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## Securitizing Property Catastrophe Risk

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*The trading of property catastrophe risk using standard financial instruments such as options and bonds enables insurance companies to hedge their exposure by transferring risk to investors, who take positions on the occurrence and cost of catastrophes. Although these property catastrophe risk instruments are relatively new products, they have already established an important link between the insurance industry and the U.S. capital market.*

The costs of property catastrophes in the United States have reached unprecedented levels.<sup>1</sup> Between 1989 and 1995, total insured losses from earthquakes, hurricanes, and other natural disasters amounted to \$75 billion, compared with only \$51 billion between 1950 and 1988. The increased frequency and size of catastrophes have fueled the 1989-95 upsurge: catastrophes averaged thirty-five per year, as opposed to just twenty-five per year over the entire 1950-88 period, while the average insured loss per catastrophe reached \$302 million, up from just \$56 million.<sup>2</sup>

The enormous costs of property catastrophes have underscored the risks borne by insurance companies.<sup>3</sup> To minimize their aggregate risk, insurance companies spread insurance risk over a large number of policyholders and purchase reinsurance (insurance for insurance companies). Until recently, these have been the only mechanisms available for transferring insurance risk. However, increased catastrophe risk, coupled with limitations on insurers' use of traditional risk-reduction alternatives, has led to the development of another method of transferring insurance risk: securitization.

Since 1992, financial market innovations have enabled property catastrophe risk to be securitized—that is, traded by using standard financial instruments such as options and bonds. These instruments have created, for the first time, a direct link between the insur-

ance industry and the capital market. Individuals and businesses can take positions on the occurrence and cost of property catastrophes, just as they can hedge or speculate on the movement of interest rates or crop prices. Insurance companies, in turn, can hedge their exposure by transferring property catastrophe risk to a wide pool of willing investors.

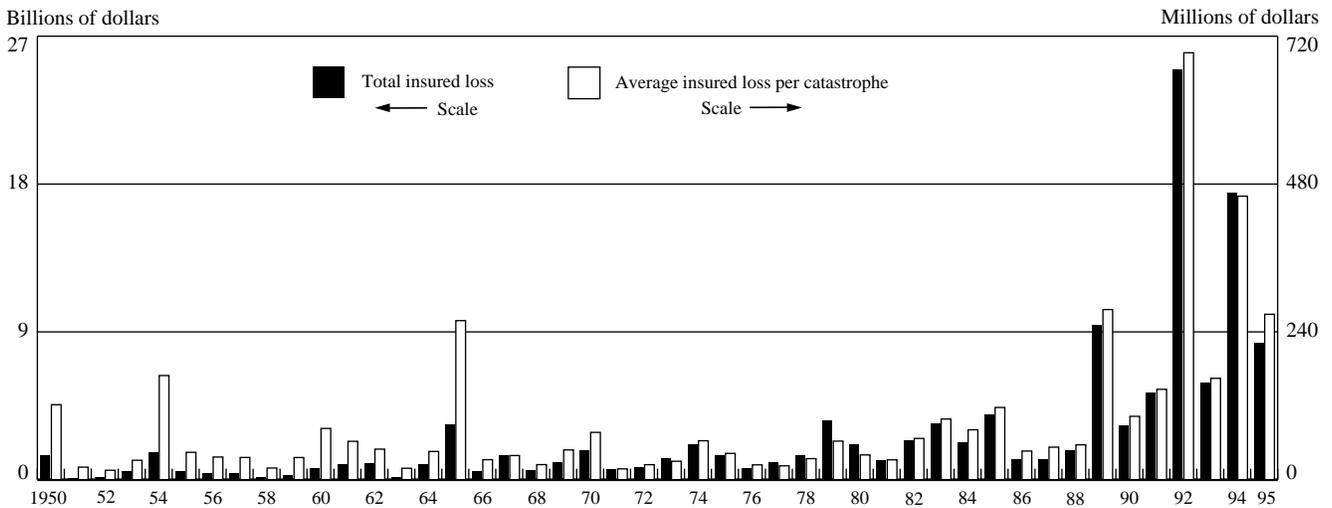
In this edition of *Current Issues*, we examine the development of catastrophe risk financial instruments. We describe catastrophe options and bonds, which are currently trading, and property catastrophe swaps, which are scheduled to begin trading later this year. We show that each instrument trades a distinct type of catastrophe risk and has unique investment risk characteristics.

