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Preference for Insuring Against Probable Small Losses: Insurance Implications

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ABSTRACT

A series of laboratory studies of insurance decision making shows that people buy more insurance against events having a moderately high probability of inflicting a relatively small loss than against low-probability, high-loss events. Two explanations are discussed, both contrary to traditional utility theory. One postulates a utility function convex over losses. The second asserts that people refuse to protect themselves against losses whose probability is below some threshold. This research provides insight into other, often puzzling, facts about people's insurance behavior. Relevance for public policy is discussed.

What determines whether people will act to protect themselves from the severe consequences arising from a low probability event? The answer to this question is vital for understanding how people cope with the risks from accidents, diseases, and natural hazards and for helping them to manage their lives more effectively in the face of such risks.

The importance of this question has motivated a major research project concerned with one class of risks, those from natural hazards (floods and earthquakes), and one class of protective mechanisms, insurance.[1] The project staff, under the direction of Howard Kunreuther, interviewed 2,000 homeowners residing in flood-prone areas, half of whom were insured and half uninsured. In addition, 1,000 homeowners residing in earthquake-

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prone areas, also divided equally between insured and uninsured, were interviewed.

The general goal of the survey was to provide an understanding of behavior useful for guiding public policy regarding the role of insurance in mitigating losses from floods and earthquakes. One specific issue under consideration was whether insurance coverage should be voluntary or compulsory. A second was whether utility theory provides a description of behavior adequate for guiding policy decisions. Survey questions considered socio-economic variables; awareness of the hazard; knowledge about the availability, costs and coverage of insurance; and previous experience with both the hazard and insurance. The study and its results are described in detail by Kunreuther (1976) and Kunreuther, et al. (1977). The experimental work described here was intended to test, in rigorously controlled settings, some hypotheses derived from the Kunreuther field survey.

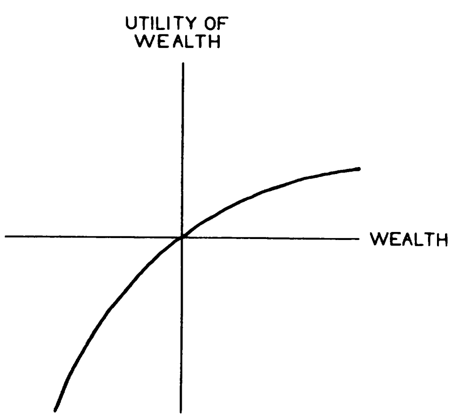
Utility Theory of Insurance

To date, nearly all thinking about insurance behavior has been within the framework of utility theory. This theory has been proposed both as a prescriptive model, indicating when insurance should be purchased, and as a descriptive model indicating how insurance decisions are made (Friedman & Savage, 1948; Murray, 1971; Neter, Williams and Whitmore, 1968).

Expected utility theory originally was formulated by Bernoulli (1738) and first axiomatized by von Neumann and Morgenstern (1944). The basic principle of the theory is that decisions under risk are made so as to maximize expected utility, the sum of the products of the utilities of outcomes and the probabilities that they will be obtained.

Traditionally, it has been assumed that individual utility functions are concave (monotonically increasing and negatively accelerated) functions of wealth, as in Figure 1. The concavity of the utility function em-

FIGURE 1
TRADITIONAL RISK-AVERSE UTILITY FUNCTION



bodies the property of risk aversion, which is assumed to characterize responsible people who buy insurance and diversify investments. Risk aversion is defined as the tendency to prefer any sure outcome, X, over any gamble with an expected value of X. Thus, a risk-averse person would prefer to receive a sure $50 rather than accept a gamble offering a 50-50 chance to win $100 or win $0. Alternatively, a risk-averse person would prefer to pay any amount, Y, rather than to play a gamble with an expected value equal to –Y. Such individuals always should be willing to buy insurance at actuarially fair rates.

Arrow (1971, p. 91) has observed that the predominance of the risk-aversion hypothesis is due ". . . to its success in explaining otherwise puzzling examples of economic behavior. The most obvious is insurance, which hardly needs elaboration."

Despite the widespread acceptance of utility theory, there are reasons to question its descriptive adequacy. First, the few controlled experimental studies of insurance buying have observed behavior contrary to the theory. For example, Murray (1971, 1972) and Neter and Williams (1971) found that utility functions scaled individually for each of their subjects failed to predict insurance preferences. Schoemaker (1976), studying clients of an insurance agency, found preferences for low-deductible policies context effects, and scale effects, all of which ran counter to the theory.

An experiment by Williams (1966) showed that people's preferences among gambles offering no chance of gain were unrelated to their preferences among speculative gambles, which have a chance of loss or gain. Neither of these preferences predicted people's insurance behavior outside of the laboratory (for similar results, see Greene, 1963, 1964). A recent review of laboratory studies by Slovic, Fischhoff and Lichtenstein (1977) found that the expected utility theory accounts poorly for preferences among speculative gambles except in some simple situations.

Field studies, too, have shown that some aspects of people's insurance behavior run counter to utility theory. One is the preference for low-deductible policies despite their disproportionately high premiums (Pashigian, Schkade & Menefee, 1966). Another is the failure of individuals to purchase insurance even when the premiums have been highly subsidized (Anderson, 1974).

