

Schade, Christian; Kunreuther, Howard; Kaas, Klaus Peter

Working Paper

Low-probability insurance decisions: The role of concern

SFB 373 Discussion Paper, No. 2002,23

Provided in Cooperation with:

Collaborative Research Center 373: Quantification and Simulation of Economic Processes,
Humboldt University Berlin

Suggested Citation: Schade, Christian; Kunreuther, Howard; Kaas, Klaus Peter (2002) : Low-probability insurance decisions: The role of concern, SFB 373 Discussion Paper, No. 2002,23, Humboldt University of Berlin, Interdisciplinary Research Project 373: Quantification and Simulation of Economic Processes, Berlin,
<https://nbn-resolving.de/urn:nbn:de:kobv:11-10048813>

This Version is available at:

<https://hdl.handle.net/10419/65339>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

Low-Probability Insurance Decisions: The Role of Concern

Christian Schade[°]

Howard Kunreuther[♦]

Klaus Peter Kaas^{*}

Reviewed and approved by Uwe Kuechler (B2) and Sabine Kroeger (C5).

Financial support of the German Research Foundation (DFG SFB 373) is gratefully acknowledged.

-
- [°] Professor Christian Schade is Director of the Institute for Entrepreneurial Studies and Innovation Management, School of Business and Economics, Humboldt-Universität zu Berlin, Germany, email: schade@wiwi.hu-berlin.de
- [♦] Professor Howard Kunreuther is Director of the Risk Management and Decision Processes Center, Wharton School, University of Pennsylvania, Philadelphia, USA, email: kunreuther@wharton.upenn.edu
- ^{*} Professor Klaus Peter Kaas, Marketing Department, Faculty of Business and Economics, Goethe-University, Frankfurt/M., Germany, email: kaas@marketing.uni-frankfurt.de

Low-Probability Insurance Decisions: The Role of Concern

On the basis of a real high stakes insurance experiment with small probabilities of losses, we demonstrate that concern is a more important driver of WTP for insurance than subjective probability estimates when there is ambiguity surrounding the estimate. Concern is still important when probabilities are exactly given. It also helps explaining the low probability insurance “puzzle” well known from the literature, where a part of individuals pays too much and a part nothing for coverage, a result we are able to replicate. In our experiment, belonging to either the group of “threshold persons” or to those that pay far too much, is not related to probability judgments but to the degree an individual is concerned in our decision situation.

Introduction

Imagine you are facing a risk that is characterized by a very small probability of occurrence; but if it occurs, the damage caused to your wealth level will be substantial. Examples of such risks are floods and earthquakes, as well as fire, theft, and certain diseases. How would you behave if you were offered insurance coverage against such a risk? Would you try to estimate the probability as precisely as possible and multiply this figure by the potential loss to arrive at the *expected value* of the loss? Would you transform your wealth levels into utility levels with and without the potential loss as implied by so called normative models of decision making? What role would affect or emotional factors play in your decision such as worry or concern with respect to specific outcomes?

The decision process with respect to protecting oneself against low-probability high consequence events has been a puzzle to economists and other social scientists since Kunreuther et al.'s (1978) field studies and Slovic et al.'s controlled laboratory experiments on insurance against natural disasters.¹ In a more recent controlled experiment McClelland et al. (1993) showed that individuals either pay zero for low-probability insurance, or they pay far too much – when compared to expected loss ($E(\text{loss})$). How can these findings be explained?

Most earlier studies in decision making including the above-mentioned, focused on explaining deviations from the predictions derived from normative models of choice such as (subjective) expected utility theory (Savage 1954; von Neumann and Morgenstern 1947). Only recently has behavioral decision theory concerned itself with the enormous impact that affect and emotion have on decision making with respect to protective measures (see e.g. Hogarth and Kunreuther 1995; Baron et al. 2000; Hsee and Kunreuther 2000; Rottenstreich and Hsee 2001; Slovic et al. 2001; Loewenstein et al. 2001; Schade and Kunreuther 2002). Affect and

emotions seem to especially influence decisions involving uncertain outcomes with large consequences (Slovic et al. 2001; Loewenstein et al. 2001). The so-called affect heuristic (Slovic et al. 2001) may lead people to undertake protective measures, even if the chances of disaster are extremely low.

