

Markets Under Stress:
The Case of Extreme Event Insurance*

Dwight Jaffee
Haas Business School
U.C. Berkeley
jaffee@haas.berkeley.edu

and

Thomas Russell
Leavey School of Business
Santa Clara University
trussell@scu.edu

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1. Introduction

The investigation of why markets fail and the analysis of the appropriate public policy response to such failures have been major themes in the work of Joseph Stiglitz. In this paper we continue with these themes, examining why insurance markets for extreme (i.e. low probability/high loss) events often experience difficulties in the period following the occurrence of the event. Our focus is on natural disaster insurance, such as earthquakes and hurricanes, as well as on terrorist insurance. Our analysis of the failure of such markets builds on several strands of the research by Joseph Stiglitz, including his work on insurance markets, credit rationing, and principal-agent problems within firms; see, for example, Rothschild and Stiglitz [1976], Stiglitz and Weiss [1981], and Greenwald and Stiglitz [1990].

With regard specifically to the terrorist events of September 11, 2001, most insurance firms reacted by raising prices, canceling policies, placing limits on coverage, or even withdrawing from the terrorist insurance line altogether. This behavior is documented in Government Accounting Office (GAO) [2002].

According to the GAO, insurance companies withdrew from the terrorism market because they did not wish to deal with the increased uncertainty with respect to the probability and cost of future attacks. We take up this issue of “ambiguity aversion” later in the paper.

Since terrorism insurance is a requirement in many industries, for example office building construction and airline transportation, the collapse of the terrorism insurance market has precipitated a demand for alternative risk sharing arrangements. Foremost among these are proposals for the federal government to provide some form of insurance of last resort. (A federal terrorism insurance bill was signed by President Bush on November 26, 2002, as this paper was in the final editorial stages. The bill is briefly discussed in the final section.)

Drawing on our previous research on the operation of catastrophe insurance markets, Jaffee and Russell [1997], this paper seeks to answer two basic questions concerning such markets:

- 1) Why do extreme insurance markets tend to collapse following a major event?
- 2) What is the best public policy response to this market failure?

2. Extreme Insurance Market Failure: The Puzzle

The standard explanations for insurance market failures are the problems caused by moral hazard and adverse selection. These problems are not completely absent in the case of extreme events, but they are unlikely to be a major contributor to an explanation for the puzzle of market collapse. In the case of terrorism insurance, for example, it is clear that enhanced airport security can lower the probability of attack, and terrorism insurance could blunt the incentive to take such measures. On the other hand, airport security measures are federally mandated (in part for

externality reasons set out in Kunreuther and Heal [2002]), so moral hazard cannot be playing a large role in this case.

There is more at stake here than simply the fact that premiums rise after an extreme event. We can readily grant that the likelihood of future terrorist attacks was higher after September 11 than before, but this simply calls for higher premiums. Alternatively, we may assume that the degree of uncertainty surrounding terrorism went up, either increasing the variance of claims or increasing parameter uncertainty, but again this could be handled by an appropriate adjustment in the price.

What is hard to understand is, for example, the reaction of the insurers of Chicago's airports. Prior to the event, Chicago carried \$750 million of terrorist insurance for an annual premium of \$125,000. Post September 11, their insurers would only offer \$150 million of coverage for the new premium of \$6.9 million. Even if the increase in premium is understandable, why was the quantity so severely rationed? ¹

In view of the observed rationing of catastrophe and terrorist insurance, it is natural to ask whether extreme event insurance is different from ordinary casualty lines, such as auto insurance. It is clear that governments do behave as if some lines of insurance present special difficulties for private markets. For example, the US government already provides insurance against (among other risks) catastrophic nuclear accidents, political risks in overseas trade, riots, floods, bank

runs, and marine and aviation war risks; see General Accounting Office [2001] and Moss [2002]. Moreover, in those countries which were exposed to terrorist attacks earlier, including Northern Ireland, Great Britain, and Israel, terrorism insurance is uniformly provided by the government. Similarly, the states of California and Florida have actively intervened in the markets for earthquake and hurricane insurance respectively.