Kunreuther, et al. (1977) found that many residents of hazard-prone areas had no information or wrong information about many factors relevant to the expected utility model, e.g., premium rates, subsidies, deductible levels. Even more telling was the fact that, when survey respondents' perceptions of flood and earthquake probabilities, likely monetary damage, and premium rates were incorporated into an expected utility analysis, some 30 percent to 40 percent of their insurance decisions were inconsistent with predictions from the theory. These and other data led Kunreuther, et al. to stress the sequential nature of insurance purchase decisions. Individuals first must consider the hazard to be a problem (stage 1) and then must be aware of insurance as a coping mechanism (stage 2) before they even begin to collect and process information relevant to insurance (stage 3).

This paper describes a series of laboratory studies of insurance decision making. Although the authors have manipulated only a few of many possible determinants of insurance decisions, the data are believed to indicate clear and important violations of the risk aversion assumption of utility theory. These results, in conjunction with those from the Kunreuther field survey, have significant implications for both insurance theory and policy making.

Methodological Considerations

The Experimenter's Problem

How does one create a laboratory situation analogous to that faced by property owners threatened by natural hazards? It is not difficult to create risks with comparable probabilities of occurrence. Simulating the loss of a home or business is another matter. Certainly, it is immoral for an experimenter to threaten a subject's economic well-being, even in return for a substantial reward for engaging in risk; it also would be improper to exploit an existing risk situation for the sake of scientific knowledge (e.g., willfully manipulating the policies offered to subjects living in hazard-prone areas). In principle, one could stake subjects to substantial assets which could then be put at risk. But, even if the economics of scientific research enabled staked assets to be substantial, losing someone else's money might not be the same as losing one's own funds.

The Urn Solution

The response to these problems was to pose insurance questions in the abstract. The hazard which the subjects faced was the drawing of a blue ball from an urn composed predominantly of red balls. Their potential losses and the premiums of insurance policies which they could purchase to protect themselves against such losses were measured in undefined "points." Subjects never played these abstract games; rather, they were asked what insurance they would purchase were they to participate. Thus, all the "urn" studies described below reflect the way people believe that they would insure themselves in a particular hypothetical situation.

As an isolated research tool, such urn studies clearly would be inadequate. However, in conjunction with the Kunreuther field survey and a more realistic paradigm called the farm game (described below), they comprise part of a multi-method research program. If these three different approaches produce similar results, one can have much greater confidence in the conclusions than would be justified solely on the basis of any one research design. In the field survey, control is traded for realism; in the laboratory experiment, the trade-off is reversed. The package of studies should indicate what results would be obtained in that realistic and controlled study which is beyond the authors' power to conduct.

Experiments With the Urn Game

General Instructions

Each urn experiment was prefaced with the following introduction:

> In the present booklet, we are going to describe a series of gambling games. Each game has the possibility of negative outcomes. Each allows you to buy insurance against the negative outcomes, although it is not compulsory. We are not going to ask you to play any of the games. Instead, we are going to ask you to consider each and then tell us how you would play were they for real. Try to take each as seriously as possible even though nothing is at stake.

Subjects were then told that each game consisted of drawing one ball from each of a set of urns; each urn contained a different mixture of red and blue balls. Drawing a blue ball incurred a loss, unless the subject had purchased insurance at some fixed premium. Unless otherwise noted, the cost of the premium was set at one point for each urn and the loss (L) and probability of loss, P(L), were adjusted so that the expected loss [P(L)•L] from drawing one ball from the urn was also one point. For example, an urn might contain one blue ball in one thousand balls, and drawing it incurred a loss of one thousand points. Thus, in each case, subjects were offered insurance for the loss cost only, known as the "pure premium." In real-life situations, the premium would be greater than the expected loss to include an allowance for expenses and additions to retained earnings.

To clarify the subjects' goals in the game, they were told:

> As you can see, you can only lose in this sort of game (either by drawing a blue ball or by buying insurance). Your object is to lose as little as possible. For each game figure out what insurance you would buy to end up with the fewest negative points.

TABLE 1

A Typical Urn Game

Urn No.		Ball Color Blue	Red	Insurance Premium	Would You Buy Insurance? (yes or no)
1.	No. of Balls	1	999	1	________
	No. of Points	-1000	0		
2.	No. of Balls	5	995	1	________
	No. of Points	- 200	0		
3.	No. of Balls	10	990	1	________
	No. of Points	- 100	0		
4.	No. of Balls	50	950	1	________
	No. of Points	- 20	0		
5.	No. of Balls	100	900	1	________
	No. of Points	- 10	0		
6.	No. of Balls	250	750	1	________
	No. of Points	- 4	0		

A typical game is presented in Table 1. In such a game:

1. Subjects incur only losses and no gains.
2. Subjects have no accrued assets (or nest egg) to protect.
3. Only one ball is to be drawn from each urn.
4. There are six urns, comprising a portfolio of risks.
5. The premium is the same for each urn.

In these features the urn game resembles some real-life situations and differs from others. The effects of changes in some of these features are investigated below; the effects of other changes await further research.

Subjects

About 700 individuals participated in these experiments. Most were volunteer subjects recruited through advertisements in either the University of Oregon student paper or the general circulation local newspaper. All were paid for their participation. They were typically between 20 and 25 years old, although the range of ages extended from 18 to 72. One exception was a study in which members of the Eugene, Oregon, chapter of the League of Women Voters and their spouses served as subjects. This group was studied to determine whether the results obtained from the younger subjects would generalize to a population of socially concerned homeowners responsible for making insurance decisions in their daily lives.