This paper analyzes how individuals' willingness to pay (WTP) for insurance for real high-stakes decisions is related to either calculations based on probabilities and/or affective factors such as a person's *concern* regarding the outcome. We use concern as a synonym for *how worried* a person is in our decision situation; worry, in turn is defined as the cognitive part of anxiety (for details see the discussion section and the more thorough treatment in Schade and Kunreuther 2002). We examine these issues through a controlled experiment using an incentive-compatible, real payments mechanism. The probabilities of a loss are very low (e.g. 1 in 10,000) and are either specified precisely, or there is ambiguity by the subjects regarding the estimate (i.e., number of rainy days in a particular city during a prespecified time period).

Our results are first of all consistent with earlier findings. A substantial percentage of individuals pay nothing for insurance, whereas most others specify WTP that are considerably in excess of the expected loss. We furthermore demonstrate that concern is a more important driver of WTP for insurance than subjective probability estimates when there is ambiguity surrounding the estimate. Concern is still important when probabilities are exactly given. Our paper thus provides additional evidence for the impact of emotional factors as drivers of choices under risk and ambiguity. One reason for the bimodality of WTP can be identified in differences in individuals' concern with respect to the possibility of a negative outcome.

¹ For a recent overview of research findings and open questions in the more general field of high stakes decision making see Kunreuther et al. (2002).

The paper is organized as follows. Section B offers a detailed explanation of our experimental design. Section C reports on our results. Section D contains a general discussion. Section E suggests the prescriptive implications of our findings.

Experimental design and sample

Sample

A total of 263 students from Johann Wolfgang Goethe-University, Frankfurt/M., Germany participated in the experiment. They were recruited via email, announcements in the main University building, and short presentations in classrooms. They were told that the experiment would take 90 minutes, that all participants would receive 10 DM for sure, and that there was a small chance (not specified) that they would earn 2.000 DM at the end of the experiment. The experiment was carried out in April and May 1999 in groups of six to ten students each of whom was situated in a separate booth. Nine of the 263 subjects had to be excluded because of nonsensical responses.^{2,3}

² Of the 254 usable responses, 54.5% were female, 45.5% male. The largest groups were psychology (29.9%) and business (28.7%) majors followed by economics (5.1%), pedagogic sciences (4.7%), law and German (each group 3.9%), and sociology (3.5%) students. The remaining 20.3% of the subjects were majoring in 18 different fields of study. The average age of the participants was 25.6.

³ Subjects were excluded from the analysis mostly because they wanted to pay more for insurance than the value of the object to be insured – an (inherited) painting or sculpture (see below) – or because they clearly misunderstood the experimental situation (derived from open-ended questions) i.e. assumed there were paying for the (inherited) painting (or sculpture) rather than the insurance policy.

Basic features and experimental conditions

Objects at stake: Participants were told that they had inherited either a painting or a sculpture and received a small picture of the art object with an individual identification number. It was announced that only one painting or sculpture was an original, worth 2,000 DM; if it was a forgery then it had zero value. All participants learned that one person in the experiment would have the original art object. This individual would be determined by a random draw.

Nature of the risks, experimental conditions, and timing: The original painting or sculpture was threatened by fire and theft. Participants were offered insurance protection against the potential loss of 2,000 DM. It was made clear that the insurer would only sell a policy to the owner of the original, and that insurance purchased by others would be hypothetical. In other words only the owner of the original *actually would have to pay for the policy*. We made it clear that it was in everyone's best interest to anticipate being the owner of the respective original when determining the maximum amount they would be willing to pay for an insurance policy. In addition to providing written instructions a diagram was presented to subjects describing the key variables and the decisions they had to make. All questions were answered, and the procedure was explained again whenever necessary. The instructions are available on request.

In *part A* of the experiment each participant inherited a painting. The original was threatened by the following ambiguous risk: the painting was declared to be stolen if it would rain exactly 23 days in July 1999 at the Frankfurt Airport; fire occurs and destroys the painting if it would rain exactly 24 days in August.⁴

⁴ Students were informed that a day is defined as a rain day by the weather station in Frankfurt if there is more than one millimeter of rain that day.