### **Evidence for Increased Catastrophe Risk**

Rising catastrophe-related costs provide clear evidence that catastrophe risk has increased significantly in recent years. As noted, both the total cost and the average cost of catastrophes between 1989 and 1995 were the highest of any period since 1950 (see chart). In fact, total insured losses for this seven-year period were 50 percent higher than they were for the entire thirty-eight-year period before it.

Rapid population growth in areas vulnerable to catastrophes also indicates a continuing trend toward increased catastrophe costs. The states most at risk—

**Insured Losses Due to Property Catastrophes, 1950-95**



Source: Property Claim Services.

Note: Figures are in 1995 dollars and have been adjusted for inflation using the consumer price index as of year-end 1995.

California, Florida, and Texas—contain large catastrophe-prone regions: the Atlantic and Gulf coast regions of Florida and Texas are exposed to hurricanes, and much of California is vulnerable to earthquakes.<sup>4</sup> In each of these states, the population grew more than twice as much as the U.S. population between 1980 and 1993 (Table 1). As a result of this accelerated growth, 25 percent of the U.S. population now resides in the three states.

The rise in the proportion of individuals buying insurance in the last ten years also suggests an increase in catastrophe exposure. Approximately 76 percent of U.S. households had insurance in 1993, compared with 70 percent in 1984. The rise was due to a 46 percent jump in the proportion of renters with insurance.<sup>5</sup>

**Obstacles to Managing Catastrophe Risk**

Insurers can respond to increased insurance exposure in a number of ways. They can reduce aggregate risk by diversifying across different types of exposures. Writing policies in several states reduces the proportion

of policies in high-catastrophe-risk areas. To offset the additional risk assumed, they can also raise high-risk policyholders' premiums. Alternatively, insurers may attempt to reduce the supply of insurance in high-risk areas, either by lowering the amount of coverage or by decreasing the number of policies. They may also use reinsurance to pass on additional risk.

However, many factors limit the use of these alternatives. The benefits of further diversification are negligible because most insurance companies are already diversified across areas. Using data from 1994, we found that only 1 percent of insurance companies were concentrated in any of the three high-catastrophe-risk states.<sup>6</sup> Because these insurers sold a very small proportion of the total insurance in California, Florida, and Texas, their efforts to diversify would have minimal influence on the industry.<sup>7</sup>

Insurers also have few opportunities to manage additional catastrophe risk through premium rate increases and withdrawal from certain insurance markets. Although premium rate regulation varies by state and type of insurance, rate changes in California, Florida, and Texas require approval by the state insurance regulator. The timing and size of premium increases are significantly restricted in these high-risk states. In addition, insurance companies' attempts to exit high-catastrophe-risk insurance markets have been constrained by legislation in several states. For example, Florida has limited the number of policies an insurance company can drop upon policy expiration and California requires insurance companies to offer earthquake insurance with homeowners insurance policies.

**Table 1**  
**Population Growth in Catastrophe-Prone States**

	Growth 1980-93 (Percentage)	Population as a Percentage of U.S. Population, 1993
California	32	12
Florida	40	5
Texas	27	7
United States	13	100

Source: U.S. Bureau of the Census, *Statistical Abstract of the United States, 1994*.

Higher reinsurance prices and reduced coverage amounts have hampered insurance companies' efforts to reduce their risk through reinsurance. Average reinsurance prices increased by 126 percent between 1985 and 1994. Reinsurers also raised their "attachment point" 73 percent between 1985 and 1994. The attachment point, which functions like a deductible, must be reached before the reinsurer pays a percentage of the insurer's claims. In addition, the maximum amount of coverage available to a single insurance company declined from \$251 million in 1990 to \$240 million in 1995.<sup>8</sup> Regulatory restrictions also prevent insurance companies from responding to higher reinsurance costs by raising premiums and decreasing coverage.

### Property Catastrophe Risk Financial Instruments

Faced with increased catastrophe risk and limited means of transferring it, insurance companies in the early 1990s sought an alternative to traditional methods of managing their risk load. That alternative emerged in the form of insurance-based financial instruments such as options, bonds, and swaps.<sup>9</sup> The instruments, which securitize property catastrophe risk, enable insurers to reduce that risk by passing it on to investors, who take positions on the occurrence and cost of catastrophes.<sup>10</sup> Exchange-traded insurance options and futures began trading in 1992, over-the-counter insurance products were first issued in 1994, and insurance swaps are expected to begin trading later this year.

