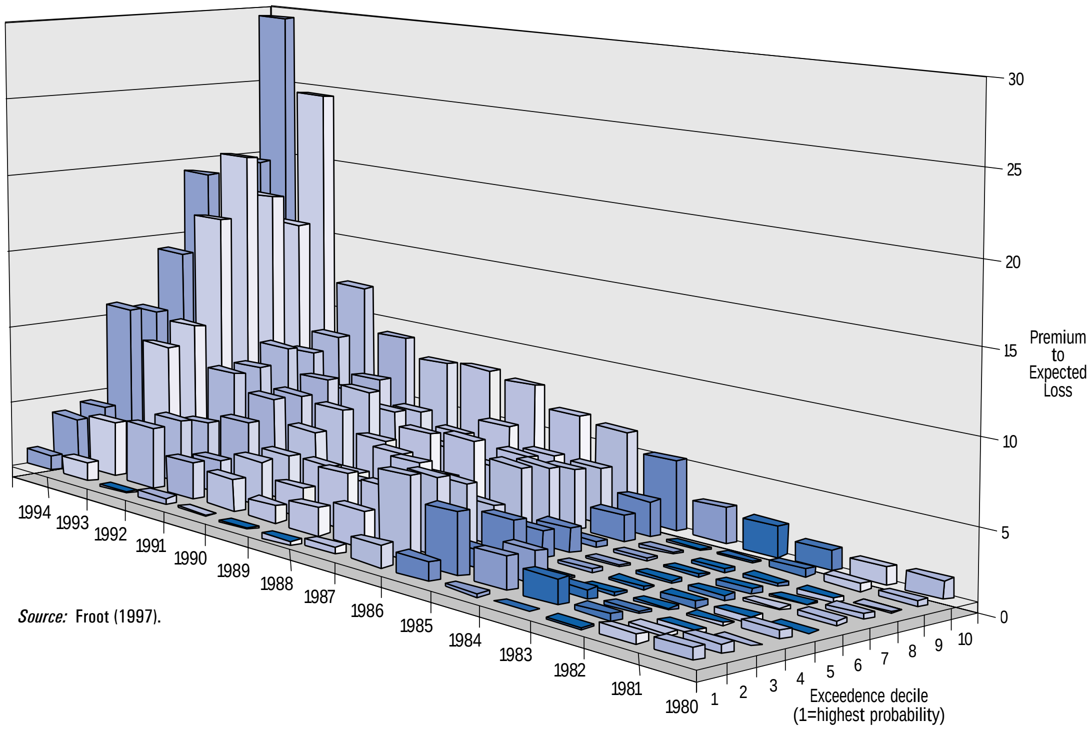
Reinsurance markets are subject to price and availability cycles, which often result in price increases and supply restrictions following catastrophic events. "The market alternates between 'soft markets,' when coverage is [somewhat] plentiful and prices are relatively low, and 'hard markets,' when availability of coverage is limited and prices are relatively high."[10] The CEA transaction occurred just after hurricane Andrew and the Northridge earthquake, so temporary supply restrictions might have significantly affected prices.

More generally, however, high prices can be explained by a couple of different factors. First, the high cost of coverage for the upper layers of natural disaster risk can be explained to some extent by the size of the losses as well as the difficulty of estimating such losses. In addition, the high cost of reinsurance coverage for low-frequency, high-severity events can be partly explained by

[8] Froot (1999), 12.
[9] Ibid., 6.
[10] Cummins and Weiss (2000), 181.

