The Limited Financing of Catastrophe Risk: An Overview[1]

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Abstract

This paper argues that the financial exposure of households and firms to natural catastrophe disasters is primarily retained or borne by insurance companies. Surprisingly, insurers use reinsurance to cover only a small fraction of these exposures, yet many insurers do not have enough capital and surplus to survive medium or large disasters for the risks they underwrite. In a well-functioning financial system, these risks would be more widely shared. This paper articulates eight different explanations that may lie behind the limited risk sharing I identify, relating them both to recent industry developments and financial theory. I then examine how financial innovation can help change the equilibrium toward a more efficient outcome.

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An Overview

Introduction

In recent years, the magnitude of catastrophic property/casualty disasters risks has become a major topic of discussion. The insurance industry now regularly discusses potential U.S. earthquake or hurricane losses of $50 to $100 billion, a magnitude of loss that was unthinkable 10 years ago. The disasters of Hurricane Andrew and the Northridge Earthquake alone totaled over $45 billion in 1997 dollars, with the insured component running to almost $30 billion. This compares with cumulative insured losses from natural catastrophes in the decade prior to those events of only about $25 billion.[3]

These enormous increases in potential losses are likely to be permanent and even to increase over time. During the 1970-1990 period, the population of the southeast Atlantic coastal counties increased by nearly 75 percent, a rate almost 4 times that of the nation as a whole. Annual growth rates in population per square mile in California and Florida have been 2 or 3 times the national average for the last three decades.[4] Indeed, analysis by Guy Carpenter & Co. suggests that, because of growth in hazard-prone areas since 1950, real dollar damages of a given size natural event have been doubling every 14 years.

With prospective event-losses that can easily exceed $50 billion, the capitalization of the insurance and reinsurance industry is at issue. Estimates of total capital and surplus of US insurers runs to about $239 billion.[5] While a large natural disaster would not bankrupt the entire industry, this capital and surplus applies to *all* risks (property/casualty, liability, workers comp., etc.), not just catastrophes. A large event could therefore place firms' capital under severe stress, potentially jeopardizing the rewards of both policy holders and investors.

Traditionally, the insurance industry has avoided these financial stresses by pooling its exposures for large events. This occurs through reinsurance treaties with separately capitalized reinsurers. Insurers can pass along the risks of low-probability / high-cost events these reinsurers, who accomplish the pooling. The pass through is, however, only partial. Very little of the reinsurance in place provides protection against industry-wide losses for catastrophic events greater than $5 billion. That is, for a $50 billion cat event, the overwhelming majority of the last $45 billion of losses (after the first $5 billion) are not covered by reinsurance. In a narrow sense, this is not surprising, given that the relatively small capital and surplus of the reinsurance industry ($26.7

[3] Data from Property Claims Services.
[4] From Christopher Lewis and Kevin Murdoch, "Alternative means of redistributing catastrophic risk in a national risk management system," NBER conference on The Financing of Property/Casualty Risks.
[5] As of September 30, 1996, from A.M. Best Co.

billion for US reinsurers, $6.5 billion for Bermudan reinsurers, $7.0 billion for German reinsurers, and $16.8 billion for others).[6] Thus, at present levels of capital, the worldwide reinsurance industry is not capable of funding large-event risks in the US alone, not to mention the rest of the world.

The paucity of reinsurance protection at high layers of exposure can be observed directly from reinsurance buying patterns. To do this we assembled data on property/casualty contracts brokered by Guy Carpenter & Co. These data cover a large fraction of all catastrophe reinsurance purchases by US insurers. From them, it is possible to gain a sense for the paucity of reinsurance coverage at high levels of losses. Figure 1 shows the relationship in these data between the fraction of pooled insurer exposure covered by reinsurance and the size of industry-wide events.[7]

There are two important points to be made from the graph. First, reinsurance coverage as a fraction of exposure declines markedly with the size of the event, falling to a level of less than 30% for events of only about $5 billion.[8] Clearly, only a small fraction of large event exposures are covered, and remarkably, this figure *overstates* that fraction. That is because the only insurers in the data included are those that actually purchase reinsurance.[9] The implication is that insurance companies overwhelmingly retain, rather than share, their large-event risks.

This point needs to be expanded in an important way. Many exposures faced by the corporate and household sectors are self-retained, and *never even reach insurers in the fist place*. Corporations, for example, tend to self-insure, and particularly so against large losses -- even while purchasing insurance against small losses. One study documents that insurance coverage is extremely limited for corporate cat losses of between $10 million and $500 million (for a single corporation) and virtually nonexistent for losses above $500 million. [10] This suggests that the vast majority of primitive cat risk in the economy is being retained. The implication is that the problem of inadequate risk sharing – and the failure of the reinsurance sector to help accomplish it -- is on a far larger scale than can be directly indicated by Figure 1.[11]

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[6] Standard and Poor's, 1996, Global Reinsurance Highlights.

[7] Event losses are in 1994 dollars, and are adjusted for changes in demographics and GNP. The procedure for attaching individual reinsurance contract layers to industry losses is described in Kenneth Froot and Paul O'Connell, "The pricing of US catastrophe reinsurance," NBER working paper no. 6043.

[8] Indeed, the Figure shows that 30% is an improvement over the past; in 1970, coverage of similar event sizes was less than 20%.

[9] For firms that did buy reinsurance and are in the database, we observe their entire reinsurance program.

[10] See Neil Doherty and Clifford Smith, "Corporate insurance strategy: the case of British Petroleum," *Journal of Applied Corporate Finance*, Fall 1993, 4-15.

[11] Of course, some types of risk are subject to asymmetric information or manipulation, and the resulting adverse selection or moral hazard makes sharing them inherently problematic. We discuss this issue below. For now, however, it is sufficient to note that catastrophe events – so called "acts of God" -- are basically exogenous to mankind. These risks (as opposed to, say, liability risks) are therefore relatively free from asymmetric information and moral hazard.

There is a second, more subtle point to take from Figure 1. It is apparent that after a large event, like Hurricane Andrew in 1992, retentions (or "deductibles") tend to increase. After an event, the total amount of coverage does not rise (indeed, it appears to fall somewhat). Most of the action is that a typical firm's window of coverage shifts toward higher layers of protection. In other words, when coverage for large events increases, it appears to do so only at the expense of coverage for small events. We will come back to interpret this point in the discussion below.

It is striking that so little reinsurance is in place for large event losses. After all, it is large events whose risks need most to be shared. This paucity of risk sharing is costly for two reasons. First, poor risk sharing means that individuals bear higher portfolio risks. With higher portfolio risk, hurdle rates for new investments are higher, and, therefore investment spending is lower than if risk sharing were perfect.

There is a second cost that makes hurdle rates rates higher and investment lower. This comes from *ex post* burden sharing. Ex post burden sharing occurs when those who bear risk try to get someone else to pay their losses. This behavior is costly because it creates bad incentives. If someone else will pay, then risk-increasing investments are subsidized while risk-reducing investments, such as mitigation, are taxed. For example: homeowners over build on exposed coastline because of subsidized insurance rates or because they expect to be bailed out by a government program; insurers are tempted to take too much risk relative to their capital, thereby shifting part of the cost of disasters onto other insurers, state agencies, and insurance customers; and some households and companies decline to purchase sufficient insurance, under the assumption that they will receive *de facto* protection. Bad incentives increase the aggregate level of risk. They also further worsen its distribution, as those with the greatest can risks have the greatest marginal incentive to take more on.

