

SYMPOSIUM ON INSURANCE FUTURES

Catastrophe Futures: A Better Hedge for Insurers

Stephen P. D'Arcy
Virginia Grace France

ABSTRACT

The Chicago Board of Trade has developed a series of futures contracts based on insurance experience that are scheduled to begin trading in 1993. Insurance futures for automobile collision coverage, homeowners, health insurance, and catastrophe losses have all been proposed. This article describes and critiques these insurance futures contracts, with an emphasis on futures based on catastrophe losses in which a single event generates sizable losses for the insurance industry. Despite the dubious prospects for the success of insurance futures, their introduction is likely to benefit the industry by drawing attention to new methods for dealing with risk.

In June 1990, the Chicago Board of Trade (CBOT) submitted for approval with the Commodity Futures Trading Commission two insurance futures contracts, one based on health insurance and one on automobile collision coverage. The proposed contracts would be based on the ratio of paid losses to written premium on policies written in a particular month. Under this proposal, information on a sample of policies would be collected from a group of insurers and disseminated regularly so futures traders could develop expectations of the ultimate settlement value. The final cash settlement on the futures would be based on the figures reported by the insurers as of four months after the policies had expired.

In February 1991, the CBOT set a target date of October 1, 1991, to begin trading health insurance futures. However, in September 1991, the CBOT announced a delay in the commencement of trading insurance futures. In January 1992, the CBOT announced that trading would commence in September 1992 on a homeowners insurance futures contract based on data collected by the Insurance Services Office (ISO). In August,

Stephen P. D'Arcy is Associate Professor and Virginia Grace France is Assistant Professor, both in the Department of Finance, University of Illinois at Urbana-Champaign.

The authors wish to thank Greg Niehaus, Greg Samorajski, Phelim Boyle, and other participants in the Options Workshop at the University of Illinois, as well as two anonymous reviewers, for their helpful comments on earlier drafts of this paper. James Welsh of Property Claim Services supplied updated information on catastrophe losses. Pyungsuk Oh and Wei-li Lu provided invaluable assistance in data collection and statistical analysis.

1992, the CBOT announced that trading on the homeowners insurance future, the health insurance future and a catastrophe future modeled on the one proposed in this paper would begin trading early in 1993.

This article describes the homeowners, health and auto insurance futures contracts proposed by the CBOT, discusses the possible benefits of a functional insurance futures market, analyzes the problems inherent in the initially proposed contracts, and explains why our alternative contract, based on insured losses from catastrophes, avoids many of the problems that affect the other CBOT insurance futures contracts.

Futures and the CBOT

Futures contracts are an institutionalized form of forward trading. Forward trading is simply the commitment of two parties to engage in the purchase and sale of a good or another financial transaction at a stated future date. Forward contracting, particularly in agricultural commodities, can be traced back to the Roman empire and classical Greece. Trading in futures developed in the 1860s, initiated by the Chicago Board of Trade. The distinction between futures and forward contracts is based principally on four attributes of futures. First, futures are traded only on an organized exchange; twelve futures exchanges are active in the United States alone. Second, futures contracts are standardized as to the quality of the item to be delivered as well as the date and location of delivery. Next, a clearinghouse is involved in every futures trade, and the commitment of each party to the trade is to the clearinghouse. The clearinghouse thus guarantees performance of the future transaction, reducing (eliminating, as claimed by futures exchanges) default risk. Finally, the major difference between futures and forward contracts is that each day futures contracts are "marked to market." Any changes in the value of a position are reflected in the accounts of the traders at the end of every trading day.

Futures contracts are now traded on a variety of goods, including the agricultural commodities that gave rise to this type of trading, metals, petroleum, interest-bearing assets, foreign currencies, and financial indices. Futures on financial indices, such as the Standard and Poor's 500 index, unlike more traditional futures contracts, cannot be fulfilled by physical delivery of the underlying commodity at expiration; instead each trader's position is closed out by a reversing trade (e.g., selling all contracts held prior to expiration) or by cash settlement. The insurance futures contracts would be settled as any other financial index. For a more detailed introduction to futures contracts, see Kolb (1985).

The CBOT's Proposed Insurance Futures Contracts

The insurance futures contracts initially proposed by the CBOT for health insurance and automobile collision coverage were devised to follow the pattern of traditional financial futures contracts. Trading would begin in the month that the policies on which the index would be based were written.

Positions would be marked to market daily, so that every day investors' accounts would be credited with any capital gains on their futures positions or be debited any capital losses that occurred that day. The contract would be based on the experience of a group of insurers on a sample of the policies they wrote that were effective in a given month. The final settlement value would be determined four months after the policies expired.

The policy requirements for inclusion in the health insurance futures index include deductible levels, minimum benefits, coinsurance provisions, group size, and a twelve-month policy term. The criteria for the automobile contract include deductible level, geographic distribution, and a six-month policy term. Thus, the health insurance futures contract would trade for sixteen months (the twelve-month policy term and four additional months for claims to be paid) and the automobile insurance contract for ten months (six-month policy term and four-month settlement period). A manager would be appointed for each type of contract to set up the pool of reporting insurers, collect the statistical information, and calculate and disseminate the index value. Coopers & Lybrand was appointed to manage the health insurance pool.

Each month during the policy term, the insurers will report to the manager written premiums and paid claims on the sample of policies included in the pool. Because the index is based on policies written in a particular month, most of the written premiums will be included in the first monthly report. Subsequent endorsements and cancellations will affect the final value of written premiums, but these changes are likely to be minor. Because the index is valued four months after the policy expires, all written premiums will have been earned by then. Thus, a fairly good estimate of earned premiums should be available early in the futures contract trading period. Paid claims will also be included in the monthly reports. Because the final index value will be based on all claims that have been paid by the insurer and reported to the pool manager by the deadline of four months after the expiration of the policies, some claims will not have been paid by then, and others will not have been included in the statistical reports for one reason or another. It is unclear whether recoveries such as salvage and subrogation will be considered, but even if they are, the early cutoff will limit the amount of recoveries included. Thus, the settlement value will be based not on ultimate incurred losses, but on a partially developed paid loss figure. Interim reports will provide some information on the final index value, but the settlement value will be unknown until the final values are released. It is this uncertainty that makes this contract suitable for a futures market.

The homeowners insurance futures contract will be slightly different from the originally proposed auto collision and health contracts. Rather than relying on individual companies to submit premium and loss reports, the Insurance Services Offices (ISO), an industry statistical organization, would provide the data on a sample of the information reported to them, supposedly without the companies' knowledge. Only policies written in December

would be included in the pool. Four futures contracts will be offered each year on policies effective in the prior December. The premium value would be earned premiums on those policies in a calendar quarter, January-March, April-June, July-September, or October-December. Losses will be claims paid within six months of the beginning of each quarter and reported to the ISO in time to be included in the final settlement to be released nine months after the beginning of the quarter.

One problem with the homeowners contract is a lag between the end of trading, which is expected to occur six months after the beginning of the quarter, and settlement, which will not occur until the ninth month. Another problem is that earthquake losses will not be included, nor will Texas experience. Finally, the insurers that report statistics to the ISO are not necessarily representative of the entire industry. For example, the two largest homeowners insurers, State Farm and Allstate, do not report their statistics to the ISO.

For the homeowners insurance future, there will be, for example, a contract for the first quarter of 1993 which will settle in September 1993. The settlement price will be based on claims incurred from January 1, 1993, through March 31, 1993, and paid by June 30, 1993, on policies effective in December 1992. To be included, paid losses will have to be reported to the ISO in time to be included in the figures released in September. The final settlement price will be $\$100,000 * (\text{Claims Paid} / \text{Earned Premiums})$.

The insurance futures price at any point in time should represent the market consensus of the final settlement value. For example, if the expected value of paid claims to premiums earned for the first quarter of 1993 for homeowners insurance policies is 40 percent, then the futures contract should be priced at $\$40,000 [\$100,000 * .40]$. If an ice storm occurred during the first quarter, then the consensus might change to expect a ratio of 42 percent. This would raise the price of the futures contract to $\$42,000$. Because the insurance futures price is likely to reflect the costs of claims for individual insurers, property insurers could use the contract as a hedging mechanism. An insurer could protect itself from an increase in claims costs by buying a homeowners future. If a general increase in claims costs occurred, the value of the insurance futures contract would increase. To reflect this change in value, the futures exchange would transfer capital from those who sold futures contracts (the shorts) to those who bought (the longs). This gain on the futures position would largely offset the unfavorable underwriting experience. Alternatively, if claims costs fell, the gain from the written policies would be offset by a loss on the futures position.