Each instrument trades a different type of catastrophe risk and has distinct investment risk characteristics. Catastrophe risk exposures can be specified by location, peril (such as hurricane, tornado, or earthquake),

and time of year. Instrument design determines which participants bear which type of investment risk: liquidity risk, basis risk, credit risk, moral hazard, and adverse selection (see box).

**Property Catastrophe Options.** Property catastrophe options are standardized financial instruments traded through the Chicago Board of Trade.<sup>11</sup> Buyers and sellers of these call and put options either hedge or speculate on the occurrence of a catastrophe and the resulting amount of claim payments. Typically, an option provides the right to buy or sell an underlying asset at a fixed price (called the strike price), and the option's value depends on the asset's price relative to the strike price. But with catastrophe options, an underlying asset does not exist, so an index is used in lieu of an asset price. The index is an estimate of the industry's total claim payments for catastrophes occurring within the contract period and specified region. The difference between the strike price and the index at the option's expiration determines the option's value.

Buyers and sellers of these options take a position on the claims of the insurance industry that relate to property catastrophe. The buyer of a call option receives a payoff if the industry claims exceed the amount specified by the strike price. Most trades create call spreads—a trading strategy in which a market participant simultaneously buys a call at one strike price and sells another call at a higher strike price, with both calls expiring on the same date. Buying a call spread is comparable to purchasing a layer of insurance coverage. The most commonly traded call spread is illustrated in Table 2.

### Risk Characteristics of Insurance-Based Financial Instruments

#### Liquidity risk

Liquidity refers to an investor's ability to trade quickly at prices that reflect current market demand and supply conditions. An illiquid market is often characterized by low trading volume and frequency. In an illiquid market, liquidity risk affects all market participants.

#### Basis risk

Basis risk occurs when cash flows from the hedging instrument do not exactly offset cash flows from the instrument being hedged. For property catastrophe securities, it arises when the counterparty's payments are based not on the insurer's claim payments but on an industry average.

#### Credit risk

Credit risk arises from the possibility of nonpayment due to counterparty default.

#### Adverse selection

Adverse selection exists when a seller has private informa-

tion about the true quality of its products. If the market price reflects average product quality, the seller has an incentive to sell products of below-average quality at that price. For property catastrophe securities, adverse selection may exist if the sellers (the insurance companies) alone know the true risk of their policies and if security prices reflect the average risk of all policies. Under these conditions, insurance companies may have an incentive to trade high-risk policies, and high-risk insurance companies may have a particular incentive to trade property catastrophe securities.

#### Moral hazard

Moral hazard exists when one party can take actions that affect the value of a transaction, but the actions cannot be monitored by the counterparty. For buyers of property catastrophe securities, it is the risk that, subsequent to the purchase, the buyers cannot accurately monitor whether insurers are properly managing the risk of policies upon

Liquidity risk is a concern with property catastrophe options. Instruments with low trading volumes tend to have high liquidity risk since market participants cannot easily find counterparties to their trades. Property catastrophe options trade in relatively low volumes. For example, between October 1995 and April 1996 the average monthly volume of catastrophe options traded was approximately 450, compared with 167,000 per instrument for all options on futures traded on the Chicago Board of Trade.

Several features of the property catastrophe options market may, however, lead to increased volume and lower liquidity risk in the future. For instance, noninsurance entities can participate in the market, enabling them for the first time to take positions on industrywide property catastrophe risk. Otherwise, they could take positions only on individual companies by purchasing stock or over-the-counter products. Moreover, the standardized nature of catastrophe options ensures familiarity with these instruments and facilitates market participation. Insurers and reinsurers should be attracted to the options because of their market transparency (real-time dissemination of trading information) and the variety of contract types, some simulating a traditional reinsurance contract and others providing targeted coverage.<sup>12</sup>

The other notable features of these options are directly related to the four other types of risk. The credit risk faced by all participants is minimized by the Chicago Board of Trade clearinghouse, which ensures the financial integrity of all futures and option contracts traded on its exchange. Only insurance companies face basis risk, since an option payoff is based on the aggregate industry claim payments and is unlikely to offset an individual company's claim payments. The risks of adverse selection and moral hazard, faced by the entity assuming risk (the seller of a call spread), are minimized by the standardized nature of the options and by an industry-based index. Standardized instruments prevent insurers from selecting only high-risk policies for trade. The use of an industry-based index means that the insurer bears any costs related to the risk and management of its policies.<sup>13</sup>