The Basic Experiment: Varying Probability of Loss

The urn game presented in Table 1 systematically varies loss and probability of loss, the one increasing as the other decreases. Different theories lead to different predictions about which of these six urns will be insured. The risk aversion property of utility theory postulates a concave relationship between (negative) utility and loss; the disutility of a loss increases faster than does the loss. Subjects behaving in accordance with this theory should purchase all insurance in which only the loss cost is charged, i.e., every policy offered in Table 1. However, it is reasonable to suppose that subjects occasionally will not purchase insurance, because of transaction costs or error in the subjective assessments of utility or because they may believe that the experimenter implicitly wants them to choose some but not all policies. In such a situation utility theory predicts that subjects would most likely insure against the lowest-probability, highest-loss urns since these provide the largest difference between the disutility of the premium and the expected disutility of the uninsured urn.

In contrast, a threshold model would predict that subjects will not buy insurance unless they view the hazard as a problem worthy of concern. Thus, they may ignore urns for which the probability of loss is too low to constitute a threat. Presumably, such a threshold would vary among individuals. For some, it might lie between urns 1 and 2 (i.e., between $P(L) = .001$ and $.005$), for others, between urns 4 and 5, and so on. If this hypothesis is correct, then one should find, over a group of subjects, a greater propensity to insure against high-probability, low-loss events.

Results. The solid curve in Figure 2 presents the pooled responses of 109 subjects who were presented the game in Table 1. Contrary to the predictions derived from utility theory, a strong preference was found for insuring against high-probability, low-loss events; events which are relatively likely to happen, but incur only minor losses. Whereas only about 20 percent of the subjects were willing to insure against the urn with P(L) = .001, over 80 percent insured against the urn with P(L) = .25. Thus four times as many subjects were willing to insure against a likely loss of 4 points as would insure against an unlikely loss of 1,000 points.

Preference patterns of individual subjects also were examined. Each subject's responses were classified into one of six categories: (1) buy all 6 policies; (2) buy no policies; (3) insure against some subset of least likely losses (i.e., urns 1; 1 and 2; 1, 2, and 3; 1, 2, 3, and 4; or 1, 2, 3, 4, and 5); (4) insure against some subset of the most likely losses (e.g., urns 6; 5 and 6; 4, 5, and 6; etc.); (5) buy insurance for some subset of contiguous middle likelihood losses (e.g., urns 2 and 3); and (6) other patterns (e.g., urns 3 and 5; 1 and 4). The results of this analysis, shown in line 1 of Table 2, further demonstrate the strong preference for insuring against the most likely losses rather than against the least likely ones. Nearly half of the subjects insured against some subset of the most likely losses, compared with only about 7 percent who insured against some subset of the least likely losses. About one subject in five bought no insurance, while one in eight purchased all available policies.

FIGURE 2

Percent of Subjects Purchasing Insurance for Urns Varying in Probability and Amount of Loss; Six- and Eight-Urn Games

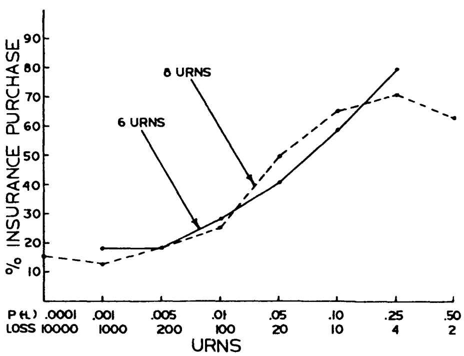


TABLE 2

Patterns of Insurance Purchase

	Buy All	Buy None	Buy Some Subset of: Least Likely Losses	Most Likely Losses	Middle Likelihood Losses	Other Patterns
6 Urns	12.6	19.6	6.7	46.0	3.7	11.4
8 Urns	6.7	9.6	5.3	48.4	16.6	14.4
Farm Game I	30.0	8.0	11.8	27.3	13.1	9.8
Farm Game II	33.3	9.4	17.2	24.7	7.7	7.7

Note: All entries show the percent of subjects exhibiting each purchasing pattern.

To extend the solid curve shown in Figure 2, this experiment was repeated with two urns added, one at each end of the probability (or loss) continuum. One urn had P(L) = .0001 and L = 10,000; the other had P(L) = .50, and L = 2. Both premiums were 1 unit. The responses of 178 subjects to this urn game are shown as the broken curve in Figure 2. The pattern found with 6 urns is substantially replicated in the P(L) = .001 to .25 range. At the low end of the probability continuum, no further decline was found in insurance purchases with the P(L) = .0001 urn. At the high end, there was a slight decline in demand with the increase of P(L) from .25 to .50. For this last urn, the premium was half as large as the possible loss. Again, nearly half the people insured against some subset of the most likely losses (Table 2, line 2, column 4).

Robustness of the Probability Effect

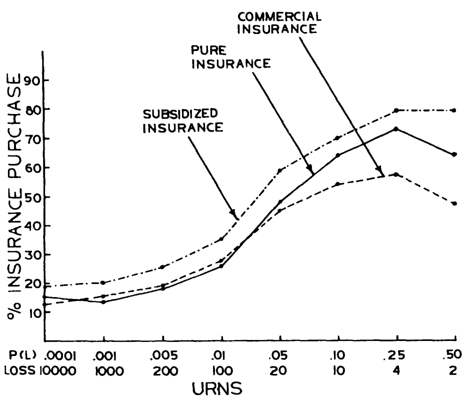
However dramatic the results depicted in Figure 2, one might ask whether they are not, at least in part, an artifact of the particular subjects or the particular version of urn game used. One would like evidence showing that these results are sufficiently resilient to withstand changes in subject population and in experimental format.