We define *ambiguity* as a state of mind in which the *decision maker* perceives difficulties in estimating the relevant probabilities.⁵ Whereas rain frequencies may precisely be estimated by meteorologists, they will be ambiguous for most if not all the participants in the experiment. This situation was designed to resemble a real life risk (e.g. of a fire or theft in ones home) where insurers estimate annual loss probabilities across all policyholders but the individual homeowner views these risks as ambiguous.

On the basis of actual Frankfurt weather data from the year 1870 to the present, we estimated the probability of each of these events occurring to be approximately 1 in 10,000.⁶ In Group 1, respondents were informed about both hazards threatening the original painting: theft and fire but were not told the chances that either theft and/or fire would occur except that it was equal to the chance of the above rain frequencies in July and August in Frankfurt. Respondents were then asked to state their maximum WTP first for theft insurance and then for fire coverage.

Group 2 differed only in that respondents were asked to state their maximum WTP for one insurance policy covering both fire and theft damage. Risks were however still presented separately. In Group 3 respondents were informed that the risk of theft was based on 23 rainy days in July. They then had to state their maximum WTP for theft insurance before undergoing the same procedure with respect to the risk of fire (based on 24 rainy days in August).

In *part B* of the experiment the participants in Groups 1 and 2 were subject to the same treatments as in Part A. The only difference was that the sculpture (instead of the painting)

⁵ Ambiguity is defined as a subjective phenomenon in the spirit of recent work on comparative ignorance by Fox and Tversky (1995) and Fox and Weber (1999).

⁶ Rain frequencies were analyzed for consistency with different distribution forms for random events, e.g. normal, binomial. Rain frequencies were consistent with a Poisson distribution (KS-test of deviation: n. s.). Lousy weather like this was fortunately never experienced in the period from 1870 to today in Frankfurt.

was threatened by theft and fire, each of which was specified as having a probability of 1 in 10,000 of occurring. To determine whether a fire occurred two random draws with replacement were taken from a bingo cage containing 100 balls. The same procedure was followed to determine whether a theft occur.⁷ Group 3 had a 1 in 10 ambiguous chance of either fire or theft in part B. (i.e., theft occurs if there is rain during exactly 11 days in July; fire occurs if there is rain during exactly 12 days in August). We used this relatively high value to see whether or not there were differences in people's decision processes between this situation and the case where the probability was 1 in 10,000. The experimental design is depicted in Table 1.

Note that the ambiguous low-probability situation is always presented first. If we had presented the exact probabilities scenario to some of the respondents, first, they might have utilized an anchoring and adjustment procedure potentially distorting our results on ambiguity, i.e. they might have judged the ambiguous probability to be somewhat "close" to the exact probability. Not counterbalancing the order of the treatments may however not be judged a limitation, here. There was no feedback at all between parts A and B of the experiment so that respondents could not learn anything for their decision in B from the situation presented in A.

INSERT TABLE 1 HERE

⁷ A theft or fire was assumed to occur if the number 1 was pulled out twice from the bingo cage.

Eliciting WTP for insurance: There were no fixed selling prices for the insurance policies. Instead, we utilized a modified Becker, DeGroot and Marshak (BDM) (1964) mechanism for eliciting maximum WTP values. In the original BDM-procedure, respondents face a random draw of selling prices for the respective object and are informed about the distribution of these prices. In theory it is incentive-compatible to state prices being equal to reservation prices under these conditions but there are practical problems in utilizing this method (Becker, DeGroot, and Marshak 1964). When utilizing the standard BDM procedure for eliciting reservation prices for single-stage lotteries, decision makers may already apply the reduction axiom without obeying to the independence axiom – they may kind of mix up the two lotteries of the mechanism and the respective good (see Safra, Segal, and Spivak 1990). Further criticism addresses the influence of given intervals on WTP of respondents in the original BDM (Bohm, Lindén, and Sonnegard 1997). We thus resorted to a procedure where the actual selling prices for each of the insurance policies were put in sealed envelopes to be opened after the experiment. The secret price was, in fact, picked before the start of the experiment using pretest results, so that about one half of the respondent's bids could be expected to be higher than that price. For a more detailed description of the price mechanism see Schade and Kunreuther (2002). A proof of the incentive compatibility of this mechanism is available on request.