It is not our goal here to gauge the magnitude of these costs. But both of these mechanisms raise costs of capital and reduce economic growth. While the link between lower capital costs and higher growth rates is not well established, it is worth noting that lowing capital costs by enough to spur even a single basis point of additional growth is worth $700 million per year in a $7 trillion economy such as the US.

The discussion below takes as its central premise the argument – that the system of redistributing large catastrophe risks has not spread risks into and beyond insurer balance sheets and out evenly across investors. The discussion also takes as given that there are large costs associated with an equilibrium in which risk sharing is inefficient. We then go on to ask whether the current framework for managing cat risk is functioning as well as is possible. What barriers (if any) prevent higher layer risks from being spread and/or mitigated? Are the capital markets likely to solve the problem?

In what follows, I enumerate eight different explanations for barriers to better risk. These explanations are drawn from the ideas discussed at the conference, and touch on all of the paper presented. As a result, they provide an excellent way of introducing the

subject matter to follow in the rest of the book. I try to state the explanations in a pure and clear form, and to provide perspective by relating each explanation to recent industry developments and financial theory. Naturally, one's view of the solution to the problem of inadequate catastrophic risk sharing depends upon the assumed cause. The discussion then turns to solutions that have been suggested, with a focus on the role of the capital markets and alternative means of redistributing cat risk.

Explanations for the paucity of catastrophe risk sharing

A problem of supply or demand

When an economist sees that there is "little" trade in a product or a service, he or she immediately thinks of two generic kinds of explanation. One is that little is exchanged because supply is somehow "low" and therefore prices are "high." The second is that demand is somehow "low" and therefore prices are not "high." Below, the first 5 explanations for poor risk sharing rely on supply factors, while the last 3 rely on demand factors.

Clearly, one can distinguish between these generic explanations by investigating whether prices are high or not. To do this we need some natural benchmark for the "fair" level of prices. For the sake of argument, I shall assume that fair prices are those which would prevail if the system for redistributing cat risk was perfect and frictionless. In such a system, catastrophe risk prices would be determined by investors, each of whose portfolio would devote a small share to cat risk. As a benchmark this equilibrium makes sense because it is investors in one form or another who must ultimately provide catastrophic risk-bearing capacity.

As is generally argued by both practitioners and financial economists, investors require relatively low average returns for bearing risk exposures that provide large diversification benefits. Take, for example, investments which are a small part of total wealth and which are uncorrelated with the returns on other forms of wealth (such as stocks and bonds). Such investments improve the reward-to-risk ratio of investor wealth as long as their average returns exceed the return on riskfree investments like US Treasury bills. This suggests that the (relatively low) short-term US treasury rate is the threshold required return for a small, uncorrelated investment.

Historical data suggests that catastrophe risk is one such investment, since returns from bearing cat risk through reinsurance contracts are uncorrelated with all other major investor asset classes.[12] If this is true, then with wide risk distribution, the "fair" catastrophe premium on a reinsurance contract is just the actuarial contract loss. In other

[12] See Froot, Murphy, Stern, and Usher, Guy Carpenter and Co., "The Emerging Asset Class: Insurance Risk," July 1995 White Paper, which presents data showing that recent returns from bearing catastrophe risk are uncorrelated with other major financial asset classes, such as US and foreign stocks and bonds, as well as currencies.

words, the contract premium should equal actuarial insurer losses covered by the reinsurance contract. Of course, actuarial losses are not known with certainty. One can only estimate actuarial losses. Nevertheless, as long as the estimate of expected loss is unbiased and the uncertainty in actuarial losses is itself uncorrelated with investor wealth, then premium should on average equal estimated actuarial losses.[13]

To those in the industry, it comes as no surprise that reinsurance premiums are today considerably greater than estimates of actuarially expected losses covered by reinsurance. A good and very visible example is the recent purchase of reinsurance by the California Earthquake Authority (CEA) from National Indemnity, a subsidiary of Berkshire Hathaway. Under the structure of that contract, NI receives an annual premium which exceeds actuarially expected losses by 530%. To see this, note that the average annual premium for the 4 year aggregate cover is 10.75% of the annual limit, whereas the likelihood that the reinsurance is triggered is 1.7%, according to EQE International, a catastrophe risk modeling firm ((10.75 / 1.7) -1 = 530%). In other words, Berkshire Hathaway has a 1.7% chance per year of losing the $1.05 billion it has put up; in return it receives $113 million per year in premium. Indeed, under the contract specifications, Berkshire Hathaway receives four years worth of premiums in the first two years. Since the $1.05 billion cover aggregates over the 4 year period, Berkshire Hathaway is effectively putting up about $600 million in net exposure for a 93.4% chance to make about $400 million in premium. [14]

The pricing of this contract is, in today's market, not unusual. Historically, reinsurance contract premiums have exceeded actuarial contract losses by large amounts. Figure 2 shows a computation of the percentage excess of premiums over expected losses. While a multiple of five appears relatively high by the standards of the early 1980s, prices on average are nearly that high since Hurricane Andrew. In many instances, the prices are greater than shown in Figure 2, which averages across both high and low reinsurance layers. In general, the multiples on low-probability, higher layers (such as the CEA tranche) have been particularly high (see Figure 2a), the more so since Hurricane Andrew.

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[13] People sometimes object to this explanation, arguing that large cats are surely positively correlated with aggregate investor wealth (even if this correlation is not apparent in that part of wealth which is traded in the stock market). This may well be true, but the correlation of cats and wealth is nevertheless very low. And if the correlation is low, then actuarial pricing would remain the appropriate benchmark. To see this, suppose that a one-in-a-hundred-year storm causes both $100 billion of losses and wealth reduction. When the cat occurs, its "beta" with investor wealth is therefore 1. But that is only when then cat occurs. During the 99 years, 11 months, and 29 days when there is no large cat, the correlation between wealth fluctuations and cat losses is zero. On average, the risk of a large cat event is therefore essentially uncorrelated with the systematic risk of aggregate investor wealth. Risk averse investors will require only a tiny premium above the risk free rate to be compensated for bearing small amounts of this risk.

[14] Based on a probability of 1.7% per year, the chance of no event over the four years is $(98.3\%)^4 = 93.4\%$. Data in this paragraph from *IBNR Insurance Weekly* (Volume III, #46), Dowling & Partners Securities, LLC, and from remarks by Richard Sandor, NBER conference on The Financing of Property/Casualty Risks.

Once reaction to the Berkshire Hathaway example and the numbers shown in Figure 2 is healthy skepticism. The computations require one to measure actuarial value, which is not really possible. The actuarial values behind the Figure are derived from the historical distribution of catastrophe losses.[15] And this historical distribution is likely to differ from what market participants considered to be relevant at various times. Indeed, a portion of what appears to be a secular increase in prices in Figure 2 may actually be attributable to increasingly large losses expected by the market.

