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LIMITED KNOWLEDGE AND INSURANCE PROTECTION

HOWARD KUNREUTHER

I. Introduction

In his 1973 presidential address to the American Economic Association Kenneth Arrow stressed that "the uncertainties about economics are rooted in our need for a better understanding of the economics of uncertainty; our lack of economic knowledge is, in good part, our difficulty in modelling the ignorance of the economic agent" [Arrow 1974, p. 1]. These problems are highlighted when one examines individual behavior with respect to events that can cause severe losses but that occur with relatively low frequency. For one thing, it is difficult for a person to collect detailed information on the probability of the occurrence of such events. Fur-
thermore, he may not fully appreciate or even care to contemplate its consequences or examine the protective measures he can take to alleviate potential losses.

Up to now public policy with respect to low probability-high loss events has been guided by normative models of choice. In particular, economists have relied on the expected utility model as a basis for recommending alternative courses of action. A principal argument for using the theory is that it is based on a set of postulates which “appear as convincing as the rules of logic” [Marschak 1968, p. 49]. These axioms imply that the consistent man behaves as if he assigns personal probabilities to different states of nature, assigns numerical utilities to the results of each possible course of action, and then chooses the action with the highest expected utility.

The following studies illustrate situations in which expected utility theory does not provide insight into individual actions with respect to low-probability events: (1) the demand for flight insurance by individuals even though it is more expensive than regular life insurance [Eisner and Strotz 1961]; (2) the preference of individuals for the lowest deductibles in their purchase of automobile insurance [Pashigian, Schkade, and Menefee 1966]; (3) the failure of most individuals in flood-susceptible areas to purchase flood insurance even though it is subsidized 90 percent by the federal government [Kunreuther 1973b]; (4) the negligible sale of crime insurance to renters, homeowners, and commercial property owners despite the fact that it is highly subsidized by the federal government [Federal Insurance Administration 1974]; (5) the reluctance of many individuals to wear seat belts despite the overwhelming statistical evidence supporting their use and the extremely low cost of buckling up [Robertson 1974]. Each of these examples describes a situation in which an individual can buy a contingent claim or a form of protection which has value if some uncertain event occurs. The fact that people have protected themselves when it is not cost effective for them to do so (e.g., purchased flight insurance) or have not protected themselves when the option is attractive (e.g., not purchased subsidized flood or crime insurance) deserves further investigation.

In the next section we will briefly review the theory of contingent claims in the context of an expected utility framework. Sec-
tion 3 presents preliminary results of a field survey of homeowners in flood- and earthquake-susceptible areas. These data suggest that the expected utility model does not provide insight into the decisions of the majority of homeowners with respect to the purchase or nonpurchase of insurance. Section 4 indicates how one would have to modify the utility model to be consistent with these findings. In section 5 we develop the elements of an alternative model of choice which explicitly focuses on man’s difficulties in processing information and undertaking computations. Section 6 presents empirical data from the field survey suggesting the importance of variables not traditionally considered as part of the expected utility framework. Section 7 develops the public policy implications of these preliminary findings. The final two sections discuss future research and the principal conclusions of the paper.

2. A Model of Contingent Claims Based on Expected Utility Theory

A conceptual framework based on the idea that individuals can purchase claims payable in money if a certain state of nature occurs was first developed by Arrow [1953] and has since been utilized by a number of economists in analyzing investment and insurance decisions in the context of the expected utility model.\(^1\)

Our interest in this paper is in investigating the conditions under which an individual will want to purchase a contingent claim with respect to losses from a low-probability event. We will illustrate these concepts by focusing on the insurance purchase decision. Not only is it the purest example of a contingent claims market, but our field survey data relate to this decision by homeowners. The conceptual framework can be applied to other decisions related to protective activities against uncertain events with negative consequences.

Specifically, we are interested in determining when an expected utility-maximizing individual will want to purchase insurance to cover his potential losses. For purposes of exposition we will

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consider the case where there are only two states of the world, disaster or no disaster, and where the utility function is independent of the resulting state of the world. To structure the analysis we assume that individuals have subjective estimates of the following parameters:

\[ p = \text{cost per dollar value of protection (e.g., insurance premium).} \]

\[ \pi = \text{probability of the disaster.} \]

\[ L = \text{loss resulting from the disaster.} \]

\[ t = \text{percent tax writeoff on uninsured losses.} \]

The individual has initial wealth or assets \((A)\) and a von Neumann-Morgenstern utility function \(U(A)\) which displays risk aversion, i.e., diminishing marginal utility. He must then determine how much protection or insurance coverage \((I)\) he should purchase against a potential loss \((L)\), so as to maximize

\[
\pi\left( \frac{U[A - L + (1 - p)I + t(L - I)]}{U[A - pI]} \right) + (1 - \pi)U(A - pI).
\]

Disaster state \hspace{1cm} Nondisaster state

The optimal amount of protection \((I^*)\) can be obtained by the Kuhn-Tucker conditions. Whenever \(I^*\) is positive but less than \(L\), then its value is given by

\[
\frac{(1 - \pi)p}{\pi(1 - p - t)} \frac{U'[A - L + (1 - p)I + t(L - I)]}{U'[A - pI]}.
\]

The left-hand side of equation (2) can be viewed as a contingency-price ratio. It indicates the ratio of the expected cost of insurance should a disaster not occur \((1 - \pi)p\) to the expected net gain in assets from insurance should a disaster occur \((\pi(1 - p - t))\). We will define this contingency-price ratio to be \(k\).

Let us now consider the two extreme cases of total insurance protection \((I^* = L)\) and no coverage \((I^* = 0)\). It directly follows from equation (2) that an individual will want to purchase insurance to cover his entire loss if \(k = 1\). Hence whenever \(k \leq 1\) then expected utility is maximized if \(I^* = L\). Similarly, equation (2) in-

\[ ^2 \text{A complete treatment for the case of } n \text{ states of the world with a state-dependent utility function is found in Arrow [1973].} \]

\[ ^3 \text{For simplicity and without loss of generality, } t \text{ is assumed to be independent of the magnitude of the loss.} \]

\[ ^4 \text{In more formal terms } U(A) \text{ is a strictly concave function so that } U''(A) < 0 \text{ for all } A \text{ in the relevant range.} \]
dicates that an individual will not want to purchase any insurance at all if there is such a high loading charge that

\[ k = \frac{U'(A - L(1 - t))}{U'(A)}. \]

Thus \( I^* = 0 \) whenever the contingency price equals or exceeds the ratio of marginal utilities of postdisaster wealth to predisaster wealth without any insurance coverage.