In all the CBOT proposals for insurance futures, the experience is based on policies that have already been written. This aspect of the calculation complicates the product and makes the results more difficult to both forecast and verify, because they are not figures normally cited by insurers. However, this precaution is an attempt to avoid adverse selection. If the experience on policies that have not yet been written were to be included, then the problem of asymmetric information becomes more serious. For

example, an insurer would have greater knowledge about forthcoming rate increases that would affect the paid loss ratio. Of even greater concern, regulators would know in advance about the approval or denial of rate filings that would impact the futures settlement price. The ability to profit from this advance knowledge could lead to abuse, even to the extent of deciding rate filings based on the personal investment positions of the regulators. Thus, the precautions taken to avoid this problem are necessary despite the added complications.

Potential Benefits of Insurance Futures

The original CBOT insurance futures proposal fostered a number of studies on the possible benefits of these contracts. Hofflander et al. (1991) examined how the insurance market would be affected by the availability of insurance futures and found that insurers would be willing to sell more insurance if a market for insurance futures existed, but the effect on prices was indeterminate. An important aspect of the benefit of the futures market was how closely the pool value varied in line with the insurer's own experience. The greatest benefit occurred if the values were highly correlated. Cox and Schwebach (1992) model the CBOT futures contract and options on the futures and compare the benefits of these contracts to reinsurance. Futures are found to compare favorably to reinsurance in some regards, specifically liquidity, confidentiality, and potentially lower transactions costs. Another potential advantage of insurance futures is the possibility of lowering the entry costs into the insurance business. An entity could participate in the market without having to become a licensed insurance company. Also, if used properly, insurance futures could decrease the risk of insurer insolvency. However, the advantages of reinsurance, surplus aid, targeting specific geographic markets, and perfect correlation with the ceding company's book of business, may limit the use of insurance futures by insurers.

Niehaus and Mann (1992) provide an excellent analysis of the CBOT insurance futures proposals and develop a model that shows how insurers could use futures to optimize their financial position. Their study demonstrates that, if the costs can be held low enough, insurance futures can enhance the liquidity of trading underwriting risk. Insurance futures are shown to provide risk reduction possibilities beyond those currently available through reinsurance. If insurance futures are successful, then the primary insurance market will probably benefit.

A number of other articles provide insights into the insurance futures market. Eramo (1991) describes how the CBOT proposal would function and points out the significant impact on the insurance market that a successful insurance futures contract, especially one on longer-tailed liability lines, would have. Rosenthal (1991a, 1991b, 1991c) and Hayes (1991) provide upbeat analyses of the potential of insurance futures. D'Arcy and France (1990) take a less sanguine view of the initially proposed CBOT contracts.

Sherman (1990) presents some numerical examples of how insurance futures will function and a general description of the futures market. Lewis (1990) points out a number of misconceptions in Sherman's article, and these points are addressed in Sherman (1991a). In a later paper, Sherman (1991b) attempts to explain insurance futures to actuaries and relies on the Black-Scholes option pricing model to determine appropriate prices. This application of the Black-Scholes model to futures is incorrect, as noted by Cox (1991) and Robertson (1991).

Insurance futures would be useful in hedging underwriting risk. Another risk for insurance companies relates to firm value, which is not necessarily directly affected by accounting profits and losses. In fact, there is some evidence that insurance stocks rise after a catastrophe as expected future profits increase (Shelor, Anderson, and Cross, 1992). Hedging market value risk could be accomplished through the use of put options, on either the company or the industry. Babbel (1989) discusses this issue in relation to the banking industry.

The general view of the literature on insurance futures is that, if an index that is highly correlated with nondiversifiable insurance risk could be established and a low transactions cost insurance futures market could be maintained, then the risk involved in writing insurance could be more widely spread and reduced for individual insurers. This risk reduction tool would then lower insurance prices. Most articles recognize the potential benefits of a viable insurance futures contract.

Problems with the Initial Futures Contract Proposals

Many articles have raised serious concerns about the viability of the initially proposed CBOT contract, in terms of the feasibility of creating the index, transactions costs, and the correlation with insurers' nondiversifiable risk. The insurance futures contracts proposed by the CBOT require the development of a new data set on which the settlement price of the contract would be based. Thus, insurers and other futures market participants would not know how the values related to their own experience. With no knowledge of how the futures prices move in relation to the other risks of the company, developing hedge ratios and trading strategies to minimize total risk would be difficult.

The premium and loss values used to generate the insurance futures index would be reported periodically by the pool manager before the ultimate settlement value. Although insurers are accustomed to working with incomplete data in using loss development factors to project ultimate loss experience, loss development factors are based on historical experience. Without historical experience, many insurers would be reluctant to participate in insurance futures, because the level of uncertainty would be so high. Thus, the insurance futures market would have to function for several years before many potential participants would become involved as

traders. Who would trade insurance futures in the meantime is a major concern.

Compiling the insurance futures indices for health and automobile insurance would require a minimum of ten insurers for each line to voluntarily report premium and loss information to the pool manager on a monthly basis so that no one insurer would have an inordinate impact on the index. Property-liability insurers are already required to report detailed information to statistical or ratemaking agencies. The automobile insurance data required by the pool manager would be a subset of this information. The ISO, which already collects data from member insurers, will serve as the pool manager for the homeowners insurance futures contract. However, generating the new reports would entail some expenses, especially in the initial programming to select the policies on which premium and loss information would be reported, as well as the ongoing computer runs and error checking. Three problems associated with generating this information directly from insurers are apparent.

First, the insurers reporting the information must be compensated in some way. Although the initial documentation produced by the CBOT indicated that insurers were expected to provide this information voluntarily, evidently the CBOT later decided to pay for this service, as the ISO is being compensated for providing the homeowners data. These payments raise the CBOT's administrative costs for the contract.

Second, the insurers that report data to the pool manager would have a significant information advantage over other traders. When the contract is first listed for trading, the company would have a much better estimate of the expected loss ratio on its business than other traders. Even if traders knew what percent of the pool each reporting insurer composed, they would not know the monthly loss ratio of the reporting insurers for months leading up to the beginning of trading or the loss ratio on policies with characteristics similar to the sample that is reported. Traders would also not know certain factors relevant for predicting the paid loss ratio as of four months after the policies expire. Such factors as the classification of the driver, deductible, rating territory, and length of time a policy has been insured with the reporting insurer all affect the expected loss ratio on a book of automobile insurance.

Even after a pattern of development has been established, the reporting insurers would have a significant advantage over other traders. Historical development patterns are affected by the actual cutoff date for generating a monthly report (just before or after a weekend, around a holiday, etc.). The reporting insurers would know if they were understaffed compared to earlier reporting periods, causing loss payments to be made at a slower rate. Any internal changes in claims processing—such as changing the dollar level of settlement authority for agents or office adjusters, adding or deleting coding requirements, or altering the caseload of adjusters—would affect the rate of claim payments. Because the reporting insurers would be able to trade insurance futures for their own accounts, there would be an

incentive to exploit this information. The fear of manipulation of the set of policies offered and of the exploitation of private information could be fatal to the contracts' success. Having the ISO report the data on the homeowners futures reduces this problem, because the companies are not supposed to know if their policies are included. However, the ISO member companies would have more information than other traders about such items as changes in coding requirements and cutoff dates that could affect the settlement value of the contract.

Finally, there are practical problems with an index that does not have a long history. In order to use the contracts, insurers would have to calculate the correlation between their loss experience and the futures index in order to determine the hedge ratio (the risk minimizing investment in futures). Without data to calculate such a correlation, insurers would either have to wait for the data to accumulate or guess at the correct hedge ratio. Further, there is no reason to believe that the correlation between the paid loss ratio on a small sample of business from selected insurers written in one given month of the year would be highly correlated with the full year of incurred losses the company wants to hedge. Pricing problems of one insurer in the sample may not affect other insurers. The experience of business written in a particular month may not correspond with experience on business written throughout the year.