However, none of this skepticism changes the fact that, while the numbers in the Figure seem high by actuarial standards, they are not high by the standards of current market prices for catastrophe risk, at least as shown by the National Indemnity / CEA reinsurance layer. Indeed, Berkshire Hathaway shareholders appear to have rejoiced at having written the reinsurance: on the day of the contract announcement, Berkshire's stock market valuation rose by over $400 million, or 1%, in excess of the broad stock market change.[16] This suggests that shareholders saw the reinsurance contract (and those that might follow) as being priced well above "fair" value.

With this evidence in mind, we turn to our eight explanations of supply and demand factors that may be driving the poor risk sharing.

Explanation 1: There is insufficient reinsurance capital, driving up prices of catastrophe reinsurance and driving down quantities of risk transfer.

The explanation considered in this section is that supply is low because catastrophic risk-taking capital is somehow limited. Such capital shortages, even if relatively temporary, might exist for a number of structural reasons: it may be costly for existing reinsurers to raise additional funds in the capital markets; it may be hard to find investors and names who expect adequate rewards for bearing catastrophic risks; it may also be that it is costly for reinsurers to accumulate large amounts of collateral on their balance sheets.

Shortages of capital are an important rationale for Berkshire Hathaway's strategy in reinsurance. In his 1996 letter to shareholders Warren Buffett observes, "Our … competitive advantage [in writing "supercat" risks] is that we can provide dollar coverages of a size neither matched nor approached elsewhere in the industry. Insurers looking for huge covers know that a single call to Berkshire will produce a firm and immediate offering." Given that easy access by new and existing reinsurers to additional capital would remove this competitive advantage, it seems clear that Buffet believes in – and profits from -- capital shortages.

[15] For a description of how these numbers are calculated, see Kenneth Froot and Paul O'Connell, "The pricing of US catastrophe reinsurance," NBER conference on The Financing of Property/Casualty Risks.
[16] Remarks by Richard Sandor, NBER conference on The Financing of Property/Casualty Risks.

Indeed, there is a perception that the shortage may become even worse once reinsurer capital is depleted by a large event. Again from Berkshire Hathaway's 1996 annual report, Buffett writes:

> "After a mega-catastrophe, insurers might well find it difficult to obtain reinsurance even though their need for coverage would then be particularly great. At such a time … it will naturally be [Berkshire's] long-standing clients that have first call on it. That business reality has made major insurers and reinsurers throughout the world realize the desirability of doing business with us. Indeed, we are currently getting sizable "stand-by" fees from reinsurers that are simply nailing down their ability to get coverage from us should the market tighten."

Buffett's entire discussion of "supercat" risks emphasizes the value to Berkshire's shareholders of Berkshire's substantial financial capacity. In a world of no capital shortages, large capital capacity is nothing to write home about.

Are there more concrete facts to suggest that capital shortages are behind high prices? There are some. A second important feature of Figure 2 above is that prices appear to rise in the aftermath of major catastrophic events and then to fall afterward. This can be seen most clearly in the period around Hurricane Andrew (1992). Prices rise substantially in 1993 and have consistently fallen since. While the figure does not include 1995 and 1996 price data, preliminary estimates suggest that prices have fallen by approximately 27% during that time.[17]

Now it is perhaps not surprising that the price of reinsurance increases in the aftermath of an event, since event losses are likely to raise the demand for insurance and reinsurance. Of course, one reason for an increase in demand is that capital and surplus are in depleted and in short supply at the insurer level.[18] In a world of perfect markets, this depletion would, by itself, have no effect on reinsurance demand. Insurance companies would simply enter the capital markets, raising equity and even debt as needed, in order to put their capital back to original levels. Indeed, given the increase in consumer demand for insurance in the aftermath of a catastrophe, one might expect insurance companies to raise considerable amounts of capital. Thus one might argue that the increase in reinsurance prices is *prima facia* evidence that there are capital shortages somewhere in the system.

However, as we have already seen, the behavior of prices alone cannot be decisive for whether the supply of reinsurance capital is relatively restricted after events. The combination of prices and quantities, on the other hand, are more decisive. Indeed, the cyclical price patterns turn out to be mirrored by synchronized declines in the "quantity" of reinsurance purchased.

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[17] Paragon produces a catastrophe price index shows the following prices since peaking in late 1994 at 2.47 (and beginning in 1/1/84 at 1.00): 1/1/95, 2.32; 7/1/95, 2.16; 1/1/96, 2.14; 7/1/96, 2.06.

[18] For a study of demand and supply issues in pricing, see Anne Gron, "The demand for reinsurance," NBER conference on The Financing of Property/Casualty Risks.

Table 1 provides a kind of event study to demonstrate this. The table shows both price and quantity responses in reinsurance purchased during the year following hurricane Andrew. (Prices and quantity are measured using the same actuarially expected annual reinsurance benefits that lie behind Figures 1 and 2 above.) It is evident that in aftermath of large events like Hurricane Andrew, reinsurance purchases fall. (In practice this occurs primarily through an increase in insurer retentions.) Indeed, the table shows that the quantity purchased fell by more -- and prices rose by more -- for those insurers which had greater exposure to the Southeastern US and to hurricanes wherever they occur.[19]

The combination of a post-event increase in price and decrease in quantity cannot be explained by an increase in demand. High demand would be associated with high prices *and* high quantities sold, much as if one were to observe transaction prices and quantities of electric generators sold during a blackout. What is going on in the reinsurance market is different: in the aftermath of events there is *less* provision of reinsurance capacity, even though prices are higher. This can only be explained by a temporary, shift backwards in the supply of capital.

In some sense, it should also not be surprising that the supply of cat risk bearing capital is restricted immediately following an event: after all, large events losses deplete reinsurers capital and surplus going forward. For at least a time, however, the high prices and low quantities are consistent with a view that additional capital has trouble flowing into the reinsurance sector.[20]

The final point in this section is that there is a kind of irony in capital market shortages and paucity of reinsurance: much primitive cat risk could be reduced through investments in mitigation, investments which are inexpensive in an actuarial sense. However, many of these investments are not made because they require individuals and corporations, who have scarce capital themselves, to raise (or deplete internal) capital. Thus, capital market shortages are in part responsible for the large and growing risk pool needing insurance and reinsurance. Without capital shortages, reinsurance capacity would be greater, but there would also be fewer risks to reinsure in the first place.[21]

Explanation 2: Prices of catastrophe reinsurance are "high" and quantities of risk transfer are "low" because reinsurers have market power

A number of observers have suggested that the evidence on prices and quantities above might be explained by market power rather than by a capital shortage per se. Under this explanation, prices rise and quantities decline not because reinsurance capital

[19] The table is from Froot and O'Connell, op cit.

[20] It is common in the industry for reinsurers to require "paybacks" for event losses and to do so through higher premiums and retentions. Note that there is nothing in this practice, to the extent it explains the data, to contradict explanation #1. However, an important question remains as to why this kind of contracting prevails and what it tells us about reinsurance markets. See explanation #5 below for one potential answer.

[21] See Howard Kunreuther and Paul Kleindorfer, "Challenges facing the insurance industry in managing catastrophe risks," NBER conference on The Financing of Property/Casualty Risks.

is impossible or costly to obtain, but because reinsurers have no incentive to increase their capital. By putting less money at risk, reinsurers keep prices high. James M. Stone of Plymouth Rock Company has argued that market power among reinsurers may be one reason that, for catastrophe exposures, reinsurance is a much more attractive business than insurance.

