NEGLECTING DISASTER:

WHY DON'T PEOPLE INSURE AGAINST LARGE LOSSES?

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ABSTRACT

This paper provides a theoretical explanation for the common observation that people often fail to purchase insurance against low-probability high-loss events even when it is offered at favorable premiums. We hypothesize that individuals maximize expected utility but face an explicit or implicit cost to discovering the true probability of rare events. This cost constitutes a threshold that may inhibit purchase but may be offset in several ways by suppliers of insurers and state regulators.

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It is well known that consumers have difficulty in dealing with low-probability, high-loss events. Frequently they fail to obtain insurance against such losses, even when the terms are so favorable that purchasing insurance should be preferred by almost everyone. That is, people continue to avoid purchasing even when the administrative loading is generally known to be moderate and subsidies are present, so that premiums are close to or below actuarially fair levels (Phelps, 1997, pp. 409-410). One obvious characterization of such behavior is that it represents non-optimal decision-making based on individuals utilizing simplified heuristics, ones that do not require making explicit tradeoffs between the expected benefits and costs of different alternatives (Kahneman and Tversky, 2000).

This paper suggests a somewhat different explanation for such behavior by modeling factors an individual should consider in deciding whether to investigate or even think seriously about the purchase of insurance. We assume individual consumers maximize expected utility, but in a world where there are transactions costs (explicit or implicit) associated with obtaining information about insurance premiums and coverage and about the underlying loss probabilities. While our simple model is based on the value of explicit information, we also argue that this model can cover situations that require considerable effort to think about and search for relevant data.

We should point out at the outset that we do not believe that individuals always go through the types of calculations that are required for maximizing expected utility whenever insurance is available. Our objective is rather to show that the types of search costs associated with collecting information can be enough to discourage individuals from undertaking these calculations; some interesting predictions about behavior follow from this.

While our model deals with consumer search, our primary focus is *not* on the problem of obtaining information about the prices and offerings of different sellers treated in the rather extensive economics literature on search theory. Rather, we initially consider the situation where all firms have identical estimates of the risk and charge the same price for insurance of uniform quality. Potential policyholders, however, cannot get information on the loss probability and/or the prevailing premium without incurring some transaction cost. By considering this simple model, we can focus on the question of whether a person would choose to get started in the search process for insurance. We then examine the case where there is ambiguity by both buyers and sellers on the probability of the event occurring so that premiums will differ between insurers.

In the case of insurance against a catastrophic event, it is the magnitude of the loss probability that determines the value of the insurance product. In our model consumers search because they do **not** have perfect knowledge of that probability. This simple model produces new insights about the role of bundling and of the provision of information on insurer profitability. It also suggests how one might improve the functioning of insurance markets in a world of imperfectly informed consumers. Here is an example of the kind of decision-making we seek to analyze. A homeowner (who also happened to be an insurance agent) in Tacoma, Washington, commented on the premium for adding earthquake coverage to his homeowners' policy as follows:

> "My dwelling is insured for $250,000. My additional premium for earthquake insurance is $768 (per year). My earthquake deductible is $43,750… The more I look at this, the more it seems that my chances of having a covered loss are about zero. I'm paying $768 for this?" (*Business Insurance*, 2001, p.8)

From this comment it appears that either the effort he put into thinking about the problem and/or the resources he put into seeking information about loss probabilities was limited. Rather than concluding that the chances of having a covered loss are “about zero,” he could have asked himself the likelihood that an earthquake would completely destroy his dwelling next year. If he was risk neutral or risk averse and estimated that the chances of such an event occurring in Seattle were greater than 1/250=. 004, then he definitely should be willing to buy insurance since 768/(250,000 – 43,750) = 0.0037. At this probability the insurance premium would equal the expected loss, and would be actuarially fair. At an estimated probability higher than this value, insurance would be a good deal for anyone who is risk neutral or risk averse. We hypothesize that the search and transaction costs (objective or subjective) may be sufficiently high, that this person didn’t want to seek information on the chances of a quake in Seattle and decided, based on his current beliefs, not to buy insurance.[2]

This example illustrates a more general point. While some rare events can surely cause enormous losses when they occur, the difference in the consumer’s ex ante expected utility with and without insurance might be small if the probability of the event is known to be low. In other words, the *expected* value of the loss is low relative to the person’s wealth. Thus whether a consumer “bothers” to think seriously about or obtain information on the magnitude of the risk relative to the insurance premium depends on the gain in expected utility from so doing versus the cost in time and energy of obtaining and processing these data.

The idea that fully rational behavior is limited by the subjective costs of paying attention and thinking hard is one of the pillars of support for the concept of bounded rationality. As Frank Knight (1921, p. 67) suggested many years ago, “It is evident that the rational thing to do is to be irrational, where deliberation and estimation cost more than they are worth," a sentiment echoed by Baumol and Quandt (1964, p. 230) who discuss "optimally imperfect decisions."