For cases when insurance premiums are subsidized by the federal government it is clear that a risk averse individual will want to purchase the maximum available coverage if his subjective estimate of \( \pi \) is at least as great as \( p/(1 - t) \). If his subjective estimate of \( \pi \) is sufficiently low, then he will not purchase any insurance. One other element might dissuade an individual from purchasing insurance. If homeowners feel that they will receive liberal relief (e.g., forgiveness grants or low interest loans) from the federal government on uninsured losses, then they might prefer to gamble on the benevolence of Congress. We will determine how important this effect actually is when we look at empirical data in the next section.

3. Empirical Evidence on Insurance Purchase Decisions

An important objective of an NSF–RANN research project based at the University of Pennsylvania [Kunreuther 1973a] is to increase our understanding of the factors influencing man's decision to protect himself against extreme events having negative consequences. In the case of flood and earthquake hazards there is empirical evidence that indicates an unwilling market for insurance protection. For example, in an experiment following the San Fernando earthquake, the Insurance Company of North America mounted a serious campaign to market earthquake insurance in California but found little interest in coverage on the part of the homeowner [Syfert 1972]. A similar pattern has been found with respect to voluntary purchase of flood insurance for which premiums are subsidized approximately 90 percent by the federal government. For example, even though Rapid City, South Dakota, qualified for the federal government's subsidized insurance in April 1971, only 29 policies were in force at the time of the June
1972 flood. Similar behavior was evident in the states hit by
tropical storm Agnes in June, 1972.

Design of Field Survey. What factors have led some individuals
to purchase insurance, and why have other people not availed
themselves of this protection? In order to discover differences
between insured and uninsured individuals a field survey was
undertaken in flood- and earthquake-susceptible areas in the
United States. The sampling plan called for face-to-face inter-
views with 2,000 homeowners residing in 43 areas in the United
States subject to coastal and riverine flooding, and 1,000 home-
owners living in 18 earthquake-susceptible areas of California.
Half of the respondents had purchased flood or earthquake in-
surance and the other half had not done so.

Hydrographic surveys had been carried out for each of the com-
munities in our flood sample, and geographic zones had been de-
lineated on the basis of the objective probabilities of flood damage.
A simple random sampling plan would have resulted in more of
the insured respondents being in the high-hazard zone (Zone A)
and most of the uninsured individuals being in the low-hazard
zones (Zones B and C). It was thus deemed desirable to utilize
a nonproportionate sampling plan by oversampling uninsured
individuals in Zone A. Cluster sampling reduced costs significantly
and enabled the project to stay within the budget for the survey.
A similar procedure was utilized for the earthquake portion of
the survey. The sample of policyholders was restricted to an 11-
county area of California where the estimated percentage of home-
owners purchasing earthquake insurance was greater than 0.75
percent. All policyholding homeowners living in communities
where there were at least five policyholders from the list of 6,000
names supplied by the insurance companies were included in the

5 The field survey portion of the NSF-RANN project was subcontracted to the Institute for Survey Research at Temple University, Philadelphia. Personnel from ISR were always in close contact with the project and generously gave of their time during this phase of the research.

6 Data on the insured individuals in flood-susceptible areas were provided by the National Flood Insurers Association. The data on earthquake-insured individuals were provided by eight of the largest insurance companies marketing policies in California through the auspices of the National Committee on Property Insurance.

7 Zone A is defined to be that part of a floodplain for which the annual probabil-
ity of flooding is at least .01. Zone B has an annual probability of flooding of be-
tween .01 and .002. Zone C has a probability of less than .002.

8 Two counties, Del Nonte and Santa Cruz, with slightly higher rates of buying were excluded because of their isolated locations and small populations.
sampled population. Table 1 presents data on the number of insured and uninsured homeowners in each of the respective samples.

<table>
<thead>
<tr>
<th></th>
<th>Insured</th>
<th>Uninsured</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flood survey</td>
<td>1,103</td>
<td>952</td>
<td>2,055</td>
</tr>
<tr>
<td>Earthquake survey</td>
<td>461</td>
<td>545</td>
<td>1,006</td>
</tr>
</tbody>
</table>

A number of questions was included in the survey to elicit subjective estimates by homeowners on the probability of a severe flood or earthquake and the resulting loss to their property if a disaster caused damage to their property. Data were also obtained on an individual's knowledge of the availability of insurance and the terms of a policy (e.g., premium, deductible, and coverage limits). These data provide insight into how well the expected utility model can explain behavior.

Preliminary Analysis of Questionnaire Data. If the contingent claims model developed in section 2 is to be used as a framework for describing insurance purchase decisions, then individuals must at least be able to estimate the values of $p$ and $\pi$ so as to yield a contingency-price ratio $k$. One of the most significant preliminary findings to emerge from our analysis of the survey data is the limited information individuals have on both the hazard itself and the insurance option. Below we will present cross tabulations and summary statistics which indicate the extent of the respondents' knowledge with respect to these key parameters.\(^9\)

Awareness of Insurance. The sample was intentionally designed to cover only communities where flood or earthquake insurance can be purchased. However, only 69 percent of the respondents in the flood survey and 62 percent of those interviewed in earthquake-susceptible areas of California are aware that insurance is available in their neighborhoods.

When it comes to awareness of the terms of the insurance policy, a surprisingly large number of uninsured homeowners are unable to provide any estimate of the premium or the deductible. Table 2 presents these data for both insured and uninsured homeowners

---

\(^9\) The survey questions used in developing these summary statistics may be obtained from the author.
Table 2. Individuals unable to provide any estimate of terms of flood or earthquake insurance* (% of sample)

<table>
<thead>
<tr>
<th>Cost of Insurance (Qq. 19, 20)</th>
<th>Insured</th>
<th>Uninsured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flood survey</td>
<td>17</td>
<td>68</td>
</tr>
<tr>
<td>Earthquake survey</td>
<td>11</td>
<td>76</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Deductible Amount (Q. 21)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flood survey</td>
</tr>
<tr>
<td>Earthquake survey</td>
</tr>
</tbody>
</table>

* Includes homeowners who had not heard of flood or earthquake insurance or who were not aware that it was available in their neighborhoods.

in the survey. Interestingly enough, 25 percent of the earthquake-insured population do not know the deductible on their insurance policies, and another 9 percent assume that there is no deductible. Should they suffer earthquake damage they undoubtedly will be surprised to find that their policy states that there is a 5 percent deductible on the actual cash value of their policies.10

Awareness of damage and probability of a flood or earthquake. A set of questions was designed to elicit estimates of damage from a minor or severe flood or earthquake. Table 3 presents

Table 3. Damage expected to property and contents from a severe flood or earthquake (Qq.119–122) (% of sample)

<table>
<thead>
<tr>
<th>Total Damage Class</th>
<th>Flood survey</th>
<th>Earthquake Survey</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Insured</td>
<td>Uninsured</td>
</tr>
<tr>
<td>No damage</td>
<td>9</td>
<td>29</td>
</tr>
<tr>
<td>$10,000 or less</td>
<td>22</td>
<td>26</td>
</tr>
<tr>
<td>$10,001 to $30,000</td>
<td>37</td>
<td>24</td>
</tr>
<tr>
<td>Over $30,000</td>
<td>24</td>
<td>12</td>
</tr>
<tr>
<td>Unable to estimate</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

data on damage expected to property and contents from a severe flood or earthquake. As one would expect, insured homeowners in both flood- and earthquake-susceptible areas expect more damage from a severe disaster than do uninsured individuals. Between 6 and 9 percent of the insured and uninsured individuals cannot

10 The deductible on a flood insurance policy is $200 or 2% of the loss, whichever is larger.
estimate how much damage they would suffer from a flood or earthquake.