The mechanism was carefully explained to the subjects so that they understood why it was designed to elicit their maximum buying prices. We explained that if they bid too high they may actually pay that price if they are the owner of the original painting and they might regret that they had made this offer. If they bid too low they may not qualify for any insurance even though they would have been willing to purchase coverage at a higher price than their stated value. Respondents were then asked to write on a prepared form their maximum buying price for the respective insurance policy and put the form in an envelope.

Eliciting subjective probability estimates: After stating maximum buying prices for insurance, respondents were asked to estimate the probability of each of the ambiguous risks. We distributed tables with likelihoods of a loss ranging from certainty to 1 in 10,000,000. We utilized a two-stage-approach: Respondents were first asked to place the probability of a fire or theft causing a loss in one of 15 intervals (e.g. the chance was between 1 in 5,000 and 1 in 10,000). Respondents could also state that the risk was less than 1 in 10,000,000. After they checked one of the intervals, they were then asked for their exact estimate. The probability table is included in the Appendix.

Results and Interpretation

Basic Considerations

Participants in the experiments appear to behave in a manner that is inconsistent with normative models of choice such as subjective expected utility theory. We begin with an analysis of the overall distribution of WTP for insurance for ambiguous and well-specified loss probabilities. We continue with an analysis of the impact of subjective probabilities and individuals' concern on their choices.

Distribution of WTP: Inconsistent with Expected Utility Maximization

To determine the proportion of subjects' estimates of maximum WTP consistent with expected utility maximization, we divided the responses into three groups: (1) $WTP = 0$, (2) responses consistent with expected utility maximization: $0 < WTP \leq 10 E(\text{loss})$, and (3) $WTP > 10 E(\text{loss})$. The last group would have to be extremely risk averse to be consistent with an

expected utility model. $E(\text{loss})$ is approximately 0.40 DM in our experiment.⁸ Therefore the cutoff point between intervals (2) and (3) is 4.00 DM. The findings for ambiguous and well-specified loss probabilities are reported in table 2.

	WTP = 0 ¹⁾	0 < WTP ≤ 4 DM ²⁾	WTP > 4 DM ²⁾			
	Percentage	Percentage	Percentage	μ	σ	$\mu/E(\text{Loss})$
Ambiguity (groups 1A and 2A; n = 168) ³⁾	17.3 %	1.7 %	81 %	235 DM ²⁾	310 DM	588
Exact p's (groups 1B and 2B; n = 168) ³⁾	35.1 %	7.8 %	57.1 %	126 DM ²⁾	198 DM	315

- 1) Persons having a WTP = 0 for both theft and fire insurance or bundled insurance.
- 2) WTP was elicited separately for theft and fire insurance in groups 1A and 1B and than added, in groups 2A and 2B WTP was elicited for a bundled insurance against fire and theft in the first place. Groups were collapsed since they did not differ significantly (p-level (MWU): .11, two-sided).
- 3) Groups 3A and 3B are disregarded, here: 3B was not comparable because of a much higher probability of the loss and a different experimental procedure as compared to 3A.

Table 2: Distribution of WTP for insurance

Most respondents either do not want to pay anything for insurance or are willing to pay incredibly high premiums. In the large group of individuals having a WTP greater than 10 times $E(\text{loss})$, the mean premium is approximately 588 times the $E(\text{loss})$ if probabilities are ambiguous and approximately 315 times the $E(\text{loss})$ if probabilities are known exactly. Most respondents' behavior thus appears to be *highly inconsistent with expected utility [E(U)] theory*.

⁸ The exact value is 0.39998 DM since the total probability of the loss is 0.00019999 or 1 in 5000.25.

Note that respondents are willing to pay more than twice the premium for coverage if the probability information is ambiguous rather than well-specified. Although 17.3 percent of those given ambiguous probability information had $WTP = 0$, this figure more than doubles to 35.1% when the probabilities are precise. Both these differences in absolute WTP as well as the proportion who were unwilling to pay anything for insurance differ significantly between ambiguous and precise probabilities (p-value (Wilcoxon): .000; for both comparisons).

Turning to respondents in Groups 1 and 2 who specified $WTP = 0$ we can analyze within subjects whether their responses differed when they were presented with ambiguous and exact probabilities. Each individual can only be situated in one of the four cells of table 3: $WTP = 0$ for ambiguous and exact probabilities; $WTP = 0$ for ambiguous probabilities and $WTP > 0$ for exact probabilities, $WTP = 0$ for exact probabilities and $WTP > 0$ for ambiguous probabilities and $WTP > 0$ in both situations.

