Leiter, Andrea M.; Pruckner, Gerald J.

Working Paper

Proportionality of willingness to pay to small changes in risk: The impact of attitudinal factors in scope tests

Working Papers in Economics and Statistics, No. 2007-30

University of Innsbruck

Working Papers
in
Economics and Statistics

Proportionality of willingness to pay to small changes in risk - The impact of attitudinal factors in scope tests

Andrea M. Leiter and Gerald J. Pruckner

2007-30

Proportionality of willingness to pay to small changes in risk – The impact of attitudinal factors in scope tests

Andrea M. Leiter[1] **Gerald J. Pruckner**[2]

November 2007

[1]Department of Economics and Statistics, University of Innsbruck, Universitätsstraße 15, A-6020 Innsbruck, Austria, email: andrea.leiter@uibk.ac.at

[2]Department of Economics, University of Linz, Altenbergerstraße 69, A-4040 Linz, email: gerald.pruckner@jku.at

This research was funded by alpS GmbH - Center for Natural Hazard Management, Innsbruck, Austria.

We would like to thank Anna Alberini, Katrin Bernath, Michael Pfaffermayr, Magdalena Thöni and seminar participants at the University of Zürich for helpful comments.

Abstract

Sensitivity (proportionality) of willingness to pay to (small) risk changes is often used as a criterion to test for valid measures of economic preferences. In a contingent valuation (CV) study conducted in Austria, 1,005 respondents were asked their willingness to pay (WTP) for preventing an increase in the risk of being killed in an avalanche of 1/42,500 and 3/42,500 respectively. WTP for the higher variation in risk is significantly greater than WTP for the lower risk change. We find evidence that those respondents who have had personal experience of avalanches in recent years combine the information about future risk increase – as provided in the survey – with the observed number of fatal avalanche accidents in the past. Proportionality of WTP holds if such prior experience is taken into account and if attitudinal factors in scope tests are controlled for.

Keywords: Contingent valuation, willingness to pay, scope test, sensitivity of WTP.

JEL classification: D81, J17, Q54.

1 Introduction

Contingent Valuation (CV) estimates are based on individual valuations of hypothetically provided goods. One possible instrument for collecting information about individual preferences is the maximum amount of money a consumer is willing to give in favor of obtaining the good in question. As the real choice and behaviour cannot be observed, the validity of CV estimates is often challenged. There are two main interpretations of CV values. According to the psychological point of view, WTP and the corresponding monetary values represent another scale for articulating one's attitude toward a specific good. Kahneman, Ritov, Jacowitz & Grant (1993) allude to a "contribution" model, in which individual responses to CV questions are to be interpreted as willingness to support goods that are seen as eligible. In contrast, economists act on the assumption of a "purchase" model, in which WTP is an expression of how much a good or service is worth to the individual. It is hypothesized that respondents report a monetary value that indicates indifference between two situations: either they pay a certain amount and obtain the good or they forgo consumption in the absence of any financial contribution.

Within the economic framework, an important criterion of (economic) preferences necessitates sensitivity of WTP to important factors such as the quantity or quality of the good in question. For the valuation of mortality risks, it therefore follows that WTP has to be larger for larger risk reductions. WTP values for risk changes are used to calculate the value of statistical life (VSL). The VSL describes the rate at which individuals are willing to relinquish money for an infinitesimal reduction in risk. The crucial point is by how much WTP increases when mortality risk decreases and how these changes influence VSL.

Using Austrian survey data about people's WTP for protective avalanche measures, this issue will be empirically analysed in this paper. We focus on two questions, examining (1) whether our WTP estimates to prevent fatal avalanche accidents are sensitive to scope and, if so, whether they are proportional to the degree of risk change; and (2) whether psychological factors influence sensitivity of WTP.

Regarding our research question (1), several papers discuss the expected outcome of scope tests. Jones-Lee (1974) shows that the marginal value of a decrease in risk increases with initial risk and initial wealth/income. Hammitt (2000) concludes that even though the VSL is not constant but depends on income and baseline risk, under the standard models of decision-making (see Section 2.4) both effects should be small. This is the case if the money spent on buying an infinitesimal risk reduction represents a small fraction of income (or if the income elasticity is low) and if the corresponding risk change is only modest in comparison to the individual's total survival probability. Nearly constant VSL figures are associated with near proportionality of WTP to (marginal) variations in mortality risks.

Hammitt & Graham (1999), however, examine CV studies on the reduction of health risk and show that many WTP estimates are unreasonably insensitive to the underlying risk variation. The reasons for the insensitivity of WTP to scope, as stated by the authors are: (i) the expected utility theory may not represent the proper model for the individual valuation process; (ii) respondents do not understand (small) probabilities of hazardous events; and (iii) individual estimates are not based solely on the information provided in the survey, but also on prior experiences/beliefs.[1]

Regarding (ii), the authors also hold poor study design responsible for the lack of sensitivity to probabilities, and recommend improving CV methods for communicating small risk changes. Corso, Hammitt & Graham (2001) take up this recommendation and examine the effects of visual aids in communicating risks. They find that WTP figures are sensitive to the degree of mortality risk reduction when visual aids are used. Thus, they conclude that the use of appropriate methods for communicating risk variations will lead to valid estimates of WTP.

The argument in (iii) refers to situations of Bayesian learning where respondents update their prior beliefs using available sources of information. In their seminal paper, Viscusi & O'Connor (1984) analyse how

[1]Assuming the appropriateness of expected utility theory for modelling consumer preferences, we focus on the understanding of probability measures and on the role of prior information in this study.

workers learn about risks on the job and how these changes lead employees to revise their reservation wages. Several more recent studies have validated the Bayesian learning hypothesis. Chang & Just (2007) estimate the impact of health information provided by the popular media on the consumption of eggs. Alberini & de Longo (2007) provide evidence that respondents in their CV study on the conservation of built cultural heritage sites in Armenia combine given information in the questionnaire with their own prior beliefs, and that the WTPs are affected by these updated beliefs.[2]

Other studies support the "purchase model" and back up the economic perspective. Carson & Mitchel (1993) and Carson & Mitchel (1995) argue for appropriate survey design and present empirical results that reveal sensitive WTP estimates. The authors blame survey design problems such as missing information about the nature of the good in question, about the manner of provision, or payment obligations, responsible for spurious insensitivity of WTP to scope.

Our second research question (2) focuses on the importance of psychological influences on risk-based WTP figures. Kahneman, Ritov & Schkade (1999) analyse dollar responses in conjunction with valuations of public goods and discuss issues such as context dependence, inadequate sensitivity of WTP to scope, framing and anchoring effects. By comparing dollar responses to other measures of attitude, the authors find that information provided by dollar responses could also be obtained by using alternative expressions of attitudes. They therefore conclude that dollar statements should be interpreted as expressions of attitudes rather than of economic preferences. Likewise, Hammar & Johansson-Stenman (2004), Hammitt & Graham (1999), Kahneman et al. (1993), Kahneman & Knetsch (1992), Olsen, Donaldson & Pereira (2004) doubt that WTP represents an appropriate measure to value economic preferences, as they find that WTP is insignificant to the degree of proposed risk reductions.

Heberlein, Wilson, Bishop & Schaeffer (2005) provide another explanation for the insensitivity of WTP. They criticize conventional scope

[2] For further papers on Bayesian learning in the context of risk perception, see for example Lundborg & Lindgren (2004), Hakes & Viscusi (1997), Viscusi (1990).

tests that compare mean/median values from separate samples without looking beyond economic scope (e. g., influence of quantity on WTP), thereby often neglecting affective, cognitive (attitudinal) and behavioural scope.[3] To overcome this deficiency the authors apply theories from social psychology in their CV survey and testing procedure for a more detailed analysis of scope effects. Comparing the results of parts and wholes for four different goods they show that psychological factors such as affective and cognitive attributes of the commodity in question provide reasonable explanations of why WTP seems to be insensitive to the variation in quantity. The authors mention that attitudinal influences may even explain negative scope effects but that they do not invalidate CV estimates. Thus, Heberlein et al. (2005) conclude that, even if in some cases poor study design may lead to scope failures, they can also occur for other reasons. Moreover, a failure to pass conventional scope tests would not necessarily invalidate CV results.