Another interesting finding from Table 3 is the relatively large percentage of uninsured individuals who estimate that they will receive no damage from a severe flood or earthquake in the area. More detailed objective data (e.g., the elevation of each home in relation to a river) are needed to determine whether or not these subjective estimates parallel reality. It is also difficult to understand why any individual who estimates zero damage from a flood or earthquake would voluntarily purchase an insurance policy.11

Table 4 presents the subjective probability estimates of a flood

<table>
<thead>
<tr>
<th>Subjective Probability of Flood or Earthquake</th>
<th>Flood Survey</th>
<th>Earthquake Survey</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Insured</td>
<td>Uninsured</td>
</tr>
<tr>
<td>.10–1.00</td>
<td>24</td>
<td>12</td>
</tr>
<tr>
<td>.01–.10</td>
<td>26</td>
<td>18</td>
</tr>
<tr>
<td>.01–.0001</td>
<td>20</td>
<td>26</td>
</tr>
<tr>
<td>.0001 or less</td>
<td>13</td>
<td>30</td>
</tr>
<tr>
<td>Unable to estimate</td>
<td>17</td>
<td>14</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

or earthquake causing severe damage to one's property within the next year. This probability is conditional on the respondent's earlier estimates of damage to property and contents from a future severe flood or earthquake. Those unable to estimate these losses based their subjective probability on $10,000 damage to their property and contents. In the Appendix we have reproduced question 126 from the survey, which elicited the responses summarized in Table 4. As would be expected, uninsured individuals in flood-susceptible areas estimate a much lower subjective probability of a flood next year than do insured individuals. In earthquake-susceptible areas the difference between the two groups is much smaller. The most interesting aspect of Table 4 is the large percentage of un-

11 Of the insured individuals who estimated zero future damage from a flood, 82% voluntarily purchased an insurance policy. The corresponding figure for the earthquake survey was 89%. The remaining group was required to purchase an insurance policy as a condition for either a mortgage or a federal disaster loan.
insured individuals in both flood- and earthquake-susceptible areas who estimate the probability of a severe disaster to be 1 in 100,000 or less (i.e., almost impossible). Some of these uninsured individuals may estimate such a low probability not necessarily because they really perceive the chance of a flood or earthquake to be so small, but rather as an ex post justification for their current uninsured status. The same bias may be true of insured homeowners who estimate a high probability of a future flood or earthquake.

**Expectation of Federal Aid.** One of the arguments raised against a system of liberal disaster relief in the form of forgiveness grants and low interest loans is that it discourages individuals from purchasing insurance in the predisaster period. In fact, in the past some homeowners were actually better off (in present value terms) after a disaster than before because they could obtain a low-interest SBA loan to cover not only their losses but also the refinancing of an existing mortgage.\(^\text{12}\)

It was thus of interest to determine what role individuals expected the federal government to play should they suffer losses from a disaster. Specifically we asked each respondent to enumerate the sources of funds and the amounts he would expect to receive for restoring his losses from a future flood or earthquake causing severe damage to property and contents. The answers clearly indicated that a substantial majority of both insured and uninsured homeowners expected to receive no aid at all from the federal government if they suffered damage from a flood or earthquake. It was clear that insured homeowners would not rely on the federal government for disaster loans. What was surprising was that almost two-thirds of the uninsured homeowners in flood- and earthquake-susceptible areas expected no federal aid at all. This factor thus appeared to be relatively unimportant in explaining a homeowner’s decision not to purchase insurance.

**Summary of Empirical Findings.** Limited Knowledge. The preliminary cross tabulation and summary statistics suggest that many individuals residing in hazard-susceptible areas have limited

\(^{12}\) Following tropical storm Agnes and the Rapid City floods of June 1972 the SBA was permitted to forgive the first $5,000 of each loan and provide 1% annual interest rates on the remaining portion. For more details on the inequities of the SBA loan program and a comparison with an insurance program, see Kunreuther [1973b] and Cochrane [1975].
knowledge about the flood or earthquake hazard or the insurance option. A substantial proportion of insured as well as uninsured individuals cannot estimate either the potential consequences of a severe flood or earthquake and/or the cost of insurance. Furthermore, a significant proportion of uninsured individuals expect no damage at all from a severe flood or earthquake. The data indicate that half of the uninsured individuals in flood-susceptible communities and two-thirds of the uninsured homeowners in earthquake-susceptible areas are unable to estimate the insurance cost, damage, or probability of a future disaster. These individuals are not in a position to evaluate the attractiveness of insurance by utilizing the expected utility model. A smaller but still significant proportion of the insured homeowners fall in this category.

Analysis of the Contingency-Price Ratio. For those homeowners who were able to estimate $\pi$ and $p$ and expect some damage from a future flood or earthquake we can calculate a contingency-price ratio $k$. Risk-neutral or risk-averse homeowners will want to purchase insurance if their contingency-price ratio is less than 1. Based on this assumption, Table 5 indicates that 39 percent of the uninsured individuals should have purchased either flood or earthquake insurance to cover their losses, even if a relatively high marginal tax rate of $t = .30$ is assumed.

On the other side of the coin there is a substantial number of insured individuals who would have to be extremely risk averse to want to purchase any insurance according to the expected utility model. A conservative assumption is that any individual whose

<table>
<thead>
<tr>
<th>Contingency-Price Ratio</th>
<th>Flood Survey</th>
<th>Earthquake Survey</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Insured</td>
<td>Uninsured</td>
</tr>
<tr>
<td>Less than .05</td>
<td>20</td>
<td>12</td>
</tr>
<tr>
<td>.05–1</td>
<td>15</td>
<td>13</td>
</tr>
<tr>
<td>.11–1</td>
<td>15</td>
<td>14</td>
</tr>
<tr>
<td>1.1–10</td>
<td>11</td>
<td>13</td>
</tr>
<tr>
<td>10.1–30</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Over 30</td>
<td>35</td>
<td>46</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>
implied value of $k$ exceeds 10 would be unlikely to buy insurance if he behaves according to the expected utility model.\textsuperscript{13} Yet we see from Table 5 that almost 40 percent of the flood-insured individuals and almost 30 percent of the earthquake-insured individuals fall into this class. In fact most of these homeowners have values of $\pi$ and $\rho$ yielding a value of $k$ greater than 30.