		Exact probabilities		
		WTP=0	WTP >0	Σ
Ambiguity	WTP = 0	28	1	29
	WTP > 0	31	108	139
	Σ	59	109	168

Table 3: $WTP = 0$ on an individual level

As shown in Table 3, approximately twice as many individuals (59 versus 29) do not want to pay anything for insurance if the risk is precisely specified than if the risk is perceived to be ambiguous. Furthermore, only one person with $WTP = 0$ for an ambiguous risk has a positive WTP for insurance with exact probabilities. The other 28 individuals in this group specify $WTP = 0$ for the risk with exact probabilities. On the other hand, 31 of the 59 individuals with $WTP = 0$ for an exact probability specify a $WTP > 0$ if the risk is ambiguous. Stated another

way, having a positive WTP with exact probabilities implies (with one exception) having a positive WTP with ambiguous probabilities; if, on the other hand, $WTP > 0$ when the risk is ambiguous does not imply having a positive WTP with exact probabilities. This seems to suggest that respondents have a clear tendency to be *ambiguity averse*. We will however deal with this finding in more detail in the discussion section.

Impact of Loss Probabilities versus Concern on WTP for Insurance

The results presented for exact probabilities are inconsistent with standard E(U) theory. Individuals should be willing to pay something for insurance but not hundreds of times the expected losses. With ambiguous probabilities, one could argue that people misestimate the loss probabilities so as to be consistent with E(U) models. In fact, 88.7% of the respondents reported subjective probability estimates higher than the total loss probability of 1 in 5,000. But E(U) models cannot explain $WTP=0$, since a person should be more concerned with purchasing insurance at some positive price as his subjective probability estimate of a loss increases.

As we will now demonstrate, the qualitative factor, *concern*, turns out to be a more powerful predictor of WTP than the quantitative estimates of the risk of a loss when the probability is ambiguous. This could be expected on the basis of findings from another experiment where individuals who had a greater tendency to worry generally had a higher WTP for protection (see Schade and Kunreuther 2002). All subjects were asked the following simple question, separately for parts A and B of the experiment:

“How concerned have you been with respect to losing the painting (sculpture)?”

Answers had to be provided on a 10-point rating scale with 1=“not concerned at all”, to 10=“very concerned”.

Respondents' answers to the concern question and their subjective probability estimations are not correlated (BP: .073 (p-level: .359); KW: .087 (p-level): 122). We ran an OLS regression with *probability estimates* and *concern* as the independent variables and *WTP* as the dependent variable. We are able to explain more than 14% of the variance in *WTP* with this model (adjusted r-squared: 14.2%). Both independent variables significantly contribute to the model. The p-level of the *concern* variable is .000, the p-level of the *probability estimates* variable is .002. *Concern* is the stronger variable explaining some 9.7% (adjusted r-squared) alone, but the model with two independent variables is significantly better than the single variable model (significant F change; p-level: .003).⁹

To illustrate the effect of concern, answers are now grouped as follows: 1: no concern, 2-5: low concern, 6-9, high concern, 10: very high concern. Of the 168 respondents in this group, 19% belonged to the no concern group, 42.9% to the low concern group, 31.5% to the high concern group, and 6.5% to the extremely concerned group. Table 4 reports on mean WTP for each of in these subgroups.

⁹ Since the WTP distribution is skewed with a large number of subjects having a WTP = 0, we in addition ran an ordinal regression using SPSS GOLDmineR 2.0. The picture came out to be the same with both variables significantly contributing to the explanation of WTP and concern being the stronger variable.

	Mean WTP for insurance (ambiguity)
Concern:	n=168
No/Very low	101.58
Low	119.64
High	277.60
Extremely/Very high	494.55
ANOVA: F-value (sig., 2-sd.)	8.96 (.000)
Kruskal-Wallis tests	.000

Table 4: Impact of concern on choice with ambiguity

WTP differs considerably across concern groups and more concern implies a higher WTP.

