

# **Demand and Supply Side Anomalies in Catastrophe Insurance Markets: The Role of the Public and Private Sectors**

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## **INTRODUCTION**

There is convincing empirical evidence that consumers and firms often do not make choices that are consistent with the conventional expected utility maximization model for decision making under uncertainty. Instead, economic agents in markets often exhibit biases and use simplified heuristics or rules of thumb in making their decisions. [Kahneman and Tversky 2000]. Even in the highly focused setting of choices with respect to protection against risk, there is considerable support for incorporating other behavioral elements that are not part of standard economic theory.<sup>1</sup>

If the conventional positive model does not hold, the outcome may then differ from the theoretically efficient outcome even in highly competitive markets with well-informed agents. This opens up the possibility that some type of public sector activity might, in some sense, constitute an improvement from a private market with voluntary choice. In fact, in most countries there is substantial governmental activity in the form of regulation, subsidization, and taxation in insurance markets, although there has been little detailed

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<sup>1</sup> See Kunreuther (2001) for a summary of how individuals and firms behave when making decisions on whether to purchase insurance and/or invest in protective measures against risks which they face.

analysis as to whether these interventions are likely to lead to improvements over a private market solution.<sup>2</sup>

Surprisingly there has been relatively little analysis of the nature of the interaction between individuals facing a potential loss and insurers who have the opportunity to offer protection against this risk in markets where many agents operate according to behavioral rather than conventional decision-making rules<sup>3</sup>. In this paper, we want to explore this interaction in the setting of an important and troubled insurance market: the market for property-casualty coverage from risks from large-scale disasters such as natural calamities (like hurricanes and earthquake) and man-made harms (like terrorism attacks). This insurance indemnifies property owners against damage both from direct destruction of property and from liability for injuries to persons connected with owned property.

The use of simplified heuristics as well as misperceptions of the risk by individuals makes both the normative and positive analysis of public sector behavior more complex, compared to the more traditional “market failure” analysis in such markets. There are three aspects of public sector behavior in this setting that we will illustrate with evidence from this insurance market.

*1. Appropriate role of government for dealing with anomalous behavior* A fundamental premise of welfare economics is that it is consumer preferences which ought to be taken as given that matter for defining what constitute improvements. Similarly firms are assumed to make decisions based on maximizing their expected utility and this should lead to

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<sup>2</sup> One recent exception is the interesting collection of papers in Cummins (2002). This book contains a number of studies which use the state- by- state cross -sectional variation of regulations on auto insurance in the US to examine the costs and benefits of various regulatory structures.

<sup>3</sup> One interesting paper exploring this ground is Carlier et al (2003).

efficient pricing in a competitive market (Stokey and Zeckhauser 1978). When the behavioral model leads to anomalies by consumers like failure to purchase insurance or over-insurance and failure to market certain coverage available by insurers, one is tempted to advocate that government step in and induce people to take certain steps. A key question that we want to address is what the appropriate role (if any) is for government to play when individuals and firms behave in a way that differs from standard normative models. One can incorporate into the normative calculus other judgments about what is good for consumers and firms, even what is in their best interests if only they were thinking clearly, but such “extra-welfarist” views have at best a weak foundation in conventional welfare economics.

*2. Anomalies may be exacerbated or improved by governmental activities or alternative institutional structures.* Decision-making under uncertainty is complicated, and it is easy for people pressed for time and with limited knowledge to make decisions that are at odds with standard economic models of choice. However, as we shall show, governments may engage in activities that make the task of understanding more complicated, or make the consequences of “error” more severe. We will argue that, especially on the supply side of property casualty insurance, some governmental activities actually enlarge the scope of anomalous behavior. Specifically, tax induced distortions in the capital market may widen the scope for anomalous behavior by investors. However, there can be other institutional structures or governmental activities that can make it easier for markets to “work around” irrational or anomalous behavior, and alleviate some of the consequences.

*3. The same consumers who make choices in markets also determine public policy in a democracy.* Suppose government wanted to correct the results of actions taken by citizens

in an insurance market who follow behavioral rules. A potential problem with doing so is that making choices for people that differ from what they would choose privately may be politically dangerous when the same people whose mistakes caused the outcome in question are also those whose support politicians must obtain to advance their own goals of getting elected and staying in office. There may then be severe constraints on what democratic governments (as opposed to the idealized benevolent omniscient welfare maximizing entity governments are supposed to be in welfare economic theory) can actually do. We do not treat this idea in this paper, but it is a logical next step in the analysis.

In the next two sections we provide a set of illustrative examples of anomalous behavior in property-casualty insurance markets relative to standard economic theory, first on the demand side and then on the supply side. We then investigate how this behavior is affected by what governments currently do and consider policy remedies that might directly improve matters. Finally, we consider the indirect issues: whether other government actions unintentionally might make the problem worse (or better) and whether the actions that would improve things would be likely to garner political support in a simple majoritarian model of democratic government.