In short, three fundamental problems are associated with generating a new index as the basis for insurance futures: encouraging insurers to provide information, dealing with the informational asymmetries resulting from having market participants provide input to the index, and the inability to calculate a hedge ratio. A better alternative would be to base the insurance futures on a pre-existing index. Such an index should be available over a lengthy historical period, represent nondiversifiable risk, and, to the greatest extent possible, not provide any participant with superior knowledge or the ability to manipulate. The next section proposes an index that meets these criteria.

A Catastrophe Index

The insurance futures contract proposed in this article is based on annual aggregate insured losses from catastrophes. The insurance industry collected detailed statistical information on losses from catastrophes until the 1970s and generated estimates of catastrophe losses since then, so creating the index should not be a problem. Further, insurers are already familiar with the historical behavior of catastrophe losses. Thus, this contract would avoid many of the problems with the CBOT's other proposed futures contracts.

Whenever a windstorm, flood, earthquake, or other natural disaster is expected to generate more than a particular level of insurance claims (currently \$5 million), the Property Claim Services assigns a catastrophe number to the event. Statistical agencies could require insurers to include this number on claims caused by this catastrophe. Estimates are made of the

Figure 1a
Catastrophic Losses, January 1949-December 1988

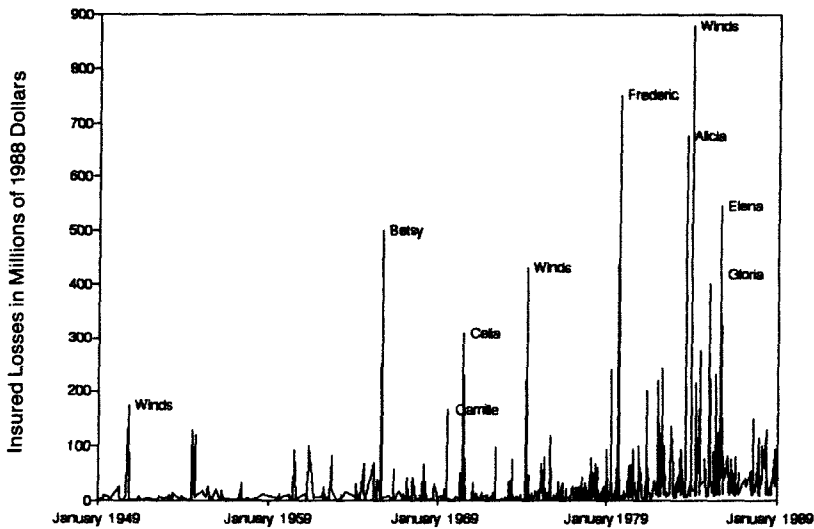
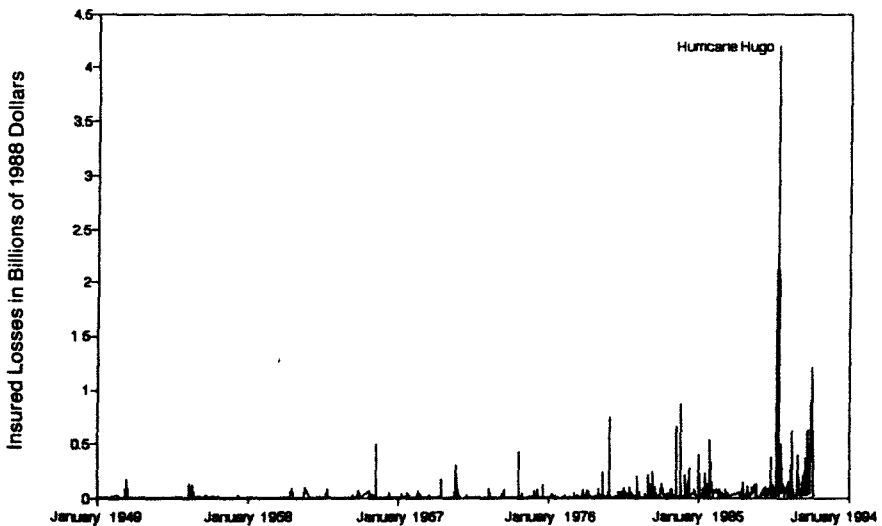


Figure 1b
Catastrophic Losses, January 1949-December 1991

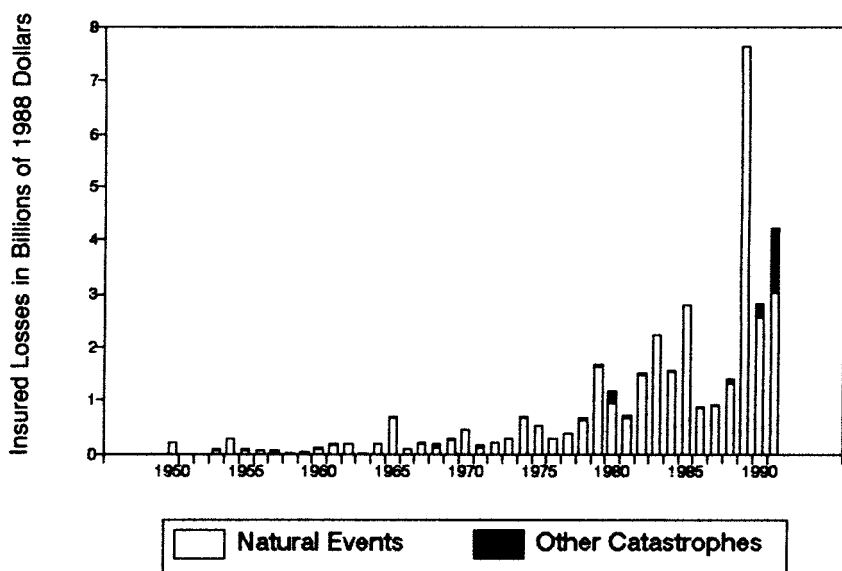


total insured damages caused by each catastrophe. Aggregate figures are published annually by the Insurance Information Institute and other sources. Figure 1a illustrates the loss payments made as a result of catastrophe losses for the period 1949-1988, and Figure 1b extends the results through 1991. Including on the chart Hurricane Hugo, which generated \$4.2 billion in

insured losses in September 1989, changes the scale enough to reduce the visual impact of earlier catastrophes.

The annual aggregate insured losses from catastrophes could serve as an effective insurance futures index. Losses from fires and riots should be excluded from this index for reasons discussed below, leaving only "natural" catastrophes, such as those caused by hurricanes, tornadoes, hail, ice storms, and earthquakes. The CBOT homeowners insurance futures contract excludes earthquakes, which represent major losses that insurance companies might wish to hedge. The annual aggregate insured losses from all catastrophes and from natural catastrophes are displayed in Figure 2.

Figure 2
Natural vs. All Insured Losses from Catastrophes



In our proposal the payoff on a catastrophe futures contract is equal to 1/1,000 times the total insured loss payments from natural catastrophes in each calendar year. A contract of this size would have had an average settlement value of about \$2.2 million over the fourteen-year period 1978-1991. If losses were less than expected, the buyer of a futures contract would incur a loss; if they were greater than expected, the buyer would have a gain.

There would be a 1993 catastrophe future, a 1994 future, etc. Trading would commence shortly before the calendar year begins, in mid-December, and final settlement would take place at the end of March of the following calendar year, by which time a fairly precise estimate of the final figure would be available. If the index is based on paid claims data, it would not reflect all the damage, because many claims would still be in process.

Incorporating case loss reserves would provide for a more accurate estimate of the final loss values but would also create the potential for manipulation of reserves. The appropriate data and cutoff would need to be established considering the problems and benefits of the different concerns. The bars in Figure 2 illustrate the final settlement value on the futures contract from year to year based on values provided by the Property Claim Services Division of the American Insurance Services Group, which estimates catastrophe losses based on data collected from a sample of companies.