Figure 3

Premium to Expected Loss, by Exceedence Probability and Year



Source: Froot (1997).

the presence of severe ex post moral-hazard problems. As Doherty explains,

> Ex post moral-hazard problems arise when the loss-settlement practices of the insurer are relaxed because of the presence of reinsurance. This is a particular problem for catastrophe losses. The loss-settlement capacity of any insurer—and the industry as a whole—is geared to its normal loss frequency. When an event such as hurricane Andrew arises, primary firms simply do not have the capacity to inspect and negotiate claim settlements thoroughly. Thus, it becomes more difficult to prevent the "build up" of claims (from policyholders' tendency to include uninsured damage in the claim or exaggerate the size of the losses) or outright fraud on the part of policyholders. However, the incentive for the primary insurer to control its claims will be relaxed if it has reinsurance protection.[11]

For catastrophe losses, concern exists that the primary insurer might pass on the costs of excess settlements to its reinsurer. "For moderate losses, the primary firm may well consider its reputation in the reinsurance market before engaging in such opportunism. . . . [But when] insurers are facing financial stress [from catastrophe losses], maintaining their reputation in reinsurance markets is likely to become a secondary concern."[12] Thus, ex post moral-hazard problems are likely to be restricted to coverage for catastrophic events, and the presence of such distortions may partly explain the existence of large premiums for the highest layers of reinsurance coverage.[13]

[11] Doherty (1997), 87.

[12] Ibid.

[13] Catastrophe reinsurance contracts are typically issued with insurance limits that preclude coverage for the very highest layers of losses. A possible explanation for this lack of coverage is that ex post moral-hazard problems are most severe for the very highest layers of losses. According to this explanation, insurance limits are in place because the presence of such severe moral-hazard problems precludes the provision of reinsurance coverage.

Securitization of Property Catastrophe Risk

Property/casualty insurers overwhelmingly retain, rather than share, their large event risks—in other words, these insurers provide coverage by holding their own capital. But because the U.S. commercial property/casualty insurance industry has only a limited amount of capital, a major California earthquake or Florida hurricane would stress the capacity of this industry.[14] More capital is needed, but raising additional equity capital would not be an efficient solution to this problem of capital adequacy. Jaffee and Russell (1997) point out that holding capital in an insurer is costly because of the regulatory and agency costs of operating an insurance company, as well as accounting and tax rules that penalize the accumulation of equity capital.

Although a $100 billion catastrophe might wipe out the capital of the property/casualty insurance industry, a loss of that magnitude is less than one-half of 1 percent of the value of stocks and bonds traded in U.S. securities markets. Securities markets have the capacity to absorb huge losses, and insurers have recently sought to address their increased exposure and the problem of capital adequacy by introducing reinsurance-like contracts that would facilitate the sharing of catastrophe risk more broadly across these markets. This securitization of insurance risk is potentially a more efficient approach to financing catastrophic losses than conventional insurance and reinsurance. Cummins and Weiss point out that "[s]ecurities markets are more efficient than insurance markets in reducing information asymmetries and facilitating price discoveries, potentially smoothing or eliminating insurance price cycles. Moreover, insurance-linked securities cover zero-beta events and thus are valuable to investors for diversification purposes."[15]

As noted earlier, despite these advantages, catastrophe securities have done little to expand reinsurance capacity. Reinsurance capacity is limited by the presence of moral-hazard and other transaction costs. Reducing these transaction costs would expand reinsurance capacity; however, it appears that these new securities have failed to reduce costs. As shown below, catastrophe options greatly reduce moral-hazard problems but only by introducing basis risk. On the other hand, catastrophe bonds do not reduce costs because they fail to adequately address moral hazard. Without effectively solving moral-hazard problems, these securities are nothing more than synthetic reinsurance that is plagued by the same incentive conflicts as conventional reinsurance.

Catastrophe Options

The similarity between an excess-of-loss reinsurance contract and a call spread (defined below) allows for an easy transformation of insurance risk into exchange-traded options. Catastrophe options can be found on the Bermuda Commodities Exchange, and until recently, catastrophe option contracts were also traded on the Chicago Board of Trade (CBOT). Catastrophe option contracts are based on various industry indices of property liability losses. For example, a contract on the CBOT was based either on a national index, a regional index (Western, Midwestern, Southeastern, Northeastern, and Eastern), or a state index (California, Florida, and Texas).