This paper formulates the idea of decision-making costs and imperfect information in ways that help explain "anomalies" in insurance markets and operationalize Conlisk's (1996, p. 675) suggestion that "anomalies are not surprising relative to theories which neglect deliberation cost, experience, and other conditions bearing on how close to unbounded rationality it is possible or sensible to be." Conlisk goes on to say that "appliances and insurance are purchases …for which the deliberation and other costs of expertise may be large relative to their potential benefits" (p. 672).

To our knowledge there has been no attempt to formally address the points raised by Conlisk. This paper takes a step in this direction for the case of insurance against low probability, high loss events.[3] With regard to insurers' information about probabilities, we consider two different situations. In our benchmark model, insurers are very sure about the probability of loss even if consumers are not. Roughly speaking, insurers would be sure about low probability-high consequence events that are independent, such as premature mortality. In the second situation both insurers and consumers are ambiguous about the probability of rare or correlated losses, such as those from earthquakes or terrorist attacks.

We construct a model with assumptions that allow us to avoid the infinite regress problem posed by Winter (1975) that making a rational decision about whether to make the costly effort to obtain and use good information depends on first deciding whether to seek costly information on how rational it is to seek costly information. Sections 1 and 2 develop these ideas more formally by formulated the consumer's problem in terms of the expected value of information and then discusses the implications of the model for behavior by consumers.

Section 3 then considers the case where the probability of a loss is ambiguous for both potential buyers and sellers of insurance. After presenting an illustrative example in Section 4, we suggest other reasons based on empirical studies as to why individuals with imperfect knowledge often do not bother to obtain additional data on the risk or purchase insurance coverage (Section 5). Based on this evidence, Section 6 proposes ways of encouraging individuals to search for information. Section 7 addresses issues associated with imperfections on the supply side so that firms will want to market coverage that should be more attractive to both buyers and sellers. The paper concludes with some broader prescriptive recommendations and suggestions for future research.

1. The Basic Model with Imperfect Information about Probability

Consider an individual who is contemplating purchasing insurance against a loss from some peril that is substantial relative to his wealth. The individual knows his own loss (L) but does **not** know the probability of the peril occurring. The person is assumed to be risk averse, have wealth (W), and want to determine how much insurance (I) to purchase. All insurers are initially assumed to know the probability p with certainty. They are also assumed to be identical and offer coverage I, where $0 \leq I \leq L$[4].

In order to focus on the effect of information about the loss probability, we assume that all insurers are known by consumers to be charging the same premium (z) that reflects expected losses using the insurer's best estimate of the (unknown-to-consumers) probability of the event occurring (p). There is a positive loading charge (λ), also unknown, which reflects administrative expenses and profit.

Insurance premiums are plausibly larger than actuarially fair rates, but consumers do not need to search across different sellers of insurance for lower premiums because prices are assumed to be the same. Hence $z = p(1+\lambda)$ or $(1+\lambda) = z/p$, the ratio of the premium per dollar of coverage to the loss probability.[5] Since the consumer knows z, but does not know either p or λ, he is uncertain about how high the premium is relative to the actuarially fair rate. He is therefore uncertain about whether buying insurance would increase his expected utility.

Suppose that the consumer initially does not know the exact loss probability, but does know that he can obtain precise information about its value at a fixed search cost (S). We think of S as representing both the subjective cost of "paying attention" and the objective cost of obtaining information on the probability p. The consumer's problem is to determine how much insurance (I) to purchase so as to maximize expected utility by either deciding to undertake a search for information or not search at all.[6] The outcome will either be EU(Search) or EU(No Search).

There are three alternative strategies available to the individual with respect to insurance:

A. Ignore Insurance. Incur no search or attention cost, gather no additional information on the probability p, and buy no insurance.

B. Buy Insurance Immediately. Incur no search or attention cost, gather no additional information on the probability p, but buy a positive amount of insurance from a randomly selected insurer at premium z.

C. Seek Information. Gather information on p at a search cost S and then decide whether or not to buy insurance based on the content of the information.

1.1. Impact of Not Seeking Information

If the person decides not to seek additional information, then one can determine the expected utility associated with Alternatives A or B. The individual's initial state of knowledge of the loss probability is imperfect in the sense that he believes that the probability has n possible values, p_j, j=1….n with subjective likelihoods or probability "weights" $w(p_j)$ associated with each p_j and $\Sigma w(p_j) = 1$. Define the individual's ex ante average subjective probability of a loss to be $p = \Sigma w(p_j)\, p_j$.[7] The quantity of search is assumed to be either zero (no search) or 1 (complete search).