It is, of course, very hard to provide evidence that market power among reinsurers has increased secularly over time or cyclically in the aftermath of events. There is a general view that the reinsurance industry has been consolidating over time. There has been a distinct drop, for example, in the number of Lloyd's syndicates since the 1960s and 1970s. There has also been an increase over time in the capital and market share of large reinsurers. But neither of these facts are necessarily associated with increased market power in setting prices or restricting supply. For example, even when there were many more Lloyd's syndicates, catastrophic risk pricing was not typically determined by individual syndicates.

Furthermore, even if consolidation has occurred in the industry, it need not be associated with greater market power. Consolidation may be a natural result of economies of scale in the reinsurance business. Information-intensity is one possible source of scale economies. For example, there may be high fixed costs of developing analytic capabilities and systems.[22] Once these systems are in place, optimal reinsurer size grows as the required investment in fixed-cost systems increases. Consolidation may also be an efficient industry response to the costs of obtaining reinsurer capital from outside markets. (Size may help here as well.) If, in the extreme case, outside capital was effectively unavailable, then consolidation would follow from reinsurers' desire to diversify exposures and reduce the probably of ruin.

There may also be a kind of interplay between explanations 1 and 2 -- the insufficient capital and market power stories. Figure 2 suggests that prices have both increased secularly and undergone cyclical fluctuations associated with cat events. One would be hard pressed to explain the secular price increase with the insufficient capital story. For example, entry of capital into the Bermudan reinsurers, beginning in 1993 with Mid-Ocean, Ltd., suggests that the barriers to capital entry are not overwhelming, at least not over time periods of more than a few years. The insufficient capital story by itself is therefore likely to be better at explaining cyclical fluctuations in prices. However, to the extent that insufficient capital also drives consolidation, it may contribute to market power, thereby indirectly driving prices up on a secular basis.

Explanation 3: Prices of catastrophe reinsurance are "high" and quantities of risk transfer are "low" because the corporate form for reinsurance is inefficient

[22]Comments by Stewart Myers, NBER conference on The Financing of Property/Casualty Risks, panel on "Barriers to and opportunities for low-cost trading of catastrophic risk."

Under this explanation, the corporate organizational form of reinsurers is costly. Observers of corporate governance often point out that there are costs associated with discretion given to managers to run a business. In principal, managers could act in ways not in shareholder interest. It may be difficult for shareholders both to identify this behavior and to discipline it. Even if most managers are benevolent, the prospect that a bad manager might use his agency relationship against shareholders reduces stock prices and drives up the cost of capital.

This generic corporate finance argument of "agency costs" has application in a number of arenas. First, it clearly can be applied to insurers and reinsurers. Many of the details of the reinsurance business and the specific contracts are not transparent to arms-length capital providers. And, given the occasional-big-loss nature of reinsurance, it takes many years to evaluate management efficacy and business profitability. In the reinsurance business, bad managers may have an unusually large incentive to effectively "take the money and run."

How costly is it to delegate discretion to managers? In the case of some businesses it is possible get a partial answer. Closed-end funds are one such business. Closed-end funds invest in publicly traded securities and then sell stakes in their portfolio to shareholders, much like mutual funds do. The difference is that mutual funds are "open-ended," so that shareholders can sell their shares back to the fund at a price dictated by the net asset value of the portfolio. Closed-end funds do not automatically buy and sell their shares; a shareholder wishing to sell must find another investor. And the price of the closed-end-fund shares, like the price of most traded stocks, must find its own value in the marketplace in accord with supply and demand.

Now there is a puzzle associated with closed-end fund shares: their prices are, on average, considerably below their net asset values. This cannot happen with open-ended fund shares. Closed-end share discounts average about 10%-20%, and are pervasive across funds. And it is often argued that agency costs account for these discounts. The agency story is that closed-end funds must pay an average return in excess of what would be required for holding the underlying net assets. The reason is that shareholders can't observe managers, nor can they easily discipline managers should they turn out to consistently make bad trades. The lack of transparency and control means higher capital costs for running a fund, even for ostensibly "good" managers.

This agency cost of capital may explain why the costs of reinsurance capital, and by inference reinsurance prices, are high. This agency argument is buttressed by two regularities. The first is that managers of reinsurers regard their capital costs as "equity-like" -- i.e., as requiring a return considerably above US Treasury rates. Writing reinsurance at anywhere near actuarially fair premiums is viewed as being against shareholder interest. Yet, given that catastrophe risks are uncorrelated with those of other financial assets, shareholders' required returns on cat risk should, as argued above, be low. Agency costs may be one factor forcing up required returns. The agency cost explanation may therefore help understand the view in the industry that, for many risks,

there is "too much" capital and that prices are "too low." Indeed, some public reinsurers (such as Renaissance Re) are, as of this writing, in the process of repurchasing stock because the returns on writing reinsurance are so "low."

There is a second regularity behind the view that the corporate form is inefficient for the provision of reinsurance. This is that, even without agency costs, there is evidence that shareholders expect reinsurer equity returns to be well above US Treasury rates. Evidence for this comes from the behavior of stock prices of public Bermudian reinsurers, such as Mid-Ocean Ltd., Renaissance Re, and Partner Re. These firms hold large property/catastrophe liabilities, and generally hold assets in the form of short term notes and bills. Neither their assets nor liabilities are correlated with the stock market, yet their share prices comove strongly with the stock market. Specifically, a 10% increase in the level of the S&P 500 is associated with an increase in the average value of these firms of about 6.5%.[23] All I know about the source of this comovement suggests that it does not emanate from the companies themselves.

If the source of the comovement lies outside the companies, there is an inefficiency. Investors who see a stock with higher systematic risk of moving with the market, they expect the stock to deliver a higher, more "equity-like" return. As a result, benevolent managers of reinsurers may be maximizing shareholder value by requiring high hurdle rates for writing reinsurance. This suggests that equity-financed reinsurance may be inefficient even if agency costs are completely unimportant. If equity capital requires an equity-like return and reinsurer assets and liabilities contain no broad equity market risks, then equity is an expensive form of capital, pure and simple. And if reinsurance is financed in an expensive manner, then reinsurance prices will be high.

Offsetting these arguments are several facts. Roberto Mendoza of J.P. Morgan has argued that Bermudian reinsurers, in particular, have a number of advantages which reduce their costs of equity capital. First, Bermuda's low corporate income tax rate means that reinsurers do not suffer by using equity finance versus debt, since there are no interest tax deductions available in the first place. Second, Bermudan reinsurer balance sheets provide an opportunity to achieve tax-free compounding on invested assets.[24] Both of these features tend to lower the cost of equity relative to what it would otherwise be.

Third, rather than an agency "cost," reinsurer managerial discretion may provide an agency "benefit." Smart managers may be able to cherry pick the better risk-writing opportunities, thereby raising share prices.[25] This set of features may imply that the typical corporate form of reinsurers, particularly those in Bermuda, is not so inefficient after all. Indeed, Mendoza argues compellingly that these advantages make the Bermudan corporate form the most efficient reinsurance delivery mechanism.

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[23] Data on unadjusted stock betas from Bloomberg.