**ADEQUACY OF THE UTILITY THEORY.** Table 6 summarizes the pre-

<table>
<thead>
<tr>
<th>Table 6. Categorization of insured and uninsured individuals in flood and earthquake surveys (% of sample)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Flood Survey</strong></td>
</tr>
<tr>
<td>Insured Uninsured</td>
</tr>
<tr>
<td>----------------------</td>
</tr>
<tr>
<td>Expect zero damage</td>
</tr>
<tr>
<td>Do not expect zero damage</td>
</tr>
<tr>
<td>Do not know premiums and/or probability of loss</td>
</tr>
<tr>
<td>Insurance highly attractive ($k \leq 1$)</td>
</tr>
<tr>
<td>Insurance possibly attractive ($1 &lt; k &lt; 10$)</td>
</tr>
<tr>
<td>Insurance unattractive ($k &gt; 10$)</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

liminary findings regarding the adequacy of the expected utility model to explain behavior. Only 37 percent of the flood-insured individuals and 42 percent of the earthquake-insured individuals had estimates of $\pi$ and $\rho$ that were clearly consistent with the expected utility model. Another 8 percent of the flood-insured group and 16 percent of the earthquake-insured group might have been sufficiently risk averse (i.e., $1 < k < 10$) to have been expected utility maximizers. Other insured persons either did not have enough information to utilize the model, had unusually large estimates of $k$ (i.e., $k > 10$), or expected no damage from the

\textsuperscript{13} Eisner and Strotz [1961] have shown that life insurance has a value of $k$ approximately equal to 2, and that air trip insurance yields $k = 3.3$. 
hazard. Thus their behavior cannot be explained by resorting to the standard expected-utility framework.

The uninsured individuals present an even more disturbing picture regarding the adequacy of utility theory to explain their behavior. Fewer than 10 percent of these homeowners in hazard-susceptible regions had values of $k > 10$. It is certainly true that another 29 percent of the uninsured respondents in flood-susceptible areas and 12 percent of those in earthquake areas estimated no damage from a severe disaster. The fact that these individuals reside in hazard-susceptible areas suggests that they had not even considered the potential consequences of a flood or earthquake in their decision process regarding insurance.

4. Modifying the Expected Utility Model

The preliminary cross tabulations presented in the previous section clearly indicate man's limited knowledge both with respect to low probability events (i.e., floods or earthquakes) and to a possible protective measure against financial loss (i.e., insurance). A model of decision-making must recognize these limitations if it is to formulate appropriate policy recommendations.

One possible direction of research would be to modify the expected utility model so that it incorporates the cost of making decisions. In other words, one would translate the efforts of gathering and processing information into monetary terms and incorporate this factor as an explicit part of the utility function. It would then be possible to determine under what conditions an individual would even want to consider the possibility of protecting himself against the consequences of a low-probability event.\(^{14}\)

As an illustration of how these ideas can be incorporated into the contingent claims model developed in section 2, let us assume that the individual does not know the insurance premium $p$. Instead he believes that there is a range of values from $p_{\text{min}}$ up to $p_{\text{max}}$ that the premium might take; he assigns a judgmental probability

\(^{14}\)In statistical decision theory the cost and value of information are considered an integral part of the decision process. The seminal work in this area is by Raiffa and Schlaifer [1961]. Raiffa [1968] offers a lucid set of introductory lectures on decision analysis. For an excellent recent application of the value and cost of information to a decision theoretic problem involving hurricane modification, see Boyd et al. [1971].
$P(p)$ to each of these possible premiums. The judgmental density function for the unknown premium $p$ must satisfy the condition

$$
\sum_{p_{\text{min}}}^{p_{\text{max}}} P(p) = 1
$$

The individual has two choices open to him. (1) He can contact his agent and learn the true insurance premium, after which he can decide how much insurance (if any) he wishes to purchase. Or (2) he can choose not to contact the agent and hence not to purchase any insurance.

The decision as to whether or not to contact the agent is made by comparing the expected utility that will result from each of these two choices. In calculating the expected utility of the first alternative, we assume for simplicity that contacting the agent involves time and effort equivalent to a fixed monetary cost $F$. For each estimate $p$ of the premium we can apply equation (2) of section 2 to determine the optimal amount of insurance, $I^*_p$; this amount may of course be zero for some values of $p$. Note also that because of the transaction cost $F$, the asset level $A$ in equation (2) becomes $(A - F)$. Equation (1) can then be utilized to determine the expected utility associate with $I^*_p$, denoted by $E[U(I^*_p)]$; again the appropriate asset level in this equation is $(A - F)$. The expected utility of the first alternative, contacting the agent, is thus given by

$$
\sum_{p_{\text{min}}}^{p_{\text{max}}} P(p)E[U(I^*_p)].
$$

The expected utility of the second alternative, doing nothing, is denoted by $E[U(0)]$. This does not imply that we are considering the expected utility of an outcome of no loss, but rather that of carrying no insurance, with all the risks that such a course implies. In determining whether or not to contact the agent, the individual then follows the simple decision rule of choosing the alternative with the larger expected utility. Implicit in this model is the notion that an individual who chooses not to contact his agent believes that over a substantial portion of his judgmental
probability distribution, $p$ is so high that the optimal course is to purchase no insurance.\textsuperscript{15}

In general, information on the unknown parameters can be collected from one or more different sources. For example, we can incorporate judgmental distributions associated with the probability of a disaster as well as those associated with the property losses should a disaster occur. These figures can be collected from published material such as historical records or through discussions with friends or neighbors. The individual balances the costs of collecting data from each source with the potential benefits of more complete information, and makes his decision accordingly.

By introducing the computation costs of processing information into the expected utility model we can also determine when it is optimal for the individual to utilize simplified procedures for computing expected losses and costs. For example, suppose that a person knows that losses from a flood of a given magnitude may take on a wide range of values. He also recognizes that the costs of computing all these values and utilizing them in a decision model are very high or constrained by his own capacity to process data. It may then be optimal for him to utilize only a point estimate of losses (e.g., his best guess) in evaluating the insurance decision.