If the individual has estimates of the probabilities of losses, but does not seek additional information about p, and then purchases I units of insurance ($I \geq 0$), the "average" expected utility EU(No Search) is:

$$EU(\text{No Search}) = \sum_j [p_j\, U(W-L+I-zI) + (1-p_j)\, U(W-zI)] \quad (1)$$

To determine whether to set I =0 (Alternative A) or to choose some positive level of insurance without seeking information (Alternative B), the person is assumed to determine the expected utility of buying insurance without search for various levels of insurance coverage. If EU(No Search) is highest when I=0, the person chooses alternative A. If EU(No Search) is highest at some $I^* > 0$, the person chooses alternative B and buys I* units of coverage with $I^* \leq L$.[8]

1.2. Impact of Seeking Information

To decide whether to search for additional information (Alternative C), the individual must determine whether the value of the information he is likely to obtain by searching will justify the search cost S compared to either ignoring insurance or buying insurance immediately. Assume that information once obtained is "complete" in the sense that the person will have obtained the most accurate estimate of the loss probability.

To determine whether to search for information on the probability of the event the following procedure can be followed:

Step 1: The person first computes the expected utility associated with the optimal amount of insurance purchased for each subjective estimate of the probability of a loss given that search takes place at a cost S. In this two-state world, demand for insurance is determined by finding the amount of coverage $I^{*}= I^{*} (p_j, z, S)$ that maximizes:

$$\max \; EU[(Search)] = p_j U[W - S + L + (1-z)I] + (1 - p_j) U(W - S - zI) \qquad (2)$$

$$\text{subject to} \qquad 0 \leq I \leq L$$

Using the Kuhn-Tucker conditions one can determine when a risk-averse consumer will want to purchase no insurance, full insurance or some insurance. The first order optimality condition is given by:

$$CPR_j = \frac{z(1-p_j)}{(1-z)p_j} = \frac{U'[W - S - L + (1-z)I]}{U'(W - S - zI)} \qquad (3)$$

The LHS of (3) is a contingency price ratio (CPR_j). It is the ratio of the consumer's estimate of the expected cost of insurance should a loss not occur [$z(1-p_j)$] to the expected net gain from insurance should a loss occur [$(1-z)p_j$]. As the premium z increases, the CPR_j will also increase, reflecting a higher cost of insurance due to a higher loading cost. The higher the loading cost, the less insurance the consumer will want to purchase. The RHS represents the ratio of the marginal utility of wealth in the "loss state" to the marginal utility of wealth in the "no-loss state" if the consumer incurs a search cost S and purchases I units of insurance. The higher this ratio, the more risk averse an individual is and the more insurance coverage he will want to purchase at any given CPR_j. Hence an individual makes a decision on whether to purchase insurance by trading off the estimated loading cost against his or her degree of risk aversion.

An individual wants to set I*=0 if $CPR_j \geq U'[W- S - L]/ U'[W- S]$. In this case, the premium is sufficiently high given p_j that the consumer is better off not having any coverage. Similarly the consumer will want to buy full coverage if $CPR_j \leq 1$ which implies that $z \leq p_j$. In other words, whenever the premium is perceived to be either actuarially fair or subsidized, a risk averse consumer would choose I* = L.

Step 2: The expected utility in each state j (with probability p_j) of each optimal insurance decision for each p_j is weighted by $w(p_j)$ to obtain the expected utility of search for any search cost S. This is given by

$$EU(Search) = \Sigma\, w(p_j) \underset{j}{EU}\, [I^* (p_j, z, S)] \qquad (4)$$

This implies our final conclusion:

A person will decide to search for information on the probability of a loss only when EU(Search) in (4) is greater than the maximum value of EU(No Search) determined by comparing Alternative A with Alternative B.

2. Implications of the Model

The above model helps to predict when consumers are likely to not purchase insurance even when it is offered at reasonable premiums. A consumer's interest in purchasing insurance depends upon the magnitude of L and his ex ante average subjective probability of a loss (p) relative to the premium (z). As indicated by (3), for any given value of L, individuals are more likely to purchase insurance as they become more risk averse. Furthermore as L increases, the amount of coverage will also increase for any given value of W.

The decision on whether or not to incur search costs also depends on p/z. As we have suggested, one way to determine this ratio is by estimating the loss probability p. But note that p/z can also be estimated if the consumer is ignorant about p but knows the loading λ. In other words, if a consumer estimates the loading charge to be λ^* then $p= z/(1+\lambda^*)$. We will deal with this point in more detail later, but we mention it here in order to highlight a special case. Suppose a consumer believes that the premium is actuarially fair or subsidized so that $\lambda^* \leq 0$. In this case, the consumer would be assuming that $z \leq p_j$ so the CPR$\leq$1. Hence, regardless of the level of p_j, it would always be optimal for a risk averse individual to buy $I^* = L$, without incurring any search.

In the more general case in which $\lambda^* > 0$, there are three possible outcomes regarding insurance purchase:

(1) If S is relatively high and p/z is low, follow strategy A (i.e., ignore insurance).