An insurer or reinsurer would be able to hedge against swings in the level of loss payments by buying an appropriate number of futures contracts. In a year with heavy claims, the futures position would show a gain, which would help offset large payments to policyholders. In a year when claims were light, the futures contract would show a corresponding loss. Most hedgers would probably maintain a continual hedge, switching their position to a new contract near the start of the year. An insurer or reinsurer could establish the number of futures needed for hedging based on the following year's expected market shares of property insurance. An insurer with a well-diversified book of business that writes 3.5 percent of the property insurance market could expect to pay approximately 3.5 percent of any catastrophe losses. By purchasing 35 catastrophe futures, any divergence from the expected catastrophe loss experience will be approximately offset by the investment gain or loss on the futures contract.

For instance, if catastrophe losses turned out to be \$3 billion rather than \$2.2 billion, the insurer's losses would be approximately \$105 million (i.e., 3.5 percent of \$3 billion) rather than \$77 million (i.e., 3.5 percent of \$2.2 billion). An insurer that bought 35 futures contracts would gain \$3 billion minus \$2.2 billion times .001 per contract on each of 35 contracts, for a total of \$28 million. Thus, the gain on the futures contract would offset the loss due to the catastrophe. If catastrophe losses were lower than expected, the favorable experience would be offset by a loss on the futures contract.

Establishing the value of the contract would be relatively simple. A mechanism for tracking losses from catastrophes is already in place. When a disaster occurs which is expected to result in more than \$5 million of insured losses, it is assigned a catastrophe number, and insurers can be required to report the amount of loss payments resulting from that catastrophe. Because this index would be based on the reports of all insurers, it would not be easily manipulated by any one company or individual.

Most disasters classified as catastrophes are the result of tornadoes and hurricanes. Both types of windstorms have regional and seasonal patterns: tornadoes occur most often during spring and summer in the southern and central states, and hurricanes generally strike the East coast during late summer and early fall. Although hurricanes create the largest individual losses (as shown in Figures 1a and 1b), tornadoes are so much more common that they represent a larger proportion of the annual totals.

The value of the catastrophe future could change drastically over a short time. Hurricane Hugo generated \$4.2 billion in losses within six days. Thus, the value of a catastrophe future might have increased by over 200 percent in just a few weeks, and perhaps as much as 40 to 50 percent in one day, as investors would have observed the formation of the storm and its approach to the coastline. If the CBOT established a margin requirement of 10 percent, in line with that of other futures, such a rapid price change could lead to losses for the CBOT, because the margin would not be enough to offset the loss in value for short sellers. Thus, margin requirements are likely to be much higher for catastrophe futures to prevent this possibility.

Until 1982, a catastrophe number was assigned when insured losses from a significant number of individual claims were expected to exceed \$1 million. In 1982, this trigger value was changed to \$5 million. Although the cutoff for a catastrophe has changed (and will continue to change) over time, knowledge of the distribution of losses allows an adjustment factor to be calculated for different catastrophe level determinations.

Who Would Trade?

Both speculative and hedging interest in the contract would probably be light before the calendar year covered by the contract begins. Insurers would use futures to hedge loss experience during the year; before the beginning of the year, any change in the value of the contract would not correspond with actual losses. Also, before the start of the calendar year covered, little information about expected catastrophe losses is likely to emerge. Although hurricanes and tornadoes are more likely at certain times of the year, long-range predictions of deviations from the seasonal pattern are not reliable. Traders taking the short side of the contract in December would have no special information yet but would be simply accommodating the hedgers, in exchange for a risk premium (see Niehaus and Mann, 1992).

However, when a tropical storm forms in the Atlantic Ocean, a surge in speculative interest should occur. Traders in the grain pits at the Chicago Board of Trade have been assessing the impact of weather on grain futures for over a hundred years. Traders at the Citrus Associates of the New York Cotton Exchange are so good at predicting the temperature in Florida that there is some evidence of them being able to out-predict National Weather Service forecasters (Roll, 1984). Adequate speculative interest in a contract is considered vital to its success, since it helps increase and maintain market liquidity.

Two parts of the insurance industry would be especially interested in using this contract for hedging their risks. A long position in insurance futures would result in an inflow of capital in years when claims are higher than usual and an outflow when claims are lower. Thus, for most insurers, the futures contract would simply provide an alternative to reinsurance. However, for the largest insurers—who currently bear most of the risk for the policies they write—the reinsurance market is not cost effective. If the

futures market proves to be sufficiently liquid, it might allow the largest insurers to manage their risks more efficiently.

The second group of potential hedgers are the reinsurers themselves. Some reinsurance contracts pass off a proportional amount of claims from the originator. By purchasing shares of claims from many companies, the reinsurer can gain some geographical diversification. Small local claims should average out. However, catastrophes typically affect several states. Even reinsurers experience such events as large, undiversifiable shocks. An insurance futures contract would enable them to partially offset such risks, if they wished. Futures were made to handle precisely this type of undiversifiable risk: if the price of wheat rises or falls, the shock hits the whole country.

Property insurers of all types—automobile, homeowners, and commercial property—are affected by catastrophe losses. Insurers that are well diversified geographically and reinsurers will probably have loss experience that varies in line with the national level of catastrophes in a given year. For smaller insurers, especially those not geographically diversified, loss experience will not be as highly correlated with the national catastrophe level. However, for small insurers, the reinsurance market is an effective tool for reducing risk. Insurance futures would be an effective risk reduction tool for organizations for which reinsurance is less useful.

Another factor that would help create liquidity for a market in catastrophe futures is the fact that these catastrophes actually benefit some segments of the economy, so they might willingly trade the opposite position from insurers. Whereas property insurers suffer losses when these events occur, industries such as building supply firms and construction companies usually incur gains (see Pearl and Brannigan, 1992). However, most of these firms are local and would benefit only if the disaster occurred in their area. Also, hedging possibilities with other futures, such as crops also affected by the disaster, may serve to reduce overall risk from positions in an insurance future based on this catastrophe index. The benefit of using an index with a long historical record for insurance futures is that potential market participants could analyze their experience as correlated with the historical values of the index to determine if insurance futures could reduce risk. In this regard, our proposed insurance futures contract is superior to the original CBOT contracts. However, there may not be any natural sellers of any of these contracts.

Moral Hazard

The last thing the exchanges would want is to give someone an incentive to cause a major disaster. To avoid moral hazard, the contract should be written to cover natural catastrophes only. This would exclude from the index a few large fires and occasional riots, which are typically a very small amount of the total loss payments from catastrophes. This method will not completely avoid human caused losses, as arson and looting frequently

follow natural disasters and are included in the loss statistics for the catastrophe. However, focusing on natural disasters at least avoids giving market participants an incentive to cause a catastrophe for financial benefit. Most catastrophe losses are due to natural occurrences (see Figure 2).

There is still some element of moral hazard in catastrophe insurance, in that some losses could be avoided, fraudulent claims could be made, or reporting could be more or less complete. An insurer could benefit by misreporting or manipulating the catastrophe index. However, given that this index is based on industry figures, individual company reports would have a small impact. Unusual values would be subject to verification by the pool manager. Further, the insurance companies that provide the statistics on which the index would be based are regulated at the state level. Opportunities for manipulation are probably small.

Insurance Futures versus Reinsurance

An insurer's standard method for dealing with excessive risk is to purchase reinsurance. In a reinsurance contract, the insurance company that wrote the original policy—the primary or ceding company—transfers some of that risk to another company—the reinsurer. Some reinsurers do not write any primary business; they only accept reinsurance. Other reinsurers write both primary and reinsurance business.

Several different types of reinsurance contracts are available. Under an excess-of-loss contract, the reinsurer pays for any loss on an individual policy over a pre-established value, called the primary insurer's retention level. A primary insurer that wrote a policy with limits above the level it could comfortably handle would reinsure the amount of loss over the retention level. For example, a primary insurer could write a fire insurance policy on a \$2 million building but might feel that a fire loss of over \$500,000 would affect its financial status excessively. This insurer could purchase a \$1.5 million excess-of-loss reinsurance policy over a \$500,000 retention. The primary insurer pays all losses under \$500,000 and the first \$500,000 on any loss over the retention.