Subjects. To test for the generality of results over subject populations, the 8-urn study was replicated with 46 members and spouses from the Eugene, Oregon, Chapter of the League of Women Voters (33 women; 13 men). Only individuals who participated in making insurance decisions for their household were studied. The results (not shown) were similar to those obtained with the younger subjects, recruited through newspaper ads. Again, insurance purchasing increased as probability of loss increased and possible loss decreased. Whereas only 33 percent said they would purchase insurance at P(L) = .0001, 63 percent would purchase insurance at P(L) = .50.

Order of presentation. One aspect of the experimental format which may have introduced some bias is the order in which the urns were presented in the questionnaire. In the foregoing experiments, subjects considered first those urns with the lowest P(L), as in Table 1. Perhaps they favored insuring against the most likely losses because of some perspective acquired while considering the least likely ones. To test this conjecture, 44 additional subjects were asked to consider the most likely losses first when making decisions about each of the eight urns. Although this sequential change produced a slight, across-the-board increase in insurance buying (not shown), it had no effect on the subjects' preference for insuring against the more likely losses.

Expected value manipulation. Another possibility is that these responses were atypical because subjects were considering insurance whose premium equalled the expected loss of the gamble, a situation seldom encountered in real life. Figure 3 compares the results of offering 178 subjects several different urn games for which the expected loss of the gamble was greater than, less than, or equal to the premium. These premiums reflected insurance that was subsidized, commercially offered, and offered at pure loss cost, respectively. Subsidized insurance was created by decreasing the premium by 20 percent or 50 percent (and holding loss constant), or by decreasing the loss by 20 percent or 50 percent (and holding the premium constant). Commercially-offered insurance situations were created by 20 percent or 50 percent increases in premium or 20 percent or 50 percent decreases in the loss. The same eight loss probabilities were used as before. The results of these variations, averaged across the four types of subsidized and commercial insurance, are shown in Figure 3. While the subjects were sensitive to these expected-value manipulations, the preference for insuring against high-probability, low-loss risks remained strong under all conditions.

FIGURE 3
EFFECT OF VARYING RELATIONSHIP BETWEEN PREMIUM AND EXPECTED LOSS OF GAMBLE



Simultaneous vs. separate urns. Another aspect of the experimental design considered was the appearance of all 6 or 8 urns in a single game. One might argue that presenting subjects with such a portfolio of risks all at one time might induce some peculiar strategies not found when risks are considered one by one. Table 3 shows the results of presenting urns separately (to 36 subjects) as opposed to presenting them simultaneously in one game (to 134 subjects). The particular urns used in this experiment were different from those used in the previous ones; they were adopted from the work of Amos Tversky and Daniel Kahneman at The Hebrew University in Jerusalem. With separate presentation, the differential preference for insuring likely losses was slightly reduced, but by no means eliminated.

Note that of the two urns for which P(L) = .25, subjects were less likely to insure against the urn with the highest loss and highest premium. Schoemaker (1976) has reported a similar finding. This result, too, is inconsistent with concave utility functions such as that in Figure 1.

Promoting Insurance Against Unlikely Calamities

Compounding with other risks. How can one get people to insure against

TABLE 3

Effect of Simultaneous Versus Separate Presentation of Urns

Proba- bility of Loss P(L)	Amt. of Loss	Premium	Proportion Purchasing Insurance: Urns Presented Together N=134	Urns Presented Separately N=36
.001	5000	5	.13	.28
.01	200	2	.20	.25
.25	200	50	.57	.47
.25	5000	1250	.43	.42
.50	1000	500	.64	.53

low-probability, high-consequence events? Perhaps disaster insurance should be treated as an unmarketable commodity and ways sought to package it more effectively. One such possibility is that if people prefer to insure against high-probability, low-loss events, perhaps they also will insure against unlikely disasters if such insurance is sold along with insurance against likely losses, at a reasonable extra cost. A test of this hypothesis was attempted by offering subjects a comprehensive policy, in which the only insurance available protected against all 8 urns (those in Figure 2) for a premium of 8 points. Of 35 subjects, only 11 bought this policy.

Whereas the previous studies offering insurance against 8 urns individually "sold" an average of 3.3 points' worth of insurance per subject, here only 2.5 points per subject were sold. The proportion of subjects insuring against the least likely losses increased from about 1 in 6 to about 1 in 3 (11 of 35 subjects), at the cost of greatly reduced purchases of insurance against high and medium likelihood losses.

With the 8-urn comprehensive insurance policy, subjects were asked to buy more than twice as much insurance as they ordinarily would have purchased (8 vs. 3.3 points). Perhaps greater success would be achieved with a relatively less expensive insurance package. In a subsequent experiment, 151 new subjects were shown three urn games. One consisted of a single urn offering a high (.20) probability of losing 10 points and an insurance premium of 2 points. The second game also had one urn, carrying a .001 chance of losing 1,000 points with a 1-point premium. The third game included both of these urns and a combined (3 point) premium; here subjects had to draw once from each urn and could insure only against both.

The three games were presented to subjects in varying orders, none of which affected the results. Pooled results appear in Table 4. Again, when considering each urn separately, subjects were twice as likely to insure against the high-probability as against the low-probability loss. However, more people were willing to buy the compound insurance than either single-urn policy, resulting in over twice as many people being insured against the low-probability loss. The subjects were willing to spend 30 percent more for compound insurance than the sum of their expenditures for the two single-urn policies. If it is in society's best interest for people to insure themselves against unlikely calamities, then adding protection against a small but likely loss might help accomplish this purpose.