(2) If S is relatively high and p/z is also high, follow strategy B (i.e., buy insurance without search). In this case the optimal amount of insurance depends on the value of L relative to W. It also depends in some way on what the person's beliefs are about the loss probability.

(3) If S is relatively low, follow strategy C (i.e., search).

In what circumstances will this model yield the stylized behavior we initially described—the failure to buy insurance? This will happen if S is relatively high *and* if p is perceived to be relatively low. In this case, a person is unlikely to think about purchasing insurance if her initial subjective loss probability is low and the expected benefits from purchasing insurance are outweighed by the search and/or thinking costs.

A key characteristic of these situations where individuals do not purchase coverage is that the loss-producing events are rare, so that the great majority of people will never have observed such an event. If they adopt the heuristic that events that have not been personally experienced are assigned a very low or even zero probability, there will "rationally" often be no search and no purchase. The few individuals who do experience a loss are likely to buy coverage immediately after a disaster by setting their subjective probabilities at a high level. But there are fewer individuals in this category compared to the number in the "it has not happened to me" category. Hence there will be a limited market for such coverage.

3. Ambiguous Insurer Probabilities

Up to this point we have assumed that the sellers of insurance know the "true" probability. What would happen in situations, not uncommon with respect to low probability-high consequence events, if the data available to the insurer is limited, so that it is uncertain about the probability distribution of losses?

There are many different ways of modeling ambiguity about probability. They all involve representing the relevant decisionmaker's beliefs as a weighted average of the person's current subjective probability distribution and something else (Schmeidler, 1989). [9] We propose a model of market equilibrium where insurer ambiguity is due to limited *credibility* of the available data (Pauly, 1983; Freifelder, 1975). The actuarial model utilized in such cases is Bayesian whereby premiums are determined by estimating the probability of a loss using past data as well as experts' views or other information that bears on the risk in question.

Suppose that there are multiple competing insurers all offering the same coverage but at different premiums based on the evidence in their available data base. When insurers know they have different and incomplete data, they should be aware of a possible winner's curse problem. Each insurer wants to avoid charging too low a premium relative to the true expected outcome; in such a case it will gain clients but have negative expected profits. Hence it will want to raise its premium to counteract this problem (Mumpower, 1991; Pauly, 1983).

Specifically, ambiguity is due to limited data available to each insurer on the event due to its novelty or rarity. Scientific experts are also not able to estimate the likelihood of the event with great confidence. From an insurer's point of view, the data available to each insurer is insufficient to provide full *credibility.* All insurers are assumed to estimate the probability distribution of losses based on their own database. In other words insurer *i* has a unique estimate of p_i that is determined by a Bayesian estimation procedure with less than fully credible data. Each insurer *i* will set its premium $z_i > p_i + \kappa$; the "risk loading" factor κ is added in order to avoid losing money on insurance for this risk given the large volume of business that will occur in the event that the insurer's data leads to unusually low premiums.

The intuitive reason for this behavior is that the insurer whose draw is from a "favorable" sample will estimate p_i to be lower than the true probability. If it were to base its premium only on its subjective probability estimation from its data, it would attract a disproportionate share of customers (in the case of perfect buyer knowledge, all customers), but it would lose money whenever it was the "winner" in terms of market share. As Mumpower (1991) has shown, if insurers are aware of this process, they will guard against the winner's curse by adding an additional amount to z_i to reflect its concern.[10]

Note that with this kind of insurer ambiguity about probability, it will not be rational for buyers to assume that all insurers will charge the same prices. Hence, if a consumer decides to engage in search behavior it will be rational to search across sellers. Suppose a buyer is not willing to engage in search behavior when they know that the probability of a loss is unambiguous (i.e. *p)* with all insurers charging an identical premium $z = p + \lambda$. Then this buyer will have even less incentive to engage in any search behavior if she knows that premiums will vary due to the ambiguity of a risk. In this situation the search process is likely to be more costly since it may involve contacting more than one insurer.[11]

4. An Illustrative Example

The following example demonstrates under what conditions a consumer would want to follow each of the three strategies noted above for the case where insurers know the probability with certainty. Clark Dripp has wealth (W)=$10,000 but faces a loss (L)=$7,500 from a possible flood. He knows the per-dollar premium offered by insurers is z=.25 but is highly uncertain of p.

Suppose he thinks that p could be 0.1, 0.2, or 0.25 with equal likelihood and needs to decide whether to seek additional information about its value. In other words he needs to determine whether to use his initial subjective distribution as a basis for making a decision on whether or not to purchase insurance or to search for more accurate data on the flood risk.