## **ANOMALIES IN CATASTROPHIC INSURANCE DEMAND**

There is a large literature on the demand for insurance coverage that has been spawned by the state-preference approach and the theory of contingent claims developed by Arrow (1953) and Debreu (1953). The standard expected utility model assumes that individuals have subjective estimates of the probability of a loss and the resulting

consequences from a loss. Insurers offer consumers a range of policies with specified deductibles, coinsurance (i.e. risk sharing) arrangements and coverage limits at premiums that exceed expected benefits because of insurer administrative “loading” costs and profit. A consumer chooses whether or not to buy any insurance by comparing the loading with her subjective risk premium, which depends on how risk averse the person is and selects the policy that maximizes her expected utility. In other words, individuals make tradeoffs between the premium that they pay for certain amounts of coverage and the expected benefits should they suffer a loss.

We now present several examples of individuals’ behavior deviating from standard expected utility theory and suggest why people are making these specific choices. After looking at anomalies on the demand and supply sides of the market we will be in a better position to examine the basis for any intervention by the public sector in the market for insurance.

### **Example 1: Demand for Coverage After a Disaster Occurs**

Many individuals and firms who have not purchased insurance before a disaster want coverage after the event occurs and then cancel their policies several years later if they have not suffered a loss. As an illustration of this point, prior to the 1989 Loma Prieta earthquake in California about 34% of the uninsured respondents in the two counties suffering substantial damage from the disaster felt that coverage was unnecessary. By 1990 only about 5% in these counties gave this response. (Palm et al 1990). In the case of flood insurance one in five policyholders cancel their coverage each year even though many of them are required to purchase coverage by their banks and financial institutions. (Kunreuther 1996).

Turning to terrorism, in 2003 most firms believed that if a terrorist attack occurred it would not affect them, whereas in the first few months after 9/11 they had the opposite belief. A study by the Council of Insurance Agents and Brokers (CIAB) indicated that more than 90% of the brokers said that their customers eschew terrorism insurance because they think they do not need it (Council of Insurance Agents and Brokers 2003).

One could argue that the rationale for buying a policy after a disaster is that the individual perceives the probability of a future event to be higher than he had anticipated before it occurred. This does not appear to be the case for either floods or earthquakes. In fact, in surveys of people's perception of the risk of seismic hazards in California, homeowners indicated that the likelihood of a future earthquake was lower now that one had occurred than it was before the event.

The *availability bias* and *saliency* of the event is a principal explanation for this behavior. Following a disaster individuals focus on the consequences of the event and do not reflect on how likely it will be to occur. If the event hasn't occurred over a period of time they then perceive the event to be highly unlikely and hence decide that the investment in protection is not necessary.

### **Example 2: Preference for Low Deductibles**

A principal reason for a risk averse person to purchase insurance according to expected utility theory is to pay a small premium to protect oneself against a large loss that has a low likelihood of occurrence. If such an individual was given a choice between two identically priced policies, she should prefer the one with higher coverage limits below the loss and a higher deductible.

A reluctance to accept high deductibles is one of the earliest documented “field” examples of a violation of the expected utility maximization hypothesis. [Pashigian et al (1966) Murray (1972), Dreze (1981)]. A more recent example is the case of earthquake insurance. Prior to the Northridge earthquake of 1994 private insurers offered homeowners earthquake coverage with a standard deductible of 10%. After this quake, insurers were reluctant to provide earthquake insurance and a State company, the California Earthquake Authority (CEA), was formed in 1996. Because the CEA entered the earthquake insurance market with such a small quantity of capital (a total claims paying capacity of \$7billion), it was essential that some form of limitation be imposed on the extent of the coverage. The principal way that they did this was to raise the deductible to 15%<sup>4</sup>. Since its introduction, demand for the CEA policy has plummeted. As yet there is no systematic study of the causes of the fall in demand, but the Consumer’s Union and others have blamed it on the high deductible. (Consumer’s Union 1999). The CEA itself is aware of the problem as evidenced by their following statement: “ Since the CEA opened its doors in 1996, policyholders and agents have asked the CEA to lower deductibles and raise limits for Contents and Loss of Use” CEA (undated).

Table 1 shows the pattern of earthquake insurance sales relative to residential insurance policies from 1996 to 2002. At the time the CEA was formed just over 30% of Californians purchased earthquake coverage. Today less than 15% do.

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<sup>4</sup> The other major method by which the CEA limited its exposure was by only offering a policy which sharply curtailed loss coverage. This is known as the “mini policy”. Damage to unattached structures such as garages and swimming pools was excluded, and compensation for damage to contents and additional living expenses was capped at very low levels. More recently a policy with expanded coverage and a 10% deductible has been offered.

**Table 1:**  
Total Residential and Earthquake Insurance Policies in Force in California (1997-2002)  
(in millions of policies)

<b>Year</b>	<b>Residential Policies</b>	<b>Earthquake Policies</b>	<b>% of Earthquake Policies Sold</b>
1996	7.60	2.39	31.4
1997	7.89	1.54	19.5
1998	7.86	1.37	17.4
1999	8.12	1.36	16.8
2000	8.16	1.28	15.7
2001	8.12	1.29	15.9
2002	8.28	1.21	14.6

It sometimes appears that individuals prefer low deductibles because they view insurance as an investment or prepayment, rather than as a contingent claim in the spirit of the Arrow-Debreu model and want to avoid regret should they not collect on their policy. (Braun and Muermann (in press)) It is hard to convince individuals that the best return on an insurance policy is no return at all. If people want to maximize the chance that they will collect on their insurance policy should they have a loss, then taking the lowest deductible will be an optimal strategy to meet this objective.