Another form of reinsurance is pro rata reinsurance. Under pro rata reinsurance, the primary insurer and the reinsurer share all losses, regardless of size, in the same proportions. In the example above, if a primary insurer wanted to limit its maximum loss on the fire policy to \$500,000 through pro rata reinsurance, it would cede 75 percent of every loss to a reinsurer. Because the reinsurer is paying on every claim and not just the large losses, pro rata reinsurance is much more expensive than excess-of-loss reinsurance. Pro rata reinsurance is generally used to meet other needs of the primary insurer, such as surplus relief or obtaining underwriting and pricing guidance from the reinsurer, in addition to reducing the impact of a large loss.

Excess-of-loss and pro rata reinsurance deal with claims that arise on individual policies. Other forms of reinsurance are available to handle risk

on the total portfolio of the primary insurer. Aggregate excess—also known as catastrophe reinsurance—applies to all losses an insurer incurs from any one event no matter how many different policies are involved. If a primary insurer purchased a \$5 million aggregate excess reinsurance policy with a \$1 million retention, and one hurricane caused \$3.5 million in covered claims on 80 different policies, all the losses over the \$1 million retention would be covered by the reinsurer. However, if the hurricane caused \$7 million in losses, the reinsurer would pay only the \$5 million coverage limit.

Finally, stop-loss reinsurance provides protection against the loss ratio of the primary insurer exceeding a predetermined level. No matter how many different losses occur or how large the individual claims are, the stop-loss reinsurance begins to pay if the loss ratio is over the set level. A primary insurer might obtain a stop-loss reinsurance contract that started paying 80 percent of all losses when the loss ratio exceeded 85 percent.

Reinsurance is an accepted method of risk transfer for insurers. Insurance regulators analyze the retention levels of an insurer during financial audits and consider the financial status of the reinsurers. In statutory accounting reinsurance recoverable is a recognized asset. Thus, reinsurance effectively reduces the variability of the primary insurer's underwriting profitability.

Direct written premiums are the total premiums on all policies that a primary insurance company writes. Reinsurance premiums, either ceded or assumed, are not included in direct written premiums. Net written premiums are equal to direct written premiums plus any reinsurance premiums written minus any reinsurance premiums ceded. Thus, a company that buys a lot of reinsurance would have a net written premiums figure well below its direct written premiums level.

One financial value that insurance regulators monitor for property-liability insurers is the premium to surplus ratio, which is calculated by dividing the net written premiums by the statutory surplus of the insurer. A ratio above 3.0 is considered unusually high. Generally, property-liability insurers have values in the 1.5 to 2.0 range. One regulatory screen of the property-liability insurance industry is the Insurance Regulatory Information System, under which a series of financial ratios for each company is determined and the number of unusual values tallied. If four or more unusual values occur for an insurer, then the company is accorded greater scrutiny to determine whether a serious financial problem exists. The premium to surplus ratio is one such test. By purchasing reinsurance, an insurer can lower its net written premiums and reduce the premium to surplus ratio. Thus, reinsurance is an acceptable method for improving the financial position of an insurer.

The CBOT insurance futures contracts are advanced as a low-cost alternative to reinsurance. However, the indices on which the futures were to be based would, at most, be only somewhat correlated with the loss experience of an individual insurer. Unlike reinsurance, which is perfectly correlated with the primary insurer's loss experience, the futures contracts

would only be an approximate hedge for loss experience. Insurance regulators do not view insurance futures as an acceptable alternative to reinsurance. Investments in insurance futures would not be allowed to reduce net written premiums, and required loss reserves would not be affected by a position in insurance futures. This position is in part due to the conservative nature of insurance regulation, evidenced by an unwillingness to accept a new technique in place of a well established one, as well as the valid recognition that insurance futures are a far less precise hedging mechanism than reinsurance.

The primary problem with the view that insurance futures can be an alternative to reinsurance is its failure to recognize that reinsurance affects the underwriting side of an insurer, and futures, insurance or otherwise, affect the investment side of insurance. The dichotomy of insurance underwriting and investment operations and the risk reducing possibilities available by properly structuring the investment portfolio have been examined previously (Tilley, 1980; D'Arcy, 1982; Panning, 1987; Casualty Actuarial Society, 1990, Chapter 8). If an insurer purchases an investment that is positively correlated with losses, then the insurer's total risk is reduced. When losses are higher than expected, the investment produces an above average gain; when losses are below expectations, investment results will also be below average. Thus, total profitability will be less volatile under this investment strategy.

Most states allow insurers to invest in futures and options, although the amount of such investments is limited to a set percentage of surplus or assets. These limitations can be found in each state's insurance laws or in summaries such as the one published by the Chicago Board Options Exchange (1991). For example, effective June 1, 1992, New York Insurance Department Regulation 142 allows property-liability insurers to invest in futures and options for nonspeculative hedging purposes to the extent of 15 percent of invested assets. These investments are treated similarly to an equity investment and valued at market values for each accounting period. A future that is correlated with insurance losses would thus be an attractive investment opportunity for an insurer. No additional regulatory approval, or sanction as an alternative to reinsurance, would be necessary. However, if catastrophe futures were treated as allowable investments only under the "basket" approach that permits a set percentage of admitted assets to be invested in any nonprohibited investment, then a potential problem could be created. When a catastrophe occurs and the value of the catastrophe futures increases, an insurer might be forced to sell these futures to avoid exceeding the limit, either immediately or just prior to an accounting period. To avoid this problem, the Illinois Insurance Department is considering separate treatment for insurance futures that are used to hedge other risks.

For a primary insurer, the purchase of catastrophe futures would be similar to buying a proportional reinsurance contract on an industry aggregate excess basis. The difference would be that reinsurance affects underwriting results, whereas catastrophe futures would have a risk reducing

effect through investment income. An option on a catastrophe future, which the CBOT may also offer, would be similar to an excess-of-loss reinsurance contract on an industry aggregate excess basis.

How Good a Hedge?

An insurance futures contract is only useful if the value of the contract tracks closely the risk to be hedged. Though catastrophe futures have many desirable properties, insurer losses from catastrophes do not represent a high proportion of the total losses to insurers. They can still represent a useful hedge, however, if changes in the futures contract value are closely correlated with changes in the profitability of insurers.

We have identified two groups of insurers that might benefit from a catastrophe futures contract, large insurance companies and reinsurers. Large insurance companies are poorly served by the reinsurance market because of the size of their exposures, but they might be able to benefit from insurance futures if the market were sufficiently liquid.

Reinsurers might also be able to use insurance futures in hedging. First, since pro rata reinsurance involves holding a portion of a large number of contracts, reinsurers' loss experience is likely to correlate relatively closely with the overall catastrophe record. Second, aggregate excess reinsurance leaves the reinsurer exposed to catastrophe losses. For these contracts, catastrophe futures are an even more obvious hedge. The correlation between the reinsurance contract's profitability and total losses on catastrophes should be high, making the futures contract a good hedging instrument.

Empirical Results

As mentioned previously, insurance claims paid on catastrophe losses are estimated by the Property Claim Services Division of the American Insurance Services Group and cited in various sources, including *Insurance Facts*, published annually by the Insurance Information Institute. Although these values are only estimates of insured losses, they represent reasonable approximations of the cost to insurers of catastrophic losses. This information has been compiled for over 40 years, so a significant loss history already exists.

The types of natural disasters that most often cause significant insurance losses—wind, hail, tornadoes, earthquakes, floods, and blizzards—are covered under property insurance policies, which are reported as a number of different lines of insurance in financial reports. Each line also includes other types of losses. This study considers the major lines under which catastrophe losses would fall: fire, allied lines, homeowners, and commercial multiperil.