In contrast to the approach of Heberlein et al. (2005) we examine the scope effect by including a dummy for the higher risk variation in our WTP regression. To analyse the effects of attitudinal factors on scope sensitivity we additionally use interaction terms with the scope dummy variable and specific characteristics. We find that proportionality of WTP to scope holds once psychological components are included. We therefore argue that the validity of stated preferences requires the control for individual risk experience and perception. Such a procedure enhances the practical use of contingent valuation methods in risk valuation.

The paper is organized as follows: Section 2 describes the survey design, the data and the estimation procedure. Section 3 discusses the scope test. Section 4 presents the results, and Section 5 concludes.

[3]In their paper economic, affective, and cognitive scope refer to the amount of the good, feeling/satisfaction with the good, and knowledge/thinking of the resource in question, respectively.

2 Survey design, data and estimation procedure

Our analysis of scope effects is based on data collected in February 2005. 1,005 residents in the Austrian province of Tyrol were asked in face-to-face interviews about their WTP to prevent an increase in the risk of dying in an avalanche. A randomized quota sample was drawn from the Tyrolean population aged over 17 years. The quota applied to the subjects' district of residence and size of domicile. Within the quota, random sampling was used. At their permanent residences, the respondents were asked about their WTP to prevent an increase in the risk of dying in an avalanche. Individuals were randomly assigned into two groups and asked to evaluate a risk change of either 1/42,500 (a doubling of the baseline risk) or 3/42,500 (a quadrupling of the status quo risk level).

2.1 Socio-demographic attributes

Table 1 represents socio-economic and risk-related characteristics of the two groups. Group 1 (confronted with a risk variation of 1/42,500) includes 672 individuals, and Group 2 (risk variation = 3/42,500) contains 333 respondents. A two-sample t-test reveals significant differences (5 % level) between the groups in gender only: the proportion of women in Group 1 is lower than in Group 2 (47 % vs. 55 %).[4] In the remaining attributes, the samples correspond well.

The average respondent is 35 years old and lives in a household with approximately 3 members. 40 % of the participants live alone. More than one-fourth has at least a university entrance qualification. The average personal take-home income per month ranges between € 1,040 and € 1,140. Almost 50 % of respondents state that they face job risks. Less than 50 % of the respondents are non-smokers; two thirds are of normal weight (measured according to body mass index – BMI); 56 % (Group 1) and 50 % (Group 2) practise sports at least once a week, and more

[4] To control for this difference, we include an interaction term of *female* and the scope dummy *largereduct* as explanatory variable *largefemale* in the regression presented in Section 4.

Table 1: Sample characteristics

Variable	**Group 1**		**Group 2**	
	Obs[a]	**Mean**	**Obs**[a]	**Mean**
female	671	0.47	333	0.55
age	655	35.05	324	34.56
alevel	672	0.28	333	0.26
alone	672	0.39	333	0.43
housemember	666	3.00	330	2.73
inceuro/month[b]	451	1.14	265	1.04
risky job	672	0.48	333	0.46
non-smoker	672	0.45	333	0.48
normal weight	672	0.66	333	0.65
weekly sport	672	0.56	333	0.50
skiing	672	0.53	333	0.57
volunteer	672	0.25	333	0.22
prior experience	672	0.21	333	0.20
low individual risk	672	0.71	333	0.68
important alternative	672	0.14	333	0.11
anthropogenic risk	672	0.37	333	0.36
natural risk	672	0.31	333	0.38
risk perception	666	26.56	326	25.53
risk aversion	552	12.56	260	12.89

[a] Differences in numbers of observations due to missings.

[b] Monthly personal take home income in € 1,000 (data collected by income classes).

than half are skiers. One-fourth and one-fifth of the interviewees, respectively, volunteer for community services. The risk-related variables indicate that one-fifth of the individuals had personal experience of avalanches in the past; more than two-thirds think that their personal risk of dying in an avalanche is below average; more than 10 % in each group favour alternative life-saving measures over avalanche protection; almost 40 % of the respondents regard avalanches as an anthropogenic event, and 31 % (Group 1) and 32 % (Group 2) think that avalanches are natural phenomena. The figures for risk perception show that, on average, respondents' perception of fatal avalanche risks is below the true value of 30.[5] The measure for risk aversion amounts to 10, indicating that the respondents are basically risk-neutral.[6]

2.2 Payment question and response sequence

The survey participants were presented with the following information (the different wording for the larger risk variation is given in brackets):

Protective measures against avalanches on roads and in residential areas have been implemented in Tyrol. At present, 2.35 people out of 100,000 inhabitants are killed on average by avalanches. Assume that all public funds for maintaining protective measures will be cut, and so servicing costs henceforth have to be paid exclusively out of private funds. If aggregate private contributions are too small, maintenance is not carried out, and the probability of a fatal avalanche doubles [quadruples]. Then, on average, 4.7 [9.4] people out of 100,000 inhabitants die in the snow bulk (see Figure 1). Would you be willing to pay - given your income constraint - a monthly insurance premium of 2.5/5/10 € to maintain the effect of previous protective measures to save human lives?

Depending on their answers to the first question, the respondents were asked whether they would also pay 5/10/20 € if they accepted the initial bid, or 1.3/2.5/5 € if they did not adopt the initial amount.[7] If the interviewees' answers were "no - no" or "do not know - no" respondents were asked whether they would be prepared to pay any positive amount or why they refused a payment. Individual responses were classified as protest answers if the interviewees stated that they generally refused payments for protection against natural hazards or if it was argued that the protection of citizens was the responsibility of the government. The proportion of protests does not significantly differ across the samples. 15.77 % (N=106) in Group 1 and 12.61 % (N=42) in Group 2 were

[5] For a detailed explanation of this measure, see Section 2.3.

[6] For more details, see Leiter & Pruckner (2007).

[7] In order to define the range of the bid vector information from a pre-test sample was used.