What makes the decision on taking the lowest deductible even harder to understand on the basis of conventional theory is that some consumers are unwilling to make small claims that exceed their deductible because of a fear that their insurance premium will increase even when the increase is small or unlikely. This decision appears to reflect the separation of the decision to purchase coverage from the one on how much to collect if one suffers a loss. People are myopic and do not consider the time dimensions and portfolio nature of their decisions---what they do today has an impact on their expenditures tomorrow.

At the time one purchases coverage, an individual is considering the relative attractiveness of low and high deductibles and is not thinking about increases in premiums should one suffer a loss. After the event occurs the person is now aware that her insurance premium may go up if she makes a claim. In other words, the individual is focusing on a different set of goals and objectives after a disaster than before the event. (Krantz 2003)

### **Example 3: Preferences for Policies With Rebates**

There is experimental evidence that individuals prefer policies with rebates even if the expected value of the policy is higher than one where there is no rebate. This may represent an institutional arrangement to get around the deductibility aversion mentioned above, since drawing down a prefunded account that is at risk should have about the same effect on administrative costs or moral hazard as would the simpler strategy of a deductible. That is, increasing the premium to create an earmarked fund for rebates, which is then at risk, is equivalent to a policy with a deductible, a lower premium, and having the consumer keep the excess premium amount as savings. But those not wanting a policy with any deductible may prefer the policy with the fund, so that the efficiency advantages of a deductible can still be obtained. In a sense, one anomaly (preference for a rebate) offsets another (preference for low deductible).

Consider the following two comprehensive and collision automobile insurance policies: Policy 1 has a \$600 deductible and costs \$1000. Policy 2 has no explicit deductible and will give you a rebate of \$600 at the end of the year minus the amount the company paid for your claims. If claims exceed \$600 then there is no rebate. Policy 2 costs \$1600. It should be clear that Policy 2 is no more attractive than Policy 1. Yet when 187

subjects at the University of Pennsylvania were asked whether they would purchase Policy 1 only 44% said “Yes”. When the same individuals were asked whether they would purchase Policy 2 68% said “Yes”. (Johnson et al 1993).

The attractiveness of rebates can be explained by the value function in prospect theory. If individuals are loss averse they will view the deductible as very unattractive since they are responsible for the first portion of their losses—the portion on the steepest part of the value function in the loss domain. On the other hand, if the premium is increased this will not have as large a negative impact as the positive gain associated a rebate at the end of the period.

#### **Example 4: Probability Neglect**

Recent research suggests that probabilities may not be a key factor in how individuals make decisions particularly if one is dealing with catastrophic events having a very small likelihood of occurring. Slovic et al. (2002) show that affect may lead people to undertake protective measures, even if the chances of disaster are extremely low so that the decisions cannot be justified if one uses standard benefit-cost or expected utility comparisons. In that regard Baron et al. 2000 show that concern and worry plays a key role in individual choices on what protective measures to adopt. According to Loewenstein et al. (2001), people may not think much about variations in probability in making judgments and choices.

Sunstein (2002, 2003) extends this argument even further by contending that there is *probability neglect* due to emotional considerations and in situations where the probability of a loss is perceived to be extremely low. In a recent high stakes laboratory experiment Schade et al (2004) show that probability played no role in the decision on the

maximum willingness to pay (WTP) for insurance. Subjects had the chance of losing \$1,200 if an event with probability 1 in 10,000 occurred. Approximately 20% were not willing to pay anything for coverage while another 25% were willing to pay over 350 times the expected loss. The concern with experiencing a loss rather than probability of the loss occurring explains a significant part of the variance in WTP.

### **ANOMALIES IN INSURANCE SUPPLY**

In an ideal world, insurers have perfect information on the risks that they are insuring and can costlessly change their premiums to reflect any changes in either the probability or consequences from events for which they are providing coverage. Furthermore insurance firms are assumed to have access to the capital markets for any needed funds should they suffer a large loss that exceeds their net worth. For these reasons firms are assumed to be risk neutral and take steps to maximize expected profits.

Actual behavior of insurers may differ from this ideal world because they do not have perfect information on the pool of individuals seeking coverage. To the extent that consumers have better information on their risks than those providing insurance, there will be asymmetric information that can create problems of adverse selection. Once coverage is sold to individuals, the insurers may not be in a position to monitor and control behavior. To the extent that insured individuals behave in a way that increases the chances of a loss occurring and the insurer is not aware of these actions, then the insurer faces a problem of moral hazard.