Fires can also be of catastrophic proportions. For example, the brush fires in the San Francisco area in October 1991 were estimated to have caused \$1.2 billion in insured losses. The only prior larger individual catastrophe

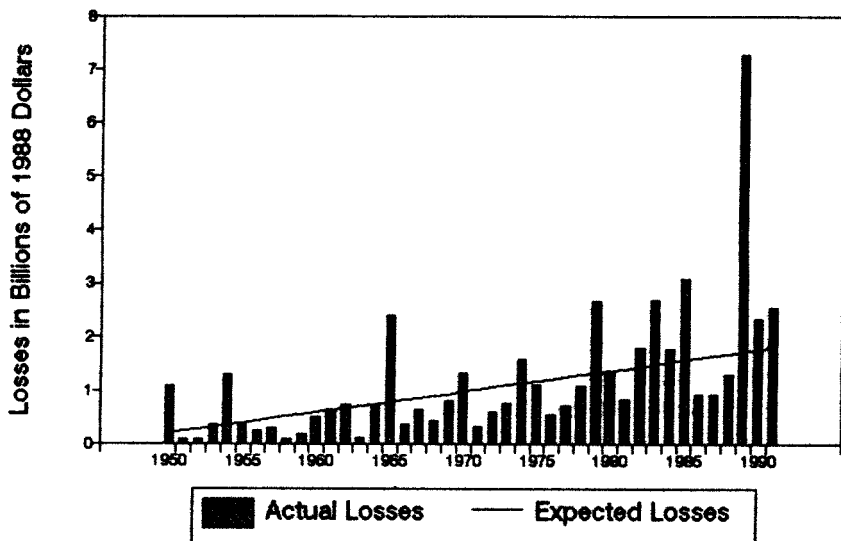
on record is Hurricane Hugo, which caused \$4.2 billion in insured losses in September 1989 (see Figure 1b). However, fires are excluded from our measure of natural disasters to reduce moral hazard in trading catastrophe futures. Otherwise, an investor holding a long position in catastrophe futures might be tempted to set a major fire to increase the value of the futures.

Statutory underwriting profit margins from *Best's Aggregates and Averages* for stock insurers and mutual insurers and for the largest primary insurers were obtained for the period 1960-1990 for each of these lines of business. The effect of catastrophes on smaller insurers should be less than on the largest insurers, because small insurers would purchase reinsurance to reduce the impact of catastrophic losses. The largest insurers tend to retain all or most of the catastrophic losses.

The catastrophic losses occurring annually from natural disasters are deflated by the Consumer Price Index to remove the impact of inflation. The deflated values still exhibit an upward trend, probably because of increasing insured property values in at risk localities, such as coastal areas (Insurance Services Office, 1990). A line fitted to the deflated catastrophes has a significant positive coefficient (see Figure 3).

Figure 3

Real Insured Losses from Natural Catastrophes



In 1989, natural disasters, led by Hurricane Hugo, caused \$7.6 billion in insured losses, a value significantly higher than the previous 38-year trend would have predicted (see Figure 3). In 1990, insured losses from natural disasters totaled \$2.8 billion, a value as high as any year before 1989. Whether these values portend a new level of losses or are simply outliers is difficult to tell at this point, although Hurricane Andrew, in August, 1992,

caused such devastation that 1992 is certain to exceed even 1989 in catastrophe losses. However, to prevent these unusually large values from distorting the calculations, all the analyses are run for the period 1960-1988 and for 1960-1990.

Using the trended value of natural disasters as the "normal" catastrophe loading, any deviation from this level would be expected to affect underwriting profitability. If the actual level of catastrophes is less than the trended level, underwriting profitability should increase. More catastrophes would mean reduced profitability (see Figure 4).

Due to the downward trend of underwriting expenses over the time period of this study, the impact of catastrophes is measured against underwriting profitability, rather than simply incurred losses. Insurers lowered commissions and became more efficient in other expense areas over the period of this study, and insurers with lower expense ratios have gained market share. For example, in 1960 the all lines expense ratio for stock insurers was 34.8 percent; by 1988 this ratio had fallen to 27.8 percent. Because lower expenses allow insurers to operate profitably at higher loss ratios, the underwriting profit margin is a more valid measure of deviation from expected results than changes in the loss ratio alone.

Roughly half (24 out of 44 for 1960-1988 and 19 out of 44 for 1960-1990) of the correlations of underwriting profitability for fire, allied lines, homeowners, and commercial multiperil for all stock insurers, all mutual insurers, and for the largest primary insurers are significant at the 5 percent level (see Table 1). Allied lines, homeowners, and commercial multiperil have more significant correlations than fire insurance. A similar pattern exists for most large insurers.

The insignificant values for fire insurance might be a result of excluding fire catastrophes or might be due to expense ratio anomalies. The fire insurance expense ratio for mutual insurers did move unexpectedly. In 1985 the ratio was 24.9 percent and in 1986, 48.4 percent. For individual insurers low correlations could be the result of reinsurance contracts that dampen the effect of catastrophic losses, the occurrence of large company-specific disasters, or expense ratio movements. Communications with one large insurer in the sample, Liberty Mutual, indicated that their reported expense ratio fluctuated significantly, and their allied lines book of business was small enough to be severely impacted by individual losses. Another explanation could be the relatively minor impact of catastrophic losses on some lines that cover many perils. For example, homeowners and commercial multiperil cover liability in addition to property losses. Liability losses, especially for commercial multiperil, could dwarf the impact of property loss fluctuations caused by catastrophes. Also, the long-tailed nature of liability claims increases the impact of interest rate changes on the acceptable underwriting profit margin for an insurer. The general upward trend of interest rates over the period studied, as well as interest rate cycles, creates an additional distortion to the underwriting profit margin.

Table 1
Relationship Between Unexpected Natural Losses
and Underwriting Profit Margins for Primary Insurers