Suppose Clark's utility function is given by U(X)= $x^{1/2}$. For Clark to decide whether to follow Strategy A, B or C, he must first determine the optimal amount of insurance to purchase if the search cost were so high that he would not seek information to verify the value of p. Table 1 calculates Clark's expected utility for different strategies that he might consider pursuing. If Clark follows Alternative B, then Clark would set I*= 23.6, which yields

EU(No Search)=9.12 as shown in the second column of Table 1. If, on the other hand, he chooses Alternative A (Ignoring Insurance), then his EU(No Search)=9.083, as shown in the third column.[12]

Clark now turns to the case where he incurs search costs to obtain accurate information on p. He can now calculate the optimal amount of insurance under each one of the above three possible values of p, but he must expend 100S dollars to get information on p. The average expected utilities under two different possible values of S are shown in the last two columns of Table 1.

We can now determine whether it would be more appropriate for Clark to ignore insurance (Alternative A), purchase it without obtaining better information on the premium (Alternative B) or undertake search at either a cost S=2 (or $200) (Alternative C1) or at a cost of S=1 (or $100) (Alternative C2).

From Table 1 we see that if S=2 Clark would prefer to purchase insurance without searching. If S=1, then it would be preferable for him to incur the cost of search and determine how much coverage to purchase based on what he learns about the probability that a flood will occur and damage his house.

Suppose we had changed the probability weights so that their average was lower than in the above example. Then Clark might choose to buy no insurance when the search costs were relatively high. If there were an opportunity to obtain information on the probability of a disaster at a relatively low cost, he might want to undertake this search and possibly purchase insurance if he discovers that the probability of a disaster were sufficiently high.[13]

5. Alternatives and Elaborations

The analysis so far has assumed that individuals have prior beliefs about loss probabilities (however diffuse), and then make rational decisions, based on expected utility maximization, about how much effort to put into refining those beliefs and choosing behavior. This model helps to explain behavior in which people ignore cost-effective ways to protect themselves against rare but costly events because of high search costs.

The same behavior could also be explained in other ways. There is considerable empirical evidence that people do not collect or process information about probabilities even in the boundedly rational way we have described. A recent study by Kunreuther, Novemsky and Kahneman (2001) demonstrated that individuals do not appear to be able to distinguish among different values of probability when all values are "low." For example, in judging the safety of a hypothetical chemical facility, people did not distinguish between probabilities of 1 in 100,000 to 1 in 10 million. Other studies have shown that people do not easily process probability estimates for low probability events. Huber, Wider, and Huber (1997) found that only a minority of subjects sought probability information or used probability information furnished to them.

If individuals do not distinguish between low probabilities, our model would offer the explanation that they judged the task not to be worth their time and attention. Alternatively, they might have decided that they were incapable of processing the information no matter how much effort they put into the task. It is not easy to separate these two alternative models in real world discussions, since, in either case, people would then have little reason to search for this type of information in making their decisions regarding the purchase of insurance, or to respond to such information if it were furnished to them at no cost.

One insight suggested by our model is that free provision of credible information on a p which takes on low values should sometimes lead to insurance purchase in an EU model, but would not necessarily do so in a model in which individuals do not distinguish among low probabilities. Of course, if the loading is so high that non-purchase is optimal in a fully informed EU model, both models would be consistent with non-purchase.

6. Possible Remedies by Suppliers of Insurance

The bounded rationality hypothesis suggests that individuals would have more of an interest in getting data on loss probabilities if they initially perceive the probability of an event as being sufficiently high for them to make an effort to understand its meaning and then to consider whether or not to protect themselves against its consequences. In other words, individuals may need to be convinced that the *ex ante* probability is higher than some threshold level before they will want to search for more accurate information on its value.

We now explore the policy options that may improve welfare. These include framing decisions so that the probability is above the threshold, providing better information on loss probabilities and/or loading factors, and packaging insurance in a different way than it is currently offered. While there have been many discussions in the literature about appropriate policies to deal with apparent underpurchase of different specific kinds of insurance, there has not been, to our knowledge, any attempt to derive policies based on a general model of consumer behavior when probabilities are not known to consumers. In what follows we derive from our model some novel rationales for such features as "bundling" of risks and public provision of insurance data..

*6.1. Better Information About Loss Probabilitie*s

We deal with the most obvious and direct solution to this problem first. Suppose an insurance industry trade association, a consumer advocacy group, or a public sector agency furnished individuals with convincing evidence at to what the best estimates are of the probabilities of specific risks at little or no cost. The public good aspect of information would provide a rationale for such provision. Then insurance purchasing behavior should improve if it is the explicit or implicit cost of the information, rather than the cost of decisionmaking, that is the source of the problem. In this case by providing evidence that the probability is high enough to justify purchase or search (without necessarily being precise about its value) consumers may decide to contact an insurer for a premium quote.

In the case of insurer ambiguity about loss probability, provision to both insurers and consumers of more accurate information about p would be doubly helpful. Such information would reduce variability in premiums and simplify insurer premium setting, at the same time as it motivates insureds to make the effort to buy coverage by reducing their expected search costs.