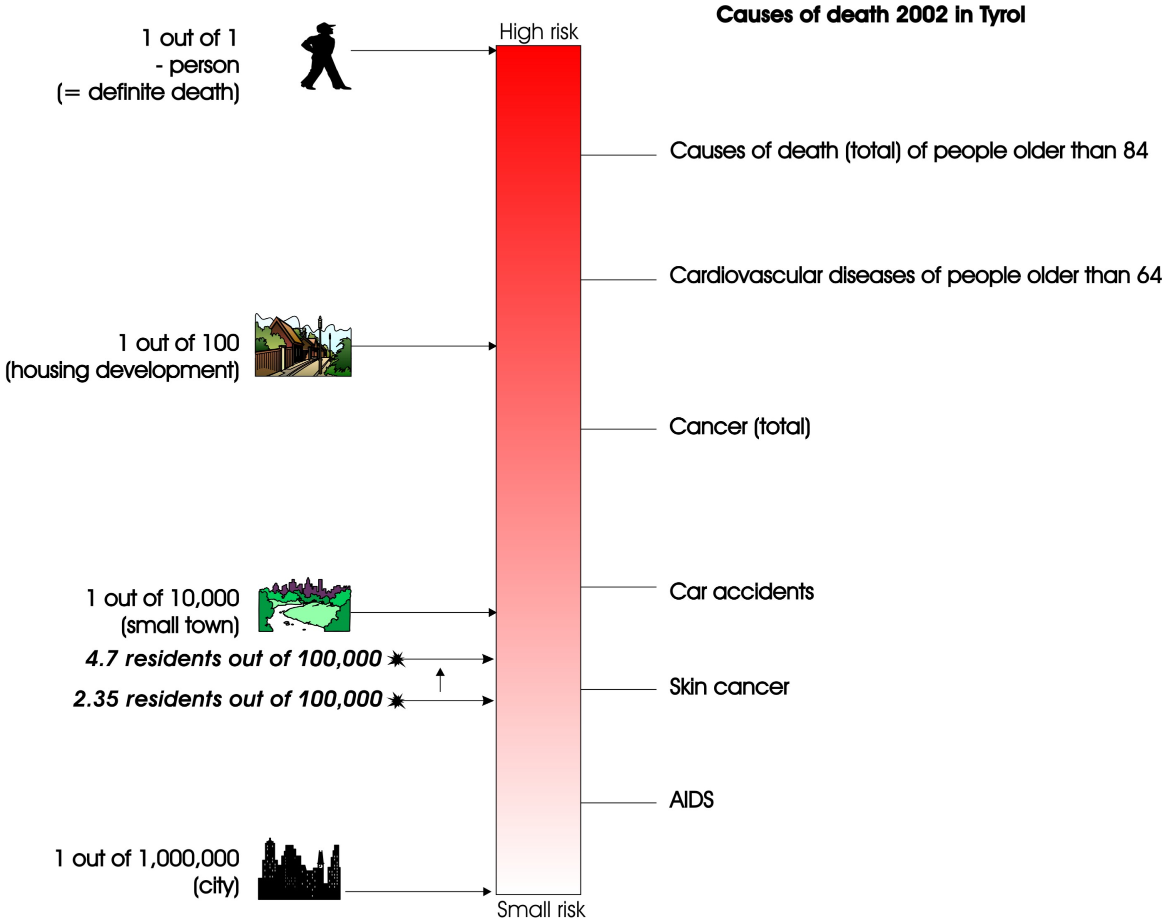

Figure 1: Causes of death in Tyrol in the year 2002 (small risk change)

identified as protest bidders. We include this group of individuals in the regression analysis to ensure conservative estimates.[8]

Since funding of publicly provided private goods via insurance premiums is common practice in Austria we have chosen this payment vehicle in our study. The conception is that monetary funds exist for protective avalanche measures that influence (private) risk exposure. These funds, encompassing both public and private components, are very similar to other risk-related markets such as the health system. As health care in Austria is financed by social and private health insurance premiums, the respondents are expected to be perfectly familiar with this vehicle. An

[8]Similarly, the "do not know" answers and individuals who did not answer the first and/or second payment question (N=27) were interpreted as negative responses and included in the further analyses.

alternative tax instrument was not used since the latter vehicle – even though theoretically appropriate – could be expected to trigger resentment and therefore to provoke biased answers.[9]

Admittedly, as in the case of other payment vehicles, this approach might also be afflicted with yeah-saying tendencies caused by altruism, or with free-riding behaviour as mentioned by Johannesson, Johansson & O'Conor (1996), Lusk, Nilsson & Foster (2007), Bateman et al. (2002), Carson & Groves (2007) and others. Even if we cannot altogether rule out some form of bias, such bias would apply equally to both sub-samples, and we have no reason to assume that the two differ in their strategic (free-riding) incentives.

Based on Corso et al. (2001), we visualized the risk variation using a logarithmic scale for a better understanding of the annual risk change. The graph shows the baseline risk, the new risk level, and other mortality risks (e. g., cancer, car accidents, AIDS) for the Tyrolean population on the right hand side. On the left, the magnitude of the risks is stated as the number of affected persons in differently sized populations (see Figure 1).

Table 2 summarizes the responses to the payment questions for both sub-samples. The requirement that the positive (negative) answers decrease (increase) when bids rise is fulfilled. Furthermore, as expected, the proportion of yes (no) answers is higher (lower) for individuals in Group 2 who evaluate the higher risk change.

2.3 Explanatory variables

Information about socio-economic characteristics and risk-specific attributes was collected to test for internal validity of WTP. Findings in psychological studies by Kahneman et al. (1993), Slovic (1987), Slovic, Fischhoff & Lichtenstein (2000) and Sunstein (1997) show how important risk characteristics such as voluntariness, controllability, and origin of risks are in individual risk valuation. As Heberlein et al. (2005) argue,

[9]Hackl & Pruckner (2005), who have successfully applied the insurance instrument in Austria in the past, and Olsen, Kidholm, Donaldson & Shackley (2004) discuss the advantages of insurance premiums over alternative payment vehicles.

Table 2: **Response sequence to payment questions**

initial bid	Group 1 yy	yn	ny	nn	Tot	Group 2 yy	yn	ny	nn	Tot
2.5	50	57	22	151	280	33	30	8	52	123
	17.9	20.4	7.9	53.9	100.0	26.8	24.4	6.5	42.3	100.0
5.0	18	28	33	116	195	19	27	11	44	101
	9.2	14.4	16.9	59.5	100.0	18.8	26.7	10.9	43.6	100.0
10.0	9	39	21	128	197	7	20	25	57	109
	4.6	19.8	10.7	65.0	100.0	6.4	18.4	22.9	52.3	100.0
Total	77	124	76	395	672	59	77	44	153	333
	11.5	18.5	11.3	58.8	100.0	17.7	23.1	13.2	46.0	100.0

attitudinal factors also play a major role in the sensitivity of WTP to the degree of risk change and therefore have to be considered in scope tests. Accordingly, we use the following attributes and their interactions with the scope dummy as inputs for the sensitivity analyses[10]

- *Risk perception (riskpercept)*: We measure individual risk perception by presenting the participants with the graph shown in Figure 1. However, the respondents were not given information about the baseline and the new risk level in the first instance. Instead, they were asked to draw in a horizontal line where they thought the average risk of dying in an avalanche was located. The distance in millimetres from the bottom of the graph (= small risk) to the self-plotted line was taken as indication for risk perception.[11] These data were gathered before we collected information about the individual WTP.

- *Subjective avalanche risk (lowrisk)*: Respondents were asked whether they thought that their subjective risk of dying in an avalanche was above/equal/below the average risk.

[10]For a discussion of the influence of risk-related variables on WTP, see Leiter & Pruckner (2007).

[11]The variable ranges from 0 to 131.

- *Preferences for alternative protective measures (impalter)*: Participants were confronted with six alternative protective measures aimed at preventing deaths due to (1) car accidents, (2) food poisoning, (3) floods, (4) rockfalls/landslides, (5) air pollution, and (6) radiation. Subsequently, the respondents were asked to rate the importance of these alternatives in comparison with prevention of avalanche accidents, bearing in mind that each measure would save the same number of lives. A dummy variable is generated which indicates the preference for alternative life-saving measures.

- *Personal experience of avalanches (famexp)*: The fact that respondents or their family members/friends were affected by an avalanche in the past may influence risk valuation.

- *Origin of deadly avalanches (anthropogen)*: Individuals responded to a question about the origin of avalanche risks. They stated whether they thought that avalanches were always/mostly/seldom/never caused by humans/nature/fate. We include a dummy variable in the regressions, indicating whether avalanches are always seen as an anthropogenic event.

Additionally, we include an indicator variable for the higher risk variation *largereduct*. This dummy variable is the main regressor in the analysis of scope effects. It controls for the larger risk variation (3/42,500). Its coefficient is expected to show a significantly positive sign indicating a higher WTP for the larger change compared to the smaller risk variation (1/42,500). Moreover, the estimated coefficient of this variable shows whether the proportionality of WTP to the risk change in question holds.

2.4 VSL and WTP for risk prevention

The standard model of WTP assumes that individuals substitute income y for a risk reduction Δp such that they maximize their expected state dependent utility

$$EU(p, y) = (1 - p)u_a(y) + pu_d(y) \tag{1}$$

where p is the probability of dying during a given period, and u_a (u_d) represents the utility conditional on surviving (dying) in that period. The VSL is derived by taking the total differential of (1)

$$VSL \equiv \frac{dy}{dp} \equiv -\frac{\delta EU/\delta p}{\delta EU/\delta y} = \frac{u_a(y) - u_d(y)}{(1-p)u_a'(y) + pu_d'(y)} \tag{2}$$

Two factors influence the VSL: the risk effect (p) and the income effect (y). The former is reflected by the difference in the marginal utilities of income in the two states (life and death). Information about the effect of income on VSL is provided by income elasticities (see Hammitt (2000) for a detailed discussion).