A typical excess-of-loss reinsurance contract provides an insurer with protection above an agreed-upon dollar amount of insurance losses. For example, a 10/30 excess-loss layer provides indemnification for the first $10 million (limit) in insurance losses over $30 million (the attachment point). This excess-of-loss policy is similar to the insurer hedging its risk by buying a catastrophe option at a strike price of $30 million and simultaneously selling a catastrophe option with a strike price of $40 million.[16] This combination of being

[14] Greenberg (2001) reports that just before the September 11, 2001, terrorist attacks, the U.S. commercial property/casualty insurance industry had between $100 billion and $125 billion in aggregate capital.
[15] Cummins and Weiss (2000), 207.

[16] On the CBOT, the level of industry-wide losses was converted to an index, and the catastrophe option contracts were written in terms of the index. Since an index point represented $10 million insurance losses, the long position described above, for example, was an option with a strike price of 3 index points.

long (that is, buying a catastrophe option) at one strike price and at the same time short (that is, selling a catastrophe option) at a higher strike price is known as a call spread.

When insurance losses have exceeded the strike price, the buyer of a catastrophe option receives (or the seller of the option pays) the difference between the industry-wide insurance losses and the striking price. Thus a long position with a strike price of $30 million enables an insurer to receive payment for the excess loss over $30 million, whereas a short position with the strike price of $40 million places a cap on this payment of $10 million. With industry-wide insurance losses of $100 million, for example, the payment is capped at $10 million because a $70 million gain on the long position is offset by a $60 million loss on the short position.[17]

Moral hazard arises whenever an insured party, by virtue of being insured, fails to take precautions to prevent the event being insured against. Reinsurance protection can relax the normal incentives for the primary insurer to underwrite carefully and settle claims efficiently. As Doherty explains,

> [T]he primary may [become] lax in its underwriting procedures, pay inadequate attention to its own spread of risk, and fail to provide adequate risk audits for potential new policies. . . . [Moreover the] primary may be able to avoid the abnormal transaction costs of settling claims, and even buy some goodwill with its policyholders by making generous settlements with policyholders and passing on the costs of excess settlements to its re-insurer.[18]

Catastrophe options seek to control this moral hazard by using industry (or sub-industry) indices. The basic idea is to define the contract payoff in relation to some variable that is correlated with insurer losses but over which the insurer has little or no control. Then when using catastrophe options, a primary insurer that is able to practice cost mitigation will receive much of the benefit of that activity in the form of reduced claims.

To illustrate, suppose an insurer has a portfolio that represents 5 percent of the market covered by an index. This insurer can obtain upper-layer coverage by purchasing a catastrophe option that pays 0.05 times the payoff on the amount by which industry losses exceed a strike price. Loss-control efforts by the insurer may lower industry losses and therefore reduce its option payoff. But, since the insurer is hedging only 5 percent of the index, every $100 reduction in direct claims reduces the option payoff for the insurer by only $5. In other words, the insurer receives a net benefit from any cost mitigation equal to 95 percent of the reduction in its direct claims.

Niehaus points out that, "various methods are used to mitigate [moral-hazard] problems, including costly monitoring (both ex ante and ex post) and incomplete risk sharing of catastrophe risk (i.e., deductibles, coinsurance, and [insurance] limits)."[19] Catastrophe options have attempted to facilitate a more complete shifting of risk by moving away from deductibles and coinsurance. These securities control incentive conflicts by tying the payoff to an index that, for the most part, cannot be influenced by the actions of market participants. Indexing greatly reduces or eliminates moral hazard, but this approach has failed to significantly increase risk sharing because it has been found to expose insurers to unacceptable levels of basis risk.