Insurers may not have easy access to additional capital should they suffer a catastrophic losses and may have to declare insolvency. If there is asymmetry of

information between outside investors who provide capital and inside managers who control its use, then Greenwald and Stiglitz (1990) show that managers who are rewarded with a share of the profits but suffer a large penalty in case the firm suffers insolvency will behave as if they are risk averse. For example, suppose an insurance underwriter is concerned with his future employment opportunities should his firm be declared insolvent. He may then limit the amount of coverage for a particular risk or charge higher premiums than otherwise if he perceives the risks in his portfolio to be highly correlated.

Even taking into account these market imperfections, the supply side of the market does not always behave as would be predicted by standard economic models. Below we discuss some examples of anomalies on the supply side that need to be considered in developing strategies for dealing with this risk.

### **Example 1: Insurers are ambiguity averse**

Surveys of underwriters support the hypothesis that insurers will set higher premiums when faced with ambiguous probabilities and uncertain losses than with a well-specified risk. For the case of an earthquake risk, on average underwriters indicated they would charge between 1.43 to 1.77 times more if they were faced with risk that has ambiguous probabilities and uncertain losses than if probabilities and outcomes were well-specified. (Kunreuther et. al. 1995).

Actual field data support this finding. The loss of \$430million caused by the 1989 Loma Prieta earthquake in California, cost insurers 130% of the earthquake premiums collected that year. Yet they had no difficulty writing insurance coverage at low rates. Following the \$12.5 billion insured loss from the Northridge earthquake, insurers were not willing to write this line of coverage in California at any price (Roth, Jr. 1998). The

occurrence of a catastrophic event no matter how rare it is perceived to be by the insurer and general public provokes a form of extreme ambiguity aversion. In the case of earthquakes no matter what the true underlying probability distribution of future losses, providers of insurance act as though the occurrence of the next event is all but certain. In the same vein, consider the impact that 9/11 had on the supply of terrorism coverage. Insurers were unable to obtain reinsurance for these events except at very high prices and felt that losses from another terrorist attack of comparable magnitude could do irreparable damage to the industry. As a result, many insurers refused to offer coverage to their clients. The few that did provide insurance charged very high prices so only organizations that were required to have this coverage actually purchased it. (Kunreuther and Michel-Kerjan 2004). An example illustrating this behavior is the case of insuring Chicago's O'Hare airport. Prior to 9/11, the airport carried \$750 million of terrorist insurance at an annual premium of \$125,000. After the terrorist attacks insurers only offered \$150 million of coverage at an annual premium of \$6.9 million (Jaffee and Russell, 2002).

One reason why ambiguous risks may be priced higher than non-ambiguous ones is that insurers feel they will be judged on the basis of actual outcomes rather than ex ante analysis of various scenarios that might occur. If there are two experts who have estimated the probability of the event to be  $p_1$  and  $p_2$  respectively, then the underwriter may feel he is safer in using the higher value to setting premiums. In effect, owners of firms (with diversified portfolios) who would prefer that their managers ignore ambiguity are unable to motivate managers to do so, because the managers feel, generally correctly, that they will

be evaluated on the basis of what actually happened not on whether they made the “correct” managerial decision before the fact.<sup>5</sup>

The inability of owners to observe managerial decisions directly induces them to rely on outcomes as a measure of managerial skill. However, a manager who can point to “objective” evidence on probability can better justify an insurance supply decision that might turn out poorly than would be the case for a manager who made a proper but subjective judgment when the probability was ambiguous.

### **Example 2: Insurer Policies are based on Safety-First Considerations**

Any standard model of choice suggests that firms make tradeoffs based on maximizing expected profit if they are risk neutral or maximizing expected utility if they are risk averse. It appears as if firms determine what type of coverage to offer and the premiums to charge (if they have the freedom to set their own rates) based on safety-first considerations rather than the maximization of some objective function.

Roy (1952) first proposed a safety-first model of managerial decision-making that can be contrasted with an expected utility maximization approach. A safety-first model concerns itself almost exclusively with insolvency when determining the maximum amount of coverage the insurer should offer and the premiums to charge. In contrast, an expected utility maximization model recognizes that firms are risk averse, so that premiums will have to be higher to reflect the chances of a catastrophic loss. It does not explicitly focus on keeping the probability of insolvency below some prespecified level.

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<sup>5</sup> It is of some interest that when AXA, a manager run insurance company cancelled its terrorism coverage on the 2002 World Soccer Cup following 9/11, Warren Buffet, the entrepreneurial owner manager of Berkshire Hathaway stepped in to accept the risk. As owner, Buffet could not have been fired if things had gone badly, see Jaffee and Russell (2004).

In the context of insurance decision-making, Stone (1973) formalized these concepts by suggesting that an underwriter who wants to determine the conditions for a specific risk to be insurable will first focus on keeping the probability of insolvency below some threshold level. Interviews with underwriters and actuaries reveal that they utilize some type of safety-first model in determining whether to offer coverage against a specific risk and if so what premiums to charge. (Grossi and Kunreuther in press).

If firms utilize a safety-first model for determining the amount of coverage to provide for a specific risk, then one way to limit the number of policies sold would be to charge a higher premium. Ambiguous risks may be ones that underwriters feel may have a higher chance of producing larger than expected losses than they are willing to tolerate. Hence safety-first considerations would be another reason to charge a higher premium for coverage against these risks.