Although the fact of government provision in these lines of insurance is not in dispute, the exact reason for state provision is far from clear. On terrorism insurance, for example, GAO [2001] states:

“It seems clear, given insurers’ increased recognition of their exposures in the aftermath of the unprecedented events on Sept. 11 2001, that coverage for terrorist acts is not now amenable to normal insurance underwriting, risk management, and actuarial techniques. As a result insurers and re-insurers are concerned about their ability to set an appropriate price for insurance coverage for terrorist acts. Given this uncertainty if this kind of insurance were to be offered at all, it is likely that either the price insurers set would be prohibitively high or so low as to invite insolvency.”

Pricing terrorism risk is certainly not a simple task, but neither is pricing say commercial satellite risk, and this is done at Lloyd’s on a nod and a handshake. Given that probabilities of loss are uncertain, each insurer would need to guard against the problem of the winner’s curse. As in the case of Lloyd’s syndicates,

however, each insurer could underwrite only a fraction of the total loss, and in this way the problem of being at the optimistic end of the loss probability prediction spectrum would be mitigated²

3. Risk Bearing and Insurance: Is Extreme Event Insurance Different?

We now revisit the primitives of insurance theory to try to understand why insurance firms may operate differently across lines. As noted by Samuelson [1963], the essence of insurance is the subdividing, not the pooling of risk. It is normally the case, however, that insurers, whether they are organized as mutuals or as joint stock companies, in fact do pool risks. This sets up a tension between pooling and subdividing, a tension made clear by Ross [1999]:

“After all, when an insurance company or a “swaps shop” opens its doors, it attracts n independent risks, it does not cut up some larger existing risk. The presumption is that the race between a financial market which cuts up risks and a business that adds them is won by the market...”

Elsewhere, Jaffee and Russell [2002], we provide a simple model of the insurance firm which is designed to capture the essence of the pooling/subdividing issue; see also Gollier [2002]. The key result of that analysis is that investors would always be willing to participate in an insurance syndicate portfolio as long as either the premium loading (the premium in excess of the expected loss) is sufficiently large and/or the number of investors is sufficiently

large (meaning that each investor takes on a sufficiently small share of the portfolio). This conclusion is true, moreover, even when the expected loss or variance of each policy is large and/or when the individual risks are highly (even perfectly) correlated. Of course, when the risks are larger or more highly correlated, then the premium loading or the number of investors will itself have to be larger in order to induce investors to purchase a share of the portfolio.

The Special Case of Extreme Event Insurance

Extreme event insurance is just a specific type of casualty risk in terms of the above findings. In particular, the result that investors can always be induced to hold such an insurance portfolio if the premium loading or the number of shareholders is made sufficiently large, applies to extreme event insurance as much as any other casualty risk. In this context, terrorist insurance, or any type of extreme event insurance, is not of another kind.

On the other hand, the parameter values that reasonably apply to extreme event insurance might be significantly different from those that apply to more standard casualty lines such as auto insurance. In particular, for extreme risks:

- i) the size of the risks are larger;
- ii) the correlation coefficients between individual risks may be higher,
- iii) the performance guarantee costs may be higher (as a result of i and ii).

The implication is that the premium loading and the number of investors

necessary to induce investors to hold an extreme event insurance portfolio is likely to be larger than for more traditional casualty risks, but this is a question of degree, not of kind.

Thus, if capital markets are perfect and all investors hold highly diversified market portfolios, then an equity position in an insurance firm should be an efficient structure for holding even large and highly correlated extreme risks. There are, however, three sets of capital market imperfections that could frustrate this result, namely asymmetric information within the syndicate, bankruptcy/agency costs, and a variety of institutional impediments to accumulating capital reserves against future possible losses. We now consider these in turn.