6.2. Better Information About Loading Factor (λ)

In the analysis so far the only information the buyer could obtain was information to refine her estimate about the loss probability p. As an alternative, the buyer could be provided with or obtain information about the loading factor.[14] For example, if a person learned that "insurers of that event typically pay out in benefits 90 percent of what they collect in premiums" then this may be enough to convince her to buy coverage. This could be done by assembling information on the difference between the premiums that insurers collect for the type of loss the person is contemplating insuring and the claims paid out. That is, the insured would seek a reliable estimate of the "loss ratio" and/or the component parts of the loading ratio, the insurer's administrative expense and its profit. Not only may this information be easier to find than information on loss or event probabilities, but it may also be easier for people to understand.

When will it be relatively easy to obtain accurate and convincing estimates of the loading factor? Events that are rare for any individual but are common for a large group (like a house fire) would fit into this category. However, if there are only limited historical data on benefits payments, consumers and insurance analysts face problems in estimating the loading factor. There is empirical evidence that actuaries and underwriters increase the loading factor as the risk estimate becomes more ambiguous (Kunreuther, Hogarth, and Meszaros, 1993). These findings suggest that it will require higher search costs for consumers to estimate the loading factor as the probability of a loss becomes more uncertain. Furthermore the higher loading factor that they would discover (if they could estimate it) could make the optimal amount of insurance zero anyway.

Finally, individuals may not believe that the information on average loading applies to them. They may assume that, whatever loading factor might be generated using the relationship between the average premium and the average expected loss, their situation will be different. They might assume that they are always so unlucky as to be paying higher than average prices for everything, including insurance: "I am always overcharged." Or they might assume that their loss probability is always less than average; most people feel themselves to have a lower chance of an accident than the average driver (Svenson, 1981). Even vigorous efforts by commissioned agents to inform people about loss probabilities may be selfdefeating, since skeptical buyers may disbelieve someone whose income comes from the difference between revenues and cost.

6.3. Bundling Coverage

Another strategy for dealing with the problem of underpurchase of insurance is to raise a policy's loss probability and premium above the threshold, so that search and thought become rational. For example, floods and earthquakes are both low probability events that might individually fall below the threshold of decisionmaking, but the combined probability that would be relevant if they were both included in a single homeowner's policy might be high enough so it was above the consumer's search/attention threshold for that type of insurance. Indeed, from the perspective of the demander of insurance, such combinations of events would seem to be natural. What matters to the individual, after all, is the extent of destruction of his property, not the cause of that destruction. Yet, in reality, we often find such coverages unbundled, and associated with a failure to insure.

The history of property-casualty insurance is interesting in this regard. The first versions of such insurance distinguished specific perils from the standard fire coverage, such as tornado, explosion, riot and hail. An Extended Coverage (EC) policy was developed in the 1930s to combine property protection against these and other perils. When first introduced the policy was purchased by few individuals and was even viewed as a luxury. However, after the 1938 hurricane in the Northeast, the first to hit New England in a century, many individuals wanted to purchase the EC endorsement and many banks required that it be added to fire insurance as a condition for a mortgage.

The EC policy eventually became part of a standard homeowner's policy. Insurers felt that included coverage of additional perils did not markedly change their expected losses but greatly improved the marketability of their products. In addition, banks found it to be attractive to protect their mortgages (Kunreuther, 1998). However, the situation has changed in recent years due to catastrophic losses that insurers experienced from specific disasters. Following Hurricane Andrew that hit the Miami/Dade County, Florida area in 1992, some insurers excluded wind coverage in hurricane-prone areas of the state.[15]

Informal empirical evidence from the homeowners' insurance market helps inform us about consumer choice and about bundling. Even when not required by a lender, many homeowners do purchase standard homeowners coverage to protect their investment against losses from fire, theft, and wind. Such insurance appears on average to be only modestly profitable, and there is only moderate variation across firms in premiums for the same coverage. Perhaps more importantly, even with no subsidy to this market and loadings on the order of 30% or more of the premium, many consumers still buy homeowners coverage.[16]

7. Dealing with Supply Side Imperfections

If consumers would benefit from insurance policies that bundled low probability events in a single policy and sold it at premiums known to involve consistently reasonable loading charges, why do insurers sometimes fail to supply such policies? There do **not** seem to be serious problems of moral hazard or adverse selection in property-casualty insurance markets. Hence, if one uses the traditional model of an expected profit-maximizing firm operating in a competitive capital market, the failure to offer a product in demand would be puzzling. There are two explanations based on departures from that model which we now describe.

7.1. Capital Market Imperfections

One of the principal reasons for insurers being unwilling to sell insurance against some *specific* low probability events at bundled and stable premiums relates to the correlation among losses and the consequent difficulties insurers have in obtaining enough capital to sustain their activity following disasters. If the damage from events such as earthquakes and hurricanes are highly correlated, causing total claims payments to be large, insurers will have depleted surplus that in some cases may be negative so that the firm becomes insolvent.