### **Example 3: Catastrophic Disasters Lead to Supply Interruption**

When losses occur from large-scale disasters that affect a number of exposures simultaneously, the supply of insurance becomes interrupted. More specifically, correlated losses from a natural disaster such as an earthquake or hurricane, or a man-made disaster like a terrorist attack, produce total losses to insurers that are much larger than average ones. Insurers will often withdraw from the market, canceling coverage wherever they can and quoting prohibitively high premiums to anyone who applies for new insurance. They do this even though the change in the expected value of benefits they would pay out in the next period should be affected only modestly by the occurrence of the catastrophe.

Insurers in turn blame this behavior on the treatment of their reserves. They are required both by law and by accreditation agencies to hold reserves to pay claims if recent

premium revenues are inadequate to do so. Payment of catastrophic claims depletes reserves to a level at which an additional infusion of capital to obtain replacement reserves is often needed. Insurers then contend that capital markets will not furnish such capital on reasonable terms, even though the higher premiums possible in such a setting would substantially exceed the expected value of the losses.

The easiest behavioral explanation is that investors are also ambiguity averse and drastically change their expectations of future losses after the catastrophic occurs. One storm could be followed by another hurricane, one terrorist attack by another. They fixate on the event itself and forget about the loss probability, in the same way that victims of disasters focus on their losses and decide to purchase insurance coverage after a disaster occurs rather than in anticipation of the event. On this basis they are only willing to provide capital at extraordinarily high interest rates for coverage against these risks.

A graphic illustration of this behavior was the difficulty that insurers and reinsurers had in obtaining funds from investors to offering terrorism insurance immediately after September 11<sup>th</sup>. During the fourth quarter of 2001 the rate of return required by investors for offering capital to cover terrorism risks was 20% per year. If one assumes a normal rate of return of 8% one can show that if an investor was risk neutral this would imply a probability  $(p) = .1$  that he would lose all his capital from terrorist attacks. (Kunreuther 2002). This is an extraordinarily high figure that is difficult to rationalize even if an investor were somewhat risk averse.

Another behavioral explanation is based on a kind of moral hazard. Suppliers of capital may believe that the high losses were not random, but were attributable to mismanagement or some kind of avoidable lack of foresight on the part of insurers; they

thus react to this perceived signal by substantially increasing the price of capital to a set of firms newly identified as poorly managed.

Harrington and Neihaus (2003) provide one explanation for insurers curtailing supply that is not based on behavioral explanations. They point out that the level of reserves insurers hold, at least in the US, may well be restricted by the tax treatment of earnings on assets held as reserves under the corporation income tax. The argument is as follows: if insurers obtain control over assets to serve as reserves against catastrophic but rare events, the current period interest on those reserves is subject to taxation under the corporation income tax, and then would be taxed a second time if paid out in dividends. In contrast, if those assets had remained in investor portfolios, they would only have been taxed once, as personal income. The net effect of this structure is to insert a wedge between the true cost of reserve capital and what the profit-maximizing firm sees as reserve capital.

Harrington and Neihaus show that if an insurer should optimally hold or control large amounts of reserves that are used only rarely, the cost of this wedge can be very substantial. The intuition is that, although the cost is relatively low per year, because the reserves must be held for many years, the cost “per catastrophe” is substantial. As a result, they hypothesize that insurers hold too little reserves, so that, when a catastrophe does occur, firms must turn to the capital market to rebuild reserves and are then not able to obtain sufficient capital at a reasonable price. They advocate tax credits to offset the earnings on reserves. Further non behavioral explanations for capital withdrawal may be found in Jaffee and Russell (1997).

#### **Example 4: Insurers Do Not Price or Exclude Certain High Consequence Risks**

For risks where there is empirical evidence that severe losses can occur, insurers should price them or explicitly exclude these risks from coverage even when the probability of such an event is perceived to be very low. In reality insurers appear to follow a threshold model whereby they do not either price some kinds of risks or exclude them from coverage because they perceive their probability of occurrence to be below a threshold level of concern. What is surprising about this behavior is that they may have evidence that the risks could happen and the resulting consequences to them could be severe. Consider the behavior of insurers with respect to terrorism coverage. Prior to September 11, 2001 terrorism coverage in the United States was included in standard commercial insurance policy packages without explicit consideration of the risks associated with these events. It was an unnamed peril on insurers' all-risk commercial and homeowners' policies covering damage to property and contents. Even the first attack on the World Trade Center (WTC) in 1993, which killed 6 people and caused \$725 million in insured damages (Swiss Re, 2002), was not seen as being threatening enough for insurers to consider revising their view of terrorism as a peril to be explicitly considered when pricing their commercial insurance policy (Kunreuther and Pauly 2004). The private insurance market had functioned effectively in the U.S. because losses from terrorism had historically been small and, to a large degree, uncorrelated. Attacks of a domestic origin were isolated and had not created major economic losses and disruption nor many casualties.