Asymmetric Information

In forming an insurance syndicate, there is always the possibility that some members will have more information regarding the risks at issue than others. This problem is distinct from the insured/insurer adverse selection problem referred to earlier. But this source of asymmetric information too can lead to market failure. It is unclear, however, why asymmetric information should be a more important problem for an insurance firm selling extreme risks to capital market investors than a firm selling, say, auto insurance risks. While extreme risks may be large and there may be substantial uncertainty surrounding the estimates of these risks,

none of this uncertainty should cause substantial asymmetry between the insurance firm and its capital market investors treated as a group.

Bankruptcy/Agency Costs

If the losses created by an extreme event threaten an insurance firm with bankruptcy, then there is a potential for deadweight bankruptcy costs and related agency costs. In particular, it is clear that the probability that an insurance firm would be made bankrupt by a particularly bad extreme loss during one year is substantially higher than the probability that the same firm would be made bankrupt by a particularly bad run of, say, auto insurance losses during a year. It could thus be quite sensible for the insurance firm's management to refuse to take on extreme risks for fear that a "big one" will cause the loss of their jobs due to the bankruptcy of their firm.

On the other hand, it would appear that agency costs created by prospective bankruptcy could be avoided by appropriate financial structures for the insurance firm. As one example, specialist insurance firms could be created to hold only terrorist risks, thus avoiding the possibility that a major terrorist loss could disrupt an otherwise profitable insurance firm. As another example, traditional insurance firms could securitize their terrorist risks, selling them directly to capital market investors. In fact, markets for securitizing natural disaster risks, such as earthquakes and hurricanes, have already been developed. Thus, while

bankruptcy/agency costs might be a short-run problem for traditional insurance firms in providing extreme event insurance, in principle the problem should be solved by quite straightforward institution or security design. As we discuss later, however, these arrangements face a number of practical difficulties and it remains to be seen whether or not these difficulties can be overcome.

Impediments to Raising Capital

Extreme event losses tend to be large, often exceeding the annual premiums collected for the coverage by a factor of 10 and possibly by as much as 100. In particular, if the event occurs early in the life of a syndicate, the premiums accumulated to that date will fall far short of the loss, leaving the syndicate responsible for the shortfall.³ Even with the risk spreading associated with reinsurance, any one risk bearing entity, and certainly the industry as a whole, must have access to substantial capital if it is to pay these losses. And surely the insurance rating agencies, such as Bests, will consider adequate capital an essential factor to assign a high quality rating. This compares with “routine” lines such as auto insurance or dental insurance, where one year’s premiums will almost always cover one year’s losses, thus requiring the insurance firm to place very little of its own capital at risk.

In a previous paper on natural catastrophe insurance, Jaffee and Russell [1997], we discussed why it may be difficult or costly for insurance entities to

raise capital against possible future losses. In particular, that paper describes three fundamental problems with retaining earnings or raising capital in anticipation of possible future losses:

- (i) U.S. accounting rules preclude “ear-marking” retained profits or other capital funds as “reserves” against future losses, if the actual events have not yet occurred. Insurance firms, of course, are always free to retain their earnings, but the accounting rules preclude pre-committing these funds to pay only catastrophe losses.
- (ii) U.S. tax rules require full taxation of profits that are retained as reserves against future losses. This makes retained earnings an expensive way to accumulate funds against possible future losses.
- (iii) A firm that accumulates liquidity to cover future large losses could become a takeover target due to its large cash assets. That is, since the liquidity cannot be pre-committed to catastrophe losses, a third party could take over the firm, allow the policies to mature, and then use the liquidity for another purpose.

4. Post Event Behavior

In the previous section we examined the conditions necessary for the formation of an extreme event insurance syndicate. In fact, we know that following the September 11 event, a previously well-functioning market for terrorist insurance became highly ineffective. Similar breakdowns in insurance markets occur

regularly following similar catastrophic events such as hurricanes and earthquakes. In this section, we now suppose that the extreme event has occurred. Going forward, we consider why the simple occurrence of a low probability, high consequence, event should cause the failure of a previously well functioning insurance market.