TABLE 4

INSURANCE PURCHASES FOR SINGLE AND COMPOUND URNS

Urn Game	P(L)	L	Premium	Proportion Purchasing	Points Sold Per Subject
Low Probability	.001	1000	1	.24	.24
High Probability	.20	10	2	.47	.94
Compound	both of above		3	.51	1.53

Compounding over time

Another variation that might change one's attitude towards insuring against an unlikely loss is to extend the time span over which that risk is faced. This extension can be accomplished in an experiment by increasing the number of times the urn must be sampled, and in life by selling multi-year policies. Perhaps when one faces repeated chances for possible disaster, the increase in subjective probability of loss may outweight the increase in premium, making insurance more attractive.

This hypothesis was tested with 72 subjects, assigned to four groups of approximately equal size. Group 1 was exposed to a gamble offering 1 chance in 100 of losing $100. Group 2 faced 1 chance in 20 of losing $20. Subjects in both groups could take their chances or purchase insurance at a premium of $1 which reflected loss cost only. Groups 3 and 4 saw these same gambles, but were told that they had to play the gamble five times. Group 3 was told that over all five plays, each having a 1/100 chance to lose $100, they faced a .05 probability of losing $100 at least one time. Group 4 was told that five plays, each having a 1/20 chance to lose $20, provide a .23 probability of losing $20 at least once. Subjects were allowed either to go uninsured on all five plays or purchase insurance for all five plays for a $5 premium.

Multiple exposure to the .01 gamble did not affect the proportion of subjects who bought insurance (63 percent for single play, 65 percent for the five-play condition). However, whereas 58 percent of the subjects purchased insurance against a single chance of 1 in 20 to lose $20, 94 percent paid the $5 premium to insure against 5 plays of this gamble. (This difference in proportions was statistically significant at $p < .01$). Thus it does appear possible that multiple exposures can induce people to purchase insurance by boosting the overall probability of loss.

Insurance as an investment

Other approaches to marketing insurance are suggested by the notion that people view insurance as an investment; that is, they like to receive some money back for their premium. The probability effect could be due, at least in part, to this preference: insuring against high-probability, low-loss urns gives people a good chance of getting a monetary return (reimbursement of a loss).

One way to improve the possibility of a monetary return with low-probability losses is to offer to reimburse subjects who make no claims. Of the many possible refund arrangements, the one selected for this study was a comprehensive insurance plan (one premium for eight urns) which refunded all of a subject's premium if no claims were made, i.e., if no blue balls were drawn. Insurance offering this option must carry a higher premium than that for insurance which reimburses only when losses occur. For the 8-urn situation, the premium based on the loss cost and the possibility of a full premium refund is 11.7 points.

Each of the 35 subjects offered the comprehensive, no-refund insurance described above subsequently was offered the opportunity to purchase "money back if nothing goes wrong" insurance, for a 12-point (11.7 rounded upward) premium. Twenty-two subjects purchased this insurance, twice as many as purchased the no-refund comprehensive. This amounted to 7.54 insurance points per subject or 62.8 percent of all insurance possible, compared with 31.4 percent of all comprehensive insurance possible and 41.3 percent of all non-comprehensive insurance purchased in the earlier 8-urn games. Examination of the subjects' reasons for purchasing this policy showed that they felt they could not lose; either they would suffer a loss and be reimbursed or they would receive a full return of their premiums. They appeared to neglect the likely possibility that they would be reimbursed for losses smaller than the premium.

Experiments with the Farm Game

In the experiments with urns, the subjects considered well-defined insurance problems in isolation and without real stakes at risk. To increase confidence in these results a farm game was designed presenting a much more realistic task, in which insurance was not the sole object of attention.

Details of the Game

Instructions and format. Subjects were told:

> Farming is a business that requires decisions. In this game, the number of decisions has been reduced considerably from the number that must be made on a real farm; however the principles are the same. The decisions you will make at the beginning of each play year are: (1) what crops you are going to plant; (2) what and how much fertilizer you will purchase and apply to those crops; and (3) what insurance you will buy, if any, against certain natural hazards.

Participants played the game for 15 rounds; each round represented one year. Their income for each year was determined by the wisdom of their decisions, by random fluctuations in crop yield and market price, and by the randomly determined occurrences of the natural hazards. At the beginning of the game, each subject was given a 240-acre farm with a permanent concrete pipe irrigation system, a variety of farm equipment, and $80,000 of debt, leaving an initial net worth of about $200,000. The instructions, which took one to one and a half hours to complete, described the characteristics of the seven crops available (mean yield per acre, standard deviation of yield, mean and standard deviation of market price), the efficacy of two types of fertilizer for each crop, the fixed costs of growing each crop (machinery, labor and water), and the risks they faced.

For each round, the subjects' decisions were entered into a computer, which then prepared a year-end report. This report showed the subjects' predecision financial situation, production results (yield and market price), hazards incurred, yearly expenses, and a year-end list of assets and debts.

The hazards. Table 5 shows the natural hazards faced by the subjects. The hazards were left unnamed, to render irrelevant any particular knowledge or beliefs subjects might have had about the probabilities or losses associated with real hazards such as hail or hurricanes. This decision afforded control over the perceived probability of each hazard. The probability values were chosen to cover the range that had produced the greatest differences in insurance purchases in the urn studies. Losses and premiums were established so that (a) the largest loss equalled or exceeded the value of the farm, thus ending the game should the largest loss be incurred; and (b) the cost of the premium would be significant. The average subject's net profit was approximately $6,000 per year. Thus, the purchase of insurance, at $500 per hazard, was a significant expense.