## **PUBLIC-PRIVATE PARTNERSHIPS FOR ADDRESSING ANOMALIES**

Given the type of behavioral anomalies on the demand and supply side the question naturally arises if there is a role for some type of role for the government to play in providing information to firms and individuals at risk so they will make decisions which will be more in their own interests and society's than current behavior and/or imposing certain requirements regarding the purchase of insurance. At the same time one needs to ask the question as to what role the public sector should play in assisting insurers so that they more receptive to providing protection against these catastrophic risks.

### **Correcting Anomalies on the Demand Side**

*Reframing Probabilities.* The first line of attack in addressing anomalies on the demand side is to provide consumers and firms with information that will lead them to appreciate more fully the elements that should be considered when making decisions regarding insurance. If individuals *neglect low probabilities* because they believe they are below some threshold level of concern, then reframing the risk may lead them to pay attention. In particular, adjusting the time frame can affect risk perceptions. People are more willing to wear seatbelts if they are told they have a .33 chance of an accident over a 50-year lifetime of driving rather than a .00001 chance each trip. (Slovic et. al. 1978).

Similarly if one an individual is much more likely to take the risk of a 100-year flood more seriously and consider insurance protection if he was to was told that the chance of at least one flood during the next 25 years doing damage to his home was greater than 1 in 5 rather than 1 in 100 next year. Studies have shown that even just multiplying the single-year risk—presenting it as 10 in 1,000 or 100 in 10,000 instead of 1 in 100 – makes it more likely that people will pay attention to the event. Most people feel

small numbers can be easily dismissed, while large numbers get their attention. (Slovic et al 2000).

*Disappearing Deductibles* One way to encourage individuals to take a higher deductible on their policy is to provide them with insurance that has a high deductible but disappears if the loss is above a certain level. Consider two homeowner insurance policies. Policy A has a \$500 deductible while Policy B has \$1000 deductible but it disappears if the loss is greater than \$20,000. Assuming that both policies are sold at the same price, individuals may prefer the disappearing deductible if they like the idea of paying nothing should their loss be sufficiently high. If at the same time one could explain to the consumer that he may want a higher deductible so he isn't faced with a decision on whether or not to process a claim for a relatively small loss and have his rates go up the next year or his policy canceled, this should make Policy B even more attractive.

*Required Insurance* Existing institutions, such as banks and financial institutions, could require insurance coverage as a condition for loans and mortgages to protect their own investments against catastrophic losses from events, which are now voluntary. Consider the risk of terrorism. If this requirement was imposed property owners would assume the cost of their risk through their insurance premiums and would be aided financially in their recovery process should a terrorist attack occur by being able to file a claim to cover their direct losses as well as business interruption. Rents to tenants in commercial buildings may increase to reflect the cost of terrorist insurance coverage.

Mandatory coverage for these and other risks would guarantee a much larger market for terrorism insurance and enable the insurance pool to diversify its risks across structures and geographical areas. By increasing the premiums contributed to the pool, the

likelihood of a catastrophic loss that would exceed the pool's resources would be reduced. But would someone who would not choose insurance on their own select a lender who requires coverage? The answer, of course, depends on the terms with and without required coverage. If the absence of coverage by the property owner could lead to default risk for the lender, then more favorable terms for a loan requiring insurance might be expected even from the conventional model and the absence of coverage in the presence of bankruptcy protection might also be expected.

An alternative is for the government to require insurance as a condition for a federally insured loan as they now do with flood insurance under the National Flood Insurance Program. In the case of earthquake protection, the California Earthquake Authority (CEA) could impose a similar requirement for all homes in California. This is unlikely to be well received by the voters who have little interest in purchasing such coverage today at current rates and coverage terms.

It is much easier to defend a voluntary private market approach for providing terrorism or earthquake insurance when no losses have been incurred. The lessons of September 11th and previous natural disasters indicate that there will be strong pressure for public sector involvement following any catastrophic event. Considering some type of required insurance before such an event occurs would alleviate the political pressure for federal relief and facilitate the recovery process through insurance claims dispersed rapidly to those suffering losses.

*Mutual insurance.* Suppose that purchasers of insurance think the loss probability is lower than that insurers would build into their premiums. Pauly, Kunreuther and Vaupel (1984) have shown that, in such a case, mutual insurance may be an attractive institutional

arrangement. Under mutual insurance, the net premium is based on whatever pooled average losses turn out to be. Thus people who expect that losses are rare would expect to pay low net premiums (or expect a dividend from the mutual plan). Sometimes it may be more efficient for the public sector to organize this mutual insurance.

Of course, this arrangement requires that people agree that they have similar loss probabilities to all other in the pool, but they need not agree on the magnitude of the expected loss. A mutual plan for terrorist protection of business property in major cities all equally at risk of terrorism would be an example of this kind of arrangement. (Such “distrust-of-insurers” mutuals are common in medical malpractice insurance, but thus far are not common in other property or liability insurance.)