In contingent valuation surveys it is common to ask respondents how much money they are willing to spend (WTP) to reduce their mortality risk by Δp. In other words, individual WTP is estimated keeping utility between the two periods (Period 1 with risk p_1 and Period 0 with risk p_0) constant

$$V(y - WTP, p_1; \mathbf{X}) = V(y, p_0; \mathbf{X}), \tag{3}$$

and the VSL is approximated by $WTP/\Delta p$.

The payment question in the Tyrolean survey is designed as a double-bounded dichotomous choice format (DBDC) under which the "true" WTP cannot be directly observed. Depending on whether an individual's WTP is above (below) a predetermined amount, the respondent answers yes (no) to the payment question. Formally, the specification of WTP (dependent variable) is:

$$WTP_i^* = \mathbf{X_i}\beta + \epsilon_i \tag{4}$$

where WTP_i^* represents the latent individual WTP for the prevention of an increase in risk, $\mathbf{X_i}$ is a vector including individual socio-economic and risk-related attributes, β is a vector of coefficients to be estimated, and ϵ_i denotes the error term. The following dummy variables are used to infer the sequence of "yes(y)" and "no(n)" responses for individual i to the payment questions (see Section 2.2):

$$\begin{aligned} d_i^{yy} &= 1 \text{ if } WTP_i^* \geq B_i^H; \\ d_i^{yn} &= 1 \text{ if } B_i^I \leq WTP_i^* < B_i^H; \\ d_i^{ny} &= 1 \text{ if } B_i^L \leq WTP_i^* < B_i^I; \\ d_i^{nn} &= 1 \text{ if } WTP_i^* < B_i^L; \end{aligned} \tag{5}$$

with the first (second) letter in the superscript representing the answer to the initial (subsequent) payment question (y = yes; n = no). B^H, B^I, and B^L are the higher, initial, and lower bid respectively. Assuming a Weibull and log-normal distribution of the error term, mean and median WTP are estimated by a maximum likelihood procedure. Each response is included with its probability in the likelihood function. Formally, this probability can be written as

$$\begin{aligned} &1 - F(B_i^H;\tau) + [F(B_i^H;\tau) - F(B_i^I;\tau)] \\ &+[F(B_i^I;\tau) - F(B_i^L;\tau)] + F(B_i^L;\tau) \end{aligned} \tag{6}$$

where $F(\bullet)$ represents the cumulative distribution function (cdf), and τ denotes the parameter vector which indexes the distribution and has to be estimated.

3 The sensitivity of WTP

In accordance with Hammitt & Graham (1999) we conduct an external scope test to examine the sensitivity of WTP to the degree of risk variation. For this purpose we include in the regressions both an indicator variable for the higher risk variation and interaction terms between this scope dummy and particular risk-related factors. For the Weibull distribution, mean and median WTP are estimated by

$$\begin{aligned} mean_{weib} &= \lambda_i \Gamma(\tfrac{1}{\rho} + 1) \\ median_{weib} &= \lambda_i [-ln(0.5)]^{\frac{1}{\rho}} \end{aligned} \tag{7}$$

with the scale parameter $\lambda_i = exp(\mathbf{X_i}\beta)$, shape parameter ρ, and $\Gamma(\bullet)$ representing the Gamma function. Assuming a log-normal distribution of the error term mean and median are calculated by

$$\begin{aligned} mean_{logn} &= \exp\left[(\mathbf{X_i}\beta) + 0.5\sigma^2\right] \\ median_{logn} &= \exp(\mathbf{X_i}\beta) \end{aligned} \tag{8}$$

with σ representing the scale parameter of the log-normal.

The core factor is the coefficient of the indicator variable for the larger risk prevention *largereduct*. In case of a Weibull or log-normal distribution the coefficient of this variable represents the logarithm of the ratio of WTP for the large risk change (3/42,500) to the WTP for the smaller one (1/42,500).[12]

We run two separate simple regressions including the bid interval and a constant to give a first impression regarding the degree of WTP in the two samples. WTP figures are calculated with a Weibull and log-normal distribution respectively. Table 3 depicts the corresponding results. As can be seen, the welfare measures for Group 2 are explicitly higher compared to Group 1. However, WTP for the latter is definitely not three times that of the estimates in the former group. What are the implications of this observation?

Based on expected utility theory, we focus on the arguments referring to insensitivity of WTP mentioned in Hammitt & Graham (1999) and Heberlein et al. (2005) and discuss their appropriateness for our data set. According to Hammitt & Graham (1999), problems in understanding probabilities and the importance of various information sources may influence the individual valuation process. As avalanches and deadly avalanche accidents in Tyrol occur frequently, the residents are expected to be familiar with the corresponding risk and assumed to be able to understand even relatively small probabilities. Moreover, visual representation of risk changes was provided in the survey in the form of a graph to improve comprehension.

[12]Formally displayed (exemplified for a Weibull):

$$\frac{WTP_{large}}{WTP_{small}} = \frac{\lambda_{large}}{\lambda_{small}} = \frac{exp(1*\beta_1)}{exp(0*\beta_1)} \Rightarrow ln(\frac{WTP_{large}}{WTP_{small}}) = \beta_1.$$

Table 3: Mean and median WTP in € per month (bid and constant)

	Weibull		Log-normal	
	Group 1	**Group 2**	**Group 1**	**Group 2**
Observations	672	333	672	333
Mean	4.39	6.12	5.89	8.46
	(0.36)	(0.58)	(0.76)	(1.35)
Median	1.53	3.02	1.56	2.84
	(0.16)	(0.31)	(0.14)	(0.27)

Notes:
Standard errors (delta method) in parentheses.
Group 1: Risk variation of 1/42,500; Group 2: Risk variation of 3/42,500.

As mentioned, Group 2 received information that the current risk of dying in an avalanche (2.35 inhabitants out of 100,000) quadruples (to 9.4 out of 100,000) if maintenance work on existing protective measures is cut. This quadrupling corresponds to an annual death toll of 64. Faced with these figures, respondents may believe in a substantial increase in deadly avalanches, but think that the quadrupling presented is too excessive. Indeed, respondents might gain this impression from previous avalanche accidents. The death toll for a recent winter period (December 2004 - April 2005) ran to 25 fatalities (ASI-Tirol, Alpine Safety & Information Center 2005), which is above the ten-year average of 16 deaths (Amt der Tiroler Landesregierung, Lawinenwarndienst Tirol 2003).[13] This tendency had already become apparent in February 2005 when the survey took place and avalanche accidents occurred frequently. A peak of 45 casualties (nearly three times the ten-year average) was observed in the winter of 1998/1999.

Apart from information provided in the questionnaire, media reports and official statistics are alternative sources of information which may influence people's understanding. We have no explicit information, however, on the extent to which individuals actually consider such (media)

[13]Transferred to the Tyrolean population, 16 people killed is equivalent to our baseline risk of 1/42,500.

reports. A source of information we can control for by including a dummy variable *famexp* is prior experience of avalanches. Respondents who state that they or a relative/friend were affected by an avalanche in the recent past are expected to take these experiences into account. This group of people may show a higher degree of concern about reports and statements referring to avalanche risks and accidents. We therefore hypothesize that the respondents who valuated the higher risk variation and acknowledged having personal experience of avalanches in the past have a risk change in mind that is below the proposed quadrupling and therefore state a lower WTP for risk prevention. This hypothesis is tested by including an interaction term *largeexp* composed of *largereduct* and *famexp*.

