University of Innsbruck

# Working Papers in Economics and Statistics

**Dying in an Avalanche: Current Risks and their Valuation**

Andrea M. Leiter and Gerald J. Pruckner

2008-11

# Dying in an Avalanche: Current Risks and their Valuation

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

May 2008

[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 Linz, Altenbergerstraße 69, A-4040 Linz, Austria; 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, Claudia Eitzinger, Michael Pfaffermayr, and seminar participants at the Universities of Innsbruck and Maryland for helpful comments.

**Abstract**

This paper examines the influence of implicit information on willingness to pay (WTP) values for prevention of the risk of dying in an avalanche. We present the results of a contingent valuation (CV) study carried out in Austria in two different periods (fall 2004 and winter 2005). The comparison of WTP results between the two waves allows identification of whether the immediate occurrence of avalanches and their attendant fatal accidents affect individual risk evaluations. Individuals state a lower WTP in winter despite the fact that avalanche accidents are predominant at that time. Personal responsibility for risk exposure and its associated voluntariness are the main reasons for the decrease in WTP from the fall to the winter period. Preferences for alternative protective measures (against car accidents and food poisoning) also lead to a decrease of WTP, while a higher risk perception and personal experience of avalanches reveal a positive influence. We conclude that the change in WTP across seasons is not arbitrary but can be explained by specific risk characteristics.

*Keywords*: Contingent valuation, willingness to pay, risk prevention, risk perception.

*JEL classification*: D81, J17, Q51, Q54.

# 1 Introduction

Different disciplines examine the influence of information on individual assessment, consumer decisions and behavior and illustrate its importance for decision making. Sources of information are multi-purpose, and the individual process of gathering and processing information is complex. This paper examines the influence of information about risk exposure on the individual valuation of protective measures to prevent fatal avalanche accidents. The underlying Contingent Valuation (CV) data were collected in Austria in two different periods (September/October 2004 and February 2005) which differ in the frequency of avalanches. While avalanches do not occur in fall, they are common in winter. The second wave of data collection started after a period of heavy snowfall (February 2005) which contributed to a number of fatal avalanche accidents. Five individuals died in avalanches in the Austrian province of Tyrol in the first week of February 2005 alone – the equivalent of one fifth of all fatal avalanche accidents between December 2004 and March 2005 (ASI-Tirol, Alpine Safety & Information Center 2005). Local and national media report such fatalities for informative and/or preventive reasons. This raises the question as to what drives WTP for reduced risk of avalanche fatalities.

The potential for observed differences in individual risk assessment is extensive. Previous studies find that risk perception plays a decisive role for designing proper risk regulation policies. It has been argued that perception of risk is a complex process which is sensitive to cultural, social, and economic influences (Huang 1993, Slovic, Fischhoff and Lichtenstein 2000).

Moreover, apart from information provided by the CV survey, individuals are expected to derive implicit information from the current occurrence of avalanches and the associated media coverage. It seems reasonable that updating risk perceptions using information on current risks matters in individual valuation; an assumption that is supported by different studies. For example, Tversky and Kahneman (1982) argue that the ease with which an event can be brought to mind influences individual assessments. Frequent, familiar, salient, imaginable, and/or recent occurrences are more available and increase subjective perception (= "availability heuristic"). Liu, Hammitt, Wang and Tsou (2005) estimate values of statistical life (VSL) based on the risk reduction of dying from SARS and find - in comparison to earlier studies - higher values. They conclude that available information on current risks may be an explanation for their results. Signalling effects of events and the corresponding media coverage provide information on various levels which different people understand differently.

Slovic (1987) and Slovic et al. (2000) argue that the cause of harm matters and find that people include hazard characteristics such as dread, catastrophic potential, voluntariness, familiarity, or controllability, in their assessments. Kahneman, Ritov, Jacowitz and Grant (1993) show that WTP is higher for the correction of man-made harm than damage from natural causes because the former seems to be considered more upsetting by the individual ("outrage effect"). Walker, Morera, Vining and Orland (1999) state that the responsibility for damage can influence WTP in the opposite way: they find lower WTP to undo problems caused by humans compared to naturally occurring events ("responsibility effect").

This paper focuses on three research questions. First, we examine whether perceived risk influences the valuation process for avalanche risks. Second, with reference to the above-mentioned literature, we analyze whether attributes such as voluntariness, controllability or fairness determine individual risk assessment of fatal avalanche accidents. And third, the salience of avalanche dangers and the update of prior risk assessment due to new (implicit) information about risks may cause differences in individual risk-related characteristics between the periods. By comparing the responses in the two samples, we test whether the new survey circumstances and the associated signals have an impact on risk perception, risk attitude, and WTP.