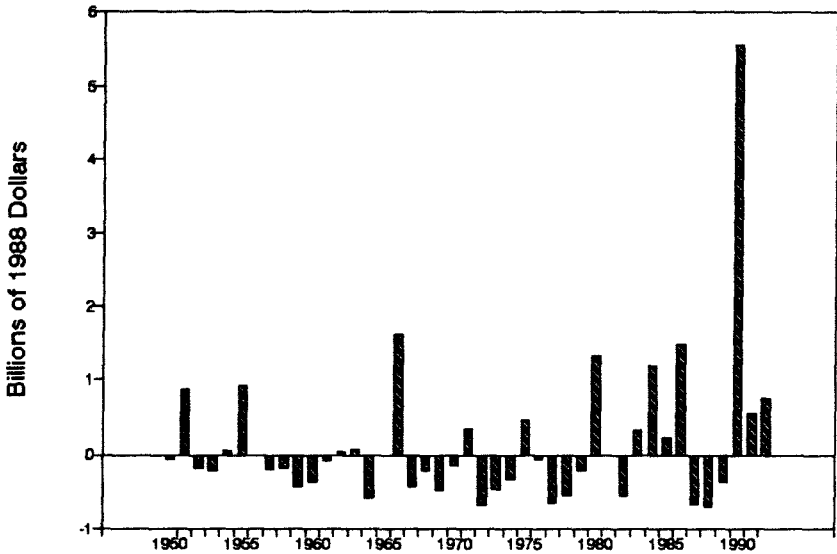
	1960-1988			1960-1990		
	R^2	T-statistic	Correlation	R^2	T-statistic	Correlation
Fire Insurance						
Stocks	0.1169	-1.890*	-0.3419	0.1583	-2.335*	-0.3978
Mutuals	0.0355	-0.967	-0.1830	0.0526	-1.268	-0.2293
State Farm	0.0094	-0.507	-0.0970	0.0275	-0.906	-0.1660
Allstate	0.0074	-0.449	-0.0681	0.0090	0.515	0.0951
Aetna	0.0288	-0.895	-0.1697	0.3281	-3.763**	-0.5728
Liberty Mutual	0.0610	-1.324	-0.2469	0.0066	-0.438	-0.0810
Nationwide	0.0348	-0.987	-0.1866	0.0218	-0.804	-0.1476
Hartford	0.1416	-2.111*	-0.3764	0.0160	-0.686	-0.1264
Travelers	0.0078	-0.460	-0.0882	0.1613	-2.362*	-0.4016
CNA	0.0256	-0.843	-0.1601	0.0029	0.291	0.0540
American International	0.0106	-0.537	-0.1028	0.1964	-2.662**	-0.4432
Allied Lines						
Stocks	0.4409	-4.614**	-0.6640	0.5359	-5.786**	-0.7320
Mutuals	0.2327	-2.862**	-0.4824	0.2712	-3.285**	-0.5207
State Farm	0.3610	-3.905**	-0.6088	0.1562	-2.317*	-0.3952
Allstate	0.1341	-1.967*	-0.3662	0.2234	-2.787**	-0.4726
Aetna	0.3098	-3.481**	-0.5566	0.3235	-3.724**	-0.5688
Liberty Mutual	0.0048	0.360	0.0691	0.0096	-0.530	-0.0979
Nationwide	0.1232	-1.948*	-0.3510	0.0375	-1.064	-0.1937
Hartford	0.0211	-0.763	-0.1452	0.2180	-2.843**	-0.4669
Travelers	0.0787	-1.519	-0.2806	0.1270	-2.054*	-0.3563
CNA	0.1297	-2.006*	-0.3601	0.0611	-1.373	-0.2471
American International	0.2130	-2.704**	-0.4616	0.3136	-3.640**	-0.5600
Homeowners						
Stocks	0.2138	-2.710**	-0.4624	0.3033	-3.553**	-0.5507
Mutuals	0.2839	-3.272**	-0.5328	0.1115	-1.908*	-0.3339
State Farm	0.1850	-2.475**	-0.4301	0.2246	-2.898**	-0.4739
Allstate	0.0834	-1.567	-0.2888	0.0720	-1.500	-0.2683
Aetna	0.1413	-2.108*	-0.3759	0.2990	-3.517**	-0.5468
Liberty Mutual	0.0069	-0.434	-0.0832	0.0573	-1.328	-0.2394
Nationwide	0.0387	-1.043	-0.1967	0.0260	-0.880	-0.1613
Hartford	0.1009	-1.741*	-0.3176	0.1080	-1.874*	-0.3287
Travelers	0.0049	-0.364	-0.0968	0.0161	-0.688	-0.1267
CNA	0.2355	-2.884**	-0.4853	0.0773	-1.559	-0.2781
American International	0.0274	-0.873	-0.1656	0.1623	-2.370*	-0.4029
Commercial Multiperil						
Stocks	0.2139	-2.711**	-0.4625	0.0633	-1.400	-0.2515
Mutuals	0.1451	-2.141*	-0.3810	0.0291	-0.933	-0.1706
State Farm	0.1697	-2.305*	-0.4119	0.1367	-2.106*	-0.3697
Allstate	0.1178	-1.827*	-0.3432	0.0098	-0.518	-0.0991
Aetna	0.1776	-2.414*	-0.4214	0.0646	-1.415	-0.2542
Liberty Mutual	0.0806	-1.538	-0.2838	0.0270	-0.896	-0.1642
Nationwide	0.1121	-1.811*	-0.3348	0.0274	-0.887	-0.1654
Hartford	0.0808	-1.541	-0.2843	0.0377	-1.066	-0.1942
Travelers	0.1669	-2.325*	-0.4085	0.0522	-1.264	-0.2285
CNA	0.1607	-2.723**	-0.4008	0.0514	-0.674	-0.1241
American International	0.0727	-1.455	-0.2696	0.0073	0.461	0.0853

Note: R^2 values and t-statistics are for ordinary least squares regressions of the form $\pi_t = a + b c_t + u_t$, where π_t is the underwriting profit ratio (1 - loss ratio - expense ratio), and c_t is unexpected catastrophic loss. C_t is the difference between actual real catastrophic loss and the trend line for this variable (see Appendix). The correlations are between π_t and c_t .

* $p \leq .05$

** $p \leq .01$

Figure 4
"Unexpected" Insured Losses



Catastrophic losses should also affect reinsurers' experience, to a greater extent than primary insurers'. However, accounting for reinsurance transactions does not always follow the same line of business allocations as the primary policy represents. The analysis of the correlation of reinsurers' underwriting profitability with the deviation from trended catastrophes shows a negative, but insignificant effect, for most reinsurers for the period 1960-1990 (see Table 2). For the period 1960-1988, the correlations for four of the seven reinsurers are significant at the 5 percent level. The effect of catastrophic losses for reinsurers is likely to be dampened by combining the results of all lines of business. Also, the distorting effects of interest rate changes on target underwriting profit margins and external influences on the reinsurance market, such as tax law changes, dilute the correlation of underwriting profits with catastrophic losses. The ideal value to measure the correlation of catastrophic losses would be a company's unexpected property losses for a year. Based on projected premium volume by line and past property losses, an insurer or reinsurer could project an expected level of property insurance losses. The difference between actual losses and the expected value represents unexpected losses, and this value could be positive or negative. Some of the unexpected losses would result from the number of natural disasters being above or below normal. This deviation could be hedged by using catastrophe futures. The correlation between the level of natural disasters and unexpected insurance losses allows an insurer to develop an accurate hedge ratio.

Table 2
Reinsurers' Relationships Between Unexpected Natural Losses
and Underwriting Profit Margins

	1960-1988			1960-1990		
	<i>R</i> ²	<i>T</i> -statistic	Correlation	<i>R</i> ²	<i>T</i> -statistic	Correlation
General Reinsurance	0.0965	-1.698	-0.3106	0.0002	-0.083	-0.0154
Employer's						
Reinsurance	0.0368	-1.015	-0.1918	0.0033	0.310	0.0575
American Reinsurance	0.1730	-2.377*	-0.4159	0.0122	-0.599	-0.1106
Swiss Reinsurance	0.2549	-3.039**	-0.5048	0.1228	-2.015*	-0.3505
Munich Reinsurance	0.1834	-2.463*	-0.4283	0.1094	-1.887*	-0.3307
St. Paul Companies	0.1261	-1.973*	-0.3550	0.0164	-0.695	-0.1280
Transatlantic-Putnam						
Reinsurance	0.0941	-1.675	-0.3068	0.0352	-1.208	-0.1875

Note: R^2 values and *t*-statistics are for ordinary least squares regressions of the form $\pi_i = a + b c_i + u_i$, where π_i is the underwriting profit ratio (1 - loss ratio - expense ratio), and c_i is unexpected catastrophic loss. C_i is the difference between actual real catastrophic loss and the trend line for this variable (see Appendix). The correlations are between π_i and c_i .

* $p \leq .05$

** $p \leq .01$

Conclusion

Solvency is a prime concern of insurance regulators. A viable insurance futures contract would provide insurers with additional opportunities to reduce the risk of insolvency. This market may prove as essential for insurance management as interest rate futures are for banks. Banking regulators now encourage banks to use interest rate futures to control their exposure to interest rate shocks.

Some insurers already trade financial futures (Hoyt, 1989), although the number is relatively low. Reasons for this low participation include unfamiliarity with these markets and a lack of appropriate risk reducing mechanisms. The CBOT's insurance futures are unlikely to change this situation. When an early draft of this article was distributed to the insurers and reinsurers whose data were used in the analysis, the companies that responded had little interest in trading insurance futures. The primary reasons cited were a lack of expertise in the area of futures in general, a concern over the default of the clearinghouse in the event of a major price change, unanswered questions about the treatment of insurance futures by regulators and rating agencies, unresolved tax issues, and a general perception of futures as speculative investments.

This article presents an index for an insurance future that avoids the problems of the other CBOT insurance futures and provides a demonstrated risk reducing method for insurers. Use of catastrophe futures would allow insurers, especially the largest primary insurers and reinsurers, to reduce the variability of total profitability. This index would have lower administrative costs and a higher correlation with profitability than the other insurance futures. Insurance futures are far more likely to become successful financial innovations if the index is based on an existing value—such as insured catastrophic losses—than if based on a new data collection process. This

preliminary analysis suggests that catastrophe futures might provide a promising hedge for some of the larger insurance companies and reinsurers. The CBOT catastrophe futures to be introduced in 1993 are not the same as the contract proposed in this paper but could function similarly.

The concerns of insurers about insurance futures will inhibit their participation in the market for these financial instruments and may cause the demise of this contract. However, even if short-lived, insurance futures could benefit the insurance industry. Insurers and regulators have been slow to adapt to financial market innovations. In part, this reluctance to get involved in new areas represents a valid risk avoidance strategy. However, another aspect of this conservatism develops from bureaucratic rigidity, an unwillingness to learn about new methods and procedures. In this regard, stifling innovation is a drawback.

