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A Solution to the Shortage of Capital in the Property Insurance Industry

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"A Solution to the Shortage of Capital in the Property Insurance Industry"

by
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April 26, 1996
Senior Research

ABSTRACT

Due to the recent increase in the severity and frequency of natural catastrophes, insurers believe that insured losses from such catastrophes can exceed $50 billion. There is not enough capital available in the insurance industry to cover such catastrophic losses. Therefore, insurers have begun looking for new sources of capital. The most promising solution is in the capital market, specifically in catastrophe insurance options. The options have a settlement index, which is the market's estimate of the losses for the covered quarter. While these options have advantages as well as disadvantages over reinsurance. The main problem hindering the market is the lack of a generally accepted pricing model. Neither option pricing models nor reinsurance pricing methods are suitable for the severity of recent catastrophes. Since a pricing model would probably dramatically increase the popularity of catastrophe insurance options, the search for such a model is the source of great discussion in the insurance industry.

DEFINING THE PROBLEM

Until 1989, there had never been a natural catastrophe that had cost the insurance industry more than $1 billion. Since 1989, there have been six (Mooney 35). Events such as these have had a dramatic effect on how insurers view their possible losses. Due to the increasing severity, as well as the unusually high frequency, of catastrophes over the last decade, insurers have come to the realization that losses resulting from a catastrophe have the potential to be much higher than originally estimated. In fact, insurers now believe that losses can easily exceed $50 billion. This realization creates numerous problems in an industry that was developed with the belief that such a catastrophe would not cost more than $1 billion.

Once insurers came to the conclusion that catastrophes could cost much more than originally believed, they immediately wanted to cover their increased exposure. First, they looked toward reinsurance companies for help in this area, since insurers ordinarily decrease their exposure with this traditional hedge. However, at the same time reinsurers came to the same conclusions as primary insurers and were afraid to offer too much coverage. As basic economic theory would predict, an increase in the demand and a decrease in the supply for catastrophe reinsurance has led to an increase in its price. A study conducted by the Reinsurance Association of America, or RAA, found that premiums increased from $11.3 billion to $12.8 billion, or 13.3%, during the first nine months of 1995. Furthermore, reinsurance premiums are growing at a faster rate than primary insurance premiums, which increased only 3.6% in the first nine months of 1995 (Gastel 2).

An extension of the problem is the shortage of capital in the reinsurance market. Most large insurance companies are able to obtain only $300-400 million in catastrophe reinsurance coverage (Gastel 1). There have been six catastrophes costing over $1 billion since 1989, including Hurricane Andrew and the Northridge earthquake, costing $15.5 billion and $12.5 billion, respectively (Mooney 35). In light of these figures, $300-400 million of reinsurance seems grossly inadequate. For example, insurers who

have a 1% share of a $50 billion catastrophe will suffer a $500 million loss. This is over the $400 million limit of available catastrophe reinsurance coverage. In other words, even insurers with a share as low as 1% cannot "lay off" their exposure in the reinsurance market (36). As a result, primary insurers are restricted in the amount of coverage they are able to write. Hence, there is insufficient capital available in today's reinsurance market to cover catastrophe losses in excess of $50 billion.

This paper will investigate a number of solutions to the capital shortage problem. Catastrophe insurance options are the most promising solution and I will therefore focus on them for a more in-depth analysis. While these options are very similar to reinsurance, there are differences, many of which are beneficial. However, there are problems, the most prominent being the lack of a pricing model. Catastrophe options trading is currently slow because of these disadvantages. Fortunately, most of the problems that are hindering catastrophe options are solvable. In fact, with a generally accepted pricing model, catastrophe options could be a very successful addition to the insurance industry.

POSSIBLE SOLUTIONS

"Act of God" Bonds

As the magnitude of catastrophe losses was brought to light, insurers began searching for new sources of capital and as a result, a number of solutions have been suggested. One new idea is "Act of God" bonds. These bonds are designed so that a "major disaster triggers some change in the underlying agreement" (Gastel 2). These bonds are issued by insurers and if a catastrophe occurs, they do not pay all or part of the principal (Ceniceros 41). If a catastrophe does not occur, the bond holder receives the principal at the maturity date of the bond. One can think of it as receiving the claim payment in advance, with the stipulation that if a catastrophe does not occur, the claim payment is returned with interest. In exchange for this loan, the insurer pays a higher than normal interest rate to the bond holder.

Catastrophe Risk Exchange

Another new innovation is called CATEX, or Catastrophe Risk Exchange. It was developed by former New Jersey insurance commissioner Samuel Fortunato. Subscribers to the system are able to trade "units" of risk, equivalent in dollar value, in order to reduce their concentration of risk. CATEX uses a set of benchmarks to measure relative values for different perils and geographic locations, and prices are determined by the actual relative loss experience between traded units of exposure (Koegel 49). To illustrate, a company could trade units of Florida windstorm for equivalent units of California earthquake (Gastel 3). This electronic trading system is an ideal method for small, local insurers to diversify their business. CATEX has the potential to develop other innovations as well. For instance, there has already been interest expressed in the financial community to use actual transaction prices as an index for secondary-market derivatives trading outside CATEX. Over-the-counter insurance derivatives trading by insurers has also been suggested. This would cut off the peaks of exposure of the primary company (49).

Surplus Note Transactions

In February of 1995, Nationwide Mutual Insurance Company pioneered yet another alternative to traditional reinsurance. In an agreement with Morgan Guaranty Trust Company of New York, Nationwide set up a trust fund which issued 30-year bonds to institutional investors. The $400 million proceeds were then invested in US Treasury securities, which served as collateral for the bonds. If at any time in the next ten years, Nationwide needs more financing, it can issue up to $400 million in surplus notes. These notes can then be substituted for the US Treasury notes which would allow Nationwide to pay its disaster claims. Under the "no utilization" option, the cost to Nationwide is the difference between the US Treasury security rate and the borrowing rate. If a catastrophe were to occur, the cost would increase (Koegel 46).

However, since the surplus notes are equity and not debt, this would not reduce Nationwide's statutory surplus which means Nationwide could write additional business (Gastel 2). Unlike reinsurance, this coverage has no trigger. Nationwide can access the funds at any time within the ten years, regardless of whether or not a catastrophe occurs. This deal also differs from reinsurance in that the note holder assumes the risk that the issuing insurer could default on repayment after a catastrophe. In the reinsurance industry, on the other hand, the reinsurer assumes timing and underwriting risks (Koegel 46).

While "Act of God" bonds, CATEX, and surplus note transactions are all viable solutions to the shortage of capital, none seem to be attracting much interest from insurers. Luckily, the Chicago Board of Trade offers yet another alternative, and this once shows a great deal of promise. That potential solution is catastrophe insurance futures and options.

Futures

The capital market is a natural place to look for large amounts of coverage since United States private financial capital totals over $13 trillion (Mooney 36). This is 100 times the $130 billion in capital that is available in the entire insurance industry (Ray 74).

The Chicago Board of Trade first introduced catastrophe futures on December 11, 1992. They represent hail, riot, flood, earthquake, or wind loss experience and are available for four geographical regions: Eastern, Midwest, Western, and National. Insurers simply choose the contract which most accurately matches their book of business (McCullough 32). The period covered by the contract is called the loss quarter and these end in March, June, September, and December. Brokerage fees are typically between $15 and $30 per contract. Settlement prices of the contracts are determined by an index prepared by the Insurance Services Office, or the ISO, and are based on the loss reports of a national pool of catastrophe policies (Ray 76). The index is comprised of at least ten of the 100 largest insurance companies that report to

the ISO and they are chosen based on their size and diversity (McCullough 32). To calculate the index, the ISO determines the loss ratio, which is incurred losses divided by earned premium, and then multiplies by $25,000, which is the face value of all contracts. The ISO then multiplies this figure by an estimated ratio of reported losses to incurred losses in order to account for reporting lags. The resulting index is essentially the market's expectations of a quarter's losses and premiums. If loss expectations rise, future contract prices rise accordingly. There is a three month reporting period, called a loss development period or run-off quarter, after the end of the quarter, plus an additional three months to collect and analyze the reports. Thus, the final settlement of a contract actually occurs seven months after the covered quarter (McLeod 34). For instance a June contract, which covers the second quarter, would not be settled until January.