The paper is organized as follows: Section 2 describes the survey design, the willingness to pay scenario, and the relevant risk characteristics. Section 3 explains the econometric estimation model and presents WTP figures. Section 4 discusses the time dependence of welfare measures and provides VSL estimates. Section 5 concludes.

# 2 Survey design

The study was carried out in the Austrian province of Tyrol. The total population of Tyrol is about 680,000, and its area is 12,600 km$^2$. It is situated in the middle of the Alps, and one third of its area is not habitable (glaciers, rocks, mountain pastures). Residential areas are often located in rather steep terrain and generally surrounded by mountains. Residents are therefore familiar with natural hazards such as landslides and avalanches and the exposure of inhabited areas to such dangers. The familiarity with avalanche risks may also arise from the fact that the average annual number of fatalities (over the last decade) due to avalanches totals 16 people.

A randomized quota sample was drawn from among the Tyrolean population aged over 17 years.[1] In personal interviews conducted at their permanent places of residence, the respondents were asked about their WTP to prevent an increase in the risk of dying in an avalanche. The data were collected in two waves, the first in September/October 2004, and the second in February 2005. Almost 1,600 observations (953 in fall and 634 in winter) have been used to examine the influence of current avalanche occurrence on WTP for protective measures.[2]

## 2.1 Socio-economic characteristics

Table 1 shows the socio-economic characteristics of the respondents and compares them with the attributes of the Tyrolean population. It can be seen that 53 percent of the respondents are female and 38 percent are single. The average respondent is 39 years old and lives in a household with 2.8 members. 86 percent of the interviewees were born in Austria and 51 percent smoke. The personal monthly take-home income is €

[1] The quota applied to the subjects' district of residence and size of domicile. Within the quota, random sampling was used.

[2] For the winter period, an additional sub sample consisting of 333 individuals who evaluated a quadruplication of the baseline risk is available. This data is used to test for scope effects (see Leiter and Pruckner (forthcoming) for further details).

1,120 on average.[3] Employment status, educational achievement, and (self-reported) health status are measured by categories ranging from "full-time employment" to "other", "elementary/junior high school" to "university", and "healthy" to "seriously disabled", respectively.[4] A comparison of the sample characteristics with the Census shows a good representation of population characteristics in terms of sex, birthplace, marital status, household members, health status, and income, while we observe differences in age, children per capita, smoking behavior, and in several items relating to education and employment.[5]

## 2.2 The WTP scenario

The survey focuses on WTP for the prevention of an increase in the risk of dying in an avalanche. After the respondents received a detailed description of the good in question, they were asked about their individual valuation. The wording of the CV question was as follows:

*Protective measures against avalanches on roads and in residential areas have been implemented in Tyrol. On average, 2.35 people out of 100,000 inhabitants are killed by avalanches at present. Assume that all public funds to maintain protective measures will be cut and henceforth servicing costs have to be paid exclusively by private funds. If aggregate private contributions are too small, maintenance is not carried out, and the probability of a fatal avalanche doubles. Then, on average 4.7 people out of 100,000 inhabitants die in the snow bulk (see Figure 1). Would you – given your income constraint – be willing to pay a monthly insur-*

[3]57.9 % (32.0 %) of respondents in the fall (winter) sample did not answer the income question.

[4]Health categories were provided and described by functionality examples (healthy: no diseases or only occasional short-lived diseases such as flu; moderate illness: chronic diseases such as hay fever and allergies; severe illness/severe disability: severe chronic illness or severe physical impairment, in need of long term care). The given categories are standard in self-reported health questions and therefore allow for comparison between different studies.

[5]Part of the discrepancy between sample and Census characteristics is due to different age classifications of variables in the two data sources. Moreover, selection effects cannot be ruled out. As an example, since the interviews took place at the respondents' residences people raising children had a higher chance of being encountered compared to childless interviewees.