We also test the importance of cognitive and affective factors for scope effects by using variables representing individual risk perception *riskpercept*, assessment of subjective avalanche risk as below average *lowrisk*, preferences for alternative protective measures *impalter*, avalanches assessed as anthropogenic events *anthropogen*, and their interactions with the scope dummy *largereduct*.[14]

4 Regression results and the value of statistical life

Whereas the predetermined risk variation for Group 1 is 1/42,500 (prevention of an increase in risk from 1/42,500 to 2/42,500), the presented risk change to be evaluated by Group 2 goes up to 3/42,500 (prevention of an increase from 1/42,500 to 4/42,500). The plausibility of the proposed risk variation to be evaluated is based on the assumption that respondents use only the direct information provided in the questionnaire. This means that other sources of information would not have any influence on the credibility of the degree of risk changes. If participants combine current and prior (personal) experience, however, they may base their assessment on a different risk variation. While the coefficient of the dummy variable for the larger risk prevention enables testing of whether

[14]See Section 2.3 for an explanation of these variables.

proportionality of WTP holds, interaction terms enable examination of the importance of prior experiences and beliefs in the individual valuation process.

As was mentioned above, the scope coefficient of *largereduct* represents the logarithm of the ratio of WTP for the larger change in risk to WTP for the smaller change. If respondents take the described risk variation in the survey at face value individuals in Group 2 value a threefold risk reduction compared to Group 1. If proportionality holds, the coefficient of the dummy must reach a value of $ln(3) = 1.099$. However, apart from standard economic theory and psychological reasons for non-proportionality (for a discussion, see Section 1), the information provided in the questionnaire may not correspond with prior experience/knowledge of avalanche risks, and individuals may attach higher importance to other sources of information. This argument may apply particularly to Group 2 members who have had personal experience of avalanches in the past. As discussed in Section 3, there is good reason to assume that the valuation given by these respondents may be influenced by prior knowledge. These interviewees can therefore be expected to state a WTP for a smaller – and according to their understanding a more realistic – change in risk. Hence, respondents in Group 2 who have had prior personal experience of avalanche accidents may express a lower WTP than expected, represented by a coefficient of the scope variable below 1.099.

In order to test the proportionality of WTP, we follow the approach suggested by Hammitt & Graham (1999) and focus on the coefficient of *largereduct*. Four different models are estimated to examine the variation of the scope coefficient and to study how it interrelates with socio-economic and risk-related characteristics. Models A and B differ in the number of included observations: while in Model B respondents who evidently had problems in understanding probability contexts were excluded, Model A uses all statements.[15] Analogously, "non-learners" are

[15]Our questionnaire starts with issues on probability comprehension. Respondents were confronted with two questions: first, they were asked to choose the higher chance of winning (15:10,000 vs. 20:100,000). Secondly, they were shown the annual mortality risk of two persons (5:10,000 vs. 10:10,000) and were then asked to state which of the two faced the higher risk of dying. Each question was followed by an explanation of the correct solution. Participants who answered wrongly twice (17.4 % in Group 1 and

included/excluded in Models C and D, too, but the number of regressors in these models is additionally extended by interaction terms of the scope variable and particular risk characteristics. Table 4 depicts closed-ended double-bounded maximum likelihood estimates for each model assuming a Weibull distribution of the error term.[16] A brief description of the included regressors can be found in Table 5.

Models A and B in Table 4 show regression results including (Model A) and excluding (Model B) "non-learners". The effect of the included regressors is quite similar in both models. The influence of risk perception (*riskpercept*) is positive and highly significant in both models, i. e., the higher individuals' risk perception the higher their WTP. Assessment of avalanches as events that are always anthropogenic *anthropogen* and preferences for alternative protective measures *impalter* induce a significantly lower WTP in both models. "Background risks", as mentioned in Eeckhoudt & Hammitt (2001), also play a role in the valuation process. While the existence of workplace risks (*jobrisk*) shows a significant positive impact in Model A only, a supposed lower health risk due to normal weight and sporting activities is relevant in both models. People who are of normal weight (*normalweight*) state a significantly lower WTP and those who go in for sports at least once a week (*weeklysport*) a significantly higher WTP respectively. The impact of income (*lncinome*) and education (*alevel*) is significant in Model B only. While higher income induces higher WTP, higher education influences individual contributions negatively.[17]

16.8 % in Group 2) may have problems in understanding probabilities. Excluding the statements of these respondents ("non-learners") is analogous to Alberini, Cropper, Krupnick & Simon (2004), for example, who distinguished individuals by the degree of confidence they have in their answers.

[16]Log-normal regressions provided similar results for both the coefficient of the scope dummy and the significance of the other right-hand-side variables. As the likelihood values of the Weibull distribution were superior to the log-normal estimates, we focus here on the Weibull alternative.

[17]In order to avoid losing 30 % of the observations, we apply a single imputation method (Davey, Shanahan & Schafer (2001), Little & Rubin (1987), Whitehead (1994)) and replace missing income by the mean value. In addition, a dummy variable is generated which equals one in cases where a replacement has been made to control for potential influences of the imputation. As can be seen in Table 4, the corresponding coefficient does not show a significant impact on the estimates.

Table 4: Regression results (Weibull distribution)

Dependent variable: bid interval

	Model A		Model B[a]		Model C		Model D[a]	
Variable	***Coef.***	***Std. Err.***	***Coef.***	***Std. Err.***	***Coef.***	***Std. Err.***	***Coef.***	***Std. Err.***
largereduct	0.346**	0.17	0.393**	0.19	1.069***	0.31	1.263***	0.34
age	−0.001	0.00	0.000	0.00	−0.002	0.00	−0.001	0.00
female	0.049	0.13	0.035	0.15	0.066	0.13	0.044	0.15
lnincome	0.149	0.09	0.180*	0.10	0.168*	0.09	0.202*	0.10
missincome	0.034	0.13	0.131	0.14	0.045	0.13	0.145	0.14
alevel	−0.202	0.12	−0.259*	0.14	−0.231*	0.12	−0.302**	0.14
housemember	0.006	0.03	0.002	0.03	0.008	0.03	0.006	0.03
volunteer	0.029	0.23	0.155	0.25	0.029	0.23	0.147	0.25
famexp	0.216	0.14	0.195	0.15	0.400**	0.17	0.449**	0.18
riskpercept	0.014***	0.00	0.014***	0.00	0.017***	0.00	0.017***	0.00
lowrisk	−0.144	0.14	−0.200	0.16	0.037	0.17	0.009	0.19
lowriskvol	−0.149	0.27	−0.215	0.31	−0.141	0.27	−0.189	0.30
anthropogen	−0.243**	0.11	−0.248**	0.13	−0.243*	0.13	−0.204	0.15
natural	−0.025	0.12	0.054	0.13	−0.031	0.12	0.045	0.13
skiing	0.007	0.12	0.001	0.14	−0.012	0.12	−0.022	0.13
riskaversion	0.014	0.02	0.008	0.02	0.017	0.02	0.012	0.02
missaversion	0.054	0.29	0.008	0.33	0.100	0.29	0.058	0.33
impalter	−0.446***	0.16	−0.434**	0.17	−0.416**	0.19	−0.361*	0.21
jobrisk	0.259**	0.11	0.183	0.13	0.244**	0.11	0.175	0.13
normalweight	−0.296**	0.12	−0.304**	0.13	−0.292**	0.12	−0.297**	0.13
nosmoke	−0.094	0.11	−0.038	0.13	−0.110	0.11	−0.058	0.13
weeklysport	0.289**	0.12	0.252*	0.13	0.287**	0.12	0.262**	0.13
largefemale	0.354	0.24	0.454*	0.26	0.315	0.24	0.450*	0.27
largeimpalt					−0.150	0.36	−0.222	0.38
largeexp					−0.539*	0.29	−0.778**	0.31
largelow					−0.508**	0.26	−0.585**	0.29
largepercept					−0.009	0.01	−0.008	0.01
largehuman					−0.013	0.24	−0.152	0.27
constant	−0.236	0.74	−0.388	0.83	−0.622	0.76	−0.851	0.84
Observations	956		794		956		794	
Log Likelihood	-1096		-915		-1091		-909	
Ratio[b]	1.41	0.24	1.48	0.28	2.91	0.89	3.53	1.21
H_0: proportionality[c]	r		r		nr		nr	

*, ** and *** indicate statistical significance at the 10-% level, 5-% level and 1-% level.