CATASTROPHE INSURANCE OPTIONS

Unfortunately, since their introduction pure futures contracts have not done well. In fact, trading has been so poor that Business Insurance reporter, Michael Schachner, has described their activity as "dormant" ("CBOT CAT Instruments..." 69). Instead, there has been a shift from complete risk transfer through futures to insuring layers of risk with catastrophe insurance options, or CAT options (Lane and Lobo, A Simple Approach 1). A catastrophe spread option is a bullish vertical spread, which is defined as the buying one call option and writing another with a larger exercise price but the same expiration date. It is called bullish because investors profit from a rise in the underlying asset, vertical because it has two different exercise prices, and a spread because it is made up of two options (Wilmott 38). These options are essentially "insurance without the principle of indemnity" (Lane and Finn 2). In order to prevent fraud, an insured is normally required to have an insurable interest in the covered property. This means that the insured must lose something if the insured property is ruined. Therefore,

people cannot buy a policy to cover something they do not care about, and then destroy it in order to receive the insurance money.

Options are similar to futures, with the exception that the owner has the right, but not the obligation, to settle at a specific price within a specific period of time. Therefore if the ISO ratio exceeds the option strike price, insurers would exercise their options. The value of the option is the difference between the index value and the strike price. Thus, if a catastrophe occurred, the index value would increase and that difference would help offset losses. On the other hand, if a catastrophe does not occur, the strike price is not reached, and the seller keeps the fee paid by the insurer. These scenarios are equivalent to an insurer buying reinsurance and then filing a claim versus an insurer purchasing reinsurance, filing no claims and losing the premium. Call options are similar to reinsurance in that layers of coverage can be obtained. These layers, or call spreads, are accomplished by purchasing a call option at one price while selling a call option at another price. The lower strike price is equivalent to the ceding company's retention, which is essentially a deductible for insurance companies. For instance, a company may buy a call option with a 50% loss ratio and sell a call option with a 75% loss ratio. This effectively allows the buyer to hedge against a loss ratio within a certain range, in this case between 50% and 75%.

In 1995, in an effort to improve their product, the Chicago Board of Trade announced that catastrophe options would be based on loss estimates provided by the Property Claims Service, or PCS. Following a catastrophe, PCS uses three techniques to arrive at their loss estimates. First, PCS conducts a general survey of insurers. This survey represents 70% of the market, based on premium-written market share. Second, PCS utilizes the National Insurance Risk Profile, or NIRP, which is an inventory of buildings and insured vehicles in over 3100 counties in the United States. An on-the-ground survey is the final technique utilized by PCS (CBOT, A User's Guide 11). The PCS index is the total

estimates of insured losses in the covered area during the appropriate period divided by 100 million (CBOT, The New Standardized Alternative 14). Thus, one point on the index is equivalent to $100 million of losses industry-wide. The indices represent nine different regions. They are National, Eastern, Northeastern, Southeastern, Midwestern, Western, and 3 state indices, Florida, Texas, and California. These three states are considered "catastrophe-prone", and therefore receive their own index (2). The California and Western contracts have annual loss periods because their catastrophes are not seasonal, while the other seven regions have quarterly loss periods (4). Furthermore, insurers can purchase contracts with loss development periods of either six-months or twelve-months (5).

Premiums are quoted in points and tenths of points, each point equaling $200 and each tenth of a point equaling $20 (16). Strike values are listed in multiples of five points (15). PCS also offers both "small cap" and "large cap" contracts. These caps limit the amount of aggregate industry losses that can be covered under a contract. A small cap contract covers losses from $0 to $20 billion while a large cap covers losses from $20 to $50 billion (CBOT, A User's Guide 4). In other words, the small cap contract settles at the lesser of (a) $200 x the settlement value of the index or (b) $40,000 ($200 x 200 cap). A large cap contract covers losses from $20 to $50 billion and settles at the lesser of (a) $200 x settlement value of the index, with a lower bound of $40,000 or (b) $100,000 ($200 x 500 cap) (CBOT, The New Standardized Alternative 15,17).

ADVANTAGES OF CATASTROPHE INSURANCE OPTIONS

By utilizing catastrophe options, insurers can essentially freeze their loss ratios, spread their exposure, and increase capacity. These are obviously phenomenal advantages to insurers. But catastrophe options have even more to offer. First, the pricing index is straightforward, understandable, and easily accessible, particularly with the PCS index. In addition, in many ways CAT options offer more flexibility than reinsurance. First,

options allow insurers to get a lower retention level since they can buy coverage below the attachment point offered by the traditional reinsurance market (CBOT, The New Standardized Alternative 8). That is, insurers can obtain claim payments at lower loss levels. Second, if insurers decide they have too much, or not enough, coverage they can easily sell, or buy, more options. In contrast, reinsurance prices and conditions are locked in after lengthy and costly negotiations. This feature can also help alleviate the volatility of the insurance industry. By allowing easy entry and exit, capacity can rise and fall with the industry's needs, thus "smoothing out" the peaks and troughs of the insurance cycle ("USA..." 2). Third, insurers do not have to worry about their premium relative to the rest of the industry. Premiums of CBOT options are public and prices are the same for all option users (CBOT, The New Standardized Alternative 5). Fourth, reinsurers can diversify their business by selling catastrophe options in a region where there is normally no opportunity to write business (9). Fifth, insurers can use catastrophe options to avoid reinstatement fees. Often, a reinsurance contract will require such a fee after a catastrophe occurs in order to keep the contract in effect. In other words, a primary company must essentially buy a new contract, although at a cheaper price, for the remainder of the period. However, if a catastrophe occurs in September, an insurer could opt to purchase a December contract to cover the remaining quarter rather than paying a reinstatement fee (10). Furthermore, any new method for covering catastrophic losses will increase competition for reinsurers, which will lead to lower prices. Finally, and perhaps most importantly, PCS options are guaranteed by the Board of Trade Clearing Corporation, or BOTCC. The BOTCC is a separate entity from the exchange and it exists "to ensure the financial integrity of all futures and options contracts traded at U.S. futures exchanges" (CBOT, A User's Guide 60). Considering the BOTCC's large amount of capital, there is, in fact, less risk of default than there is with reinsurance.

After considering the simplicity, flexibility, and

predictability of losses of catastrophe options, insurers may soon begin choosing this new path instead of reinsurance. Yet trading of catastrophe insurance options and futures on the Chicago Board of Trade has been slow. If these derivatives have so many positive characteristics that reinsurance does not, why are they trading poorly? Perhaps it is because despite their numerous advantages, catastrophe derivatives also carry some distinct disadvantages. These problems fall into into three categories: the risk associated with the options market, the newness of the market, and basis risk.

DISADVANTAGES OF CATASTROPHE INSURANCE OPTIONS

Risk Associated with the Market

Many still consider the capital market to be a "crapshoot" (Ray 77). In other words, derivatives are high risk and speculative, particularly for the often conservative insurance industry. Derivatives are not the traditional way of doing business, are often viewed as "trendy", and have not proven themselves over the long term. This hesitancy is understandable considering the fact that many insurance companies "pride themselves on the simplicity and strength of their current condition" (McCullough 35).

The reputation of the capital market has caused a shortage of buyers and sellers. Outside investors have not yet attempted to play this new market. It was originally hoped that pension fund managers would enter the market as sellers. However it was soon discovered that such companies did not want to risk losing their customers' pension funds. Perhaps Michael Smith, an industry analyst with Lehman Bros. in New York, summed it up best when he said "What? Pension funds betting on the weather? It better not be mine or yours" (Schachner, "CBOT CAT Instruments..." 72). This lack of investors also creates a liquidity problem. Since the CBOT wants contract prices to be based on the index rather than demand, it has placed a limit on the number of purchases, sales, or holdings that are allowed as long as the market is small. However, this means that large insurers cannot buy enough to hedge

properly and contracts cannot be bought or sold on short notice. Consequently, a catch-22 is created. Liquidity would improve if more companies participated in the market, but more companies will not participate until liquidity improves (McCullough 35).

In order for any market to be successful it must have buyers and sellers. While buyers and sellers of catastrophe insurance options are scarce at the moment, there is a place for them in the market. Investors just need to open their eyes to the possibilities. The Chicago Board of Trade has identified three groups of potential buyers: large insurers, reinsurers, and small insurers (McCullough 31). Large insurers would utilize these options because they have a well diversified portfolio risk. Therefore, their losses are more likely to correlate with the index. They also have more historical data in order to compare their loss history with the index over several years (33). The same advantages are true for reinsurance companies. In contrast, small insurance companies would buy more regional contracts than national contracts. They would also have to look more closely at their historical data in order to see how their losses correlate with the index. However once this is determined, they should be able to decide which contracts are best for them (33).