The occurrence of an event, of course, may contain information requiring the reassessment of the means, variances, and covariances of the underlying risks. But after an appropriate adjustment in premiums, it would appear insurance syndicates should again be viable. Clearly, however, this is not what happens. Typically, following an extreme event, insurance markets are seriously disrupted. We now offer two sets of explanations for this type of market failure, one associated with post-event capital market imperfections, the other with behavioral responses to bad draws.

Post-Event Capital Market Imperfections

After a major event wipes out most of the industry's capital, firms might be expected to use the financial markets to replenish their capital base. With minor exceptions, however, insurance firms have not issued new equity to replenish their capital following an extreme event. This is puzzling, since the period following an event is in many ways the perfect time for a syndicate to raise new capital. Rates normally harden following an event, and this will be reflected in

higher stock prices, reducing the cost of equity. The markets have responded in exactly this way since September 11, yet insurance firms have not used the financial markets to replenish their capital in any significant way.

Jaffee and Russell [1997] discuss two main difficulties that insurance firms may have in accessing capital markets after the event:

- a. Potential investors in the new securities will be concerned that their funds will be used to pay off past losses, not to support new profitable initiatives. This is a more extreme version of the classic Myers [1977] debt overhang argument, with insurance policy claimants playing the role of Myers' bond holders.
- b. The potential for asymmetric information may lead potential investors to evaluate future risks at a higher level than does the issuing firm, causing the new investors to require a lower price for the new securities than the firm is willing to accept.

On the other hand, a number of insurance derivatives have been created in recent years, including option and futures contracts and catastrophe bonds.⁴ These securities are motivated by the notion that catastrophe events represent, by and large, zero beta risks, so that capital market investors should be willing to take on these risks at a price that reflects only the expected loss, with little or no risk premium above that amount. These instruments have also been analyzed in Jaffee and Russell (1997). They point out that these securities have also failed to provide an effective mechanism for transferring catastrophe risks from insurance firms to

the capital markets, for three basic reasons:

- a) Just as with new security issues, the potential for asymmetric information may lead potential investors to evaluate future risks at a higher level than does the issuing firm.
- b) With the future and option instruments, the need to provide adequate performance guarantees has restricted the amount of risk transfer to relatively small amounts.
- c) Investors may believe that catastrophic events will depress the economy and stock market generally, creating a positive, possibly even very large, expected beta value, and thus raising the cost of the catastrophe insurance securities.

The absence of new issues of capital to restore the capital lost by the extreme events could, of course, also reflect the hope for federal government assistance. For whatever reason, it is clear that new capital does not immediately flow into catastrophe lines following an event, so that private insurers either limit coverage or withdraw from the line completely. We next turn to behavioral explanations for this phenomenon including a new explanation based on a behavioral interpretation of attitudes to risk.

Explanations for Post Event Behavior: Ambiguity Aversion

The occurrence of an extreme event will frequently trigger an increase in uncertainty surrounding future events. How does this increase in uncertainty

affect markets? Froot and Posner [2001], using an expected utility framework, have investigated this issue in the context of the observed high rate of return on catastrophe bonds. Perhaps rather surprisingly, Froot and Posner show that parameter uncertainty has a very small effect on cat bond spreads, and indeed in the case of independence between event probabilities and parameter uncertainty, the latter has no effect on these spreads.

Bantwal and Kunreuther [2000] also investigated the issue of catastrophe bond pricing. They assume investors are ambiguity averse in the Gilboa and Schmeidler [1989] sense; that is, faced with a set of probability density functions, G , investors act to maximize expected value = $\int u(x) \min f(x) dx$ for $f(x)$ in G .

Bantwal and Kunreuther showed that ambiguity aversion would require that cat bonds offer a premium over the risk free rate, though not as large as that observed. Hogarth [2002] has also recognized the relevance of ambiguity aversion for analyzing attitudes toward catastrophic risks, particularly terrorist insurance.