**Over-the-Counter Products.** The over-the-counter market has introduced two types of catastrophe risk instruments: contingent surplus notes and catastrophe bonds (also called act-of-God bonds). To date, only one contingent surplus note transaction has been completed, by Nationwide Mutual Insurance Company. This transaction did not entail the immediate issuance of surplus notes.<sup>14</sup> Instead, Nationwide retained the option to issue up to \$400 million in surplus notes to a guaranteed buyer, a Nationwide trust. Thus, investors did not buy surplus notes; they purchased bonds issued by the

trust. These Nationwide trust bonds are backed by U.S. Treasury securities. However, if Nationwide exercises its option to issue surplus notes to the trust, the collateral backing the Nationwide trust bonds held by investors would change from U.S. Treasury securities to Nationwide surplus notes. In this case, the trust would sell its holdings of U.S. Treasury securities to finance the purchase of Nationwide's surplus notes. Whether or not Nationwide issues surplus notes, investors receive the same coupon payments.

Although the Nationwide trust bonds provide a higher coupon rate than U.S. Treasury securities, investors bear the risk that the collateral on their investment may change from U.S. Treasury securities to Nationwide surplus notes. For Nationwide, the primary advantage of the contingent surplus note structure is that in the event of a catastrophe, it would have immediate access to cash because the trust serves as a guaranteed buyer of Nationwide's surplus notes.

Unlike contingent surplus notes, catastrophe bonds create a direct relationship between repayment and catastrophe. The repayment terms vary by issuance. For example, an insurance company would issue a five-year bond providing a fixed coupon rate for the first two years. If a catastrophe occurred and the associated insured losses reached the specified amount, the coupon rate would decline to a new fixed rate for the next three years; otherwise, the rate would remain at the initial fixed rate. Repayment of principal can also be linked to catastrophic occurrence.

Contingent surplus notes and catastrophe bonds share several investment risk characteristics. Low volume exposes investors in both instruments to liquidity risk, much as it does with participants in the property catastrophe option market. Moreover, the customized

**Table 2**  
**Catastrophe Option Call Spread**

**Option Trade**

Suppose a market participant ...

*buys a call* with a strike price of 20 index points (equivalent to \$2 billion of insurance claims)

and

*sells a call* with a strike price of 30 index points (equivalent to \$3 billion of insurance claims)

**Payoff**

If industry claims are:	the payoff is:
less than \$2 billion	\$0
greater than \$2 billion and less than \$3 billion	\$200 for every point over 20 index points
greater than \$3 billion	\$2,000 (\$200 X 10 points)

Note: The payoff depends on the amount of insurance claims paid by the insurance industry.

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design of the over-the-counter products may further limit investors' ability to change their positions. A contingent surplus note or catastrophe bond issuer does not face basis risk, because claim payments can be offset with the proceeds received when the securities are issued. Investors in both instruments bear credit risk because they face possible issuer default. They also face the risk of adverse selection if only those companies with larger than average catastrophe risk issue securities. Investors need to take such possibilities into account when evaluating a security's coupon payment. Because moral hazard incentives depend on how directly repayment is linked to the issuer's own catastrophe costs, investors can reduce this risk by buying securities in which repayment is determined by an industrywide figure rather than by a company-specific one.

**Property Catastrophe Swaps.** The swaps exchange, scheduled to begin operating in October 1996, will be an electronic exchange run by the Catastrophe Risk Exchange (CATEX). Insurance swap instruments will enable primary insurers, reinsurers, and self-insurers to diversify their risks by trading blocks of insurance policies in different regions of the United States. Each swap will be a bilateral agreement, creating reciprocal reinsurance between two insuring entities. Participation in this exchange will be more limited than in the options or over-the-counter markets: only the bearers of insurance risk—insurers, reinsurers, or self-insurers registered with the New York State Insurance Department—can take part.

Property catastrophe risk varies by location, and participants will be able to swap types of risk (for example, hurricane risk on the North Carolina coast for tornado risk in Kansas). The units of exchange will be standardized in terms of equivalent risks and exposure. A trading unit will be \$1 million of insured property risk, and risks will be classified by location and peril. The exchange will report the proportional relationship between different risks, called "relativities." Although industrywide catastrophe risk in the United States and its regions, as well as in the states of California, Florida, or Texas, is reflected in option prices, swap relativities represent more specific catastrophe risks. For example, one unit of Los Angeles earthquake exposure may be equivalent to two units of Long Island wind-storm exposure. The supply and demand for each type of risk will determine the relativities.

The design of property catastrophe swaps will determine which market participants bear which type of risk. Since swaps are not currently trading, volume and the associated liquidity risk are unknown. Volume will depend on insurers' demand for catastrophe risk diversification. Although very few insurers are concentrated in the three high-risk states, there may be small insurers with policies concentrated in other high-risk areas, such as the New Jersey coast.