Next, the market needs sellers of catastrophe options. Bill Scott, Finance professor at the Katie Insurance School at Illinois State University said, "To play in this market you have to have deep pockets. Sellers can build up some pretty major capital over several years. But if something like Hurricane Andrew hits, you can meet God in a hurry" (Schachner, "CBOT Cat Instruments..." 71). Fortunately, there are potential investors who have deep enough pockets.

Hedgers are one group of sellers who could utilize these new products. Since catastrophe options are uncorrelated with bond prices, investors could use the derivatives to diversify their portfolios (CBOT, The New Standardized Alternative 2). As an employee of Guy Carpenter said, "Insurance risk can be considered an asset class. And it's diversification for investors" (Schachner, "Protecting Against the Big One..." 5). Building

supply firms and construction companies could also benefit from selling catastrophe insurance options. Their profits after a catastrophe are inversely related to that of the insurance industry. Their demand increases due to repairing damaged buildings. Likewise, if insurers have low claims following a catastrophe, construction companies have a low demand. These players could add depth and liquidity to the market (McCullough 33).

Others may want to enter the market as speculators. A study conducted by Lane Financial of Chicago found that speculators can make a profit by selling these derivatives. Tables IIa and IIb compare the relative premiums of catastrophe spreads to the relative premium of T-bond spreads using prices for the 1994 September Eastern contract.

TABLE IIa: Relative Premium of 40/60 CAT Option vs. T-bond

Position	Futures Price	(A) Lower Strike Price	(B) Upper Strike Price	Volatility	Prob. Above Lower Leg	Prob. Above Upper Leg	(C) Market Premium	(C) Black Model Premium	Relative Premium [C/(B-A)]
CAT option		40	60		13.64%	9.09%	6.5		32.5%
T-Bond	118	124	125.37	9.41%	13.64%	9.09%		0.1531	11.15%

TABLE IIb: Relative Premium of 100/120 CAT Option vs. T-bond

Position	Futures Price	(A) Lower Strike Price	(B) Upper Strike Price	Volatility	Prob. Above Lower Leg	Prob. Above Upper Leg	(C) Market Premium	(C) Black Model Premium	Relative Premium [C/(B-A)]
CAT option		100	120		6.82%	4.55%	3.5		17.5%
T-Bond	118	126	127.14	9.11%	6.82%	4.55%		0.0634	5.57%

(Lane and Lobo, <u>More Premium</u> 2-3)

Lane Financial chose the strike prices of the spread so that the probability of the lower strike of the bond option finishing in-the-money is the same as the probability of the lower leg of

the CAT spread finishing in-the-money. Similarly, the probability of the upper leg of the bond option finishing in-the-money and the upper leg of the CAT option finishing in-the-money are equal (Lane and Lobo, More Premium/Less Risk 1). The catastrophe insurance probabilities are based on histograms from simulated settlement values for the September Eastern Catastrophe index using a 10% constant growth rate while probabilities for the T-bond were computed using the Black futures option model (1). Technically, when the risk of these two options are equal, their relative premiums should be equal as well. However, the relative premium for both the 40/60 and the 100/120 CAT spreads are approximately three times that of the bond call spread. In other words, catastrophe spreads offer much more premium for the same amount of risk. This suggests that catastrophe spreads may be overpriced. Or "perhaps the market is pricing in features that are presently unknown" (2). No matter what the reason, it is definitely an incentive for sellers to enter the market.

Thus, insurance catastrophe options are desirable for speculators as well as hedgers. When these sellers are added to the three groups of buyers suggested by the CBOT, large insurers, small insurers, and reinsurers, a market for these options becomes a very real possibility.

A New Market

The second category of problems arise from the fact that the market is still very young. While the Chicago Board of Trade is finding ways to improve upon the product every day, CAT options were introduced just four years ago, in December of 1992.

Regulation, which differs from state to state, is a prime example of a problem resulting from the newness of catastrophe options. For instance, California's insurance code requires that "the insurer's relevant underwriting experience or insurance-related risk exposure bear a correlation to the risk exposures of the index underlying the insurance...options thereon entered into as part of the hedging transaction" (Koegel 48). If that correlation ceases to exist, the contract will be terminated as

soon as possible (48). Illinois was the first state to address regulatory standards for catastrophe derivatives (McCullough 34). Here it was decided that insurance derivatives would be allowed but they must be treated as investments rather than reinsurance (Koegel 48). Many states, following Illinois' lead, have investment-basket clauses. In order to prevent the profitability of insurers from being dependent upon the outcome of their investments, they are prohibited from having "baskets of investments" (McCullough 34). This means that regulators have placed limits on the amount of investments insurers can hold and on the riskiness of those investments. Consequently, the amount of coverage insurers are able to obtain through the capital market is usually significantly lower than the amount needed for an effective hedge (31). Within the area of regulation, accounting procedures are a concern. Currently, there are no standards for accounting procedures for catastrophe insurance derivatives. This is creating a sense of confusion about the market, which only serves to hamper its success even further (34). In order to be completely successful, catastrophe derivatives will need appropriate decisions from state regulators. Proper regulation could provide a favorable atmosphere and at the same time, assure the general public that options will not affect the stability of their insurance companies. Currently however, most regulatory bodies are not making any decisions. They are waiting to see how accurately catastrophe derivatives perform (McCullough 34).

Another problem associated with the new options is that they are only available on the Chicago Board of Trade. The market has not had time to expand and is therefore geographically limited to the United States. This is obviously a problem for insurers with international catastrophe coverage. On the other hand, a study conducted by Swiss Reinsurance Company based on 1992 data found that at $30.6 billion in premiums, the United States is the largest supplier of reinsurance among top nations. The study also concluded that the United States has the highest demand for reinsurance. In fact, insurers here pay $43.3 billion in premiums for business ceded and retrocessions, which is reinsurance for

reinsurers. That translates to 28.9% of the world-wide non-life reinsurance premiums (Gastel 1). In other words, although options are limited to the United States, a significant portion of the world-wide market is able to utilize this hedging technique. Furthermore, the market could eventually expand internationally.

Basis Risk

Basis risks, which are "risks arising from differences between the way the property/casualty insurance market works and the way the [Chicago Board of Trade]...market works" (McLeod 35). An example of a basis risk is the limited reporting period. The settlement date of a contract allows only a three month reporting period after the covered quarter. Thus, if there is a significant amount of incurred-but-not-reported losses, or IBNR, the settlement price of a contract will not accurately reflect losses. Therefore, hedging with derivatives is unsuitable for long-tail lines, such as liability insurance.

Basis risk is often a question of whether the indices are accurate assessments of losses. One way to measure the basis risk of CAT options is to study the "industry" trigger and then adjust for market share. For example, a $10 billion trigger and a 1% market share company in Florida translates to a $100 million attachment point, which is the point at which the insurance would be activated. Insurers can use historical data for these calculations and the resulting theoretical numbers can then be compared with actual damage. The closer these figures are, the more accurate the index and the lower the basis risk (Schauble 1).

The ISO index was tested after the Northridge earthquake in Los Angeles. Northridge was the biggest catastrophe to occur since the CBOT listed catastrophe contracts, so the earthquake was a good test for the accuracy of the index (Lane 1). The earthquake was covered by the March, 1994 contract, and ISO's loss estimates as of March 31, 1994 were approximately $2.2 billion. At the same time, PCS loss estimates were $4.5 billion and A.M. Best estimates were $5.3 billion (Lane 2). Obviously, ISO's figures were low. However, there are five possible explanations

for these differences. First, ISO does not try to estimate ultimate net loss, which is the object of A.M. Best's estimates. Second, none of ISO's sample companies are on A.M. Best's "under review" list. This removes companies that are writing more poorly than others from the index. Third, perils covered by the ISO index differ from those in A.M. Best's loss estimations. For instance, both sprinkler damage and fire following an earthquake are not considered ISO perils but are on A.M. Best's list of perils. Table I illustrates this idea further.