TABLE 5

FARM GAME HAZARDS

Hazard No.	Probability	Loss	Premium
1	.002	$247,500	$500
2	.01	49,500	500
3	.05	9,900	500
4	.10	4,950	500
5	.25	1,980	500

Subjects

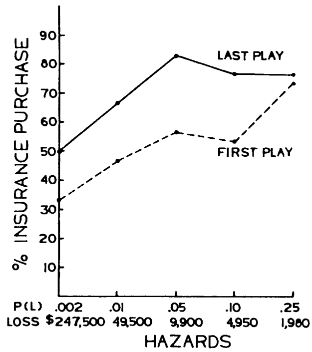
Thirty subjects were recruited through an advertisement in the local city newspaper offering $2.25 per hour for participation in a 5-hour decision-making experiment. Applicants were screened to eliminate those uncomfortable or unfamiliar with working with numbers. There were 19 men and 11 women, with a mean age of 25.

Results

The clearest comparison between the farm game and the urn study is afforded by the farm game subjects' first round responses. On that round, they, like urn subjects, had no direct experience with the possible disasters, knowing them only in the abstract. Figure 4 shows that the first round responses of the farm game subjects were similar to the responses of the urn game subjects in avoiding insurance against low-probability, high-loss hazards and preferring insurance against high-probability, low-loss hazards. Farm game subjects were much more willing to spend $500 to insure against a $1,980 loss than they were to spend the same amount of money to insure against the loss of their whole farm.

Figure 4 also shows the subjects' responses on the last (15th) round of

FIGURE 4
EFFECT OF PROBABILITY OF LOSS ON INSURANCE PURCHASING IN FIRST FARM GAME



this game. Here, a marked increase is found in the subjects' willingness to insure against all but the most likely losses. This increase is due largely to an increase in the number of subjects who bought all policies (from 5 on the first round to 15 on the last one). Indeed, all but one of the subjects who insured against the least likely loss on the last round also insured against all other losses, suggesting that the attractiveness of insuring against the rarest event increased only as a result of the increase in "buy all" strategies.

There are several possible reasons for the increased purchase of insurance over time: (1) As subjects became more familiar with the game, they may have devoted relatively more attention to insurance decisions (as opposed to crop and fertilizer decisions) and thereby discovered the wisdom of insurance. (2) As the farms were gaining in value over time, the subjects may have become more conservative, wishing to protect their increased assets. (3) The differentially greater increase in purchasing low- and middle-probability insurance may have been due to a ceiling effect. There is more room for increase when the starting rate is 33 percent than when it is 73 percent. (4) Subjects may have believed that the lower-probability disasters, which rarely occurred, were "due to happen soon," while high-probability disasters, which occurred more frequently, had "already had their share" of occurrences. This interaction between the occurrence of disasters and purchase of insurance is examined more closely below.

Over all rounds, farm-game subjects bought much more insurance than urn subjects; 30 percent of the time they insured against all five disasters, compared to 12.6 percent of the subjects buying full coverage for the 6-urn games and 6.7 percent for the 8-urn games. Nevertheless, farm game subjects still were more than twice as likely to buy insurance against some subset of the most likely losses as against some subset of the least likely losses (see Table 2, row 3, columns 3 and 4).

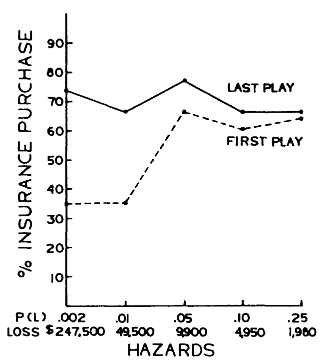
Farm Game II

Rationale. One possibly important difference between the farm game and real-life decisions is that subjects were not rewarded for managing their farm properly. Although subjects appeared to be intrinsically motivated by the game, intrinsic motivation may have induced some strategy other than profit maximization (e.g., experimenting with different crop-fertilizer combinations to see what would happen).[2] A final experiment explored this possibility with 31 new subjects whose earnings for participating in the experiment depended upon their farm earnings. They were paid from $2.50 to $20, depending on their net worth at the end of Round 15.

Results. Figure 5 shows first play and last play decisions. Hourly pay (Game I) and pay-by-farm-earnings (Game II) produced remarkably similar patterns. The only marked difference was increased purchase of insurance against the greatest possible loss on the last play. This result appears to have been due to specific end-game behavior, with some subjects taking care not to lose the farm on the last round before "cashing out."

In as realistic a context as may be possible in a laboratory experiment, where insurance was not the subjects' sole consideration, there was found unwillingness to insure against low-probability, high-loss events. Although this aversion was weaker than with the urn games, these results still clearly violated the predictions of utility theory.

FIGURE 5
EFFECT OF PROBABILITY OF LOSS ON INSURANCE PURCHASING IN SECOND FARM GAME



Effect of Experience

What effect did the occurrence or non-occurrence of a disaster have upon subsequent insurance behavior? Table 6 shows insurance purchases as a function of whether or not a hazard was incurred on the previous round. Looking at the last two columns of line 1, one sees that when no

[2] It should be noted that since subjects in the first farm game were paid by the hour, they should have been particularly motivated to avoid losing their farm, thus terminating the game early. This pecuniary consideration should have increased their readiness to insure against the least-likely (greatest loss) hazard.