5. \textit{An Alternative Approach to the Insurance Purchase Decision}

The descriptive data from the field survey imply that the traditional expected utility model does an unsatisfactory job of explaining homeowners' decisions regarding the purchase of flood or earthquake insurance. Hence if expected utility is the appropriate framework for modeling contingent claims behavior, the theory must be expanded to include transaction costs associated with collecting and processing information.

There is an alternative way of viewing the decision-making

\textsuperscript{15} Naturally one can always find a set of values for $P(p)$ or $F$ which will explain a person's behavior. In a similar manner one can postulate a specific form of the utility function to rationalize unusual behavior by individuals. For example, Gould [1969] shows that the expected utility model is always consistent with the purchase of the lowest deductibles on insurance if the utility function has an exponential form. With an exponential utility function one can always make the individual sufficiently risk averse so that he wants to protect himself against very small losses.
process. We can hypothesize that his limitations with respect to processing information force man to simplify the decision-making process. According to this view the individual will not collect data unless motivated to do so. Hence he may not take any positive action because of his limited knowledge. In this section we sketch the elements of such a process of choice. According to this model only a subset of individuals will reach a stage at which they have collected enough information to utilize the contingent claims model developed in section 2. The insurance status of the remaining group of individuals will be determined primarily by factors that reflect computational limitations rather than by explicit cost tradeoffs.

Considerably more research must be undertaken to formalize this process of choice. Similarly there is a need to undertake a rigorous treatment of expected utility with transaction costs. To compare these two approaches at this time would thus be premature.

_Antecedents in the Literature_. Recent empirical studies by social scientists indicate that man has a difficult time making decisions and hence may behave in a manner unlike the rational economic man which forms the basis of the expected utility model.\(^{16}\) The leading critic of utility maximization as a descriptive theory has been Herbert Simon, who observed:

The classical theory is a theory of a man choosing among fixed and known alternatives, to each of which is attached known consequences. But when perception and cognition intervene between the decision maker and his objective environment, this model no longer proves adequate. We need a description that takes into account the arduous task of determining what consequences will follow on each alternative [Simon 1959, p. 272].

As an alternative to the expected utility model, Simon introduced the notion of _bounded rationality_, in which the decision-maker's cognitive limitations force him to construct a simplified model of the world. Simon [1955] argues that in actual choice situations man has a difficult time making the computations re-

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\(^{16}\) For an excellent summary of research undertaken by geographers in the hazards area, see Burton, Kates, and White [1976].
quired to maximize some objective function. Furthermore, it may be very difficult for him to gather the information necessary to make these decisions. Simon therefore introduces the concept of an aspiration level which itself adjusts upward or downward on the basis of experience and which may lead to satisficing behavior. He sees decisions as frequently being made so as to satisfy short-run goals and constraints rather than to maximize some long-run objective function.\textsuperscript{17} Economists such as Georgescu-Roegen [1954] and Chipman [1960] have also emphasized the importance of short-run goals in consumer behavior and have advocated the use of a lexicographic ordering as a more appropriate tool for structuring a certain class of decisions than is a cardinal utility framework.\textsuperscript{18}

Recent laboratory research described in Tversky and Kahneman [1974] and Slovic, Kunreuther, and White [1974] has documented man’s weaknesses as a processor of probabilistic information. These recent studies have uncovered some startling deficiencies in man’s ability to think in probabilistic terms or to integrate probabilities and utilities into his decisions. One of the most important concepts is the notion of availability, according to which one judges the probability of an event by the ease with which relevant instances are imagined, or by the number of such instances readily retrieved from memory [Tversky and Kahneman 1973].

The concept of availability is potentially one of the most useful ideas for helping us to understand why individuals in flood- and earthquake-susceptible areas have had difficulty in estimating probabilities of and losses from a future disaster. Kates [1962, p. 140] points out that “a major limitation to human ability to use improved flood hazard information is a basic reliance on experience. Men on flood plains appear to be very much prisoners of their experience.” He further attributes much of the difficulty in achieving better flood control to the “inability of individuals to conceptualize floods.” In fact, Burton, Kates, and White [1976], in characterizing individual behavior with respect to hazardous events, postulate that the choice process does not begin unless a

\textsuperscript{17} Those arguments have been used by Cyert and March [1963] in their classic work on the behavioral theory of the firm. For an excellent contrast of normative and descriptive models in the theory of the firm, see Winter [1975].

\textsuperscript{18} For an application of a lexicographic model to consumer behavior with respect to natural hazards, see Kunreuther [1974].
first threshold of awareness of actual or anticipated loss is reached. They point out that only after the individual exceeds a certain limit will he begin to think about an extreme event and of ways of dealing with it. If one relates the concept of awareness of actual or anticipated loss to past experience with the hazard, then availability should play a key role in the decision-making process.

The idea that experience with misfortune is a stimulus to action is also very much in the spirit of a bounded rationality model. For example, Cyert and March [1963] argue that managers in firms act and react on the basis of short-term feedback so that action is normally triggered by a failure to meet one’s goals. Lindblom [1964], in his analysis of governmental policy-making, contends that the decision-maker attempts to proceed through a succession of small changes triggered by remedying a negatively perceived situation. After interviewing flood plain residents, Kates [1962] concluded that individuals must experience floods relatively often and suffer severe losses from them to want to invest in protective activities.

A Sequential Choice Process. The picture emerging from these earlier studies is one of a person reluctant to take any protective action unless he has passed through a sequence of steps which alert him to the dangers of the hazard and the availability of insurance. Figure 1 depicts such a sequential process by indicating four separate stages. Below we will examine the factors influencing behavior in each of these stages.

Of primary importance is the individual’s awareness of the hazard (stage 1). Using the concept of availability, it becomes important for an individual to have a graphic picture of the consequences of the hazard through either past experience or discussions with individuals who have personally suffered losses. The mass media may also play a role in depicting the consequences of a disaster through graphic pictures, but these will have less impact on behavior because they are impersonal in nature.19

Only if a person is aware of the hazard is he likely to investigate protective activities such as purchasing insurance. One reason he may do so is because he wants to relieve his anxiety about the

19 It would be interesting to determine what effect, if any, the movie Earthquake and the cover story in Time magazine on “Forecast: Earthquake” (September 1, 1975, pp. 56–41) has had on the purchase of earthquake insurance by residents of California.
Figure 1. Sequential Model for Insurance Decision.

consequences of a particular state of nature.\textsuperscript{20} Even then, if the product is relatively new (e.g., flood insurance) or not marketed on a mass level (e.g., earthquake insurance) he may not be aware of its existence. One reason for his lack of awareness is the high transaction costs associated with obtaining data on the availability of insurance by such means as contacting an insurance agent.\textsuperscript{21}

\textsuperscript{20} For an interesting discussion of this point in the context of low-probability events see Zeckhauser [1975].