As an example of such ambiguity aversion, suppose that there are fixed binary probabilities before the event, the probability of the event not occurring being P . Suppose that after the event the probability parameter P itself becomes uncertain, the new probability being $P-e$ with probability $\frac{1}{2}$ and $P+e$ with probability $\frac{1}{2}$. An ambiguity averse investor now sees two possible density functions over payoffs, $G = \{[P-e, 1-(P-e)], [P+e, 1-(P+e)]\}$, where the first entry in each square bracket is

the probability of the event not occurring. This has no effect on pricing in the Froot and Posner framework, but in the ambiguity averse framework the payoff on a cat bond now becomes $(H)(P-e) + (0)(1-P+e) = H(P-e)$, where H is the contractual payoff if the event does not occur and 0 is the payoff if it does; (for a similar analysis see Dow and Werlang [1992]). In this case, even given that the cat bond has no non diversifiable risk, its reduced expected payoff will require it to be priced to yield a premium vis a vis the zero beta excess return. This premium might better be called an ambiguity premium than a risk premium. By itself this will cause required yields to rise following an event, but it is not clear that by itself this will cause the market to fail. For this we need further effects.

Explanations for Post Event Behavior: Fairness

Fairness as discussed by Kahneman, Knetsch, and Thaler [1986] provides a further effect to consider. In this view, when events require a sharp increase in price, markets may fail because the seller is reluctant to incur the bad will caused by an apparently unfair price increase. That fairness may play a significant role in the explanation of the regulation of insurance markets has been discussed elsewhere, Jaffee and Russell [1998].

It is less obvious that fairness plays a significant role with extreme event insurance. First, Kahneman, Knetsch, and Thaler note that unfairness is generally associated with price increases for which there is no obvious cost justification. The losses created by extreme events—earthquakes, hurricanes, or terrorist

attacks--however, are all widely reported, which blunts any accusations of opportunism from raising premiums. Second, the primary concern of buyers of extreme event insurance appears to be availability, not price. For example, we noted above the example of Chicago's O'Hare, in which premiums rose fifty fold, hardly an indication that fairness is a key issue. We now explore another explanation which we may call irrational abhorrence.

Irrational Abhorrence

The models of decision making which underlie the analysis of insurance presented so far have all been relentlessly cognitive. Recently, however, some researchers have recognized that decisions under uncertainty involve additional psychological considerations. In a recent survey Loewenstein et al [forthcoming] have called this new approach "Risk as Feelings." A withdrawal of supply is predicted in the "risk as feelings" literature, where non-cognitive factors lead to inaction rather than wrong action in the face of some risks.⁵ These non-cognitive factors have been extensively studied by Slovic and his collaborators. Peters and Slovic [1996], for example, reduced the psychological dimensions of risk to two primary factors, dread defined by Loewenstein et al as "the extent of perceived lack of control, feelings of dread, and *perceived catastrophic potential* (italics added) and risk of the unknown defined as the extent to which the hazard is judged to be unobservable, unknown, new, or delayed in producing harmful

impacts.

That dread could lead to inaction and, in the context of terrorist insurance, to a withdrawal of supply, is consistent with the findings of Damasio and his colleagues, see Bechara et al [1997]. As reported in this study, subjects were told that they could earn hypothetical money by turning over cards from one of 4 decks. Two of the decks contained high payouts (\$100) and two contained low payouts (\$50). The high paying decks, however, also contained a “catastrophe”, a card marked with a very high loss.

On average, healthy subjects sampled from all four decks until they drew the cat card, at which point they thereafter avoid the catastrophe deck. The observation that individuals shun investment opportunities which have just experienced a major loss does provide a unifying framework for the analysis of a number of extreme event phenomena. We focus on two issues here

Good and Bad Multiple Equilibria.

Since the essence of insurance is risk sharing, it is essential that anyone contemplating joining an insurance syndicate believes that there are enough other potential members of the syndicate to make his or her share of the risk small. For example, this seems to have been the case pre September 11. However, following the event, even if a non-emotional investor believes that the syndicate could be profitable if sufficiently subdivided, the syndicate will not be viable if

- a) the event causes a sufficient number of investors to become unavailable, or
- b) it causes sufficient investors to have the belief that a sufficient number of investors will be unavailable.

In the latter case the belief that the syndicate was not viable becomes a self-fulfilling prophecy.