TABLE 6

EFFECT OF HAZARD EXPERIENCE ON ROUND N UPON DECISIONS FOR ROUND N + 1

Outcome on Round N	No. of Decisions	Decisions on Round N + 1: Keep Existing Policy	Remain Uninsured	Buy a New Policy	Cancel Existing Policy
1. No Hazard	2485	58.0	33.0	4.9	4.1
2. Hazard Occurred	1840	57.0	33.5	5.8	3.8
2a. Hazard Occurred: Decision for Same Hazard	368	55.7	29.9	5.4	9.0
2b. Hazard Occurred: Decision for Different Hazard	1472	57.3	34.3	5.8	2.5

Note: Numbers are the percent of all decisions made on Round N + 1. These results are combined over both farm games.

hazard occurred on the previous round, only 9 percent of the decisions on the next round were changes from the previous decision. These changes were about equally divided between buying a policy against a previously uninsured hazard (4.9 percent) and cancelling an existing policy (4.1 percent).

In examining decisions after the occurrence of a hazard (line 2), it is instructive to divide the data into two categories—decisions made relevant to the hazard that had just occurred (line 2a) and decisions for the other hazards, which had not just occurred (line 2b). Here, one sees that there was a much greater rate of cancellation of existing policies for hazards that had just occurred (9 percent) than cancellation of other policies (2.5 percent). This suggests a belief that, as the hazard has just happened, it is unlikely to repeat soon. This belief, known as the "gambler's fallacy", often has been found in laboratory studies as well as among residents of hazard areas (Slovic, Kunreuther, and White, 1974; pp. 192-193).

A slightly different way of looking at the effect of hazard experience is to examine people's behavior toward hazards on which they have just incurred an uninsured loss. On the round following such losses, 15.4 percent purchased insurance for that hazard. This percentage is only slightly higher than the rate of new insurance purchases on hazards other than the one that just occurred (14.5 percent) or the rate of new insurance on rounds that were not preceded by hazards (13.0 percent). Thus, people did not markedly increase their insurance holdings after an uninsured hazard, a result that conflicts with observations of actual insurance behavior in the aftermath of a disaster (e.g., Kunreuther, et al., 1977, Chapter 2). The reasons for this difference are unclear. One possibility is that the odds in the farm game are well defined and unchanging, whereas in the real world the occurrence of a disaster may greatly increase the perceived probability of its recurrence.

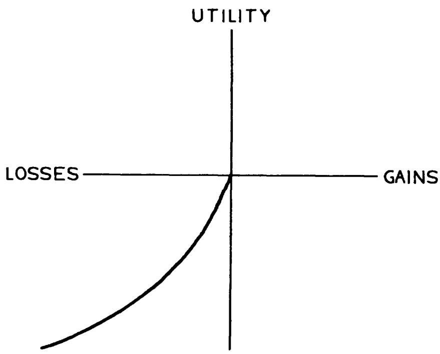
Discussion

Explaining the Probability Effect

A utility explanation. The most striking result of the experiments just described is that people buy more insurance against moderate- or high-probability, low-loss events than against low-probability, high-loss events. How might this behavior be explained? Two possible explanations come to mind, both of which are contrary to traditional utility theory. The first postulates a utility function which is convex over losses, as shown in Figure 6, instead of the traditional concave (risk averse) curve shown in Figure 1.

A convex curve, implying diminishing marginal utility over losses, has solid empirical support beyond the present study. Galanter has repeatedly obtained convex functions in carefully performed psychophysical experiments aimed at scaling the subjective value of various monetary and nonmonetary losses (Galanter, 1975; Galanter and Pliner, 1976). Swalm (1966) observed convex functions over monetary losses with corporate executives, a result apparently neglected by other theorists and practitioners. Most recently, Kahneman and Tversky (1977) have observed preferences among gambles that could be explained only by a convex utility function for losses. Kahneman and Tversky noted that diminishing marginal utility is compatible with well-substantiated principles of perception and judgment, according to which sensitivity to changes decreases as one moves away from a neutral point (here, no change in asset position).

FIGURE 6
A Utility Function That Is Convex in the Domain of Losses



Taken at face value, a convex utility function for losses implies that people never will buy insurance (just as a concave function implies that they always will buy insurance). Anderson (1974) has extensively discussed people's reluctance to purchase insurance. He cited the following testimony by George Bernstein, the Federal Insurance Administrator, before a U.S. Senate subcommittee:

> . . . most property owners simply do not buy insurance voluntarily, regardless of the amount of equity they have at stake. It was not until banks and other lending institutions united in requiring fire insurance from their mortgagers that most people got around to purchasing it. It was also many years after its introduction that the now popular homeowners' insurance caught on. At one time, too, insurers could not give away crime insurance, and we just need look at our automobile insurance laws to recognize that unless we force that insurance down the throats of the drivers, many, many thousands of people would be unprotected on the highways. People do not buy insurance voluntarily unless there is pressure on them from one source or another (Bernstein, 1972; p. 23).

If Bernstein is correct, then utility theory should be modified not only by postulating a convex disutility function, but also by adding factors like social or sales pressures, errors, and so on.

A threshold explanation. An alternative hypothesis invokes the notion of a probability threshold to explain the tendency to buy less insurance as probability of loss decreases. As suggested above, people may refuse to worry about losses whose probability is below some threshold. Probabilities below the threshold are treated as though they were zero.