Insurers use reinsurance to hedge their underwriting risk. A conventional reinsurance contract provides an insurer with a perfect hedge; that is, the reinsurance payment exactly offsets insurance losses. The option payoff is based on aggregate claim payments, but since industry and firm losses are not perfectly correlated, the payoff will not necessarily offset the insurance losses suffered by the primary insurer. In fact, if little correlation

[17] A call option provides the holder with the right to buy an underlying asset at a fixed price, called the strike price. The holder exercises a call option only if the value of the underlying asset is greater than the strike price. A catastrophe option is a call option in which insurance losses determine the value of the underlying asset. In the example above, the holder exercises the option because the level of industry-wide insurance losses sets the value of the underlying asset to an amount that is greater than the strike price.

[18] Doherty (1997), 87.

[19] Niehaus (2002), 590.

exists between industry and firm losses, then it would be highly probable that an insurer would suffer large underwriting losses while at the same time receiving a zero payment on its option position. This hedging risk is referred to as basis risk, and as Harrington and Niehaus point out, "[catastrophe options] can have considerable basis risk, i.e., the losses on a particular insurer's book of business may not be highly correlated with the indices underlying the contracts so that little underwriting risk can be eliminated."[20]

Ideally, insurers would bear some amount of hedging risk in exchange for reducing moral hazard. However, the significance of basis risk can be observed from contract design. Conventional reinsurance has no basis risk since the payoff is based on insurer-specific (or hedger-specific) losses. Conventional reinsurance contracts can always be structured so that the payoff is triggered by industry losses rather than the insurance firm's own losses. "But the fact that reinsurance contracts traditionally have not been designed in this way suggests that basis risk is an important consideration."[21] In fact, "the perception among insurers that index securities are subject to unacceptable levels of basis risk has been identified [by the American Academy of Actuaries (1999)] as the primary obstacle to the more rapid development of the market."[22]

Today, trading in catastrophe options is limited to the Bermuda Commodities Exchange. In 1992 the CBOT launched an option contract based on the U.S. Property Claims Service (PCS) Index, but the volume of PCS index option contracts peaked at only 15,706 contracts in 1997 and declined to 561 contracts in 1999. The CBOT has since delisted these options because of a lack of interest. In addition to basis risk, the lack of interest might also be attributed to credit risk. A seller of a call spread is required to deposit liquid securities with the option exchange, but the size of the deposit amounts to only a fraction of the largest possible loss. With less than full collateralization, the buyer of a call spread faces credit risk similar to that involved in purchasing reinsurance. Conventional reinsurance involves the risk that the reinsurer will be unable to pay its obligations to the primary insurer. With a call spread, the insurer has a claim only on the counterparty, so these transactions expose the insurer to credit risk associated with potential counterparty default. Exchanges typically address counterparty credit risk by guaranteeing contract performance, but huge potential losses raise questions about an exchanges' ability to ensure the performance of any significant volume of contracts linked to property liability losses.

Catastrophe Bonds

Like catastrophe options, the market for catastrophe bonds has been rather slow in developing. Cummins, Lalonde, and Phillips (2000) report that markets have accommodated only about 20 catastrophe-bond issues, totaling around $3 billion of insurance coverage. High cost explains the limited interest in these securities, and, as illustrated below, high prices can be attributed to the failure of the securities to adequately address moral hazard.

United Services Automobile Association (USAA), the fourth largest U.S. homeowner insurer, issued one of the first catastrophe bonds in mid-1997, selling $477 million of one-year bonds tied to hurricane losses.[23] Buyers of these catastrophe bonds could generally expect to receive full payment; however, in the event of a hurricane, bondholders

[20] Harrington and Niehaus (1999), 50.
[21] Doherty (1997), 87.
[22] Cummins, Lalonde, and Phillips (2000), 2. However, a few studies have concluded that the basis risk associated with derivative contracts based on state-specific indices is not large. See, for example, Harrington and Niehaus (1999) and Cummins, Lalonde, and Phillips (2000).