\textsuperscript{21} Most insured homeowners interviewed in our field survey initiated contact with their agents regarding the purchase of a policy. Over 85\% of the earthquake-insured and over 80\% of the flood-insured individuals contacted their agents first rather than being contacted by them.
In order to obtain information on both availability (stage 2) and terms of insurance (stage 3), the person is likely to rely primarily on friends and neighbors. This personal contact will be important because it greatly reduces the costs of obtaining data on both the hazard and the insurance. The following example illustrates this point. In pretesting the earthquake questionnaire in San Francisco, Paul Slovic and I interviewed a homeowner who responded to a question by saying that he did not have insurance against earthquake damage. A friend who was listening to the interview could not resist commenting that he himself had purchased earthquake insurance a couple of years before. The respondent was dumbfounded and asked the friend about the availability of coverage and its cost. He then added, "I am going to have to look into earthquake insurance myself." 22

The individual who is aware of both the hazard and the insurance terms will have reached the point in the decision process at which he can decide how much if any insurance he wants to purchase (stage 4). Because of the difficulty in processing information and in computation he is likely to make his decision by focusing on comparable dimensions (e.g. premium-loss ratios) rather than by multiplying losses by probabilities. He is then likely to use simple decision rules to justify his action to himself and to others.23 Thus he may examine the cost of insurance in relation to some budget constraint and decide on that basis that it is too expensive. He may also investigate how premiums compare with the cost of related insurance policies or the potential loss of the hazard. If individuals make decisions on this basis, their behavior may be inconsistent with the contingent claims model of section 2 but consistent with an alternative theory of behavior recently developed by Kahneman and Tversky [1975].

22 Tversky and Kahneman have speculated that such personal interaction also opens one up to regret. For example, if most people in your circumstances purchase insurance and you do not, then you would be open to severe regret if a loss occurs. However, if almost all others are uninsured, a loss will probably not cause you to regret being uninsured. It is not only the loss per se that determines regret, but the loss in conjunction with social norms or accepted rules of conduct.

23 Slovic and Tversky are collecting data from previous studies to investigate whether simple decision rules are applied in making choices because they provide a plausible justification. For example, people might say "I don't have earthquake insurance because the premiums are too high," or "I canceled my flood insurance because it just wasn't paying off."

One of the objectives of the NSF-RANN project based at the University of Pennsylvania [Kunreuther 1973a] is to determine how well a sequential model of choice actually describes the individual decision-making process. Data from the field survey will enable us to differentiate between insured and uninsured homeowners, particularly with respect to their awareness of the hazard (stage 1) and their awareness of insurance (stages 2 and 3). Controlled laboratory experiments on insurance to be undertaken at the Oregon Research Institute will enable us to gain a clearer understanding of the factors influencing the insurance purchase decision once an individual has reached the stage at which he is considering how much, if any, insurance he wants (stage 4).

Preliminary Findings. The results of the field survey presented in section 3 clearly imply that a large number of uninsured individuals have not even reached the stage where they can utilize the expected utility model. Furthermore, those who do frequently behave differently from what utility theory would have predicted. Other factors undoubtedly played a role in their behavior.

Preliminary analysis of data from the flood and earthquake portions of the survey suggest that factors which facilitate information processing by individuals play a key role in the decision on whether or not to purchase insurance. This section will examine several hypotheses implied by the sequential model of choice by looking at differences between insured and uninsured homeowners. These cross tabulations are the first stage in a systematic analysis of the field survey data and hence should be viewed only as suggestive.

Awareness of the Hazard. The first two hypotheses relate to the individual's awareness of flood or earthquake problems.

Hypothesis 1. An individual who is aware of flood or earthquake problems when he moves into a neighborhood is more likely to be insured than one who is unaware. This hypothesis implies that individuals who have collected information on the potential dangers of the hazard when making a decision to locate in the area are also more likely to search for protective mechanisms. The survey data indicate that twice as many insured as uninsured home-
owners were aware of the flood hazard at the time they moved into their homes. In earthquake-susceptible areas one and one-half times as many insured as uninsured were aware of the hazard when they located in the neighborhood.

_Hypothesis 2._ An individual who has experienced floods or earthquakes that caused damage to his house is more likely to purchase insurance than one who has not experienced damage. By looking at data on actual hazard experience we can determine the proportion of homeowners who purchased insurance after personally experiencing property damage from a flood or earthquake.\(^{24}\) Almost 70 percent of the homeowners in the survey who have experienced flood damage purchased insurance, whereas only 45 percent of the homeowners with no prior flood damage purchased insurance. In earthquake-susceptible areas prior losses showed a negative relationship, if any at all, to the purchase of insurance.

Table 7 sheds some light on the reason for the differences be-

<table>
<thead>
<tr>
<th>Damage Class</th>
<th>Flood Survey</th>
<th>Earthquake Survey</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>% Insured</td>
</tr>
<tr>
<td>No damage</td>
<td>1514</td>
<td>46.4</td>
</tr>
<tr>
<td>$1–$1,000</td>
<td>114</td>
<td>57.0</td>
</tr>
<tr>
<td>$1,001–$5,000</td>
<td>126</td>
<td>76.2</td>
</tr>
<tr>
<td>Over $5,000</td>
<td>169</td>
<td>81.1</td>
</tr>
<tr>
<td>Unable to estimate</td>
<td>132</td>
<td>78.0</td>
</tr>
</tbody>
</table>

* Cumulative damage prior to purchasing insurance.

The table focuses on cumulative dollar losses caused by floods or earthquakes prior to the date the homeowner purchased insurance or to the interview date should the homeowner be uninsured. As one might expect, small flood or earthquake losses had a negligible or even negative effect on the purchase of insurance.\(^{25}\) As shown by Table 7, very few homeowners had earthquake losses exceeding $5,000, and most suffered losses of less than $1,000. Many flood victims suffered large losses,

\(^{24}\) Individuals whose only flood or earthquake losses occurred after they had purchased insurance are categorized as having had no prior experience.

\(^{25}\) Given the deductible clauses in the flood and earthquake policies, it does not pay to purchase insurance if one expects to experience only small losses.
and most of these homeowners then purchased insurance. This table suggests that prior experience influences the insurance decision only if the damage is relatively high. Otherwise the experience will have no effect, or will have a negative relationship to the purchase of insurance.

AWARENESS OF INSURANCE. The expected utility model, which is a formal statement regarding individual choice under uncertainty, does not focus explicitly on the role that friends and neighbors may play in the decision-making process. If one introduces costs of obtaining information and processing data into the model, then friends and neighbors may serve a useful function. The following two hypotheses argue for the importance of friends and neighbors with respect to the insurance decision.