[a] Exclusion of respondents with lack in probability comprehension ("non-learners")

[b] Ratio of WTP for large risk prevention to WTP for small risk prevention: $= exp(largereduct)$

[c] r = H_0 of proportionality has to be rejected; nr = H_0 of proportionality cannot be rejected

Table 5: Explanatory Variables – Description

Variable	Description
age	Age of respondent in years.
alevel	Dummy = 1 if respondent holds a university entrance qualification; 0 otherwise.
anthropogen	Dummy = 1 if respondent always regards avalanches as an anthropogenic event; 0 otherwise.
famexp	Dummy = 1 if respondent or another family member has had personal experience with avalanches; 0 otherwise.
female	Dummy = 1 if respondent is female; 0 otherwise.
housemember	Number of persons in the respondent's household.
impalter	Dummy = 1 if the respondent prefers alternative protective measures; 0 otherwise.
jobrisk	Dummy = 1 if respondent states that she faces workplace risks; 0 otherwise.
largereduct	Dummy = scope variable. 1 if the predetermined risk variation = 3/42,500; 0 otherwise.
	Interaction terms:
largeexp	*largereduct* * *famexp*
largefemale	*largereduct* * *female*
largehuman	*largereduct* * *anthropogen*
largeimpalt	*largereduct* * *impalter*
largelow	*largereduct* * *lowrisk*
largepercept	*largereduct* * *riskpercept*
lnincome	Logarithm of personal monthly take home income.
lowrisk	Dummy = 1 if respondent assesses her personal risk of dying in an avalanche below average.
lowriskvol	Interaction term: *lowrisk* and *volunteer*.
missaversion	Dummy = 1 if missing observations of riskaversion are replaced by zero; 0 otherwise.
missincome	Dummy = 1 if missing observations of income are replaced by mean income; 0 otherwise.
natural	Dummy = 1 if respondent always regards avalanches as a natural event; 0 otherwise.
normalweight	Dummy = 1 if respondent is of normal weight; 0 otherwise.
nosmoke	Dummy = 1 if respondent does not smoke; 0 otherwise.
riskaversion	Respondent's behavior in risky situations. Ranges between 0 (risk loving) and 21 (risk averse).
riskpercept	Respondent's perception of deadly avalanche risks. Ranges between 0 (no risk) and 131 (death).
skiing	Dummy = 1 if respondent is a skier; 0 otherwise.
volunteer	Dummy = 1 if respondent volunteers; 0 otherwise.
weeklysport	Dummy = 1 if respondent goes in for sport at least once a week; 0 otherwise.

The coefficient of the interaction of the scope variable and female (*largefemale*) shows a positive sign. It is significant in Model B and implies that women who valuated the larger risk variation state a higher WTP. This term is included to control for the significant difference between the two samples as regards the proportion of women.

A glance at Models A and B shows that the coefficient of the scope variable is considerably lower than 1.099.[18] Although it is higher if we only include credible individuals who show some confidence in dealing with probabilities, WTP for Group 2 is definitely not three times as high as for Group 1. This may be taken as evidence that participants in Group 2 seem to attach higher importance to other sources of information (e. g., prior experience) concerning the risk of fatal avalanche accidents.

To examine such influences, we include additional interaction terms in Models C and D. The effect of these interactions on the coefficient of the scope dummy (*largereduct*) is considerable. If we control for prior experience and attitudinal factors (such as preferences for alternative protective measures or respondents' assessment of their subjective avalanche risk) the hypothesis of proportionality of WTP estimates can no longer be rejected. While the scope coefficient is almost identical to the postulated value of 1.099 in Model C, it is even higher in Model D. A Wald test on the coefficients of the scope dummy reveals that they are not significantly different from 1.099. The interaction terms in Models C and D enable identification of reasons for the observed non-proportional increase in WTP in Models A and B.

As expected, respondents who mentioned that they have had personal experience of avalanches in the past (*famexp*) state a higher WTP than those who have not been personally affected by avalanches. However, the WTP for the former is significantly lower (42 % and 54 % in Models C and D, respectively) when they evaluate the larger risk reduction (*largeexp*). From this we conclude that people with prior experience combine the information about the degree of prevented risk provided in the survey with their personal knowledge and probably value a smaller risk change. The peak of fatal avalanches per year within the last 10 years – 45 casu-

[18] A Wald test on the scope coefficient reveals that it differs significantly from 1.099.

alties – is approximately three times the baseline risk. It seems realistic that people who are particularly affected will be more sensitive in avalanche matters, use different sources of information, and therefore value a lower and more realistic risk change than the proposed risk variation.

A similar effect can be observed when respondents assess their personal avalanche risk as below average. While the coefficient of the indicator variable for lower subjective risks (*lowrisk*) indicates a positive but insignificant impact on WTP, its interaction with the scope variable (*largelow*) reveals a negative influence on WTP: WTP for participants who value their subjective mortality risk due to avalanches below average state a 42 % (Model C) and 44 % (Model D) lower WTP respectively. One explanation for this observation is that people who already regard their current risk of dying in an avalanche as low may think that a fourfold risk – as compared to the baseline – will be even less likely to apply to them. Hence, they seem to be less willing to pay for preventing a quadrupling in risk.

Besides these attitudinal influences, which other significant impacts occur? In contrast to the regressions without scope interaction terms, the positive influence of income (*lnincome*) is significant in both models, and WTP in regressions C and D is significantly lower for more highly educated people (*alevel*) compared to those who do not hold a university entrance qualification. Highly educated people seem to anticipate that they can reduce their own risk exposure by their individual behaviour and therefore state a lower WTP. The view that avalanches are always caused by human activity (*anthropogen*) shows a significant impact in Model C. Regarding the remaining significant variables *impalter*, *jobrisk*, *normalweight*, *weeklysport*, and *largefemale* the results are very similar to Models A and B. Preferences for alternative mitigation measures negatively influence WTP. People who face job risks, those who exercise at least once a week, and women state a higher WTP while persons who are of normal weight reveal a lower WTP.

The main finding of this analysis is that the observed impact of attitudinal variables on the scope dummy supports the arguments of Heberlein et al. (2005) who demand the inclusion of social and psychological attributes in scope tests. Our results provide evidence that such characteristics do indeed matter and therefore have to be included in similar analyses.[19]

We find evidence that the WTP for the larger risk reduction is significantly higher than the figures for the smaller prevention of risk. Moreover, we show that the ratio of WTP for the larger reduction to that for the smaller reduction depends on psychological attributes such as individual risk attitudes and risk assessments. We therefore argue that scope tests must include attitudinal factors to prevent premature judgments on the scope insensitivity of WTP figures in risk assessment.

WTP figures for reduced mortality risk are often used for the calculation of VSL. As was pointed out in Section 1, the VSL is a monetary measure for the utility of fatality prevention. It is defined as the ratio at which individuals are willing to exchange income for risk changes and is calculated by dividing the annual WTP by the corresponding risk variation.

If the increase in WTP is less (more) than proportional, the VSL for the larger risk variation will be lower (higher) than for the smaller risk reduction. In order to examine the range of VSL depending on the risk change, we use the coefficients of Models C and D (see Table 4) and multiply them by the characteristics of an average respondent. The scope effect on WTP and VSL can be shown by setting the scope dummy equal to zero for Group 1 and equal to one for Group2. Table 6 summarizes these results.

For Group 2, mean and median WTP per year to prevent the increase in risk amounts to € 171 (€ 14.25 * 12) and € 77 (€ 6.41 * 12) respectively, if non-learners are excluded. Dividing these values by the risk variation of 3/42,500 results in a mean (median) VSL of € 2.42 million (€ 1.09 million) for Group 2. Analogously calculated, mean (median)

[19]Another potential influence on individual valuation is the effectiveness and likelihood of allocation of the good. As Carson & Mitchel (1995) argue, respondents might discount the likelihood of provision of the larger good more than they discount the likelihood of the less extensive good. Powe & Bateman (2004) show that perceived realism regarding the good in question may be an important factor influencing scope analyses. Our data do not, however, provide the necessary information to explicitly control for these influences.