[23] The bonds were actually sold by a special purpose reinsurer called Residential Re. For tax and regulatory purposes, this company had to be run independently of USAA. USAA paid Residential Re a monthly premium, and Residential Re used this payment plus the earnings on a portfolio of liquid securities to pay interest to bondholders. If USAA were to incur insurance losses greater than $1 billion, Residential Re would provide insurance coverage by liquidating its portfolio.

could forfeit interest and/or principal if USAA's insurance losses were greater than $1 billion.[24] By purchasing a security with event-linked payments, bondholders provided catastrophe excess-of-loss coverage for 80 percent of the $500 million risk layer between $1 billion and $1.5 billion of insured losses suffered by USAA during a one-year period in certain U.S. coastal states. That is, coverage would pay for insurance losses in excess of $1 billion, with the maximum payment capped at $400 million.

The generic design of these instruments can allow for interest and/or principal forgiveness, and the extent of the forgiveness can be total, partial, or scaled to the size of the loss. In the case of USAA, a portion of the bond issue was principal protected. Of the $477 million that USAA raised from the sale of notes, the company used $77 million to purchase ten-year U.S. Treasury strips with a maturity value equal to the $164 million of principal-protected notes. If an event resulted in USAA losses exceeding $1.5 billion, $400 million of debt would be forgiven, while the principal-protected notes would be repaid (with no interest) in ten years from the proceeds of the Treasury securities.

Debt-forgiveness instruments like catastrophe bonds avoid the credit risk that is common to reinsurance transactions—that is, the risk that the reinsurer will be unable to pay its obligations. Bondholders provide a hedge to the insurer by forgiving existing debt. Thus, the value of the hedge is independent of bondholder wealth, and the issuing primary insurer faces no risk of nondelivery of the hedge.

A catastrophe bond can be forgiven on the basis of either the primary insurer's own catastrophe losses or some industry index of catastrophe losses. Moral hazard is limited when debt forgiveness is triggered by an industry index of catastrophe losses. In the case of USAA, however, the company's book was concentrated at military establishments, so the basis risk from a debt issue with forgiveness tied to an industry index was large. Since little correlation existed between industry and firm losses, debt-forgiveness triggered by a level of industry losses would not necessarily offset catastrophe losses suffered by USAA. For this reason, USAA chose to issue bonds with debt forgiveness triggered by the level of the company's own insurance losses.

USAA's failure to use an industry index to address moral hazard may partly explain the high cost of issue for the company. Catastrophe exposures are not correlated with the returns on stocks and bonds.[25] Under the assumptions of the capital asset pricing model, the required rate of return on a zero-beta asset is the risk-free rate of return. Theoretically the interest rate on USAA bonds would be the risk-free rate plus a premium large enough to offset the expected loss of principal and/or interest due to a catastrophic event. USAA paid bondholders 451 basis points above the London interbank offer rate (LIBOR) for principal and interest forgiveness. For the principal-protected notes, USAA paid bondholders 125 basis points over LIBOR.[26] Although the estimated probability of a loss exceeding the trigger was only 1 percent, interest rates included a premium for principal and interest forgiveness of over seven times the expected loss and about twice the expected loss for only interest forgiveness.

Moral-hazard problems appear to explain the existence of such large premiums. Cummins, Lalonde, and Phillips (2000) reports that Goldman Sachs & Company estimated a median risk-premium to expected-loss ratio of 6.8 for all catastrophe bonds

[24] Notice the similarity between catastrophe bonds and the historical marine insurance described by Jaffee and Russell (1997, p. 207): "[A] market for marine insurance operated among ancient Greeks and Phoenicians and flourished in London from as early as the seventeenth century. [The insurance took the form of a loan that offered the ship owner some degree of debt forgiveness.] In . . . the so-called contract of bottomry, a lender advanced the ship-owning merchant the full cost of the voyage as a loan. If the voyage was successful, the ship owner repaid the bank at an interest rate which included a premium to reflect the risk of loss. If the ship was lost, the loan was forgiven."