TABLE I: Losses according to ISO

	CALIFORNIA		ALL OTHER STATES	
LINES	4th Qtr 1993 (FINAL)	1st Qtr 1994 (INTERIM)	4th Qtr 1993 (FINAL)	1st Qtr 1994 (INTERIM)
Allied Lines	2.0	2.3	12.1	22.4
Commercial Auto PD	0.1	0.8	10.4	3.0
Commercial Multi-Peril	1.8	259.1	14.7	23.5
EARTHQUAKE	0.0	1833.5	0.0	1.0
Farm	0.8	1.5	8.1	5.1
Fire	0.2	0.4	1.3	1.5
Homeowners/Mobile	18.6	18.6	77.4	164.0
Inland Marine	2.8	101.6	34.8	64.3
Personal Auto PD	2.7	30.8	86.8	39.2
TOTAL	29.1	2,248.6	247.7	324.2
Premium Base	1,746.1	1,819.5	10,495.9	11,164.8
Loss Ratio	1.7%	129.6%	2.4%	2.9%

(Lane 2)

The table shows ISO's loss figures for the December 1993 contract and the interim results for the March 1994 contract, which includes the Northridge earthquake. Losses are further divided into two groups, California and all other states. This table demonstrates that the Northridge Earthquake had substantial effect on only four lines of coverage: earthquake, commercial multi-peril, inland marine, and personal auto PD (physical damage). It is also interesting to note that winter storm damage did not affect ISO's loss estimates. This is because "freeze" and "flood" are also not included in the loss index (Lane 2). The fourth explanation is that the lack of IBNR losses in the ISO

index creates a significant difference in estimates. Finally, the ISO is concerned with pure loss while A.M. Best takes loss adjustment expenses into account. As mentioned earlier, the CBOT has attempted to improve upon some of these differences in PCS options. Like A.M. Best, PCS considers all perils and include IBNR. However, like ISO they are concerned with pure loss only (3). These flaws were exemplified in ISO's final loss ratio for the contract covered by the Northridge Earthquake. The March, 1994 contract closed with a 105.8% loss ratio, or a $26,450 settlement price per contract. Considering the catastrophe's final losses totaled $12.5 billion, these figures were extremely low (Lane 2). As Dena Karras, who is in charge of market development for the Chicago Board of Trade, says, "We're only as good as the industry reports we get...If those are slow and underestimated, there isn't much we can do" (Schachner, "CBOT CAT Instruments..." 71). Unfortunately, insurance companies can only hedge as well as their losses correlate with the index.

Once again, there is a solution to the problem of basis risks. First, as the CBOT makes improvements to the index, basis risk will decrease. The PCS index is already one improvement over the ISO index. Second, reinsurance companies could fill in the gap by selling coverage for basis risks. For example, primary companies could purchase reinsurance for fire following an earthquake, which is a peril not covered by catastrophe options.

Proponents of insurance catastrophe options remain optimistic because all of these problems are solvable. Prospective buyers and sellers simply need time to learn about the market and acclimate themselves to the new idea. Insurers have been buying reinsurance for a long time and it is not surprising that they need some convincing in order to leave that security. However, with a little education, investors' misconceptions could be corrected (McCullough 35). One suggestion for finding solutions to many of the CAT options obstacles is for the CBOT to interact with potential investors. This would encourage participation and perhaps even create other derivatives (35). Richard Sandor, chairman and chief executive officer of Center Trading Partners in

New York and a pioneer in the field of financial futures, believes that, "Like all things, it will take time and education. If you recall, 10 years ago we were using typewriters, not PCs" (Schachner, "CBOT CAT Instruments..." 70).

PRICING

The Problem

The hottest topic related to catastrophe insurance options is their pricing. In fact, lack of a generally accepted pricing model is probably the main reason the market has not been more successful. Within the pricing debate, expected losses are obviously the major factor. Many methods of predicting losses are based on historical data and the assumption that loss trends of the past will continue into the future. However, due to the low frequency of catastrophes, historical data is often lacking (Lane and Finn 2). Hence, it seems beneficial to study a longer period of time in which case inflation becomes an important consideration (Cozzolino 3). On the other hand, the magnitude of catastrophe losses has increased over the years. Explanations for this include an increase in population density along coastal regions and increased construction costs. This suggests studying a more recent history (Lane and Lobo, A Simple Approach 2). Obviously, trying to predict the future by studying historical trends has numerous complications and involves making many assumptions. It is possible, however, to make an educated guess. Reinsurance companies do it every day.

Reinsurance Pricing Methods

Each reinsurance company uses its own pricing method and one could spend years trying to learn them all. Three common methods of pricing catastrophe reinsurance are Pareto, comparable cover, and experience rating. All three methods use past loss experience (Lane and Finn 2). The Pareto distribution, which models the severity of catastrophes, is often used in conjunction with the Poisson distribution, which models frequency (Cozzolino 5). The Pareto distribution has a "fat-tail" and is therefore a good

estimate for extreme values of insured losses such as catastrophes. The Poisson distribution, or "the distribution of rare events," is well suited for measuring catastrophe frequency (5). Reinsurers use the Pareto and Poisson distributions to fit historical data and find the expected value of losses. This method results in consistent pricing, but does not consider factors such as the market's perception of catastrophe frequencies or changes in supply and demand of risk capital (Lane and Finn 2). Comparable cover consists of comparing a new reinsurance contract to another one that is slightly different. For instance, one contract may have more risk or less coverage. By making slight adjustments to the original, a price can be established for the new contract (Grandisson). Experience rating includes payback or rate-on-line (Lane and Finn 2). Rate-on-line, or ROL, is the ratio of premium to exposure. In other words, it is the premium divided by the upper limit of coverage. Payback is 1/ROL. The resulting number tells reinsurers the minimum number of years they would have to receive payments from the primary company in order to pay for a loss of the policy limit, ignoring interest. This does not take into consideration investment income. For instance, a 5% ROL translates to a payback of 20. This means the reinsurer does not want a loss to occur more than once every 20 years. Otherwise, they will not have made enough money from the contract to pay for a claim and still make a profit (Grandisson).

Many reinsurers also utilize modern technology to estimate future catastrophe losses. Computer programs are becoming the latest craze in today's reinsurance industry. One well-known program is called CATMAP. To use this program, a reinsurer enters data about the exposure being priced into the computer, such as the premium and the location. The computer then applies Monte Carlo simulations to 10,000 years worth of catastrophes. Sometimes it assumes the best case scenario, in which there are no losses, sometimes it assumes the worst case scenario, in which full coverage is needed, and sometimes it assumes scenarios in between. In the end, the program gives an average loss, which can then be used to price the contract (Grandisson). CATMAP is just

one of many of these types of programs. Eurocat, for example, is another popular program and is designed for catastrophe coverage in Europe. Other programs are designed for specific types of catastrophes, such as windstorms or earthquakes.

Unfortunately, Pareto, comparable cover, experience rating, and computer programs are all based on historical data. Since catastrophe losses have only recently become exceedingly high, there is not enough historical data regarding losses in excess of $1 billion. Thus, reinsurance pricing models are not a suitable solution for the pricing of catastrophe insurance options. Perhaps the solution lies in the pricing of options.

Option Pricing

The value of options consists of two factors, time value and intrinsic value. The time value is the difference between the option value before and at the expiration date, and is affected by the volatility of the underlying asset and the time to maturity. The higher the volatility and the more time to maturity, the greater the time value (CBOT, A User's Guide 18). Intrinsic value is the difference between the strike price and the stock price. An option has intrinsic value if it is in-the-money (18).

In 1973 in "The Journal of Political Economy", Fischer Black and Myron Scholes published a model for the pricing of options that "rocked the financial world" (Lane and Finn 2). Their model has become commonly known as the Black-Scholes model. Most new ideas for the pricing of options, including computer programs are based on this formula. In the derivation of the Black-Scholes formula, seven assumptions are made. They are:

1) Short-term interest rate is known and is constant through time.

2) The asset price follows the lognormal random walk. The variance rate of the return on the stock is constant.

3) The stock pays no dividends or other distributions.

4) The option can only be exercised at maturity. This is known as a European option. Catastrophe options are considered European options because they are not exercised until the settlement date.

5) There are no transaction costs in buying or selling the stock or the option.

6) It is possible to borrow any fraction of the price of a security to buy it or to hold it, at the short-term interest rate.

7) Short selling is permitted (Black and Scholes 640).

The Black-Scholes equation is

$$C(S,t) = S \times N(d_1) - (E)(e^{-rt}) \times N(d_2)$$

where

$$d_1 = \frac{\log(S/E) + (r + 1/2\sigma^2)(t)}{\sigma t^{1/2}}$$

$$d_2 = \frac{\log(S/E) + (r - 1/2\sigma^2)(t)}{\sigma t^{1/2}}$$

and

S = current value of the underlying asset
E = exercise price
t = time to expiration
r = interest rate
σ = volatility

(Wilmott 100).