Table 6: WTP/month (in €) and VSL (in mio. €)

	non-learners included		**non-learners excluded**	
	Group 1	**Group 2**	**Group 1**	**Group 2**
Mean WTP	3.70	10.77	4.03	14.25
	(0.75)	(3.52)	(0.86)	(5.08)
Median WTP	1.67	4.88	1.81	6.41
	(0.35)	(1.58)	(0.40)	(2.24)
Mean VSL	1.89	1.83	2.06	2.42
Median VSL	0.85	0.83	0.93	1.09

Notes:
Standard errors (delta method) in parentheses.
Group 1: Risk variation of 1/42,500; Group 2: Risk variation of 3/42,500.

VSL in Group 1 is € 2.06 million (€ 0.93 million) when "non-learners" are excluded again. Obviously, VSL figures between the groups are quite similar as a result of the observed sensitivity (proportionality) of WTP to the degree of risk variation.

5 Conclusions

Scope analyses are a common instrument for testing the validity of CV estimates. WTP is hypothesized to be sensitive to major characteristics such as the quantity of the good provided. In this study, WTP is expected to increase with the magnitude of risk prevention. For the purpose of testing the sensitivity of WTP to the degree of risk change, 1,005 Tyroleans were randomly assigned into two groups and asked about their WTP for preventing an increase in risk of 1/42,500 and 3/42,500 for the first and second group respectively.

Provided that buying an infinitesimal risk reduction only requires a small fraction of income and the risk change thus bought is modest in comparison to the individual's total survival probability, WTP for small reductions is hypothesized to vary proportionally to the underlying risk variation. Thus, as the provided change in risk for Group 2 is three times the variation for Group 1, we expect a threefold WTP for Group 2 compared to Group 1 – provided that respondents take the information given in the questionnaire at face value. However, this assumption must not necessarily hold, and the information content of external sources (e. g., prior risk beliefs or experiences and media coverage) may influence individual risk valuation.

Based on two separate regressions including the bid interval and a constant, we find that WTP is significantly higher for the group with the larger risk variation. The proportionality hypothesis of welfare measures cannot be supported, however, since the WTP for a tripling of risk prevention increases by considerably less than threefold. This result indicates that Group 2 participants may not take current information provided by the questionnaire at face value. Economic variables are one important source of potentially influential factors in scope tests, but attitudinal characteristics (such as preferences for alternative protective measures or the perceived subjective risk exposure) may also play an important role in explaining the sensitivity of individual WTP statements to quantity changes. These hypotheses are empirically tested by including interaction terms between the scope variable and particular risk-related variables in the regression model.

Our findings highlight the importance of controlling for individual experience and perception, particularly in the case of risk valuation. Controlling for cognitive impacts leads to the final conclusion that WTP for preventing fatal avalanche accidents is proportional to the risk variation for particular groups of respondents. These results are mirrored in the narrow range of VSL figures across different variations in risk in the full regression model.

Inadequate accounting for interactions between psychological impacts and the scope variable may lead premature rejection of the proportionality hypothesis. This does not necessarily mean that previous CV studies on risk evaluation are invalidated. However, our results may at least challenge those finding where attitudinal influences have not been taken into account even though it may reasonably be assumed that they influence people's WTP statements. We argue, finally, that the validity of stated preference methods requires thorough analysis of affective, cognitive and attitudinal factors to enhance the use of CV in practice.

References

Alberini, A., Cropper, M., Krupnick, A. & Simon, N. B. (2004), 'Does the value of a statistical life vary with age and health status? Evidence from the US and Canada', *Journal of Environmental Economics and Management* **48**, 769–792.

Alberini, A. & de Longo, A. (2007), Valuing the Cultural Monuments of Armenia: Bayesian Updating of Prior Beliefs in Contingent Valuation, Working Paper 36.2007 Fondazione Eni Enrico Mattei. `http://www.feem.it/Feem/Pub/Publications/WPapers/default.htm`.

Amt der Tiroler Landesregierung, Lawinenwarndienst Tirol (2003), 'Schnee und Lawine 2002-2003', Innsbruck.

ASI-Tirol, Alpine Safety & Information Center (2005), 'Lawinentote Tirol 2004/2005', Landeck.

Bateman, I. J., Carson, R. T., Day, B., Hanemann, M., Hanley, N., Hett, T., Jones-Lee, M., Loomes, G., Mourato, S., Özdemiroglu, E., Pearce, D. W., Sugden, R. & Swanson, J. (2002), *Economic Valuation with Stated Preference Techniques. A Manual*, Edward Elgar Publishing Limited, Cheltenham.

Carson, R. T. & Groves, T. (2007), 'Incentive and informational properties of preference questions', *Environmental and Resouce Economics* **37**, 181–210.

Carson, R. T. & Mitchel, R. C. (1993), 'The Issue of Scope in Contingent Valuation Studies', *American Journal of Agricultural Economics* **75**, 1263–1267.

Carson, R. T. & Mitchel, R. C. (1995), 'Sequencing and Nesting in Contingent Valuation Surveys', *Journal of Environmental Economics and Management* **28**, 155–173.

Chang, H. & Just, D. (2007), 'Health Information Availability and the Consumption of Eggs: Are Consumers Bayesians?', *Journal of Agricultural and Resource Economics* **32**(1), 77–92.

Corso, P. S., Hammitt, J. K. & Graham, J. D. (2001), 'Valuing Mortality-Risk Reduction: Using Visual Aids to Improve the Validity of Contingent Valuation', *The Journal of Risk and Uncertainty* **23**(2), 165–184.

Davey, A., Shanahan, M. J. & Schafer, J. L. (2001), 'Correcting for Selective Nonresponse in the National Longitudinal Survey of Youth Using Multiple Imputation', *Journal of Human Resources* **36**(3), 500–519.

Eeckhoudt, L. R. & Hammitt, J. K. (2001), 'Background Risks and the Value of a Statistical Life', *The Journal of Risk and Uncertainty* **23**(3), 261–279.

Hackl, F. & Pruckner, G. J. (2005), 'Warm Glow, Free-riding, and Vehicle Neutrality in a Health-related Contingent Valuation Study', *Health Economics* **14**, 293–306.

Hakes, J. K. & Viscusi, W. K. (1997), 'Mortality Risk Perceptions: A Bayesian Reassessment', *Journal of Risk and Uncertainty* **15**, 135–150.

Hammar, H. & Johansson-Stenman, O. (2004), 'The value of risk-free cigarettes – do smokers underestimate the risk?', *Health Economics* **13**, 59–71.

Hammitt, J. K. (2000), 'Evaluating Contingent Valuation of Environmental Health Risks: The Proportionality Test', *AERE Newsletter* **20**(1), 14–19. `http://www.aere.org/newsletter/Newsletter_May00.pdf`.

Hammitt, J. K. & Graham, J. D. (1999), 'Willingness to Pay for Health Protection: Inadequate Sensitivity to Probability?', *Journal of Risk and Uncertainty* **8**, 33–62.

Heberlein, T. A., Wilson, M. A., Bishop, R. C. & Schaeffer, N. C. (2005), 'Rethinking the scope test as a criterion for validity in contingent valuation', *Journal of Environmental Economics and Management* **50**, 1–22.

Johannesson, M., Johansson, P. O. & O'Conor, R. M. (1996), 'The Value of Private Safety Versus the Value of Public Safety', *Journal of Risk and Uncertainty* **13**, 263–275.

Jones-Lee, M. (1974), 'The Value of Changes in the Probability of Death or Injury', *Journal of Political Economy* **82**, 835–849.

Kahneman, D. & Knetsch, J. L. (1992), 'Valuing public goods: The purchase of moral satisfaction', *Journal of environmental economics and management* **22**, 57–70.

Kahneman, D., Ritov, I., Jacowitz, K. E. & Grant, P. (1993), 'Stated Willingness to Pay for Public goods: A Psychological Perspective', *Psychological Science* **4**(5), 310–315.