Hypothesis 3. An individual who has purchased flood or earthquake insurance is more likely to know someone who has purchased a policy than is an uninsured individual.

Hypothesis 4. An individual who has purchased flood or earthquake insurance is more likely to have discussed insurance with friends, neighbors, or relatives than is an uninsured person.

The data support these hypotheses for both the flood and earthquake samples. Over 70 percent of flood-insured individuals and 40 percent of the earthquake-insured group know someone who has purchased a flood insurance policy; only 26 percent of the flood-uninsured and 6 percent of the earthquake-uninsured homeowners know any insured individuals. Over half of the flood and earthquake policyholders had discussed insurance with a friend, neighbor, or relative. The proportion of uninsured homeowners who had discussed the subject was less than 20 percent. These data alone provide relatively little insight into the actual decision-making process regarding the purchase of insurance. For example, there is no way to determine from the cross tabulations whether a discussion with a friend or a neighbor triggered the purchase of a policy, or if the individual approached a friend or neighbor after he was already committed to buying a policy or had actually purchased one. The data do suggest that further work should be

\[26\] For many years sociologists have stressed the importance of reference groups in the decision-making process, but they have not, to my knowledge, focused on their role regarding the reduction of information costs. For a book on sociologists' viewpoints on reference group behavior, see Hyman [1968].
done to determine the importance of reference groups and social norms in individual choice under uncertainty.

7. Implications for Public Policy

The principal conclusion that emerges from this preliminary analysis of field survey data is that the expected utility model, as traditionally used by economists, provides relatively little insight into the individual choice process regarding the purchase of insurance. Most insurance policies are designed to protect an individual against a low-probability event which may produce relatively large losses. But as we have seen, individuals find it difficult to assess the probability of these events or to estimate the potential losses. Furthermore, they have little interest in actively seeking information on insurance protection. It is thus not surprising that few individuals have protected themselves against the consequences of a disaster, and that Congress has responded with liberal federal relief in the aftermath of the event [Kunreuther 1973b].

If one is to market insurance and other protective activities effectively without making them compulsory, then programs must be designed to cope with the following two phenomena suggested by the sequential model of choice: (1) the lack of awareness by individuals of the losses from the hazard and its probability of occurrence; (2) the lack of awareness by individuals of the availability of insurance and the terms of a policy. Regarding losses and probabilities, the concept of availability may be a useful guideline. It implies that any factor which makes the losses from a hazard highly memorable or imaginable—such as a recent disaster or a vivid film—can considerably increase the perceived risk of the event and hence increase the individual’s awareness of its consequences. The Tennessee Valley Authority recognizes this on an intuitive level by going to considerable lengths to try and bring home the graphic reality of potential floods. It plots potential

27 For example, it is possible to reduce greatly the damage to property on the flood plain by floodproofing the structure with special materials. The expense is small relative to expected benefits, but few homeowners or businesses have engaged in this activity. For more details on floodproof measures and techniques, see Sheaffer [1968] and U.S. Corps of Engineers [1972].
floods on easily read maps, and shows flood heights on photographs of familiar buildings.

A study of the effects of a promotional campaign for the oil industry [Bureau of Applied Social Research 1953] concludes that graphic presentations such as films make deeper impressions on individuals than do presentations by any other media [pp. 121–122]. On the other hand, this study also found that films reached only a small percentage of the population in the area and hence had limited impact in changing attitudes or providing information.

To improve probabilistic perception of hazards, it is essential that complete historical records be kept, analyzed, and made available in a form understandable to resource managers. Technical experts should be taught how to express the future occurrence of hazard in probabilistic terms. Their opinions should then be presented in a format comprehensible to individuals not particularly skilled in probabilistic thinking.28

With respect to the second phenomenon, the agent can improve the awareness of insurance by initiating contact with individuals in hazard-vulnerable areas who have purchased other policies through him. He can inform these people of the availability of flood or earthquake insurance, the rate schedule, and the stated deductible. In the case of flood insurance he should indicate that premiums are subsidized 90 percent by the federal government on all existing homes.29 Commission rates do not encourage such personal contact, for the agent receives an amount proportional to the total premium. For earthquake and flood insurance this is usually only a small sum.

Individuals are also likely to be unaware of the terms of an insurance policy because it is extremely difficult for them to comprehend the "fine print" indicating coverage, deductibles, and exclusions. The insurance industry views a policy as a legal document and thus feels it must protect itself by expressing in

28 See Slovic, Kunreuther, and White [1974] for a more detailed description of other policy implications regarding improving perception of probabilities and losses from natural hazards. The role that a psychological study of decision processes can play in improving societal risk-taking is explored in detail in a very stimulating paper by Slovic, Fischhoff, and Lichtenstein [1976].

29 Owners of homes constructed after the date the community enters the National Flood Insurance program are charged an actuarial rate based on the ground elevation of their house in relation to the river.
writing all possible occurrences. Recently efforts have been made by some companies to rewrite automobile and homeowners policies in simple English, to define explicitly all the appropriate terms, and to print the policy in much larger type. Such policies are now considerably easier to read, but they are still lengthy. Without the agent's help it is still a time-consuming process to understand the conditions of the policy.

Even if the individual is aware of the hazard and the terms of his insurance policy, the evidence from the field survey suggests that few individuals will make their decisions by evaluating the costs and benefits of alternative courses of action. Evidence from the other studies on insurance behavior reinforces these conclusions. In fact it suggests that the consumer views insurance as an investment rather than as a contingent claim. For this reason he is likely to favor policies with the lowest deductible in order to maximize the chance of obtaining a return for his premium. It is interesting to note that an attempt was recently made in Pennsylvania by former State Insurance Commissioner Herbert Denenberg to institute a mandatory deductible of $100 for automobile collision coverage. Although the plan purported to save consumers millions of dollars per year it proved so unpopular that it was eventually rescinded [Cummins et al. 1974, p. 146]. In the same spirit many individuals are attracted to cash-value life insurance policies because they obtain a dividend at the age of 65 years as a bonus for remaining alive.

If most individuals treat insurance as an investment, then one of the principal functions of the agent should be to educate the policyholder that the biggest return on one's policy is not to have any return at all. Unless the homeowner adopts this point of view he is likely to purchase a flood or earthquake policy only after suffering damage, and to cancel his policy several years later because he has not received a return on his investment. Such a process of education is likely to be slow and tedious unless the agent plays an active role.