*Recognizing the Importance of Affect* If individuals purchase insurance in order to gain peace of mind and reduce their anxiety, then one can emphasize this point in providing protection. Insurance companies do this as a matter of course because they know it is important in selling a policy. One may be able to convince an individual of the importance of insurance by stressing the advantages of paying a small premium for protection against a large loss following a disaster so that s/he now believes that buying a policy will satisfy both economic as well as emotional concerns. While we have no direct evidence of the importance of this phenomenon for insurance coverage of catastrophic events, it seems likely that it may play a role. Further research is needed.

### **Correcting Anomalies on the Supply Side**

*Government Providing Needed Capital* To deal with capital withdrawal following an event, the government may offer to make capital available as a “lender (or reinsurer) of last

resort” on a temporary basis. As is the case with the Federal Reserve and the banking industry, this offer by itself may be enough to restore the market to normal operation.

An alternative arrangement which utilizes no public capital is the California Earthquake Authority. As noted earlier, the California Earthquake Authority was created in 1996 in response to a crisis in the California homeowner’s insurance market brought on by the Northridge earthquake of Jan 1994. Under the terms of a previous agreement, providers of standard homeowner’s insurance (fire, theft etc.) in California were required to offer the additional coverage of earthquake insurance at the buyer’s option. In Northridge, insured earthquake losses were so large (eventually exceeding \$15 billion), insurance companies threatened to withdraw from the standard homeowner’s insurance market rather than be forced to add the earthquake clause.

With new home construction and mortgage lending now threatened by not having homeowners insurance available, the State (in some haste) created the California Earthquake Authority to offer the earthquake line. Although the California Earthquake Authority is a public agency, the capacity to pay is provided entirely by a combination of assessments on private insurance companies, reinsurance, and retained premium earnings. At this time the CEA is the largest provider of earthquake insurance in the world.

Since the CEA has no access to the budget of the State of California, how is it able to find the capital necessary to underwrite this risk when the private sector claims that no funds are available for this purpose? The answer appears to be that those who provide capital to the CEA have their losses capped at levels with which they are comfortable. For example the private insurance companies who are members of the CEA and who issue the policies and administer the loss process have a maximum capital exposure of \$4 billion.

The device of limited liability is an obvious antidote to ambiguity aversion. Indeed insurance companies have sought limited liability in other catastrophe lines, such as hurricane insurance. Looking beyond insurance, as Moss (2002) pp53-84 has noted, the inclusion of limited liability in contracts of capital supply played a major role in the development of the manufacturing industries in the North East of the United States in the early part of the 19th century. However, as he points out the benefits of limited liability can be incorporated into private contracts of capital supply without any government mandate. In the case of insurance, it would not be difficult to draft a contract of partial or limited coverage, in this way protecting the reserves of the insurer. Why did such contracts not emerge following the Northridge event?

Behavioral issues caused difficulties. As Wakker, Thaler, and Tversky (1997) indicate, buyers require much larger compensation to accept even small deviations from full insurance than is predicted by expected utility theory. This suggests that if private markets try to attenuate losses by developing policies with high deductibles or other forms of partial coverage, such policies will be difficult to sell. This may explain why such “limited liability” policies did not emerge in the private sector, and indeed as noted above, the partial insurance “mini policies” issued by the CEA have also encountered consumer resistance. [ For details see Jaffee and Russell (2000)].

*Modifying Tax Policies* We have suggested above that firm decisions on how much reserves they wish to hold are affected by public sector tax policies. Of course, these tax policies are not specifically directed at insurers; they are just caught up in the same tax rules as apply to all corporations. But the main consequence of this intervention is to

exacerbate the impact of behavioral factors. Let a catastrophic loss occur, and suppose (as would usually be the case) that the firm has sufficient reserves to pay actual claims. But then, in order to continue to offer insurance in the next period, it must “rebuild” its reserves. To do so, it must turn to a capital market exhibiting the kind of anomalous behavior we have described.

Contrast this scenario with what might have happened had tax treatment been more neutral with regard to the return on assets. Insurers would have found it rational to hold much large levels of reserves, so that they could ride out a disaster without necessarily turning to the capital market. While it would not be possible or desirable to accumulate reserves to such a level as to completely prevent the need to rebuild, the number of cases in which this would be an issue would (in theory) be greatly reduced. Firms with adequate reserves could still offer insurance in the next period, and could wait until capital market behavior returns to normal to rebuild reserves to their long run ideal level.

It is often noted that one reason why firms may fail to offer coverage is their expectation that government will step in and offer subsidized help. This story obviously assumes fully rational behavior on the part of insurers and investors; no behavioral theory need be invoked. However, it is clear that this action by government is based in part on the expectation of the anomalous capital market behavior described above. In at least some circumstances, government waits to intervene until it is apparent to them that private insurers funded by private capital are unable to supply insurance to new customers.

There is, however, a sense in which anomalous behavior is at the heart of this kind of phenomenon. Think of there being two sources of capital to back insurance against catastrophes: private market capital and capital that government can raise. In the latter case,

assume that the source of capital is government borrowing, although in practice it could also be higher taxes or foregone government spending on other goods and services.