How do probability estimates and concern differ between those who want to pay a positive price for insurance and those who do not want to pay anything for protection? The results are presented in table 5. Those who indicate $WTP > 0$ have higher levels of concern than those whose $WTP = 0$ and the difference is statistically significant at the .000 level. There is no significant difference at the 5 % level between the probability estimates for those whose $WTP = 0$ and those with $WTP > 0$. Thus concern is even more important in explaining why $WTP = 0$ for some individuals than when one looks at the entire distribution of responses.

	Concern Means	Probability estimations Means
WTP = 0	3.05	.079
WTP > 0	5.37	.070
Total	4.55	.073
ANOVA: F-value (sig., 2-sd.)	28.45 (.000)	.18 (.673)
MWU tests	.000	.393

Table 5: Concern and probability estimations for WTP = 0 versus positive WTP

Objective differences of ambiguous probabilities: What is the effect if we increase the ambiguous probability of a loss by a factor of approximately 950? To address this question, Group 3B was presented with two weather scenarios in Frankfurt which had much higher probabilities than the previous ones. The probability for fire was 1 in 10 and for theft 1 in 10 as well. Hence the probability of losing the sculpture was approximately 1 in 5.26 or 19%.^{10,11} By comparing 1A and 2A with 3B we can examine whether increasing the probability by these large magnitudes had an impact on WTP, concern, and subjective probability estimations? The differences in mean values for each of these estimates are reported in table 6. Again, there is only a relatively small correlation between concern and probability estimates (BP: .084 (p-level: .19); KT: .083 (p-level: .067)¹²).

¹⁰ This results from the probability calculus with disjoint events.

¹¹ Note that the high probability condition also differs in that it was presented in the second part of the experiment rather than the first as was the case with the small probabilities. We however do not think that this is much of an issue since there was no feedback on either success in getting the insurance policies nor the outcome of the risk before the respondents entered the second part of the experiment.

¹² Note that the non-parametric coefficient is significant in a one-sided test. Such a test is appropriate since the direction of the relationship (more concern should be related to higher probabilities) is obvious.

The findings do not square with predictions by models of choice where risk estimates play the central role. Despite the fact that the subjective probability estimates in the two cases differ significantly, neither WTP for insurance nor level of concern differ by very much from the previous experiments. We have shown above that concern appears to be the dominant driver of WTP. Since individuals' concern is not much higher for Group 3B than Groups 1A and 2A, even though the loss probability is about 950 times larger, it is not surprising that mean WTP is approximately the same for both groups. Even though the subjective probability estimates are more than twice as high for Group 3B than Groups 1A and 2A, it has little impact on the mean WTP difference between the two groups. In fact, the slight increase in WTP could be attributed primarily to the slightly higher level of concern than the increase in probability of a loss.

Means:	Ambiguity with low probabilities of 1 in 5,000.25 (groups 1A and 2A) N = 168	Ambiguity with high probabilities of 1 in 5.26 (group 3B) N = 86	ANOVA (F-value, sig., 2-sided) MWU tests
WTP	190.58	213.68	.350 (.555) .392
Concern	4.55	5.06	1.799 (.181) .147
Probability estimates	.073	.164	15.133 (.000) .000

Table 6: Ambiguous probabilities objectively differing with a factor of approximately 950;
impact on WTP, concern and probability estimations

Impact of concern with precise probabilities: One could argue that concern is only important if probabilities are ambiguous. If this would be the case, concern should lose its impact if exact probabilities are provided. This interpretation can be ruled out according to the results reported in table 7 where we see that the greater the concern the higher is WTP (analysis based on groups 1B and 2B).¹³ Concern also differs significantly between the groups with WTP = 0 and WTP > 0. If WTP > 0, concern is much higher (mean: 5.08) then if WTP = 0 (mean: 2.85) (p-value (ANOVA), two-sided: .001; MWU, two-sided: .000).

¹³

Three values are missing since the respective respondents did not report on their concern.

	Mean WTP for insurance (exact probabilities)
	Concern n=165
No/Very low	7.07
Low	53.76
High	148.47
Extremely/Very high	236.25
ANOVA: F-value (sig., 2-sd.)	9.621 (.000)
Kruskal-Wallis tests	.000

Table 7: Impact of concern on choice with exact probabilities

General Discussion

In this section, we briefly address the following key issues that arise from our findings.

(1) How should one interpret *concern* using a decision theoretic framework and why is it so strong? (2) Why are individuals paying much more for insurance when probabilities are ambiguous?