The equation states the value of a call option as the probability that the option will be exercised, $N(d_2)$, times the discounted exercise price subtracted from the current stock price multiplied by another probability factor, $N(d_1)$ (Nielsen 1). $N(d_1)$ is the factor by which the present value of an exercised call exceeds the current stock price (2). Both probability distributions are risk-adjusted and assume that the distribution of stock prices is lognormal (12).

Lars Tyge Nielsen, an Associate Professor of Finance at INSEAD in France, explains the formula using a very simplified method. Notice that the payoff of the call option at maturity T is

$$C_T = \max\{0, S_T - E\} = \begin{array}{ll} S_T - E & \text{if } S_T \geq E \\ 0 & \text{otherwise} \end{array}$$

(3).

The equation represents the fact that the value of the option will be the difference between the value of the stock and the price paid for the stock if the exercise price is less than the value of the stock. The payoff will be 0 if the exercise price is greater than the stock price. Assuming the option finishes in-the-money, this value has two components. One is the payment of the exercise price. It is

$$C_1 = \begin{array}{ll} -E & \text{if } S_T \geq E \\ 0 & \text{otherwise} \end{array}$$

The second component is the value of the stock, defined as

$$C_2 = \begin{array}{ll} S_T & \text{if } S_T \geq E \\ 0 & \text{otherwise} \end{array}$$

(4).

By finding the expected values of C_1 and C_2 separately, it is easier to find the value of the option. The current value of C_1 is the exercise price, discounted at a riskless rate to the present value. Thus

$$E(C_1) = (-e^{-rt})(E) \times P\{S_T > E\}$$

$P\{S_T > E\}$, or the risk-adjusted probability that the option will finish in-the-money, is $N(d_2)$. Therefore, the present value of the exercise price is

$$(-e^{-rt})(E) \times N(d_2)$$

which is the second component of the Black-Scholes equation (4).

The expected value of C_2 is a conditional expectation. That is, it is the value of the option given that the option finishes in-the-money. In mathematical terms, this means

$$E(C_2) = [E(S_T \backslash S_T > E)] \times P\{S_T > E\}$$

Once again using a risk-adjusted probability for P, this is equal to

$$(e^{rt})(S) \times N(d_1)$$

Nielsen then multiplied by e^{-rt} to discount to present value, which resulted in

$$S \times N(d_1)$$

(6).

Placing the two components together, once again results in the Black-Scholes formula.

$$C(S,t) = S \times N(d_1) - (E)(e^{-rt}) \times N(d_2)$$

Under the given assumptions, any derivative security that is paid for up front and whose price depends only on 'S' and 't' must satisfy the Black-Scholes equation (Wilmott 44). It would therefore seem that the formula would be perfect for those who wish to invest in catastrophe insurance options. However, some of the assumptions of the model are often incorrect.

The first problem stems from assuming that the stock price is distributed lognormally. In reality, the stock market is not this predictable. Likewise, this assumption does not apply to the catastrophe options market since losses are not lognormally distributed. In addition, the Black-Scholes model overprices deep in-the-money options (Gibson 145). When a catastrophe strikes, a CAT option will most likely be deep in-the-money, since losses, and thus the index, will be very high. Therefore, the theoretical price of the options at this time would be too high. Another problem with the model has to do with the standard deviation, s, which measures the variability of the stock price over a certain period of time. Unfortunately, the assumption of constant volatility is not always correct. This can be shown by finding the implied volatility, which estimates volatility without the use of historical data (Lane and Finn 3). It is calculated by substituting r, S, E, t, and the market option price into the Black-Scholes formula and solving for σ. The result represents

the market's estimation of volatility. If t, r, and S are fixed, the implied volatility should be constant. In reality, however, options that are deep in-the-money have a greater implied volatility than those at-the-money. The graph of this phenomena is called the "volatility smile." Depending on market conditions, the smile may be lopsided, or even a frown. Specifically, catastrophe options are more volatile at the end of the season (Lane and Finn 7). Furthermore, volatility is greatest during the loss period (CBOT, A User's Guide 20). In any event, volatility is not constant and there is a flaw in the Black-Scholes model (Wilmott 66). Mark Rubinstein, finance professor at the University of California at Berkeley, said "What people have observed is that when stock prices go up, volatility tends to go down. When stock prices go down, volatility goes up. Black-Scholes assumes that does not happen" (Hemmerick 1). It is important to realize that historical volatility and implied volatility are only estimations. The correct volatility is the one which actually occurs. This is known as the realized volatility (Lane and Finn 3).

The Insurance Value of Options

While most people associate the value of options with their intrinsic values and their time values, many forget the feature that distinguishes an option from other financial assets, the insurance value. It is this component that insurance companies are utilizing in catastrophe options. Therefore it is beneficial to study it more closely by neutralizing the intrinsic and time values (Brenner 25). One method for doing this is to assume the present value of the strike price equals the current stock price. Then

$$S = E \times e^{-rt} \qquad \{1\}$$

where e^{-rt} is the present value factor. Then

$$S \times e^{rt} = E \qquad \{2\}$$

The option is therefore considered to be at-the-money on a forward basis (26). {2} is substituted into the Black-Scholes equation for d_1 and d_2, obtaining

$$d_1 = \sigma(t^{1/2})(1/2) \qquad \{3\}$$

$$d_2 = -\sigma(t^{1/2})(1/2) \qquad \{4\}$$

The cumulative normal density function can be written as:

$$N(d) = 1/2 + (2\pi)^{-1/2}(d-d^3/6+d^5/40...). \qquad \{5\}$$

Using a first order approximation, which means dropping any terms that are of the third order or higher, and substituting equations {3} and {4} into equation {5}, we arrive at

$$N(d_1) = 1/2 + .2\sigma_t \qquad \{6\}$$

$$N(d_2) = 1/2 - .2\sigma_t \qquad \{7\}$$

where $\sigma_t = \sigma(t^{1/2})$ is volatility. Next, equations {2}, {6}, and {7}, can be substituted into the Black-Scholes equation, obtaining

$$C \approx .4S\sigma_t \qquad \{8\}$$

(28).

This result is the insurance value of the option. It can also be thought of as the insurance premium (25). Furthermore, the value of a put is

$$P \approx 0.4S\sigma_t \qquad \{9\}$$

This is tabulated using the put-call parity, which says

$$P = C + (E)(e^{-rt}) - S \qquad \{10\}$$

Notice that the two values are equal. This is because puts and calls provide the same service, insurance, after the effects of intrinsic and time values are taken away (26). For instance,

investors who want to sell short are hoping the price of the stock will decrease. In order to guard against the possibility of an increase in stock price, investors can buy a call option. Then if the price of the stock rises, the short sale will lose money, but the investor can exercise call option. This transaction will make a profit and help offset losses. Similarly, a put option can be bought to insure against a decrease in stock price.

The best method of pricing catastrophe insurance options would combine the models for pricing options with models for pricing catastrophe reinsurance. While finding the right combination has proved to be a difficult and much debated subject, there are a number of viable solutions.

Pricing Catastrophe Insurance Options

In 1993, Morton Lane and Steve Lobo of Lane Financial published a simple suggestion to the problem of pricing catastrophe options. They began their procedure by developing synthetic histories from loss estimates from 1949 through 1992. Lane and Lobo obtained their loss estimates from the Property Claims Service and adjusted the data to a 1991 basis in five different ways. The first three methods assumed a 6%, 10%, and 15% constant growth rate. In these cases, the formula is

$$\text{Adjusted Loss} = e^{x}(\text{current year loss})$$

where x = (assumed growth rate) x (1991 - current year) (Lane and Lobo, <u>A Simple Approach</u> 6). The fourth method adjusted current year losses assuming that the growth rate for a specific year is equal to the growth in the Consumer Price Index between that year and 1991 multiplied by the growth in the population between that year and 1991. The formula is

$$\text{Adjusted Loss} = (\text{current year loss}) \times (1 + \%\Delta\ \text{CPI}_{\text{current year to 1991}}) \times (1 + \%\Delta\ \text{population}_{\text{current year to 1991}}).$$

The final method assumed that the growth rate is equal to the growth in nominal GNP between a specific year and 1991. This formula is

Adjusted Loss =

$$(\text{current year loss}) \times (1 + \%\Delta\ GNP_{\text{current year to 1991}}) \quad (6).$$

Lane and Lobo then divided the adjusted losses by the 1991 premium (2). Attachment I shows the resulting loss ratios for the September Eastern Catastrophe.