The cost of capital differs between the two sources. Precisely because of the tax treatment noted above, the ostensible cost of capital to the government is lower than to private firms, since the government does not pay corporation income tax or earn profits. Of course, the real social cost of capital probably is quite similar between the two sources, even taking into account the large size of the government's portfolio.

But this tax distortion actually makes government crowd out private activity despite politicians' often-expressed preferences for the market to function. The reason is that the government has access to capital at lower cost than does the private sector. This argument would hold even in the absence of anomalous behavior.

There is another dimension, however. Government also must raise funds to provide the protection it covers. If investors knew that the investments they were making in government securities was going to be used for back payments of claims from a recent catastrophe, they should have the same reaction as in the private sector: fear that money will be wasted on a newly dangerous investment, and concern that it will be poorly managed. That is, the same anomalous behavior that shuts down capital flows to private sector efforts to deal with catastrophes ought to have the same effect on government.

There are however some obvious reasons why there does not seem to be the same kind of market failure. One reason is that government funding for purposes of catastrophic coverage is a much smaller portion of total government investment than would be provision of insurance by private firms, who themselves do not have as large a portfolio. The private market has a larger portfolio than government, but that pooling cannot apparently be

mobilized in this case. Second, government has access to taxation or money creation to be able to guarantee repayment to investors. On the other hand, it is generally felt that public provision of insurance is less desirable than functioning of a private market, and it is very difficult for the government to overcome the anomalous behavior in private markets without the need to use some government spending.

Sometimes, however, government is simply asked to guarantee private insurance which, in effect, puts the government in the role of surrogate sources of capital. The main problem here again is that the government is not thought to be especially capable of judging the risks and avoiding moral hazard behavior on the parts of insurers. That is, if insurers were reassured that government would offer support in the event of catastrophic losses, they would be induced to sell insurance for inappropriately risky prospects, unless government had some way of distinguishing bad luck from bad judgment.

*Mutual insurance.* Mutual insurance is also a potential solution on the supply side when opinions differ about loss probabilities. The capital for mutuals is contributed by those who will be insured, and when claims exceed reserves, this does not trigger bankruptcy, but (at worst) a future premium increase or present-period assessment. Obviously consumers would prefer insurance that could draw on the much larger resources of the entire capital market but, compared to no insurance at all or very overpriced insurance, mutual insurance may make sense.

#### *New capital market instruments*

Is there any action that could be taken to prevent or avoid the anomaly of capital shortage after a disaster? The key point here is that the behavioral model seems to fit temporary but not permanent behavior. Investors respond to a catastrophic event by

drastically and irrationally curtailing the supply of capital, but eventually they return to furnishing capital to insurers on reasonable terms.

If this conjecture is correct, a possible solution would be for investors, anticipating this kind of behavior at some point in time, planning in advance to constrain themselves to more “rational” behavior. In particular, imagine that an insurer would make a contract with a source of capital in which, in return for an upfront payment, investors would agree to make additional capital available in the event of a catastrophe. This would be equivalent to an agreement by investors to buy additional stock in the insurer at a predetermined price should the firm choose to exercise this option, over a given period of time. Of course, one would be envisioning here a multi-year time horizon, not the relatively brief period in which puts and calls are sold in today’s securities markets. This would avoid the double taxation problem, since the reserves would be retained by investors until and if they are needed. The question is whether investors would agree to this arrangement at a reasonable cost. They would know that when the call is exercised, they will be in a frame of mind that makes them very reluctant to follow through, since they will be fixating on the recent catastrophic event. Some research on how people would respond to this type of “lash-to-the-mast” contract would be interesting.

What ought to be more effective in deterring action in a representative democracy is the fact that any subsidies offered in connection with a catastrophe will, in the short run, go to only a small fraction of taxpayers, but all will be required to pay. “Fiscal illusion” in which voters are encouraged by politicians to ignore costs and fixate on the benefits of public spending may offset this possibility, and there may be genuine feelings of solidarity with one’s unlucky fellow citizens. Moreover, people could look at disaster relief as a kind

of public insurance from which they will expect to benefit, although the assumption of uniform risk seems heroic. In effect, they support public payments covered by their taxes to people elsewhere who suffer losses in the expectation that they would receive the same benefit if a disaster should strike them.

## **CONCLUSION**

The losses from catastrophic events, whether man-made (like terrorist attacks) or natural (like earthquakes and hurricanes) can have devastating consequences for economic growth and development. For this reason, it is extremely desirable to share the risk of these potential losses through ex ante insurance arrangements. In this paper we have documented a number of behavioral reasons, both on the demand side and on the supply side, why a private market for catastrophe insurance runs into difficulties.

The failure of the private market naturally raises questions as to the appropriate form (if any) of the public sector response. On the demand side, some of the behavioral anomalies can be corrected by an appropriate reframing of the terms of the insurance purchase decision. On the supply side many of the difficulties stem from the adverse reaction of capital markets to a large loss. The paper has discussed a number of ways in which the government can step in to fill this capital breach. A key consideration in designing such programs is to foster policies which encourage adequate private capital reserves before a catastrophic event, and speedy return of private capital to this market afterwards.



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