[24] Comments by Roberto Mendoza, NBER conference on The Financing of Property/Casualty Risks, panel on "Similarities and differences between catastrophic risk and other markets."

[25] Of course, the same argument is often made in defense of closed-end fund managers.

Explanation 4: Prices of catastrophe reinsurance are "high" and quantities of risk transfer are "low" because frictional costs of reinsurance are high

This explanation says that prices are high because, as financial instruments, reinsurance contracts are illiquid, have high transactions costs, brokerage, etc. These sources of friction imply that there are important costs in getting capital and reinsurance contracts together in a repository called a reinsurer.

There is abundant evidence that illiquid assets trade at significant discounts. Letter stock, as one example, typically trades at discounts of 25% versus publicly-traded stock; on-the-run bonds trade at significant premiums versus less liquid off-the-run bonds; and so on.

However, illiquidity of reinsurance contracts is not enough to drive up prices. In order to raise the cost of capital for reinsurers, reinsurers would themselves need to be financed through illiquid placements. This may arguably have been the case for Lloyd's commitments from names; it is unlikely to be true for publicly traded reinsurers in Europe, the US, and Bermuda.

Other frictions such as brokerage costs and servicing expenses can legitimately raise the cost of procuring reinsurance. However, these costs are not out of line with other financing charges. For example, in the National Indemnity transaction described above, annual brokerage fees were less than 1% of premium, and 0.1% of limit. If the reinsurance had been issued as a capital market instrument, as had been anticipated by some, these costs would have amounted to about 5% of annual premium. Brokerage / underwriting costs, for both traditional and new capital markets instruments can be expected over time to be competitive with those on other instruments.

Another kind of frictional inefficiency is the means by which reinsurer portfolios are managed. Oftentimes today, and in many more cases in the past, reinsurers manage their portfolios by aggregate limits, rather than exposures. For example, a reinsurer might decide it will risk up to $100 million on Florida, but without specifying the *probability* of Florida losses on contracts written, or the covariance of Florida losses with potential losses on North Carolina contracts. Removing such portfolio inefficiencies could have a substantial impact on the cost of risk transfer.

However, the main point here is that the high level of prices seems well above anything that can be explained by brokerage and underwriting costs. Even if brokerage and underwriting expenses had come to a high of 10% of premium in the National Indemnity deal, complete elimination of these expenses would have driven down the multiple of premium relative to actuarially expected losses by about 0.6 from 5.3 to 4.7. Brokerage and underwriting expenses cannot explain observed price levels.

Finally, it is hard to argue that inefficient reinsurance portfolio practices keep prices high. The financial technology to improve efficiency exists and can be transferred fairly cheaply. Indeed, the fact that these inefficiencies prevail today seems evidence for the lack-of-competition view (explanation #2).

Explanation 5: Prices of catastrophe reinsurance are "high" and quantities of risk transfer are "low" because of moral hazard and adverse selection at the insurer level

There is often agreement, implicit or explicit, that reinsurers will charge more in the aftermath of a catastrophe loss. In this sense, property / catastrophe reinsurance is much like "finite" reinsurance. Finite reinsurance does not so much transfer risk from the cedent, as it smoothes the risk over time. The insurer uses the reinsurance as a financing vehicle more than an instrument of risk transfer. During an event, the reinsurer makes funds available, expecting to be paid back later. In its purist form, the arrangement is just event-contingent borrowing.[26] Thus, to the extent catastrophe reinsurance resembles finite reinsurance, it may be transferring even less risk than might appear on a year-by-year basis. Indeed a prevalent view in the industry is that it is appropriate to have a "payback" to reinsurers after an event loss, and that this drives retention levels up.

While this theme is frequently echoed among practitioners, it further begs the question of why there is so little risk transfer in the first place. Two mechanisms that would explain both the use of finite-risk type contracts as well as high prices and low quantities would be moral hazard and adverse selection.

Moral hazard says that an insurer's behavior might change if it were too easily allowed to transfer risk to reinsurers. Once the risks are transferred, insurers have much less stake in prudent underwriting in the first place. Thus, it may be that the most efficient form of reinsurance is to allow very little risk transfer at all: it is only by forcing cat risk back upon insurers (or by charging a very high price to assume risk) that reinsurers get insurers to expend the resources to monitor and mitigate exposures. A reinsurance intermediary who came along willing to charge a low price and take a substantial quantity of risk from an insurer might find that the insurer misbehaves.

Adverse selection is a related problem. It says that insurers know more about their exposures and underwriting than do reinsurers. Those that are most eager to reinsure at any given price probably have private information that says their exposures are worse than average. Similarly, those that are least eager to reinsure have private information that their exposures are better than average. The result is that, at any given price, reinsurers will do business with an adversely selected group of (the worst) insurer risks. Clearly, in the presence of adverse selection, the reinsurer needs to charge more to make up for the degree of adverse selection.[27]

[26] The contingent credit arranged for the Nationwide by JP Morgan has many of these features.

[27] In some circumstances, higher prices may actually exacerbate the problem, making it impossible for the market to function. For a discussion of the implications of adverse selection on reinsurance contracts, see

This explanation has some interesting implications (see the discussion below). Unlike explanation 4, it does have the ability to explain high levels of prices. However, it is not clear how it fits all of the facts. For example, it is hard to see how the cyclical pattern of prices and quantities would emerge. Why, for example, are reinsurers worried that insurers have a greater motive to forego monitoring after cat events? Why might the information-gap between insurers and reinsurers be greater in the aftermath of an event? Is there a pattern whereby insurers who transfer more risk are less profitable? Much needed is further evidence along these lines that moral hazard and adverse selection are operative in the behavior of prices and quantities. Personally, I am skeptical that these explanations can explain prices and quantities, particularly at higher layers. These layers should be relatively immune to moral hazard and adverse selection considerations because the retentions (deductible amounts) are so high.[28]

Explanation 6: Regulation prevents primary insurers from pricing cat properly and discourages the purchase of reinsurance

This explanation observes that a number of major high-catastrophic-risk states use regulatory barriers to keep insurance prices down. In some states, lines of business, and specific geographic areas, insurers must underwrite risk at prices well below those that are actuarially and financially profitable. This is perhaps not a surprising state of affairs when the insurance commissioners are publicly elected officials in 12 states, including California and Florida.

Clearly this explanation cannot lead to a high level of prices in the reinsurance market. However, it can explain why there is so little reinsurance purchased, even if prices are actuarially fair. The basic reasoning is that if insurers are unable to earn a profitable return by underwriting risk, they need to cut costs. One way of cutting costs is to avoid purchasing reinsurance.

The mechanism here is analogous to that of rent control. Rent control is intended to make housing more affordable. It does so by reducing the return owners receive from making improvements in the housing stock. Owners therefore make fewer improvements, and the quality of the housing stock falls. This goes on until equilibrium is reached: eventually, the low rents are matched by a similarly low level of housing quality. The equilibrium rental rate – high or low -- is none other than a fair one. The old saw, "you get what you pay for," holds even in regulated markets.

In response to price controls, insurers likewise have an incentive to provide a product which is lower quality, and therefore cheaper to produce. They have less

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David Cutler and Richard Zeckhauser, "Reinsurance for catastrophes and cataclysms," NBER conference on The Financing of Property/Casualty Risks.