Heterogeneous Response

It seems unlikely that all investors will pass on a positive profit project just because it once generated a bad draw. It is known that some individuals are less prone to “irrational abhorrence” than others; see Peters and Slovic [forthcoming].

The basis of this variation across individuals lies outside the scope of economics, but there does seem to be an interesting difference between the response of individuals and the response within corporations. For example, following the cancellation of the 2002 Soccer World Cup insurance by the large French insurer AXA, Warren Buffett, an executive who exercises strong individual control over his insurance companies, quickly offered to fill the gap; see Business Week [2002] for an intriguing discussion of Buffett’s willingness to take on such risks.

It would appear that the tendency to stay away from projects which have suffered a loss is more pronounced in corporations with all their well known agency problems than it is in entities run by single individuals. This may seem somewhat paradoxical, however, because we would expect that systematic

quantification would be more prevalent in entities run by professional managers.

5. Public Policy and the Market for Extreme Event Insurance

How should public policy be conducted when insurance firms and/or capital markets “dread” the prospects of carrying catastrophe insurance risks. In this section, we discuss a range of alternative policy solutions.⁶ For this discussion, we assume that premium setting by insurance firms is not constrained by issues of fairness or by regulations.

Public Entities to Bear the Risk

One obvious solution is to create a public or quasi-public entity to hold the catastrophic insurance risks; for further analysis, see Cummins and Doherty [2002]. The California Earthquake Authority (CEA), created as a quasi-public entity to hold California earthquake risks after the Northridge quake of 1994, is one example. Participating primary insurers transferred all their earthquake risks to the CEA, thus insulating their firms from all earthquake claims. The CEA, however, also had no claim on government resources, leaving only its initial capitalization, its premium income, and its retained profits to meet claims. The result is that in the event of a really “big one”, policy holders will not receive full payment for their losses. This possibility was explicitly recognized in the legislation creating the CEA, although there is, of course, the question of what a government would actually do in the event.

The Pool Re agency for terrorist insurance in Great Britain, created after the 1993 IRA attack in Central London, expands the quasi-public role of the CEA by having the British Treasury provide reinsurance policy to backstop all its losses; see Tillinghast-Towers Perrin [2001]. The result is that the British government guarantees full payment on any terrorist losses. A major drawback to Pool Re, however, is that the primary decisions of insurance underwriting and pricing are taken out of the hands of the private market.⁷ It is thus useful to consider catastrophe bonds as an instrument which could retain the participation of the private firms in the underwriting process, while allowing the government to limit the losses faced by these firms were an extreme event to occur.

Catastrophe Bonds as Insurer of Last Resort

We have noted that a limited number of catastrophe bonds have been issued by insurance firms to hedge their hurricane and earthquake risks, but the high risk premium required so far by capital market investors has limited their usefulness. To overcome this pricing problem, the government could purchase specific tiers of catastrophe bonds, representing the riskiest layers of the catastrophe risks. The catastrophe bonds would substitute for the role held by the British Treasury as insurer of last resort under the British Pool Re plan. The advantage of the catastrophe bonds is that the primary insurance firms could underwrite and hold the policies directly, using the catastrophe bonds to hedge the tiers of extreme

event risk that might otherwise threaten their solvency. Catastrophe bonds sold by insurance firms to the government would represent the securitization of insurance risks, and government ownership of the bonds can be seen as parallel to the implicit and explicit guarantees that the U.S. Treasury currently provides to Fannie Mae and Freddie Mac to back their mortgage market securitization.

Lender of Last Resort versus Insurer of Last Resort

Guaranteed catastrophe bonds still imply a potential government presence as the insurer of last resort, so it is worth considering whether even that role can be minimized. One notion would be to transfer the insurer of last resort function to that of lender of last resort. The concept of the lender of last resort could be applied to catastrophe insurance if a government agency, possibly the Federal Reserve itself, stood ready to make loans to insurance firms who were in need of liquidity. These loans might appear similar to catastrophe bonds, but (a) would be issued only after the losses occurred, and (b) would be collateralized by assets of the insurance firm. The loans would be repaid from the insurance firms' ongoing profits. A difficulty, of course, is that the government would face potential default risk on these loans. Furthermore, it is an open question whether access to such a lender of last resort, without an insurer of last resort, would provide sufficient incentive for major insurance firms to continue to commit their capital and other resources to extreme event lines of insurance.