Froot, Scharfstein, and Stein (1993) point out that if insurers require funds from outside sources for post-loss financing, this involves significant costs. External capital encounters issues costs and underwriting costs that are avoided if internal sources of funds, such as retained earning, are utilized. In addition, investors have imperfect knowledge of the firm's behavior and hence may force the insurer who borrows money to adopt costly controls involving reporting and monitoring. This increases the cost of capital. In the case of insurers this can be translated into decisions by firms not to offer too much coverage in areas where there are potentially highly correlated losses.[17]

Due to the difficulties that insurers face in raising capital, consumers are likely to be aware that premiums may increase significantly from time to time or that coverage may be withdrawn without warning following a disaster. Some people may decide that such insurance is not even worth considering for that reason. These people know that it will be too time consuming to adjust the amount of coverage on their policies or to possibly withdraw temporarily from the market in reaction to fluctuating premiums.

Capital market imperfections may also cause managers to utilize decision rules that differ from those implied by maximization of expected profits. Empirical evidence suggests that insurance mangers are quite concerned with the consequences of experiencing a large loss and hence utilize a safety first rule when determining what type of policies to offer.[18] These can also lead to supply-side-induced-unbundling.

7.2. Premium Regulation

State regulators may constrain the level of premiums and the extent of variation in premiums for certain kinds of losses like hurricanes to such an extent that there is no profitable way for insurers to supply bundled coverage that covers those losses. In Florida, insurers have not been able to charge premiums reflecting the risk of hurricanes and some threatened to discontinue homeowners' coverage in the state for this reason. Regulators responded by restricting the ability of insurers to undertake this action. The only avenue open to insurers wishing to reduce their catastrophe exposures was to close down all their insurance operations in the state of Florida, an action that they were not willing to take (Grace, Klein and Kleindorfer, 2003).

These well-known supply side problems may have led insurers to unbundle certain coverage and to price that insurance at a high level relative to expected payouts following the occurrence of an event with significant claims payments on their part. These responses to large aggregate losses do more than disrupt insurance markets during the aftermath of disasters. They may interact with the buyer decision-making process. Buyers may reasonably ignore insurance that is unbundled and subject to periodic price spikes, even if it is usually reasonably priced. Buyers subject to information and attention costs may rationally ignore a market that demands constant vigilance. Public policy actions that could mitigate supply-side imperfections would then provide benefits beyond the period of disruption.

8. Conclusion

The story that we have postulated is that some serious events are perceived to have such a low chance of occurring that they are not worth checking out. Events that have a low expected value also have a low expected return from searching for information on the benefits of insurance relative to its cost. A related explanation is that this type of coverage is perceived by consumers to be priced at "rip off" levels so they are not worth their time and attention.

Of course, if consumers thought that there were some insurers who priced at exorbitant levels but that there were some reasonably priced sellers, they might be motivated to search among different sellers. A traditional search model would then apply. But if the bargains are thought to be few and far between, consumers may decide not to seek any information on insurer premiums. In effect, both transactions costs and supply-side inefficiency breed demand-side inefficiency.

At a prescriptive level, we believe that better information about probabilities as well as about the level of insurer profits and their pricing decisions could help to motivate better insurance purchasing behavior. At present, this kind of information is not generally available with ease. The insurance buying decision process can be so complex and confusing that people will eschew either searching for information or purchasing insurance for low probability high-consequence events. Politically motivated regulators may be inclined to spotlight occasional high premiums and profits. But things need not be this way. State insurance commissioners can play a creative role in this process by regulating the insurance industry appropriately so that bundling is encouraged not discouraged. (e.g. by approving rates based on risk). Insurance trade associations and consumer advocacy organizations can play a positive role in providing information on insurance prices, profitability, and probabilities. Finally, governments can provide accurate data on the profitability of insurance firms and the probability of rare events so the general public is aware of how well they and the industry will fare if they decide to become insured.

There is also a need for future empirical research to determine when consumers will be unlikely to search. It would be useful to collect data to determine whether insurers are ambiguous about loss probabilities and what their loading charges are. This would help us to know what the search costs would have to be for individuals to want to obtain premium information from an insurer. It would also be interesting to obtain data on the relationship between the degree of bundling of insurance policies and purchase behavior.