[28] See also the discussion below for how capital market innovations might help solve these problems to the extent that they exist.

incentive to purchase reinsurance, even at fair prices, since much of the benefit of that reinsurance accrues to others (policyholders, state guarantee funds, other insurers, taxpayers, etc.). The result is that state guarantee funds must bear considerably greater risks that a large catastrophe will become their responsibility or the responsibility of policyholders and taxpayers. In short, everyone suffers if regulation makes it unprofitable for insurers to provide high quality insurance contracts.

This explanation also fits the cyclical behavior of quantities. After a big event, insurers may feel that their underwriting prices are particularly low. Thus, even with reinsurance offered at a fair price, they will cut back more on reinsurance purchases. The major weakness of this explanation is that it cannot explain high prices. However, it does explain why insurers may perceive reinsurance prices as high, i.e., as being in excess of what they can profitably afford to pay.

Much like with rent control, there is a social policy issue here that won't be dispensed so easily. What if, for example, the risk of earthquake along an old fault line in a local working class town suddenly surges? Charging the actuarially justified rate on homeowners insurance would result in reduced insurance purchases. Housing values would be hit with high homeowners rates in addition to the hit from the initial earthquake risk. And what of the uninsured? What is the appropriate policy? Should the state or federal government transfer taxpayer funds to subsidize insurance purchases? Should insurers be forced to bear the cost, and spread the burden across all their policyholders by either raising general homeowners rates or lowering the quality of their product? And whatever the answer, how does it change if the affected area is not a single town, but all of California?

Explanation 7: There is ex-post third-party financing present, driving down the demand for risk transfer

Ex-post financing of catastrophes occurs when other parties step in to prevent losses from being financed by policyholders. Chief among these entities is, of course, the US government. As is well known, the government has a major role in funding disasters at both state and federal levels, through a number of agencies, and through both the executive and legislative branches. During the 1977-93 period, the average Federal expenditure for disaster assistance was $7.04 billion (in 1993 dollars).[29] This is far greater than the average annual loss borne by reinsurers on US catastrophe coverage. In some forms of disasters, notably floods, the federal government has effectively eliminated the incentive for the creation of private market insurance contracts. Indeed, before the Federal government stepped in to provide disaster relief, private insurers *did* offer flood insurance.[30]

[29] See David Moss, "Courting disaster? The transformation of federal disaster policy since 1803," NBER conference on The Financing of Property/Casualty Risks.

[30] See David Moss, "Government, markets, and uncertainty: An historical approach to public risk management in the United States," working paper, Harvard Business School, 1996.

The federal government is not the only entity involved in ex-post financing of catastrophes. State guarantee funds and other insurers are often the next line of defense if an insurer is unable to meet is customer obligations. And if the fund is exhausted, then solvent insurance companies in many cases are to make good on claims against insolvent companies. This creates two types of bad incentives. First, companies have an incentive to shift the burden onto the fund or other insurers before the fund is exhausted. Second, companies who do not act to shift high layer losses onto the pool are themselves likely to have to pay for others. Well behaved insurers will wish to avoid doing business in states with guarantees funds and pools. This is another way in which adverse selection can increase the cost of insurance. Overall, the outcome is an incentive for insurers to enter a race to the bottom in customer credit quality.[31] This strengthens the need for regulation and can create a kind of vicious cycle in market vs. regulatory incentives.

From an economist's perspective, such ex-post financing should be viewed as a form of market failure. The federal government cannot credibly commit *not* to fund disasters after the fact: even if it says it will not provide disaster relief *ex ante*, the political incentives to do so *ex post* are overwhelming . Given that this is the case, no one would have the incentive to buy a private insurance contract at an actuarially fair price or greater, since the government effectively subsidizes losses through these programs. Of course, by some means taxpayers will pay for subsidized losses. The government is unlikely to administer a disaster program and monitor disaster payments as well as a dedicated insurer, so the size of the loss (net of processing costs) paid by taxpayers is likely to be that much greater. Also, there is no mechanism to discipline risk-taking incentives: population growth in high flood-risk zones is not moderated by charging risk-takers for the expected losses that they impose on the system.

How does ex-post financing affect the price and quantity of reinsurance? Clearly, insurers have less incentive to provide insurance in the presence of ex-post financing. One way of doing this is not underwriting risk in the first place. A second way is to shift the actuarial costs of the risks onto others. Since insurers must pay for reinsurance, but may obtain ex-post financing at lower (even zero) costs, they have an incentive to substitute away from reinsurance.

As with explanation 6, ex-post financing cannot explain why prices might be high. It can, however, explain why insurers perceive reinsurance prices are high. It can also explain low quantities of high-layer reinsurance, and the cyclical downturns in quantities after major events.

Explanation 8: There are behavioral factors at work which dampen demand

[31] See Brian J. Hall, "The moral hazard of insuring the insurers," NBER conference on The Financing of Property/Casualty Risks.

A commonly cited reason for the low quantity of high-layer reinsurance is that the *perceived* likelihood that reinsurance will pay is too low to matter. This issue about perception is ubiquitous in insurance markets.

For economists who use a utility-based approach to understand behavior, insurance against severe, but low-probability events is very valuable to consumers. Utility type approaches argue that outcomes which lose twice as much are perceived by people as more than twice as bad. Yet, in contrast, people often don't insure against low-probability, severe outcome events. They often under purchase insurance. They often do not take mitigation seriously, and when they do, they require too high a return on mitigation expenditures.[32]

There are many potential reasons for this behavior. One is that people discount too heavily events they cannot readily perceive. Famous studies from the 1970s show that the rate of smoking is higher among the general populace than among general practitioners, higher among general practitioners than among internists, and higher among internists than among specialists who work directly with lung cancer patients. Even when the consequences and probabilities of bad outcomes are well-known, repeated hammering home of the bad outcomes affects behavior.[33]

A second behavioral effect is that individuals often seem "ambiguity" averse. A lack of clarity about the risks and events being insured may lead insurers and reinsurers to set premiums high.[34] Behaviorally, people distinguish between risk and uncertainty. With risk the probabilities of different outcomes are knowable. Examples would be from lotteries or card games. With uncertainty, however, the probabilities are unknowable. What is the likelihood of an earthquake in Boston? How frequently is a well-build house on the Florida coast destroyed by wind? Uncertainty is inherently more ambiguous, and surveys suggest that individuals charge more to bear it.

A related behavioral argument is that big events don't generate enough "job risk" for people in charge of buying insurance and reinsurance. Studies of corporate insurance purchases, for example, tend to show that mid-layer risks are often insured more frequently than high-layer risks. The argument is that managers are off the hook if the event is large enough, since many others will be in the same boat. For smaller events, insurance is easily available and purchased by others, which reinforces the desire for a manager to purchase (re)insurance. It is worth noting that this argument is another form of agency cost – "job risk" would not be an issue if people were buying insurance on their own behalf.

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[32] See Howard Kunreuther and Paul Kleindorfer, "Challenges facing the insurance industry in managing catastrophe risks," NBER conference on The Financing of Property/Casualty Risks.
[33] Comments prepared by Peter Diamond, NBER conference on The Financing of Property/Casualty Risks.
[34] See Howard Kunreuther, Robin Hogarth, and Jacqueline Meszaros, "Insurer ambiguity and market failure," *Journal of Risk and Uncertainty*, 7:71-87 (1993).