Kahneman, D., Ritov, I. & Schkade, D. (1999), 'Economic Preferences or Attitude Expressions?: An Analysis of Dollar Responses to Public Issues', *Journal of Risk and Uncertainty* **19**, 203–235.

Leiter, A. M. & Pruckner, G. J. (2007), Dying in an Avalanche: Current Risk and Valuation, Working paper, Department of Economics, University of Linz. `http://www.economics.uni-linz.ac.at/Pruckner/papers/risk.pdf`.

Little, R. J. A. & Rubin, D. B. (1987), *Statistical analysis with missing data*, John Wiley & Sons, Inc., New York.

Lundborg, P. & Lindgren, B. (2004), 'Do They Know What They are Doing? Risk Perceptions and Smoking Behavior Among Swedish Teenagers', *Journal of Risk and Uncertainty* **28**(3), 261–286.

Lusk, J. L., Nilsson, T. & Foster, K. (2007), 'Public Preferences and Private Choices: Effect of Altruism and Free Riding on Demand for Environmentally Certified Pork', *Environmental and Resouce Economics* **36**(4), 499–521.

Olsen, J. A., Donaldson, C. & Pereira, J. (2004), 'The insensitivity of 'willingness-to-pay' to the size of the good: New evidence for health care', *Journal of Economic Psychology* **25**, 445–460.

Olsen, J. A., Kidholm, K., Donaldson, C. & Shackley, P. (2004), 'Willingness to pay for public health care: a comparison of two approaches', *Health Policy* **70**, 217–228.

Powe, N. A. & Bateman, I. J. (2004), 'Investigating Insensitivity to Scope: A Split-Sample Test of Perceived Scheme Realism', *Land Economics* **80**(2), 258–271.

Slovic, P. (1987), 'Perception of Risk', *Science* **236**, 280–285.

Slovic, P., Fischhoff, B. & Lichtenstein, S. (2000), Facts and Fears: Understanding Perceived Risk, *in* P. Slovic, ed., 'The Perception of Risk', Earthsan Publications Ltd., London, pp. 137–153.

Sunstein, C. R. (1997), 'Bad Deaths', *The Journal of Risk and Uncertainty* **14**, 259–282.

Viscusi, W. K. (1990), 'Sources of Inconsistency in Societal Responses to Health Risks', *American Economic Review* **80**(2), 257–261.

Viscusi, W. K. & O'Connor, C. J. (1984), 'Adaptive Responses to Chemical Labeling: Are Workers Bayesian Decision Makers?', *American Economic Review* **74**(5), 942–956.

Whitehead, J. C. (1994), 'Item Nonresponse in Contingent Valuation: Should CV Researchers Impute Values for Missing Independent Variables?', *Journal of Leisure Research* **26**(3), 296–303.

University of Innsbruck – Working Papers in Economics and Statistics
Recent papers

2007-30 **Andrea M. Leiter and Gerald J. Pruckner:** Proportionality of willingness to pay to small changes in risk - The impact of attitudinal factors in scope tests.
2007-29 **Paul Raschky and Hannelore Weck-Hannemann:** Who is going to save us now? Bureaucrats, Politicians and Risky Tasks.
2007-28 **Harald Oberhofer and Michael Pfaffermayr:** FDI versus Exports. Substitutes or Complements? A Three Nation Model and Empirical Evidence.
2007-27 **Peter Wechselberger, Stefan Lang and Winfried J. Steiner:** Additive models with random scaling factors: applications to modeling price response functions.
2007-26 **Matthias Sutter:** Deception through telling the truth?! Experimental evidence from individuals and teams.
2007-25 **Andrea M. Leiter, Harald Oberhofer and Paul A. Raschky:** Productive disasters? Evidence from European firm level data.
2007-24 **Jesus Crespo Cuaresma:** Forecasting euro exchange rates: How much does model averaging help?
2007-23 **Matthias Sutter, Martin Kocher and Sabine Strauß:** Individuals and teams in UMTS-license auctions.
2007-22 **Jesus Crespo Cuaresma, Adusei Jumah and Sohbet Karbuz:** Modelling and Forecasting Oil Prices: The Role of Asymmetric Cycles.
2007-21 **Uwe Dulleck and Rudolf Kerschbamer:** Experts vs. discounters: Consumer free riding and experts withholding advice in markets for credence goods.
2007-20 **Christiane Schwieren and Matthias Sutter:** Trust in cooperation or ability? An experimental study on gender differences. *Conditionally accepted for publication in: Economics Letters.*
2007-19 **Matthias Sutter and Christina Strassmair:** Communication, cooperation and collusion in team tournaments – An experimental study.
2007-18 **Michael Hanke, Jürgen Huber, Michael Kirchler and Matthias Sutter:** The economic consequences of a Tobin-tax – An experimental analysis.
2007-17 **Michael Pfaffermayr:** Conditional beta- and sigma-convergence in space: A maximum likelihood approach.
2007-16 **Anita Gantner:** Bargaining, search, and outside options. *Revised version forthcoming in: Games and Economic Behavior.*
2007-15 **Sergio Currarini and Francesco Feri:** Bilateral information sharing in oligopoly.
2007-14 **Francesco Feri:** Network formation with endogenous decay.
2007-13 **James B. Davies, Martin Kocher and Matthias Sutter:** Economics research in Canada: A long-run assessment of journal publications. *Revised version forthcoming in: Canadian Journal of Economics.*
2007-12 **Wolfgang Luhan, Martin Kocher and Matthias Sutter:** Group polarization in the team dictator game reconsidered. *Revised version forthcoming in: Experimental Economics.*
2007-11 **Onno Hoffmeister and Reimund Schwarze:** The winding road to industrial safety. Evidence on the effects of environmental liability on accident prevention in Germany.
2007-10 **Jesus Crespo Cuaresma and Tomas Slacik:** An “almost-too-late” warning mechanism for currency crises.
2007-09 **Jesus Crespo Cuaresma, Neil Foster and Johann Scharler:** Barriers to technology adoption, international R&D spillovers and growth.
2007-08 **Andreas Brezger and Stefan Lang:** Simultaneous probability statements for Bayesian P-splines.
2007-07 **Georg Meran and Reimund Schwarze:** Can minimum prices assure the quality of professional services?.

2007-06 **Michal Brzoza-Brzezina and Jesus Crespo Cuaresma:** Mr. Wicksell and the global economy: What drives real interest rates?.

2007-05 **Paul Raschky:** Estimating the effects of risk transfer mechanisms against floods in Europe and U.S.A.: A dynamic panel approach.

2007-04 **Paul Raschky and Hannelore Weck-Hannemann:** Charity hazard - A real hazard to natural disaster insurance. *Revised version forthcoming in: Environmental Hazards.*

2007-03 **Paul Raschky:** The overprotective parent - Bureaucratic agencies and natural hazard management.

2007-02 **Martin Kocher, Todd Cherry, Stephan Kroll, Robert J. Netzer and Matthias Sutter:** Conditional cooperation on three continents.

2007-01 **Martin Kocher, Matthias Sutter and Florian Wakolbinger:** The impact of naïve advice and observational learning in beauty-contest games.

University of Innsbruck

Working Papers in Economics and Statistics

2007-30

Andrea M. Leiter and Gerald J. Pruckner

Proportionality of willingness to pay to small changes in risk - The impact of attitudinal factors in scope tests

Abstract

Sensitivity (proportionality) of willingness to pay to (small) risk changes is often used as a criterion to test for valid measures of economic preferences. In a contingent valuation (CV) study conducted in Austria, 1,005 respondents were asked their willingness to pay (WTP) for preventing an increase in the risk of being killed in an avalanche of 1/42,500 and 3/42,500 respectively. WTP for the higher variation in risk is significantly greater than WTP for the lower risk change. We find evidence that those respondents who have had personal experience of avalanches in recent years combine the information about future risk increase - as provided in the survey – with the observed number of fatal avalanche accidents in the past. Proportionality of WTP holds if such prior experience is taken into account and if attitudinal factors in scope tests are controlled for.

ISSN 1993-4378 (Print)
ISSN 1993-6885 (Online)