Current Developments for Government Terrorist Insurance

In the year following the 9/11 event, real estate markets continued to operate tolerably well in the absence of any government program, although there was considerable pressure from both the real estate and insurance industries to provide government protection against the higher layers of terrorist risks. Finally, on November 26, 2002, President Bush signed a federal terrorism bill into law. Passage of this bill finds this paper in its final editing stages, so our comments here are brief and preliminary.⁸ The bill shares the risks for terrorism between the private markets and the insurance industry. At the lowest level of actual losses, the insurance industry will bear the losses directly, as if there were a deductible limit. At higher levels of losses, there is coinsurance between the industry and the government, with the government share reaching 90% of the total. Losses about \$100 billion are again placed with the industry, although it could be expected that the government might then step in with post-event support. Some components of the government insurance require post-event repayments by the insurance industry (in the form of mutual insurance), whereas other components are provided without charge by the government. Another intriguing component of the bill is that all casualty insurance carriers are *required* to offer terrorism insurance to their clients, although there are no restrictions on the price at which this coverage must be offered. The presumption is that market competition will force firms to offer coverage at sensible prices. At this writing, no data are yet available

on the type of coverage that is actually being offered.

6. Conclusion

In this paper we have attempted to understand why the occurrence of an extreme event causes supply problems in the market for extreme event insurance.

Although more standard explanations such as ex post moral hazard and adverse selection in syndicate formation surely contribute to an explanation of the market failure, the timing of this failure as a response to the occurrence of a loss suggests that the “there is nothing to fear but fear itself” syndrome may play an important role. Consistent with the “risk as feelings” literature, government action may be required even when disruptions are temporary, caused by “irrational abhorrence”.

In this case, the goal of government policy should be not to replace the market, but rather to calm the market until it restores itself. The alternatives for government policy range from direct government insurance (such as in Northern Ireland and Israel), to insurer of last resort (such as with the British Policy Re or possibly with guaranteed catastrophe bonds), and finally possibly just to be lender of last resort. Generally speaking, the less government intervention the better, but the key is to make sure that capital continues to flow into these lines.

Memories fade after an extreme event, and with the help of government guarantees, it is to be expected that markets will soon return to normal operation. At that time, government support can be withdrawn.

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End Notes

¹ The primary carriers of insurance might answer that the quantity of insurance was rationed because reinsurance was not available. That merely pushes the question one step back. See City of Chicago [2001] for O'Hare insurance costs.

² We are grateful to Barry Nalebuff for calling our attention to the role of the winner's curse in this context.

³ This problem could be avoided by creating decade-long insurance contracts, with premiums still paid at the initial date of the contract. However, policyholders would then face a serious counterparty/performance risk. The fact that we do not see such long-term contracts suggests the performance risk issue is serious.

⁴ Catastrophe bonds are a class of securities, issued by insurance or re-insurance firms. The issuer places the proceeds from the bond sale in Treasury securities. If the cat event does not occur, the Treasury securities are sold to repay the principal to the bondholders. If the cat event does occur, then the insurance firm receives the proceeds from the Treasury bond sale, and the firm is also relieved of its obligation to repay the principal and any further interest on the bonds.

⁵ Refusal to trade can be motivated by other non-Laplacian models. For example, if the individual exhibits behavior represented by a Choquet integral, then refusal to trade can be a consequence of "model uncertainty". See Routledge and Zin [2001].

⁶ For other concurrent discussions, see and Cummins and Doherty [2002] and Kunreuther [2002].

⁷ Otherwise, the private markets would have incentive to cherry-pick, keeping the best terrorist risks in their own portfolio and passing the others to the public pool

⁸ For a more complete discussion of the bill, see Thomas Russell [2003].