[25] *See* Froot et al. (1995) for a discussion of the lack of correlation between catastrophic risk and traditional asset classes.

[26] USAA paid a total premium of 576 basis points for this layer of coverage. The premium for essentially identical coverage fell to 412 basis points in 1998 and to 366 basis points in 1999. These bonds provided no principal protection and the reduction in costs can be attributed to lower estimates of expected losses.

issued through March 2000. Employing a sampling of Florida call spread transactions, the authors in this paper estimated a median risk-premium to expected-loss ratio on Florida calls of 2.1. Like catastrophe bonds, the risk premium on call spreads might be attributed to illiquidity, uncertainty about expected loss estimates, and/or investor unfamiliarity with the contracts. However, such factors should be somewhat similar across both securities. But since only catastrophe options resolve incentive conflicts by employing industry (or sub-industry) indices, the higher premium on catastrophe bonds is likely attributable to the failure of these securities to address moral hazard by indexing.

Catastrophe Swaps and Catastrophe Equity Puts

A catastrophe swap enables insurers to diversify their risk by trading blocks of insurance policies. "Each swap [is] a bilateral agreement, creating reciprocal reinsurance between two insuring entities. . . . Property catastrophe risk varies by location, and [with a swap] participants [are] able to [trade different] types of risk (for example, hurricane risk on the North Carolina coast for tornado risk in Kansas)."[27] Since August of 1997, property catastrophe swaps have been trading on the Catastrophe Risk Exchange (CATEX). Over 1,400 listings have appeared on CATEX, and the 500-plus completed transactions involved nearly $3 billion of insured coverage. However, only a portion of these transactions involved property catastrophe risk.

A catastrophe equity put (CEPut) is a post-loss financing arrangement in which the price of the equity issue is fixed. More specifically, a CEPut is an option contract that gives the insurer the right to sell a given number of shares to a specific counterparty for a fixed price, and this option can be exercised only after the occurrence of a catastrophe of an agreed-upon magnitude (whereas the typical option can be exercised at any time during the contract period). To minimize potential moral hazard, the trigger is most often defined in terms of a level of industry-wide losses. However, defining the trigger in this way introduces basis risk. The contract also exposes the insurer to the credit risk associated with potential counterparty default, but, again, some degree of credit risk is present in all reinsurance transactions.

Reinsurance or Securitization for Deposit Insurance Risk?

As pointed out above, catastrophic insurance losses from earthquakes, hurricanes, and other natural disasters are highly correlated, with a hurricane (for example) causing damage to many homes in a particular region. Similarly, the failure of a financial institution may cause all depositors across a bank to suffer losses. Furthermore, because of population growth in exposed areas such as Florida, property/casualty losses are increasingly more correlated: one can expect *more* homes to be damaged when a hurricane hits the coast. For the FDIC, too, deposit insurance losses are *more* correlated today: because of bank consolidation, a bank failure is likely to be associated with much larger deposit insurance losses.[28] Thus, for property/casualty insurers and the FDIC alike, insuring against risk from highly correlated losses requires either reinsurance or having access to a larger pool of liquid capital to cover the larger insurance losses.

Ideally, the FDIC would obtain reinsurance coverage for its exposure to large-bank failure. The Federal Deposit Insurance Corporation Improvement Act authorized the FDIC to transfer up to 10 percent of its risk exposure to market participants, and in fact the Corporation is currently exploring a limited reinsurance program. Although reinsurance might allow the Corporation to reduce its exposure, deposit reinsurance would also involve moral-hazard and other prob-

[27] Borden and Sarkar (1996), 5.