Next, Lane and Lobo created histograms and placed the results in bins, as shown in Attachment II. Obviously, this can be done for any of the five adjusted loss scenarios as well as any catastrophe spread and contract quarter. As an example, the results on Table III assume a 10% constant growth rate and the 40/60 spread.

TABLE III: Expected Value of the 40/60 CAT Spread

Index Settle	Frequency (A)	Probability A/(Sum of A)= (B)	40/60 CAT Settle (C)	Expected Value = BxC
<40	38	86.36%	0.0	0.00
>40 & <50	1	2.27%	5.0	0.11
>50 & <60	1	2.27%	15.0	0.34
>60	4	9.09%	20.0	1.82
Total	44	Expected Value of 40/60 Spread		2.27

(Lane and Lobo, A Simple Approach 2)

Column A displays the frequencies from the information in Attachment II. The probability of a loss ratio being below 40, between 40 and 50, between 50 and 60, are given in column B. The settlement value of each scenario, which was the midpoint of the loss ratio bin, is given in column C. The expected value of the spread, which in this case is 2.27 (2).

As mentioned earlier, historical data of catastrophes has changed over the years. Therefore, it may be more desirable to

apply the same method to more recent history. Table IV displays the results of such an application.

TABLE IV: Expected Value of the 40/60 CAT Spread

Index Settle	Frequency (A)	Probability A/(Sum of A)= (B)	40/60 CAT Settle (C)	Expected Value = BxC
<40	8	80.00%	0.0	0
>40 & <50	0	0.00%	5.0	0
>50 & <60	0	0.00%	15.0	0
>60	2	20.00%	20.0	4.00
Total	10	Expected Value of 40/60 Spread		4.00

(Lane and Lobo, A Simple Approach 3)

This expected value was calculated using data from the last ten years only. As predicted, the resulting expected value is higher, which suggests a higher premium (3). Again, an increase in population density in the coastal regions and increased construction costs have resulted in higher catastrophic losses. Thus, when more recent historical data is used, expected losses are higher.

The expected value method has another useful application. It can be used to compare the relative prices of different CAT spreads, either for the same loss period or across different loss periods. For example, the expected value of the 60/80 catastrophe spread is 1.48, while the 80/100 spread's expected value is 1.36. These figures suggest that the expected values of catastrophe spreads decline more rapidly at lower levels than at higher levels (2).

This is just one suggestion for the pricing of catastrophe options. There are many others. For instance, a separate distribution could be modeled for each cause of losses. In other words, hurricanes, snowstorms, earthquakes, and other types of catastrophes would have their own distribution (Lane and Lobo, A Simple Approach 3). Another possibility is a model that somehow accounted for IBNR. Unfortunately, until a generally accepted method is found for pricing these options the confusion and

uncertainty will only serve to hinder this market's chances for success.

One effect of this pricing confusion is that it makes it difficult for insurance companies to know if they are paying a reasonable price for this form of reinsurance. One way to get a better idea of the fairness of an option price is to study implied loss distributions. The idea behind implied loss distributions, or ILDs, is similar to that of implied volatility. Catastrophic losses are often assumed to follow some statistical distribution. The distribution is fitted to historical data and it is once again assumed that the trend will continue into the future. Like implied volatility, this process can be reversed by using market premiums to derive the best statistical distribution of losses (Lane and Finn 2).

Since option pricing models assume that the price of the underlying asset is lognormally distributed, the price of a call option is the expected value of all outcomes in which the option finishes in-the-money. This is discounted to present value. Then

$$\text{Options Price} = \text{PV} \sum[(\text{value}_i)(\text{probability}_i)]$$

where value_i is the ith price minus the strike price and the probability_i is the lognormally distributed probability of that outcome. However, this distribution is not appropriate for catastrophic losses because the probability of a catastrophe is too small and the normal distribution does not have a long enough tail. With the proper parameters, a Gamma distribution has a long enough tail (3). Lane Financial used a proprietary algorithm to search the Gamma distributions and select the one that best fits the current market prices. The resulting implied loss distribution is an explanation for those prices (4).

Attachment III shows the ILDs for the third quarter Eastern catastrophes, which is where the most trading has taken place. An important observation to make is that there is a significant difference in the ILDs of the three years. The 1993 line reflects the fact that insurers believed that the probability of high

catastrophe losses were low compared to the probability of lower losses. In 1994, the market thought that the probability of large events was greater compared to 1993, while their perception of the probability of smaller events was lower than in 1993. One possible explanation for this belief is the occurrence of the Northridge Earthquake in January of 1994. Insurers became scared and therefore, demand went up and they were willing to pay more for coverage, and they did. 1995 prices settled in between the previous two years. The changes in these prices can also be seen in Table V, which gives the theoretical prices of 50 and 150 calls, using rate-on-line (4).

TABLE V: Theoretical Prices (ROL%)

	1993	1994	1995
50 Call	11%	20%	15%
150 Call	4%	11%	7%

(Lane and Finn 4)

Table V once again illustrates that changes in supply and demand, in the both the reinsurance market and at the Chicago Board of Trade, have a great effect on the prices. Insurers can also use theoretical ROLs to compare the prices of catastrophe options with traditional reinsurance.

Insurers can also measure the value of options by comparing theoretical prices to the actual bid and ask prices. Table VI displays the theoretical prices with the bid and ask prices as of February 15, 1995.

TABLE VI: Actual vs. Theoretical Prices
Eastern Catastrophe Contracts
Third Quarter 1995

Instrument	Bid/Ask	Theoretical Price
Calls		
100	8.5/12.0	10.0
150	4.0/5.5	3.5
190	0.2/0.9	0.5
Call Spreads		
35/55	6.2/7.5	7.0
45/65	6.0/6.5	6.1
50/70	5.3/5.5	5.7
60/80	4.0/5.5	5.0
140/160	1.5/2.0	1.9

(Lane and Finn 7-8)

According to Table VI, pricing is reasonable, with the exception of the 150 call, which is overpriced, and the 50/70 call spread, which is underpriced (8).

PREDICTIONS FOR THE FUTURE

At the present time, catastrophe options are not being utilized to their fullest potential. This is probably largely due to a fear of the unknown. In other words, "CBOT insurance options have not taken off yet because they just don't look like insurance" (Sclafane 6). Insurance companies are not risk-takers. On the contrary, they are well-known for their stable, conservative philosophies and thus, none of them want to be pioneers in this new market. However, if companies would just give catastrophe options a chance, they could be very successful. As stated earlier, the market is caught in a catch-22. No one wants to buy CAT options because no one else is buying CAT options, but if insurers would enter the market, others would follow and performance would improve.

What can be done to increase trading? The answer is in the pricing. In fact, this problem has occurred before. Prior to 1973, options were bought and sold over-the-counter and trading was "virtually non-existent" (Copeland 283). On April 26, 1973,

the Chicago Board of Options Exchange, or CBOE, introduced options for trading (240). At nearly the same time, Fischer Black and Myron Scholes introduced their pricing model. By the end of 1974, volume of the CBOE was larger than that of the American Stock Exchange, and today, options are considered an integral part of the stock market. In fact, the volume of options traded daily on the New York Stock Exchange is greater than that of physical stocks. Trading has expanded to include markets such as Tokyo, London, Paris, Singapore, and Geneva (Gibson 181). The publication of the Black-Scholes pricing model was most likely a major factor in the explosion in the volume of trading. A similar phenomena could occur for catastrophe options.

In the end, as in all markets, supply and demand determine prices for futures, options, and insurance. The market sets the ultimate price and as Table V illustrated, it is setting a fair one for CAT options. Insurers simply need a model to assure themselves that they are paying a good price for their coverage. Once a standardized method of pricing is found, history could repeat itself and catastrophe insurance options would be a substantial addition to the capital market.