As under explanations 6 and 7, pricing may be fair, but the quantity of risk transfer is nevertheless low under the behavioral hypothesis.

Moving ahead: changing the distribution of risk through capital markets, deregulation, and alternative risk transfer

Many observers, practitioners, and academics have argued that bringing cat exposures directly to the capital market can help reduce reinsurance prices and increase risk transfer. Mechanisms include cat-linked bonds, swaps, exchange traded options and futures, cat-linked issues of equity, etc.[35]

Clearly, the degree of success that the capital markets can hope to bring depends upon one's assessment of the explanations above. If the problem is that catastrophe-risk taking capital is insufficient (explanation 1), then the capital markets clearly represent a potential solution. Indeed, the $50-100 billion dollar events discussed earlier are equal in size to a normal day's fluctuation in the value of US equities. With US financial assets totaling over $12 trillion, a large catastrophic event represents only about 50 basis points of wealth.

Similarly, if the problem is that the corporate form of today's reinsurers is inefficient (explanation 3), capital market devices would seem to help. Cat bonds specifically collateralized in a special-purpose trust to fund an insurers' higher-layer cat risks would not be subject to the kinds of agency costs experienced by firms. Moreover, if the equity of these firms is costly because of its tendency to move up and down with the market then these costs could also be eliminated by embedding the risk in a cat bond, which would be treated more as debt.

Certainly at first, these investments would need to provide an average return in excess of US Treasury bills. Indeed, cat bonds were originally envisioned for the CEA reinsurance layer written by Berkshire Hathaway, and were to be offered on terms not so different from the reinsurance. If these prices are to decline, it is clear that considerable infrastructure must first be laid. Investor education about cat risks, for example, is an important externality and will take time to build.

Another important piece of infrastructure is a means for standardizing risk. Simple securitization of existing reinsurance contracts is unlikely to lower costs or increase capacity. Reinsurance contracts have tailor-made features and cover company-specific exposures; they are therefore informationally intensive as investments. It makes little sense for each individual investor, or their institutional investment agents, to analyze these instruments. Existing reinsurance conserves on analysis by concentrating the

[35] See, for example, J. David Cummins, Christopher Lewis, Richard D. Phillips, "Pricing excess-of-loss reinsurance contracts against catastrophic loss," NBER conference on The Financing of Property/Casualty Risks.

exposures in a few places. Clearly, if it is to be economical to spread cat risk more widely, more standardization will be required.

Catastrophe indexes are one way to accomplish this. Indexes help avoid the redundant analysis of distinct risks. They also help promote liquidity, which further lowers the cost of risk transfer. Furthermore, to the extent moral hazard and adverse selection (explanation 5) are sources of high prices and low quantities, indexes can help. If insurers transfer risks that are linked to industry-wide losses, they can reduce problems of moral hazard and adverse selection faced by investors. Individual insurers may have control over their own losses and know more about those losses than reinsurers. However, they do not have control over, nor do they know more about, index outcomes. Thus indexes can make risk transfer more efficient, regardless of whether it occurs through capital market devices or traditional reinsurers. Indeed, index-linked cat reinsurance is already gaining popularity as a way of reducing reinsurer capital costs.

Of course, the standardization of an index is, all else equal, a disadvantage from the perspective of the (re)insurance buyer. An insurer would like to protect itself against *its* losses, not insurance industry losses. Thus, a critical issue in index design is that the index be flexible enough to keep down the "basis" between insurer-specific and index risk. An effective index must provide good hedging tools for cat-risk cedents.

Indeed, my own view is that existing indexes have not caught because they are poorly correlated with individual insurer losses, given a large event. Existing indexes aggregate industry losses at a state-wide level. Unfortunately, however, insurer exposure as a percentage of total industry exposure varies considerably across a state. The right hedge ratio therefore varies considerably across the state. To see this, suppose a company hedges on the basis of its 5% state-wide market share, and that a storm destroys a small portion of the state where the insurers market share happens to be 10% of the market. Only half of the insurer's losses will be covered by the index. In short, state-wide blocks are too large to yield low basis risk. To serve as good insurer hedges, indexes will need to report industry-wide losses for smaller geographic blocks (i.e., zip codes). [36]

Much of this will be soon be tested, as a new catastrophe exchange located in Bermuda, has, as of this writing, recently been announced. The Bermuda Commodities Exchange (BCE), owned by AIG, Guy Carpenter, and Chase Manhattan, and involving the Chicago Board of Trade, will trade contracts based on a US homeowners catastrophe index developed by Guy Carpenter. The index aggregates losses at the zip-code level, and therefore can match the exposure of certain insurer portfolios more precisely than state-wide indexes.

Clearly though, capital markets devices will not help solve all of the above explanations for the paucity of risk transfer. For example, if the problem is purely

[36] For an analysis of how hedge performance is affected by geographic aggregation, see John Major, "Index hedge performance: insurer market penetration and basis risk," NBER conference on The Financing of Property/Casualty Risks.

reinsurer market power, then innovations in financing will lower prices and increase quantities only if new entrants come along and make the market more competitive. On the other hand, to the extent that market power is created by high reinsurer costs of capital, capital-markets solutions could help reduce the adverse effects of market power.

Lowering the costs of risk transfer may provide savings, but it cannot directly solve the problems which result from state regulation and insurance pricing (explanations 6 and 7). However, transparent pricing of catastrophe risks in the reinsurance market may have important benefits for the efficiency of regulation. The market pricing of electricity is forcing the rationalization of utilities across the US. This process will result not only in more efficient plant and equipment, but also in more rational pricing by utilities and their public commissions. Customers will benefit by having a transparent and observable market energy price to which to tie rate-payer contracts and service. By analogy, reinsurer and insurer financing costs can be useful benchmarks for regulatory review of underwriting prices. However, pricing is only one of many regulatory hurdles which may prevent efficient distribution of catastrophe risk.[37]

Clearly, government regulation can facilitate or impede risk transfer outside of traditional reinsurance channels. Regulation can also mandate reporting of loss and exposure information to authorities, thereby permitting easy aggregation. Much as with Fannie Mae, the government can pursue "market-enhancing" policies designed to jump start broader market exchange of these risks.

Going forward, it is most likely that traditional reinsurance contracts will continue as the preferred risk transfer vehicle, even if capital market and other alternative-risk-transfer solutions take off. Insurers that are small, and/or have less well diversified exposures are likely to continue placing their risks with reinsurers. Indeed, it may well be that reinsurers, not insurers, will be the direct beneficiaries of capital-market products. These products will simply allow reinsurers to place their risks with investors in many forms other than those of standard equity. The almost inevitable result is that reinsurer cost of capital will decline, and specialized capacity will increase. As a result, more insured assets will be insurable than ever before. This will make risk sharing in society better, with better risk sharing being the fundamental goal of an insurance system.

[37] Another example of costly regulation is that financial instruments linked to catastrophe losses can in some cases be considered insurance contracts by state insurance commissioners. Because only licensed insurers are allowed to write such contracts, financial instruments which transfer premiums to investors in return for catastrophic risk bearing must seek exemptions and approval from commissioners.