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Table 1

Expected Utilities for Different Alternative Strategies for
Probability Estimates (p_j), z =.25 U(x) = x ^{½}

Probability Estimate	***Alternative B Purchase Insurance***	***Alternative A Ignore Insurance***	***Alternative C1 Search for Probability(S=2)***	***Alternative C2 Search for Probability(S=1)***
p_1 =.1	I=23.6 E(U) =9.38	I=0 E(U) =9.5	I=0 E(U)=9.39	I=0 E(U)=9.45
p_2 =.2	I=23.6 E(U) =9.07	I=0 E(U) =9.0	I=36 E(U)=8.95	I=35.5 E(U)=9.01
p_3=.25	I=23.6 E(U) =8.91.	I=0 E(U) =8.75	I=75 E(U)=8.90	I=75 E(U)=8.96
Weighted EU	**EU(No Search)= 9.12**	**EU(No Search) =9.083**	**EU(Search) =9.080**	**EU(Search)=9.14**

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[2] We contacted several seismological experts in Seattle regarding the chances of a severe earthquake in the area that could cause severe damage to homes. All of them were unwilling to give us an estimate or provide us with any references to published studies that we could cite in this paper. This suggests that homeowners in Seattle would have a difficult time getting data on the earthquake risks that they face.

[3] There has been considerable work undertaken on the expected value of collecting additional information but not where there is a fixed cost of getting the process started. For more detail on the value of information in the standard model of decision making under uncertainty see Lindley (2001) Chapter 7.

[4] We are assuming that $0 \leq I \leq L$ to avoid moral hazard problems (e.g. committing arson because one can collect more from insurance than the house is worth).

[5] In the empirical literature loading is assumed to be proportional to the *gross* expected loss (pL). This is how we have treated λ in this paper. The theoretical literature applies the loading charge to the net (of premium) expected loss p(L-pL). The issue is whether the premium in the "loss" state is netted out of the benefit payment before the loading is calculated. If p is small, as we assume here, the two formulations are virtually identical.

[6] One may wonder why the consumer would consider incurring a cost to find out the true value of p when he could at minimal cost ask the insurer what the value of p is that the insurer is using. The insurer may not want to reveal this information. If it does, then the insurer has an incentive to overstate the value of p in order to make buying insurance at the market premium appear more attractive. Because of this motivation, consumers would be skeptical of insurer-provided information and might therefore seek the objective "outside" information we have included in the model. For example, insurers tell prospective purchasers of long term care insurance that "40 percent of nursing home residents are working age adults," without mentioning that the great bulk of those residents are people with lifelong medical and physical disabilities; the probability that prospective insurance purchasers, adults not now in a nursing home, will enter one during working years is much lower than implied by this information.

[7] Note that the optimal amount of insurance depends only on p, not on the distribution of values about the average, because expected utility is linear in probabilities.

[8] Alternatively an individual could determine the optimal amount of insurance to purchase by assuming that the probability of a loss was $p=\Sigma\ w(p_j)\ p_j$. He could then use the Kuhn-Tucker conditions to determine whether to purchase zero insurance or some insurance. The procedure for doing this is discussed in the next section.

[9] In the case of the Schmeidler model, the “something else” is an additional nonzero expected value of the most adverse outcome.

[10] Another reason why insurers may charge higher premiums for ambiguous risks is because they are risk averse. Hogarth and Kunreuther (1992) show that when losses are not perfectly correlated risk averse insurers who are maximizing their expected utility will charge more for ambiguous risks than if the probability of a loss was known with certainty.

[11] Even if there were a single seller of insurance, it would fear the winner’s curse if aggregate quantity demanded was sensitive to price.

[12] If the only insurance policy available were full coverage, he would prefer no insurance to purchasing it, since EU (No Search) = 9.014 when I=75.

[13] The following example illustrates this point. Suppose he thinks that p could be 0.1, 0.2, or 0.25 with weights of w (.1) =.7 w (.2)=.2 and w (.25) = .1. In this case it will be optimal to not to purchase insurance (i.e. I=0) if S>.542 but worth undertaking search (and perhaps eventually buying some insurance or full coverage) if S were less than this value.

[14] Indeed, a person who believes that insurance against a certain class of events is not highly profitable and is inexpensive to administer has an easy task of deciding on coverage: he may not even need to determine (within a wide range) what the loss probability is. If loading is low enough relative to how risk averse the person knows himself to be, and relative to the person’s wealth, he should just buy insurance against all events in a specific risk class without worrying about exactly what loss probabilities are and without incurring search costs to determine these probabilities.

[15] This led to the formation by the state legislature in November 1993 of the Florida Hurricane Catastrophe Fund to reduce exposures by insurers to catastrophic hurricane losses (Lecomte and Gahagan 1998).

[16] Indeed, in some states regulation keeps the price of hurricane coverage artificially low for homeowners in high-risk areas, and insurers then find themselves facing substantial losses precisely because those homeowners do make sure that they have this coverage. See Grace, Klein and Kleindorfer. (2003) for more details on the case of Florida.

[17] For details on the cost of capital and why risk is expensive to firms, see Doherty (2000), Chap. 7.

[18] Stone (1973) suggested that insurers are interested in maximizing expected profits subject to two constraints representing survival of the firm and the stability of its operations. In discussions with underwriters today these constraints still play an important role in their decisions on what coverage to offer.