Attachment I

Synthetic History

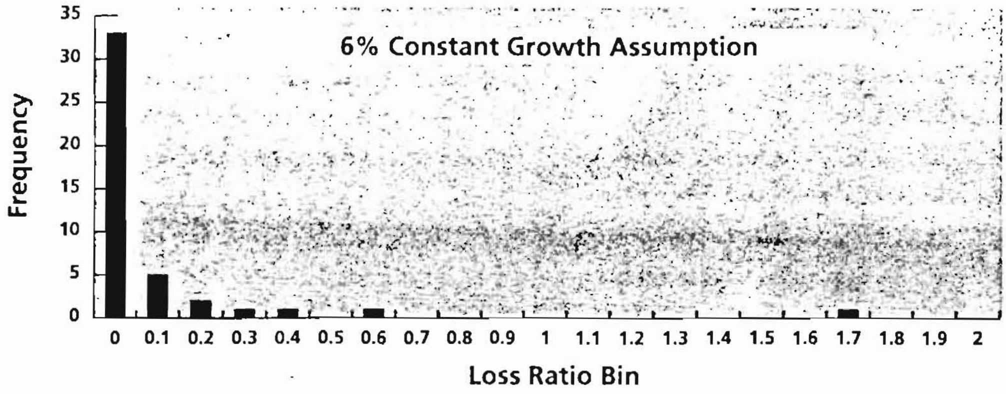
Simulated Settlement Values
for September Eastern Catastrophe Contract

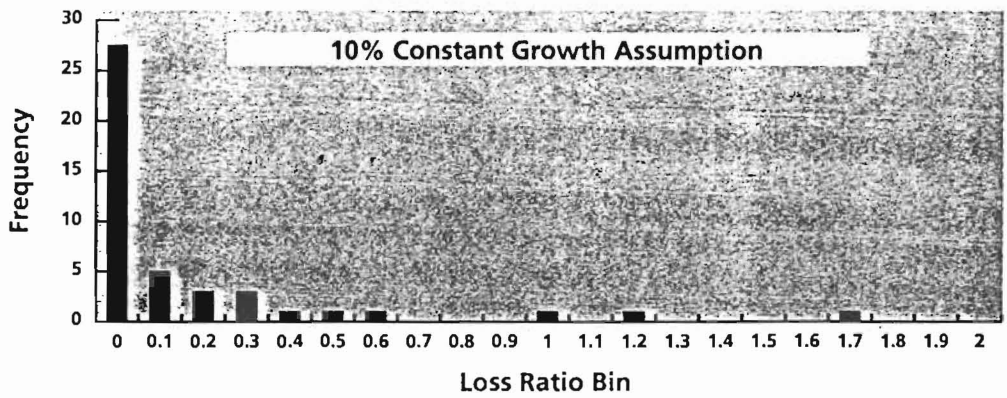
			Adjustmen factor for losses				
	Loss	Number	6% Constant	10% Constant	15% Constant	CPI &	
Year	Quarter	of Events	Growth	Growth	Growth	Population	GNP
1949	3	1	1.80%	9.68%	79.04%	1.35%	3.12%
1950	3	0	0.00%	0.00%	0.00%	0.00%	0.00%
1951	3	0	0.00%	0.00%	0.00%	0.00%	0.00%
1952	3	0	0.00%	0.00%	0.00%	0.00%	0.00%
1953	3	1	0.18%	0.82%	5.49%	0.15%	0.28%
1954	3	4	24.82%	109.03%	693.39%	20.97%	40.53%
1955	3	2	4.50%	19.01%	114.99%	4.00%	7.09%
1956	3	1	0.53%	2.14%	12.33%	0.49%	0.84%
1957	3	0	0.00%	0.00%	0.00%	0.00%	0.00%
1958	3	1	0.63%	2.37%	12.34%	0.60%	1.06%
1959	3	2	2.49%	8.97%	44.41%	2.42%	4.11%
1960	3	1	10.22%	35.32%	166.42%	10.24%	17.22%
1961	3	2	11.03%	36.61%	164.10%	11.35%	18.95%
1962	3	0	0.00%	0.00%	0.00%	0.00%	0.00%
1963	3	1	0.47%	1.44%	5.83%	0.52%	0.80%
1964	3	2	7.00%	20.61%	79.49%	7.95%	11.80%
1965	3	1	42.86%	121.25%	444.89%	50.54%	70.85%
1966	3	0	0.00%	0.00%	0.00%	0.00%	0.00%
1967	3	3	6.22%	16.25%	53.95%	7.67%	10.02%
1968	3	0	0.00%	0.00%	0.00%	0.00%	0.00%
1969	3	2	10.92%	26.32%	79.08%	13.74%	16.77%
1970	3	1	19.11%	44.26%	126.48%	23.80%	29.56%
1971	3	5	1.55%	3.46%	9.40%	1.93%	2.35%
1972	3	1	0.00%	0.01%	0.02%	0.00%	0.00%
1973	3	3	0.45%	0.92%	2.27%	0.57%	0.62%
1974	3	2	0.81%	1.60%	3.74%	1.00%	1.10%
1975	3	3	5.72%	10.85%	24.16%	6.62%	7.56%
1976	3	4	1.19%	2.17%	4.59%	1.36%	1.51%
1977	3	5	3.14%	5.50%	11.08%	3.58%	3.74%
1978	3	5	0.49%	0.83%	1.59%	0.55%	0.55%
1979	3	7	33.58%	54.26%	98.87%	36.16%	35.85%
1980	3	5	2.24%	3.47%	6.02%	2.22%	2.37%
1981	3	3	0.37%	0.55%	0.91%	0.35%	0.37%
1982	3	0	0.00%	0.00%	0.00%	0.00%	0.00%
1983	3	3	19.41%	26.74%	39.89%	17.81%	19.37%
1984	3	1	0.96%	1.27%	1.80%	0.89%	0.92%
1985	3	4	25.36%	32.24%	43.52%	23.89%	24.29%
1986	3	2	0.40%	0.49%	0.63%	0.38%	0.39%
1987	3	4	1.22%	1.43%	1.75%	1.21%	1.18%
1988	3	5	1.78%	2.01%	2.33%	1.78%	1.69%
1989	3	4	61.73%	66.87%	73.90%	62.13%	58.06%
1990	3	1	0.19%	0.19%	0.20%	0.19%	0.18%
1991	3	2	10.79%	10.79%	10.79%	10.79%	10.58%
1992	3	5	178.27%	171.28%	162.92%	182.51%	177.38%

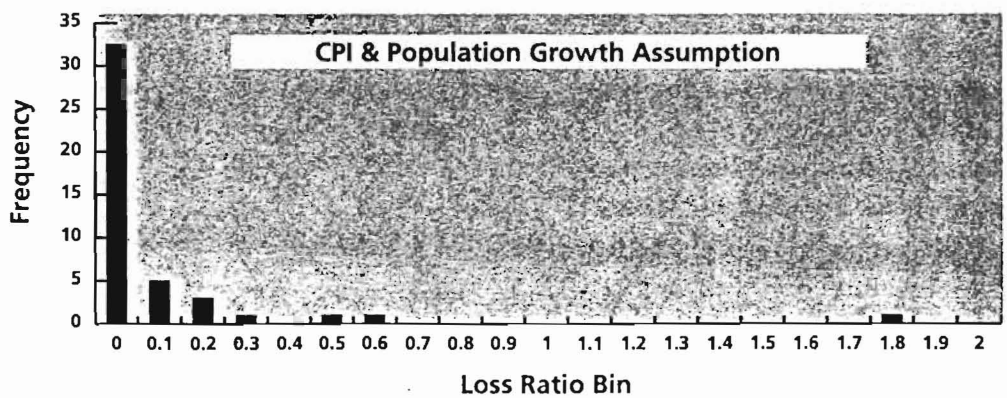
(Lane and Lobo, A Simple Approach 4)

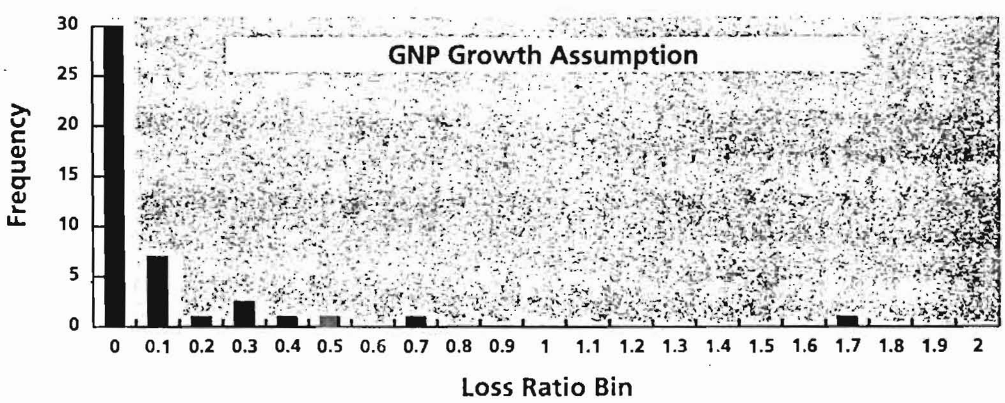
Attachment II

Histograms of Simulated Loss Ratios
for September Eastern Catastrophe Futures 1949–1992