Figure 1

Percentage of Exposure that Insurance Companies Reinsure (by various event sizes)

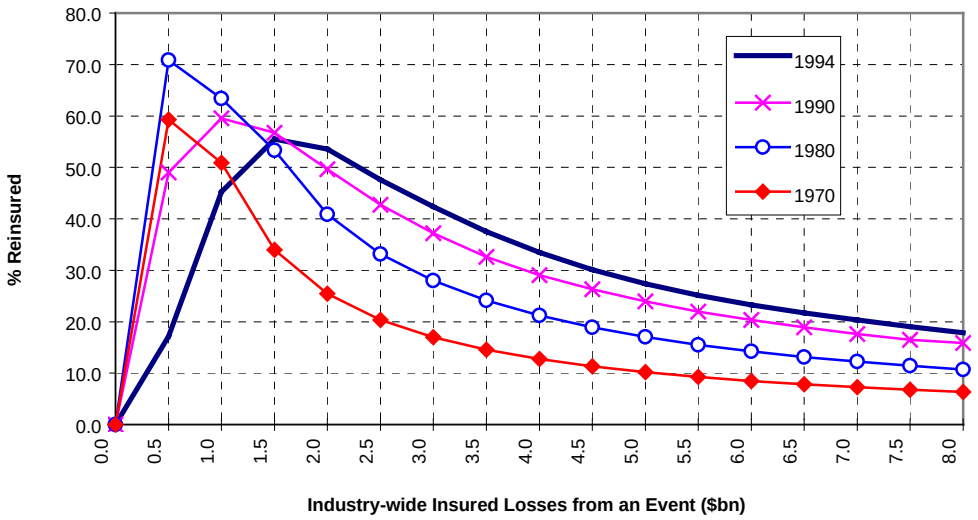

Figure 2:

Industry price per unit of ceded exposure

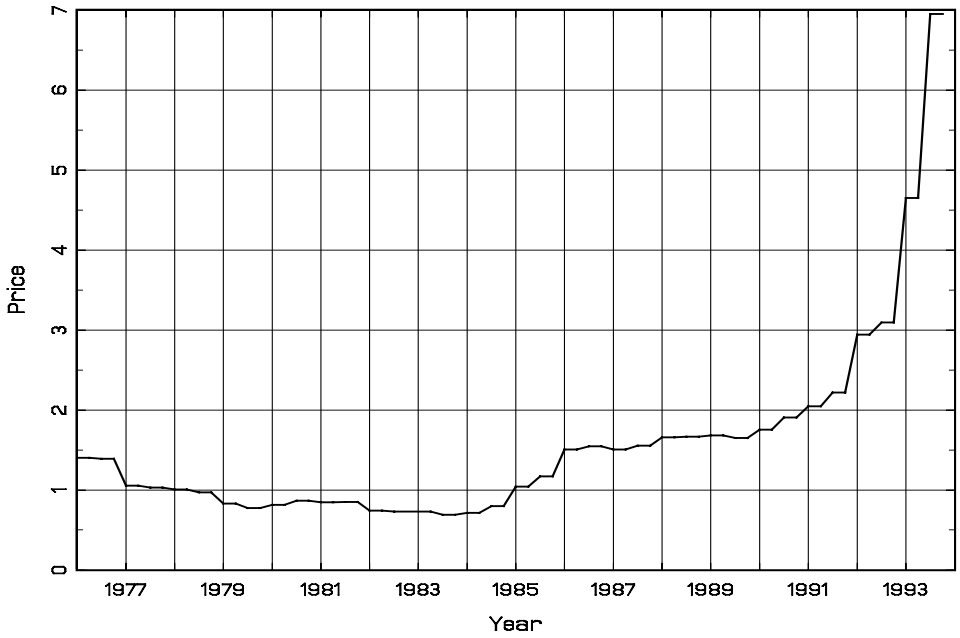

Figure 3
Relation of price to attachment probability, by year, 1970-1994

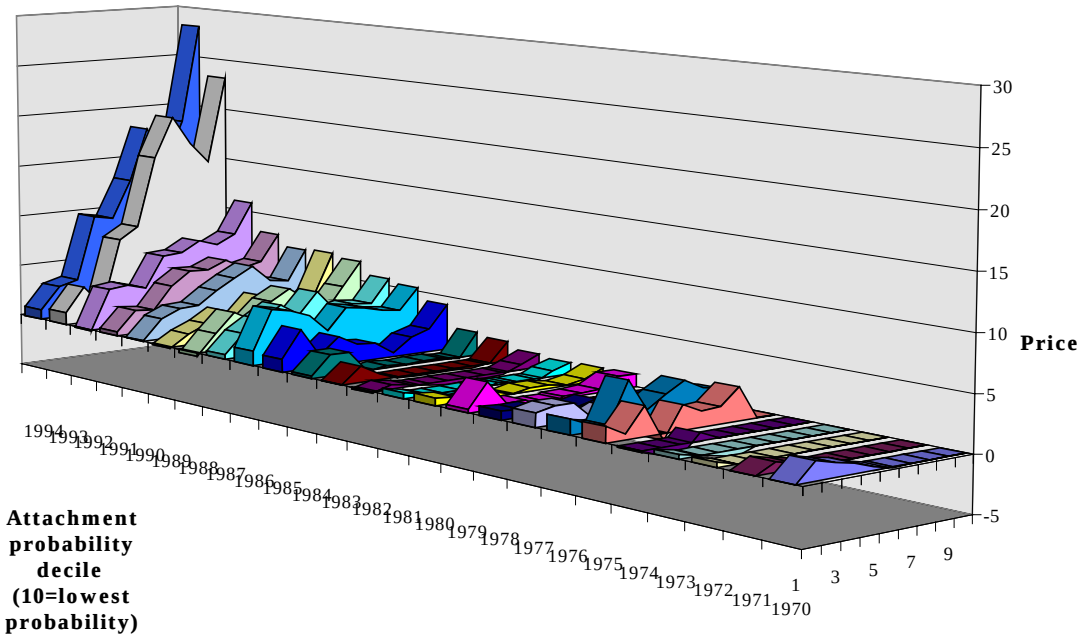

Table 1
Event study of hurricane Andrew

	(a) Southeast exposure			(b) Hurricane exposure		
	Mean exposure	Mean $\Delta\ln(p_{j,t})$	Mean $\Delta\ln(q_{j,t})$	Mean exposure	Mean $\Delta\ln(p_{j,t})$	Mean $\Delta\ln(q_{j,t})$
5 most-exposed insurers	0.707	0.415	-0.021	0.918	0.583	-0.082
5 least-exposed insurers	0.000	0.335	-0.013	0.561	0.336	-0.047

Comparison of price responses in the year after hurricane Andrew (8/20/92–8/19/93) for different insurers. Panel (a) contrasts insurers which have high and low exposure to the Southeast (as measured by market share). Panel (b) contrasts insurers which have high and low exposure to hurricanes. The table shows the mean exposure and the mean price change of the 5 most extreme contracts in each case. The mean price change for the insurers with lesser exposure to the Southeast is calculated using all 14 of the insurers that have zero market share in that region.