[28] Even though potential insurance losses have increased, consolidation may be responsible for a decline in the likelihood of losses. That is, consolidated banks hold portfolios that are more diversified, so the probability of bank failure may be lower.

lems. The presence of these distortions suggests that, unless the factors producing them are accounted for appropriately, deposit reinsurance coverage would probably be available only in limited quantities and at high prices. Indeed, the cost of coverage for this large-event risk would probably mirror the pricing for catastrophe reinsurance coverage for the highest layers of risk. A recent survey of reinsurers estimated initial deposit reinsurance capacity at about $2 billion; the survey also found that reinsurers would expect to receive a premium as high as 4 percent for a layer of coverage with an annual expected loss of only 1 percent.[29]

Like reinsurance coverage for the upper layers of natural disaster risk, deposit reinsurance coverage for large banks would be characterized by the problems of size and parameter uncertainty. In addition, deposit reinsurance would probably include a premium that accounted for the presence of significant regulatory risk, including the risk of ex post moral-hazard problems. These problems arise because the reinsurer's losses could be materially affected by the FDIC's actions in regulating bank activities, resolving failed institutions, liquidating assets of failed institutions, and accounting for such activities.

Moving to an event-oriented contract might mitigate concerns about regulatory risk. Such a contract would call for a specified payment if a bank failed, rather than an amount contingent on the ultimate resolution and liquidation costs. While a contract of this type would reduce risks associated with FDIC actions related to asset sales or receivership accounting policies, it would not address regulatory risks associated with the regulation of troubled banks. Thus the challenge facing the FDIC would be to identify a contract design that minimized these and similar moral-hazard problems.

Even with such a contract, deposit reinsurance coverage would probably be subject to price and availability cycles. After the failure of a large bank, renewing reinsurance coverage would probably require the FDIC to pay premiums significantly greater than expected losses. (Of course, in the opposite phase of the market cycle, the FDIC might enjoy premiums that were lower than actuarial pricing would dictate.) And even in the absence of a large-bank failure, renewing reinsurance coverage would probably be difficult during down economic times.

Proponents of deposit reinsurance argue that reinsurance premiums could provide the FDIC with valuable pricing information. That is, the FDIC would acquire reinsurance coverage for individual banks (or groups of banks) and then use reinsurance prices to price its own risk more effectively. However, reliable pricing signals might be limited by the presence of moral-hazard and other transaction costs. Deposit reinsurance would probably involve a premium reflecting the presence of these transaction costs. As shown above, such a phenomenon exists in the pricing of catastrophe securities. Recall that the premium was found to be significantly higher on catastrophe bonds than on catastrophe options. "The most likely explanation for the difference between the premium-to-expected-loss ratios of CBOT options and catastrophe (CAT) bonds is investor concern about moral hazard—CAT bonds, most of which settle on losses of specific insurers, are potentially subject to significant moral hazard whereas moral hazard is a relatively minor concern for CBOT options."[30] If such premiums could not be disentangled from the observed prices, the cost of deposit reinsurance would provide misleading information about the underlying price of deposit insurance.

As pointed out above, property/casualty insurers are turning not to reinsurance to manage the problem of increased exposure, but to securitization—catastrophe bonds, catastrophe options, and so forth. The FDIC, too, might gain access to the pool of liquid capital it would need by similarly securitizing its deposit insurance risk.

[29] *See* Marsh & McLennan Companies (2001), 5 and 21.

[30] Cummins, Lalonde, and Phillips (2000), 32.

The FDIC could securitize its insurance risk by issuing its own catastrophe securities. More specifically, the Corporation could issue bonds (or options) with payments linked to deposit insurance losses at large banks.[31] The catastrophe in this case would be the failure of a large bank, and by issuing these catastrophe bonds, the FDIC would cede a portion of its risk to investors. In this way, the FDIC would take a less-prominent role in insuring large-bank deposits, since private markets would now absorb a larger amount of the risk of bank failure.

However, just as property/casualty securitization of risk is limited by the presence of moral-hazard and other transaction costs, securitized deposit insurance risk would probably face similar distortions. Thus, to evoke interest in its catastrophe securities, the FDIC would have to be more successful than property/casualty insurers in addressing moral hazard.