As for credit risk, each swap participant will be exposed to its counterparty's risk of default because the swaps exchange will not serve as a clearinghouse guaranteeing trades. Basis risk will depend on the payment conditions of each individual swap agreement: if each party's individual claim payments determine its counterparty's payments, basis risk will be eliminated; if each party's payments are based on an industry aggregate, both swap participants will face basis risk.

Certain attributes of the swap design will reduce adverse selection and moral hazard incentives. Prohibiting swap participants from transferring all of their policies will encourage careful policy management and lessen moral hazard. The potential for mispricing associated with adverse selection will be reduced because swap participants will be required to provide policy and claim data to their counterparties. In addition, the exchange will randomly select the policies to be swapped, preventing insurers from trading only their highest risk policies.

### Conclusion

By establishing a direct link between the insurance industry and the capital market, catastrophe risk instruments introduce the strategic advantages of the financial markets to the insurance industry. Not only do these instruments provide insurers with more hedging alternatives, they also enable investors to participate in the property catastrophe risk market. Consequently, property catastrophe risk can be spread across a broader pool of individuals and businesses, reducing the impact of catastrophes on individual insurance companies and the insurance industry as a whole.

Since catastrophe risk instruments are relatively new financial products, their low trading volume currently exposes market participants to high liquidity risk. However, trading volume should rise as exchanges, underwriters, and insurers make these instruments more accessible and investors and other market participants become more familiar with them. Increased volume should then reduce liquidity risk and promote more competitive pricing.

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### Notes

1. A property catastrophe causes insured property damage in excess of \$5 million and affects more than 1,000 policyholders.
2. Losses are aggregate insurance industry claims and have been adjusted for inflation using the consumer price index as of year-end 1995 (data provided by Property Claim Services of Rahway, New Jersey).
3. Catastrophe risk relates to the value of property insured by individuals and businesses. When a catastrophe occurs, insurance companies receive claims from a variety of insurance policies, including homeowners and renters insurance policies.

4. Over half of the costliest catastrophes since 1950 were earthquakes and hurricanes (data provided by Property Claim Services).
5. The percentage of renters with insurance increased from 28 to 41 percent between 1984 and 1993. During this period, the ratio of homeowners to renters was stable (Insurance Information Institute 1996).
6. A company is considered concentrated if at least 20 percent of its written premiums are in one of the following insurance lines: earthquake in California and homeowners multiple peril in Florida, Texas, or California.
7. The insurers concentrated in California, Florida, or Texas represent 1 percent of the insurance industry's premiums for all property-casualty insurance lines and 4 percent of the industry's premiums in the following insurance lines: earthquake in California and homeowners multiple peril in Florida, Texas, or California. Data were provided by A.M. Best of Oldwick, New Jersey.
8. All reinsurance price and coverage figures were provided by Guy Carpenter & Company, Inc., a reinsurance broker and major source of reinsurance industry data located in New York City.
9. The concept of exchange-traded insurance has been discussed for the last twenty years. For example, see Goshay and Sandor (1973).
10. Property Claim Services, a not-for-profit company that provides information and analysis on property insurance business issues, is the single source within the insurance industry for identifying catastrophes and aggregating the corresponding insurance costs.
11. Property catastrophe options represent a type of option known as a European option, which can be exercised only on its expiration date. The other type of option, an American option, can be exercised before or on its expiration date. The Chicago Board of Trade introduced the current catastrophe options (called PCS catastrophe options because the index is provided by Property Claim Services)

in September 1995. The futures and options introduced in 1992 and terminated at the end of 1995 were American options that used an index based on insurance industry loss ratios provided by the Insurance Services Office, Inc., of New York City.

12. Catastrophe options have four specifications: strike value, geographic region, contract period, and development period (that is, the time during which loss estimates affect the loss indexes computed by Property Claim Services). The geographic regions include national, eastern, northeastern, southeastern, midwestern, and western, as well as the states of California, Florida, and Texas. Contract periods are quarterly for all regions except California and western, which are annual.

13. See Niehaus and Mann (1992) for a discussion of moral hazard and adverse selection incentives with reinsurance and futures contracts.

14. Surplus is an insurance company's statutory net worth. Surplus notes are subordinated debt obligations and are considered equity capital (surplus) for statutory purposes. Because mutual insurers cannot issue stock, they are the largest issuers of surplus notes.

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