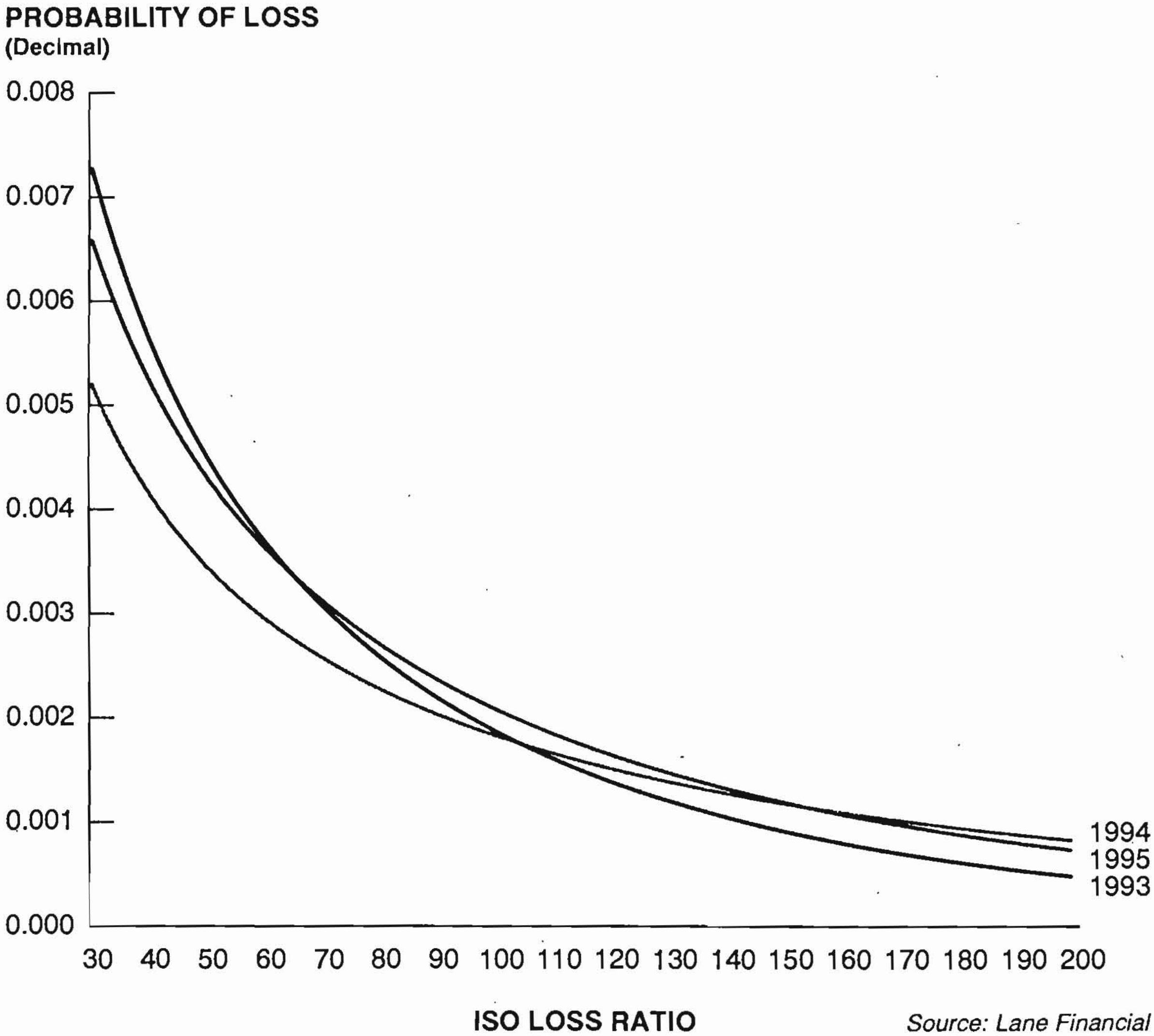




(Lane and Lobo, <u>A Simple Approach</u> 8)

Attachment III
Implied Loss Distributions

Third Quarter Eastern Contract
1993-1994



WORKS CITED

Black, Fischer and Myron Scholes. "The Pricing of Options and Corporate Liabilities." Journal of Political Economy May/June 1973: 637-654.

Brenner, Menachem and Marti G. Subrahmanyam. "A Simple Approach to Option Valuation and Hedging in the Black-Scholes Model." Financial Analysts Journal March-April 1994: 25-27.

Ceniceros, Roberto. "New Financial Tools Seen As Next Source of Industry Capital." Business Insurance 29 May 1995: 41-42. Lexis Nexis.

Chicago Board of Trade. The New Standardized Alternative for Managing Catastrophe Risk: PCS Options, Board of Trade of the City of Chicago, 1995.

---. A User's Guide: PCS Options, Board of Trade of the City of Chicago, 1995.

Copeland, Thomas E. and J. Fred Weston. Financial Theory and Corporate Policy, 3rd edition. USA: Addison-Wesley Publishing Company, 1988.

Cozzolino, John M. and Eugene M. Gaydos. "The Risk of Catastrophic Property Loss." Journal of the Society of Insurance Research March 1992: 1-13. Lexis Nexis.

Gastel, Ruth. "Reinsurance." Insurance Information Institute Reports July 1995: 1-5. Lexis Nexis.

Gibson, Rajna. Option Valuation: Analyzing and Pricing Standardized Option Contracts. USA: McGraw-Hill, Inc., 1991.

Grandisson, Mark, FCAS. Personal interview, 9 April 1996.

Hemmerick, Steve. "New Options Pricing Models Gain Ground; Investors Look Past Black-Scholes." Pensions & Investments 16 May 1994: 3-6. Lexis Nexis.

Koegel, David. "Securitizing Insurance Risk: A Technique for Spreading Catastrophic Exposure." Best's Review: P/C January 1996: 44-49.

Lane, Morton and Steve Lobo. A Simple Approach to Pricing CAT Spreads. 7 October 1993: 1-12.

---. More Premium/Less Risk. 20 September 1993: 1-4.

Lane, Morton. The Northridge Earthquake, the ISO Index, and the CBOT. 12 July 1994: 1-4.

Lane, Morton and John Finn. The Perfume of the Premium...or Pricing Insurance Derivatives. March 1995: 1-8.

McCullough, Kathleen. "Catastrophe Insurance Futures: despite their value in hedging loss, catastrophe insurance futures issued by the Chicago Board of Trade face several obstacles before they can be widely accepted by the insurance industry." Risk Management August 1995: 31-36. Lexis Nexis.

McLeod, Douglas. "Wider Use of Cat Futures and Options Predicted." Business Insurance 11 April 1994: 34-36. Lexis Nexis.

Mooney, Sean F. "Capital Markets May Be Key To Bolstering Cat Capacity." National Underwriter 24 July 1995: 35-37. Lexis Nexis.

Nielsen, Lars Tyge. "Understanding $N(d_1)$ and $N(d_2)$: Risk Adjusted Probabilities in the Black-Scholes Model." Fontainebleau, France: INSEAD, October 1992.

Ray, Russ. "Catastrophe Derivatives: Insuring the Insurer Against Catastrophic Losses." Risk Management October 1993: 74-77. Lexis Nexis.

Schachner, Michael. "CBOT Cat Instruments' Future Still Cloudy Potential Investors Cite Complexity But Keep Eye On Progress." Business Insurance 31 October 1994: 60-72. Lexis Nexis.

---. "Protecting Against the Big One; Exposures Force Insurers to Look Beyond Standard Risk Financing." Business Insurance 22 January 1996: 3-6. Lexis Nexis.

Schauble, Barney. "Re: Insurance or Catastrophe Derivatives." Internet.

Sclafane, Susanne. "CBOT Forges Ahead With New Disaster Options." National Underwriter 9 October 1995: 6-9. Lexis Nexis.

"USA: Passing the Buck - Financial Reinsurance." Reinsurance 31 May 1994: 1-2. Lexis Nexis.

Wilmott, Paul, Jeff Dewynne and Sam Howison. Option Pricing: Mathematical Models and Computation. Oxford: Oxford Financial Press, 1993.