When asked why they made their decisions about insurance purchases, most of the subjects in the foregoing experiments referred to some sort of threshold notion. For example:

> "Only in urns number 7 and 8 were the probabilities high enough to warrant buying insurance."
>
> "I thought the odds of my coming up with a blue ball had grown sufficiently by urn number 4 to start taking insurance."
>
> "I bought insurance only if the chance of selecting a blue ball was significant."
>
> "In the first two, the chances of picking the blue ball are too small to worry about. The remainder caused increasing concern for me."

Judging by these comments and the experiment results, the threshold apparently varies across individuals. Whether it also varies within individuals across situations, is a topic for future research. If the threshold is affected by factors other than probability, then it might best be viewed as defined on a variable called "worry" or "concern." The worry generated by a particular situation could be a function of several variables, including probability. The threshold concept makes good intuitive sense. There are only so many things in life one can worry about. Without some sort of threshold for concern, people would spend their entire lives obsessively protecting themselves against a "Pandora's urn" of rare horrors.

Ideas similar to the threshold notion have appeared in previous discussions of people's failure to protect themselves against natural hazards. Haas (1971) classed people's inattention to earthquake risks with their failure to check the air pressure in their spare tire before a long auto trip or to examine their house roof yearly for leaks. He commented:

> What do people attend to most of the time? They pay attention to that which is most pressing, that which must be attended to, that which has

deadlines, that which is generally considered most critical, that which one would be severely criticized for if he or she didn't attend to (p. 78).

Senator Robert Taft Jr. (1972) observed:

> The most difficult obstacle for the flood insurance program to overcome, however, does not relate to the difficulties of certifying communities for insurance. Instead, it relates directly to the psychological outlook of individual homeowners and businessmen in the flood plain areas. People just do not buy the insurance. The probability that a flood will damage their property once in a hundred years is apparently not a matter of concern to most individuals (p. 18).

The notion of a threshold protecting a finite reservoir of concern helps explain why so many respondents in the Kunreuther field survey were unconcerned about floods or earthquakes and collected little information about the hazards or about protective measures such as insurance.

The influence of perceived probability provides insight into the failure of premium subsidization to facilitate the purchase of hazard insurance (Anderson, 1974). It may be that subsidization does not work because the hazards seem so unlikely that insurance is not even considered. If the event is not going to happen, it does not matter how inexpensive the insurance is. The role of perceived probability might also explain the inconsistency of insurance behavior across situations where probability of loss varies (Vaughn, 1971) and the inability to predict insurance decisions on the basis of risk aversion indices obtained from gambling preferences (Green, 1963, 1964; Williams, 1966).

The popularity of low-deductible insurance plans (Pashigian, Schkade & Menefee, 1966; Schoemaker, 1976) and appliance service contracts is further evidence of the preference for insuring against high-probability events. Although the authors are attracted to the threshold hypothesis, it should be noted that the idea that people view insurance as an investment (and like to be able to make claims, thereby getting a return on their money), also is consistent with most of these results.

Implications for Public Policy

Though changing rapidly in certain insurance markets, it is axiomatic in the insurance industry that "insurance is sold, not bought." People's reluctance to purchase insurance voluntarily long has been a matter of concern and debate (Anderson, 1974). The experiments reported above suggest that people's natural predisposition is to protect against high-probability hazards and ignore rare threats. Individuals will not use insurance to protect themselves against rare, large losses if most of their attentional capacity is devoted to dealing with likely events.

The policy maker, on the other hand, has a different perspective on hazards and insurance. For example, when one considers natural hazards aggregated over many individuals and locations, over a long period of time, the probability of disaster becomes high. This difference in perspective from that of the individual resident of a hazard area, who is concerned with one particular house and a shorter time horizon, may be a source of conflict and mutual frustration between the policy makers and the public.

The present study, however, not only highlights the policy maker's problem, but also suggests some remedies. In particular, it seems that, in order for individuals to insure themselves against low-probability, high-consequence events, they must believe that these events are likely enough to warrant protective action. Two methods of changing people's perspective on hazard probability suggested by the foregoing experimental results are: (1) combine low probability hazards with higher probability threats in one insurance "package" and (2) compound the hazard over time. Thus, for the latter, instead of describing the chances of a 100-year flood as .01 per year, one could note that an individual living in a particular house for 25 years faces a .22 chance of suffering 100-year damage at least once. Either technique might make the probability of loss (and the chances of collecting on one's premiums) high enough to warrant insuring.

Also known is that the probability of an event is determined, in part, by the ease with which relevant instances are imagined or remembered (Tversky & Kahneman, 1973). Memorability and imaginability may be increased by publicity or use of visual displays like the Tennessee Valley Authority's device of plotting flood heights on photographs of familiar buildings (Kates, 1962). It might also help to persuade the public to view insurance and other protective measures as problems of community risk and welfare rather than from their own limited and subjectively safer point of view.

Although the foregoing results appear to tell a coherent story, the surface of understanding the insurance decision process has just been scratched. A number of variables (hazard probability, size of loss, realism, order of presentation, etc.) have been studied, but many other factors that may play important roles have been neglected. For example, Kunreuther's subjects apparently were influenced by communications with friends and neighbors; they may have been following social norms regarding insurance without engaging in any sort of analytic thinking. Other research has shown that subtle changes in problem formulation can have marked effects upon risk taking and insurance decisions (Lichtenstein & Slovic, 1971, 1973; Williams, 1966). Even within the urn and farm game paradigms, issues have only begun to be explored—issues like premium and deductible rates, refund plans, information costs, requirements for insurance coverage and information about qualitative aspects of hazards and the losses they entail. Until further research has clarified the roles of such factors, knowledge of the determinants of insurance behavior will be incomplete.

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