With respect to the first question, we would like to suggest that *concern might be viewed as an emotional probability estimate*. Concern is “easier” than probabilities since it comes to mind without one having to calculate. This may especially be important with low probabilities since individuals have a hard time understanding their meaning (Kunreuther, Novemsky, and Kahneman 2001).

With respect to the second question, individuals seem to exhibit a strong aversion to ambiguous rather than precise probabilities. Part of this effect may result from probability

estimates being in general too high in our experiment compared to the objective rain probabilities. More specifically the median judged probability for the occurrence of the ambiguous loss was about 120 times greater than the objective risk (1 in 42 instead of 1 in 5000). Consequently, WTP must also be higher than when one uses precise estimates. Note however, that individuals only pay twice as much when risks are ambiguous than when they are precise. But probability alone only accounts for 5.5% of the variance in WTP. We conclude that ambiguity is just perceived as “something aversive” and leads to a much higher WTP than for the case where probabilities are given precisely. Decision makers may feel that a risk is somehow “less predictable” with ambiguity and this generates concern on their part.

Implications

Our study demonstrates that for low probability high consequence events, concern plays a significant role in determining WTP for insurance. Rather than trying to explain bimodal distributions of WTP on the basis of estimates in the “probability of loss”, one can turn to “concern” as the critical variable. A concerned decision maker is willing to pay much for insurance than one who is unconcerned about the outcomes. Our findings suggest that insurers can charge a premium considerably in excess of expected loss when probabilities are extremely low and still generate considerable demand for coverage. Interest in terrorism insurance coverage at extremely high prices supports this finding. (General Accounting Office 2002). Insurers may also want to take advantage of the fact that ambiguous probabilities lead to higher WTP than well-specified estimates. This may be a principal reason why one rarely learns about the chances of making a claim at the time one purchases a policy.

Future research may want to address the following fascinating issues. Is it just concern and subjective probabilities that count or are there other qualitative variables that also impact on

WTP for low probability insurance? How pervasive a role concern plays when probabilities as well as losses are varied, when we are e. g. analyzing high probability low consequence events? A recent paper of Schade and Kunreuther (2002) demonstrates that at least a person's *tendency* to worry has much of an impact also on behavior with a precise loss probability of 1 in 6. But certainly more research is necessary, here. Finally, can our findings be generalized to other low probability high consequence events such as health risks and ecological risks? Are threshold decisions here also related to the degree of concern of the respective individual in the decision situation?