Insurance futures will, if nothing else, help educate insurance companies and regulators about the futures market. A number of well established futures instruments, including interest rate and commodity futures, offer effective risk reducing opportunities for insurers. Insurers may make the effort to learn about insurance futures and decide not to participate in this market. However, that knowledge will also apply to other futures instruments that may prove useful to insurers.

Appendix Catastrophic Losses

<i>Year</i>	<i>Insured Losses from Natural Catastrophes in 1988 Dollars</i>	<i>Trend in Real Natural Losses (through 1988)</i>	<i>Deviation from Trend in Real Natural Losses</i>
1949	\$110,844,118	\$175,793,933	(\$64,949,815)
1950	\$1,090,961,618	\$214,520,152	\$876,441,467
1951	\$74,847,500	\$253,246,371	(\$178,398,871)
1952	\$79,278,857	\$291,972,590	(\$212,693,733)
1953	\$388,351,873	\$330,698,809	\$57,653,063
1954	\$1,290,085,688	\$369,425,028	\$920,660,660
1955	\$403,455,970	\$408,151,247	(\$4,695,277)
1956	\$247,038,235	\$446,877,466	(\$199,839,230)
1957	\$309,642,883	\$485,603,685	(\$175,960,802)
1958	\$83,915,225	\$524,329,904	(\$440,414,679)
1959	\$191,881,787	\$563,056,123	(\$371,174,336)
1960	\$519,560,811	\$601,782,342	(\$82,221,531)
1961	\$669,641,304	\$640,508,561	\$29,132,743
1962	\$753,281,126	\$679,234,780	\$74,046,346
1963	\$126,418,627	\$717,960,999	(\$591,542,371)
1964	\$755,059,290	\$756,687,218	(\$1,627,928)
1965	\$2,395,481,111	\$795,413,437	\$1,600,067,674
1966	\$389,951,852	\$834,139,646	(\$444,187,804)
1967	\$655,219,072	\$872,865,875	(\$217,646,803)
1968	\$432,168,937	\$911,592,094	(\$479,423,157)
1969	\$816,076,594	\$950,318,313	(\$134,241,719)
1970	\$1,335,119,165	\$989,044,532	\$346,074,633
1971	\$333,036,407	\$1,027,770,751	(\$694,734,344)
1972	\$565,338,861	\$1,066,496,970	(\$501,158,109)
1973	\$780,340,372	\$1,105,223,189	(324,882,817)
1974	\$1,593,235,605	\$1,143,949,408	\$449,286,197
1975	\$1,126,425,993	\$1,182,675,627	(\$56,249,634)
1976	\$567,870,490	\$1,221,401,846	(\$653,531,356)
1977	\$714,809,400	\$1,260,128,065	(\$545,318,665)
1978	\$1,094,436,302	\$1,298,854,284	(\$204,417,983)
1979	\$2,661,050,221	\$1,337,580,503	\$1,323,469,718
1980	\$1,348,494,234	\$1,376,306,722	(\$27,812,488)
1981	\$848,900,472	\$1,415,032,941	(\$566,132,470)
1982	\$1,792,790,345	\$1,453,759,160	\$339,031,184
1983	\$2,678,099,393	\$1,492,485,379	\$1,185,614,013
1984	\$1,762,837,943	\$1,531,211,598	\$231,626,344
1985	\$3,060,120,852	\$1,569,937,817	\$1,490,183,035
1986	\$940,696,828	\$1,608,664,036	(\$667,967,208)
1987	\$942,442,782	\$1,647,390,255	(\$704,947,474)
1988	\$1,309,000,000	\$1,686,116,474	(\$377,116,474)
1989	\$7,290,714,516	\$1,724,842,693	\$5,565,871,823
1990	\$2,317,123,183	\$1,763,568,912	\$553,554,270
1991	\$2,625,704,112	\$1,802,295,131	\$823,408,980

References

- Babbel, David F., 1989, Insuring Banks Against Systematic Credit Risk, *Journal of Futures Markets*, 9(6): 487-505.
- Casualty Actuarial Society, 1990, *Foundations of Casualty Actuarial Science* (New York: Casualty Actuarial Society).
- Chicago Board Options Exchange, 1991, *The Chicago Board Options Exchange Guide for Institutional Investors*, Use of Options by Domestic Life Insurance Companies (Chicago: CBOE), U1-U97.
- Cox, Samuel H., 1991, Insurance Futures, *Actuarial Review*, 18(2): 4.
- Cox, Samuel H. and Robert G. Schwebach, 1992, Insurance Futures and Hedging Insurance Price Risk, *Journal of Risk and Insurance*, 59: 628-644.
- D'Arcy, Stephen P., 1982, A Strategy for Property-Liability Insurers in Inflationary Times, *Proceedings of the Casualty Actuarial Society*, 69: 163-186.
- D'Arcy, Stephen P. and Virginia G. France, 1990, Will Insurance Futures Fly? *Journal of Commerce*, 386(27,337), October 19: 8A.
- Eramo, Robert P., 1991, The General Nature of Insurance Futures and the Contract's Expected Price, *Actuarial Review*, 18(2): 5-7.
- Hayes, James A., 1991, Rx for Health Care Financial Risk: Futures Contracts, *Contingencies*, 3(4): 26-29.
- Hofflander, Alfred E., Blaine F. Nye, and Jane D. Nettesheim, 1991, The Impact of Insurance Futures on the Insurance Cash Market, presentation to the Risk Theory Seminar, State College, Pennsylvania.
- Hoyt, Robert E., 1989, Use of Financial Futures by Life Insurers, *Journal of Risk and Insurance*, 56: 740-748.
- Insurance Services Office, 1990, *Catastrophes: Accurately Projecting Losses* (New York: ISO).
- Kolb, Robert W., 1985, *Understanding Futures Markets* (Glenview, Ill.: Scott, Foresman).
- Lewis, Jonathan E., 1990, Insurance Futures, *Business Insurance*, 24(53), December 31: 27.
- Niehaus, Greg and Steven V. Mann, 1992, The Trading of Underwriting Risk: An Analysis of Insurance Futures Contracts and Reinsurance, *Journal of Risk and Insurance*, 59: 601-627.
- Panning, William H. 1987, Asset/Liability Management: Beyond Interest Rate Risk, *Casualty Actuarial Society Discussion Paper Program*, 322-352.
- Pearl, Daniel and Martha Brannigan, 1992, Recession-Battered Building Concerns See a Silver Lining in Florida's Gloom, *Wall Street Journal*, 73(226), August 31: A12.
- Robertson, John P., 1991, Insurance Futures, *Actuarial Review*, 18(2): 4.
- Roll, Richard, 1984, Orange Juice and Weather, *American Economic Review*, 74(5): 861-880.

- Rosenthal, Leslie, 1991a, CBOT's Insurance Futures Open Up Huge Risk-Management Opportunities, *Financial Exchange*, 10(1): 3-5.
- Rosenthal, Leslie, 1991b, Insurance Futures, *Contingencies*, 3(1): 26-28, 48.
- Rosenthal, Leslie, 1991c, New CBOT Futures Contracts Developed to Help Hedge Insurance Risk, *Health Insurance Futures Report*, 1(1): 1-4.
- Shelor, Roger M., Dwight C. Anderson, and Mark L. Cross, 1992, Gaining from Loss: Property-Liability Insurer Stock Values in the Aftermath of the 1989 California Earthquake, *Journal of Risk and Insurance*, 59: 476-488.
- Sherman, Richard E., 1990, Attempting to Fathom Insurance Futures, *Business Insurance*, 24(46), November 12: 67-68.
- Sherman, Richard E., 1991a, Clarifying a Few Points about Insurance Futures, *Business Insurance*, 25(2), January 14: 27-28.
- Sherman, Richard E., 1991b, Actuaries and Insurance Futures, *Actuarial Review*, 18(1): 6-7.
- Tilley, James A., 1980, The Matching of Assets and Liabilities, *Transactions of the Society of Actuaries*, 32: 263-300.

Copyright of Journal of Risk & Insurance is the property of Blackwell Publishing Limited and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.