An alternative means of shifting the cost burden from the public to the private sector would be to require the individual to purchase insurance. The National Flood Insurance program may serve as a prototype for developing a realistic plan to mitigate future disaster losses. In this program subsidized flood insurance
is made available to homes and businesses in a hazard-susceptible area, but only after the community has taken positive steps toward reducing potential losses by adopting permanent land-use measures and building code regulations with effective enforcement procedures. The initiative thus lies with the communities rather than with the federal government. In essence, the federal government helps pay the costs of protecting individuals now residing in hazard-susceptible areas from future disaster losses while at the same time requiring that the communities make these areas safer places in which to live. The subsidized rates are not available to homeowners who build new homes in communities identified as being flood-susceptible because this would in fact encourage further developments in these areas. A program of government reinsurance whereby insurance companies pay a small charge for protection from unusual losses allays the insurance industry’s concern with possible bankruptcy of companies following a severe disaster.\footnote{A more detailed description and evaluation of national flood insurance can be found in Kunreuther [1973b]. A booklet, “Questions and Answers on the National Flood Insurance Program” is available from the Federal Insurance Administration.}

The flood program represents a joint effort by the insurance industry and the federal government to mitigate future flood losses. This plan has been strengthened by several recent pieces of legislation. The Flood Disaster Protection Act of 1973 (PL 93–234) has as its principal provision that no federal financial assistance for acquisition or construction purposes be available to any flood-susceptible community unless it is participating in the flood insurance program. A key provision of the Disaster Relief Act Amendments of 1974 (PL 93–338) is that recipients using disaster assistance to repair or reconstruct public and private non-profit facilities must insure this property against future disaster loss. The federal government has also recently eliminated its liberal disaster relief provisions: PL 93–24 (April 1973) rescinded the $5,000 forgiveness grants available to disaster victims and increased the annual interest rates on SBA loans from 1 to 5 percent; PL 94–68 (August 1975) further raised the SBA loan rate to 6\% percent. There is no guarantee, however, that following a future severe disaster these provisions will be maintained.

The most effective way to minimize the potential pressure for reinstating liberal relief following the next major disaster would
be for the vast majority of the victims to be insured. This can be achieved by having federal agencies, such as the Veterans Administration and Federal Housing Administration, as well as private lending institutions require some form of comprehensive disaster insurance as a condition for issuing a mortgage.\footnote{31} The costs of developing and marketing such a system of insurance may be relatively high in the short run, but the payoff in the long run with respect to the reduction of future disaster losses promises to be enormous.

8. Future Research

Examination of the separate effects of independent variables on the purchase of insurance, as reported in section 6, yields suggestive results but does not make full use of the information present in the survey data. Multivariate analyses will be undertaken to examine the joint effects of several qualitative independent variables (e.g., past experience, discussions with friends or neighbors, education level) and quantitative independent variables (e.g., income, years lived in neighborhood) on a qualitative dependent variable (purchase or nonpurchase of insurance). The most appropriate statistical models for analyzing such data are contingency table analysis, logit regression, and other log-linear models.\footnote{32}

Controlled laboratory experiments will supplement the field survey data analysis in discriminating between the relative merits of the expected utility model and a bounded rationality model. The experiments should enable us to understand better how man's deficiencies in processing information on probabilities and losses affect insurance purchase and cancellation decisions. Some experiments will examine the relative importance of economic parameters (e.g., probability of disaster, insurance premiums, losses) and transaction costs on the insurance purchase decisions. Others will determine what effects such factors as low deductibles, refunding a portion of the premium, and the premium-loss ratio will have on the attractiveness of insurance to an individual.

\footnote{31} Detailed proposals regarding a system of comprehensive insurance are presented in Kunreuther [1968], and in Dacy and Kunreuther [1969].

\footnote{32} The specific procedures we will use are described in Goodman [1972] and in Nerlove and Press [1973].
9. Conclusions

A principal purpose of this paper has been to increase our understanding of the economics of uncertainty by studying the decision-making process of the economic agent. The analyses thus reflect Arrow's concern as illustrated by his quotation at the beginning of the paper.

Preliminary findings from data collected in a field survey of 3,000 homeowners in flood- and earthquake-susceptible areas indicate that many individuals do not have enough information to utilize a contingent claims model based on expected utility theory. Furthermore, a substantial number of those who do have enough information frequently behave in a manner inconsistent with what would be predicted by expected utility theory.

What accounts for this behavior by individuals who face a low probability hazard with potentially large negative consequences? The principal reason appears to be man's difficulty in processing information and making computations. It is thus not surprising to find homeowners basing their insurance decisions primarily on past flood or earthquake experiences or on data provided them by friends and neighbors. The importance of such factors and the lack of importance of economic variable suggests that man utilizes a sequential model of choice in order to simplify his decision-making process. If such a model does in fact describe man's behavior, then we have shown that it implies policy recommendations with respect to protection against low-probability high-loss events that differ from the recommendations suggested by traditional expected utility theory.
**Appendix. Question Eliciting Subjective Estimate of Severe Flood**

In the next few questions, we would like to know your estimates of the chances of a flood causing damage to your home sometime in the future. The following example may be helpful.

(HAND R CARD #3)

126. Using birth and death statistics, it is possible to estimate the number of males born today who will be alive at a certain age. This card shows the chances of males being alive at different ages. For example, 1 out of every 2 male babies will be alive at age 70, while only 1 out of every 100,000 will be alive at the age of 108.

(ALLOW R TO READ CARD #3)

Now, I'd like you to think about the chances of a flood occurring here in the next year.

(SHOW R CARD #4)

Please tell me, one out of how many is your estimate of the chances of a flood occurring in the next year causing *total damage from Q. 124 or $10,000* or more damage to your home. (PROBE FOR AN ESTIMATE)

<table>
<thead>
<tr>
<th>1 OUT OF</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>NUMBER</td>
<td></td>
</tr>
<tr>
<td></td>
<td>50-55</td>
</tr>
<tr>
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<td>999998</td>
</tr>
<tr>
<td>CARD #3</td>
<td>CARD #4</td>
</tr>
<tr>
<td>-------------------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td><strong>CHANCES</strong></td>
<td><strong>CHANCES</strong></td>
</tr>
<tr>
<td>1 out of 1</td>
<td>1 OUT OF 1 (certain to happen)</td>
</tr>
<tr>
<td>1 out of 2</td>
<td></td>
</tr>
<tr>
<td>JUST BORN</td>
<td></td>
</tr>
<tr>
<td>1 out of 5</td>
<td>ALIVE AT AGE 70</td>
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<tr>
<td>1 out of 100,000</td>
<td>ALIVE AT AGE 106</td>
</tr>
<tr>
<td></td>
<td>1 OUT OF 100,000 (almost impossible to happen)</td>
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References