References

- Baron, J., Hershey, J. C. and H. Kunreuther (2000): Determinants of priority for risk reduction: The role of worry, in: *Risk Analysis*, Vol. 20, No. 4, pp. 413-427.
- Becker, G. M., DeGroot, M. H. and J. Marschak (1964): Measuring Utility by a Single-Response Sequential Method, in: *Behavioral Science*, Vol. 9, pp. 226-232.
- Bohm, P., Lindén, J. and J. Sonnegard (1997): Eliciting reservation prices: Becker-DeGroot-Marschak mechanisms vs. markets, in: *Economic Journal*, Vol. 107, No. 443, pp. 1079-1089.
- Einhorn, H. and R. M. Hogarth (1985): Ambiguity and Uncertainty in Probabilistic Inference, in: *Psychological Review*, Vol. 92, pp. 433-461.
- Fox, C. R. and A. Tversky (1995): Ambiguity Aversion and Comparative Ignorance, in: *Quarterly Journal of Economics*, Vol. 110, pp. 585-603.
- Fox, C. R. and M. Weber (1999): Ambiguity Aversion, Comparative Ignorance, and the Role of Context, Working Paper # 99-47; DFG-Sonderforschungsbereich 504, University of Mannheim, Germany.
- General Accounting Office (2002.) "Terrorism Insurance: Rising Uninsured Exposure to Attacks Heightens Potential Economic Vulnerabilities" Testimony of Richard J. Hillman Before the Subcommittee on Oversight and Investigations
- Hogarth, R. and H. Kunreuther (1995): Decision Making under Ignorance: Arguing with Yourself, in: *Journal of Risk and Uncertainty*, Vol. 9, pp. 15-36.
- Hsee, Ch. and H. Kunreuther (2000): The affection effect in insurance decisions, in: *Journal of Risk and Uncertainty*, Vol. 20, No. 2, pp. 141-159.
- Kunreuther, H., Ginsberg, R., Miller, L., Sagi, P., Slovic, P., Borkan, B. and N. Katz (1978): Disaster Insurance Protection; Public Policy Lessons, New York et al.
- Kunreuther, H. et al. (2002): High Stakes Decision Making: Normative, Descriptive and Prescriptive Considerations, forthcoming: *Marketing Letters*.
- Kunreuther, H., Novemsky, N. and D. Kahneman (2001) „Making Low Probabilities Useful“ , in: *Journal of Risk and Uncertainty*, Vol. 23, No. 2, pp. 103-120.
- Loewenstein, G., Weber, E., Hsee, C. and Welch, N. (2001): Risk as Feelings, in: *Psychological Bulletin*. 127, pp. 267–286.
- McClelland, G. H., Schulze, W. D. and D. L. Coursey (1993): Insurance for Low-Probability Hazards; a Bimodal Response to Unlikely Events, in: *Journal of Risk and Uncertainty*, Vol. 7, pp. 95-116.
- Rottenstreich, Y. and Ch. Hsee (2001): Money, kisses, and electric shocks: On the affective psychology of risk, in: *Psychological Science*, Vol. 12, No. 3, pp. 185-190.
- Neumann, J. von and O. Morgenstern (1947): *Theory of Games and Economic Behavior*, 2nd ed., Princeton. (Deutsch: *Spieltheorie und wirtschaftliches Verhalten*, Würzburg 1961.)
- Safra, Z., Segal, U. and A. Spivak (1990): The Becker-DeGroot-Marshak Mechanism and Nonexpected Utility; a Testable Approach, in: *Journal of Risk and Uncertainty*, Vol. 3, pp. 177-190.
- Savage, L. J. (1954): *The Foundations of Statistics*, New York et al..
- Schade, Ch. and H. Kunreuther (2002): Worry and the Illusion of Safety: Evidence from a Real-

Objects Experiment. Discussion Paper Nr. 25, SFB 373, Humboldt-Universität zu Berlin.

Slovic, P. et al. (1978): Controlled Laboratory Experiments; Chapter in H. Kunreuther et al. (1978): Disaster Insurance Protection: Public Policy Lessons, New York et al., pp. 165-186.

Slovic, P. et al. (2001): The Affect Heuristic, in: T. Gilovic, D. Griffin, and D. Kahneman (eds.): Intuitive Judgment: Heuristics and Biases, Cambridge University Press, in press.

Appendix

A1: Probability table

Please report how probable you have judged „exactly 24 rain days in July“ occurring. Please check an interval that covers the probability you are judging to be correct first. Afterwards please report the exact probability in the right column.

Explanation: A chance of 1 in 1.000.000 implies that a July with exactly 24 rain days occurs – on average – every 1.000.000 years.

Chance: 1 in	Please check:	Exactly:
1 to 5		1 in
5 to 10		1 in
10 to 50		1 in
50 to 100		1 in
100 to 500		1 in
500 to 1.000		1 in
1.000 to 5.000		1 in
5.000 to 10.000		1 in
10.000 to 50.000		1 in
50.000 to 100.000		1 in
100.000 to 500.000		1 in
500.000 to 1.000.000		1 in
1.000.000 to 5.000.000		1 in
5.000.000 to 10.000.000		1 in
Less probable		Exactly 1 in

		Within-subjects	
		Part A of experiment: inherited painting	Part B of experiment: inherited sculpture
Between-subjects	Group1 (n=87)	Rain frequencies in July and August each with probability of 1 in 10,000 ; separate insurance policies for each of the risks	Two precise risks each with probability of 1 in 10,000 ; separate insurance policies for each of the risks
	Group 2 (n=81)	Rain frequencies in July and August each with probability of 1 in 10,000 ; one insurance policy for both risks	Two precise risks each with probability of 1 in 10,000 ; one insurance policy for both risks
	Group 3 (n=86)	Rain frequencies in July and August each with probability of 1 in 10,000 ; insurance against first risk sold before second risk mentioned	Rain frequencies in July and August each with probability of 1 in 10 ; separate insurance policies for each of the risks

Table 1: Experimental design