Moreover, the cost of such synthetic reinsurance coverage might be prohibitive. For the few property/casualty insurers that found a market for their catastrophe securities, investors required premiums that were significantly greater than expected losses. The FDIC could expect to pay even higher premiums. Bank failure is not completely independent of movements in the market, so catastrophe securities issued by the FDIC would not be valuable to investors for diversification purposes. It is this inability to provide the same diversification benefits as property catastrophe securities that would probably make the premium higher for securitized deposit insurance risk than for securitized property catastrophe risk.

[31] The FDIC could issue catastrophe bonds on individual banks, but such securities would introduce problems of adverse selection. Adverse selection arises when one side of a transaction has more reliable information than the other side. Disclosure is a common solution to this problem, and in an insurance market for catastrophic bank losses, the disclosure of information would address any such problems. However, it is highly unlikely that the FDIC or other federal regulators would provide investors with proprietary information on large banks. Still, the FDIC could address this problem by issuing a security with payments linked to deposit insurance losses across *all* large banks. The risk of adverse selection would then be minimized inasmuch as such a security would prevent the FDIC from (adversely) selecting only high-risk banks for securitization.

Conclusions

In an article that anticipated the capital asset pricing model (CAPM), Karl Borch (1962) defined the Pareto optimal risk-sharing arrangement in the market for reinsurance. According to Cummins and Weiss,

> In a market in which risk bearing is costly to firms but where transacting between firms is costless, the Pareto optimal risk-sharing arrangement is one in which the industry "mutualizes" its risk in the sense that all insurers hold the same net (after reinsurance) liability portfolio. According to Borch, the Pareto optimal reinsurance arrangement is one in which each insurer holds a net portfolio that is a proportionate claim on total insured losses. This result is equivalent to the CAPM proposition that each investor will hold a share of the market portfolio.[32]

In a world with no transaction costs, primary insurers would shed a large amount of their insurance risk by entering into reinsurance contracts. However, such risk shifting is constrained in the real world by reinsurance contracts that include deductibles, coinsurance, and insurance limits. Deductibles and coinsurance are introduced as a method of controlling incentive conflicts. "It may be that the most efficient form of reinsurance is to allow very little risk transfer at all: it is only by forcing . . . risk back upon insurers that reinsurers get insurers to expend resources to monitor and mitigate exposures."[33] A more complete shifting of risk would involve a movement away from deductibles and coinsurance; unfortunately, to this point, addressing moral hazard by alternative methods has been shown to expose insurers to unacceptable levels of basis risk.

The FDIC may find that it can shed a large amount of risk simply by entering the reinsurance market. Or the Corporation may find that this method of risk shifting is severely limited by the presence of moral-hazard and other problems. In

[32] Cummins and Weiss (2000), 165–66.
[33] Froot (1997), 13.

the latter case, the FDIC may decide to retain its risk. If the FDIC retains its risk, it may address its increased exposure from banking consolidation by increasing the size of the Bank Insurance Fund (BIF) (currently mandated to equal 1.25 percent of insured deposits). The appropriate size of the insurance fund will be hard to determine, but even so, setting aside huge sums of money for the rare event of a large-bank failure seems incredibly inefficient. Alternatively, the FDIC can minimize the funding of the BIF by using contingent capital, which it can do by increasing its line of credit with the Treasury (currently set at $30 billion). A larger line of credit will allow the FDIC to cover potentially huge losses while placing only limited demands on the economy's finite stock of capital.

Finally, the FDIC may consider increasing capital requirements of banks. If the Corporation requires large banks to hold more capital, this additional capital will not reduce the exposure of the FDIC to large-bank failure, even though it may reduce the likelihood that a large bank will fail. If such an event—although perhaps less likely—occurs, the FDIC will still be exposed to potentially huge deposit insurance losses. Exposure to such losses requires the FDIC to have access to a larger pool of capital, and this article has examined a number of ways that the Corporation might increase its insurance capital.

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