**Table 1: Sample and population characteristics**

| Variable | Fall | | Winter | | Pooled | | Census |
|---|---|---|---|---|---|---|---|
| | Obs[I] | Mean | Obs[I] | Mean | Obs[I] | Mean | Mean |
| sex of respondent (female = 1, 0 otherwise) | 953 | 0.57 | 633 | 0.47 | 1586 | 0.53 | 0.52[a] |
| age of respondent (in years) | 936 | 40.25 | 617 | 36.17 | 1553 | 38.63 | 43.79[a] |
| marital status of respondent (single = 1, 0 otherwise) | 933 | 0.37 | 629 | 0.40 | 1562 | 0.38 | 0.35[a] |
| number of household members | 947 | 2.76 | 629 | 2.95 | 1576 | 2.78 | 2.56[b*] |
| children per capita | 953 | 0.47 | 634 | 0.35 | 1587 | 0.42 | 0.23[a] |
| birthplace of respondent (Austria = 1, 0 otherwise) | 953 | 0.90 | 634 | 0.80 | 1587 | 0.86 | 0.88[a*] |
| smoking behavior (smoker = 1, 0 otherwise) | 949 | 0.49 | 631 | 0.55 | 1580 | 0.51 | 0.30[c] |
| personal take home income per month | 401 | 1.05 | 431 | 1.17 | 832 | 1.12 | 1.11[d] |
| *Self reported health status of respondent* | | | | | | | |
| healthy | 923 | 0.76 | 618 | 0.77 | 1541 | 0.76 | 0.80[c] |
| moderate illness | 923 | 0.20 | 618 | 0.19 | 1541 | 0.20 | 0.16[c] |
| bad illness/bad disability | 923 | 0.04 | 618 | 0.04 | 1541 | 0.04 | 0.04[c] |
| *Former education of respondent* | | | | | | | |
| elementary/junior high school | 941 | 0.19 | 629 | 0.21 | 1570 | 0.20 | 0.37[a] |
| apprenticeship | 941 | 0.35 | 629 | 0.33 | 1570 | 0.34 | 0.33[a] |
| vocational school | 941 | 0.15 | 629 | 0.16 | 1570 | 0.15 | 0.13[a] |
| secondary school/post-secondary courses[II] | 941 | 0.21 | 629 | 0.23 | 1570 | 0.22 | 0.10[a] |
| college/university | 941 | 0.10 | 629 | 0.07 | 1570 | 0.09 | 0.07[a] |

To be continued on next page . . .

| **Variable** | **Fall** | | **Winter** | | **Pooled** | | **Census** |
|---|---|---|---|---|---|---|---|
| | **Obs** | **Mean** | **Obs** | **Mean** | **Obs** | **Mean** | **Mean** |
| *Employment status of respondent* | | | | | | | |
| employed fulltime (38 working hours per week) | 937 | 0.49 | 622 | 0.58 | 1559 | 0.53 | 0.48[a] |
| employed parttime | 937 | 0.10 | 622 | 0.10 | 1559 | 0.10 | 0.07[a] |
| employed shorttime (monthly income not over € 323.46) | 937 | 0.02 | 622 | 0.02 | 1559 | 0.02 | 0.03[a] |
| retired | 937 | 0.15 | 622 | 0.11 | 1559 | 0.13 | 0.22[a] |
| homemaker | 937 | 0.05 | 622 | 0.02 | 1559 | 0.04 | 0.10[a] |
| student | 937 | 0.11 | 622 | 0.09 | 1559 | 0.10 | 0.06[a] |
| unemployed | 937 | 0.02 | 622 | 0.02 | 1559 | 0.02 | 0.03[a] |
| others | 937 | 0.06 | 622 | 0.06 | 1559 | 0.06 | 0.02[a] |

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

[II] The Austrian educational system provides a 2-years-program ("post-secondary courses") designed for students who did not get vocational education in their secondary school.

[a] Population in 2001. Source: Statistics Austria. Statistical Yearbook 2005, Table 2.14.

[b] Source: Tyrolean Provincial Government 2004. Tyrolean Population - Results of the Census 2001, Table 25.

[c] Population in 1999 > 15. Source: Tyrolean Provincial Government 2003. Gesundheitsbericht 2002, Table 3.4.1.

[d] Monthly take home income (= annual income/14; in 1,000 €) of employees in 2003. Source: Statistics Austria, Statistical Yearbook 2005, Table 9.07.

* The exclusion of children was not possible.

The survey sample refers to Tyroleans $\geq 18$ interviewed in September/October 2004 and February 2005. The Census represents the whole population of Tyrol (= 673,504) in 2001 (exceptions are mentioned). Where feasible, children $< 15$ (= 123,855) are excluded for comparison reasons.

*ance premium of € 2.5/5/10 to maintain the effect of previous protective measures to save human lives?*

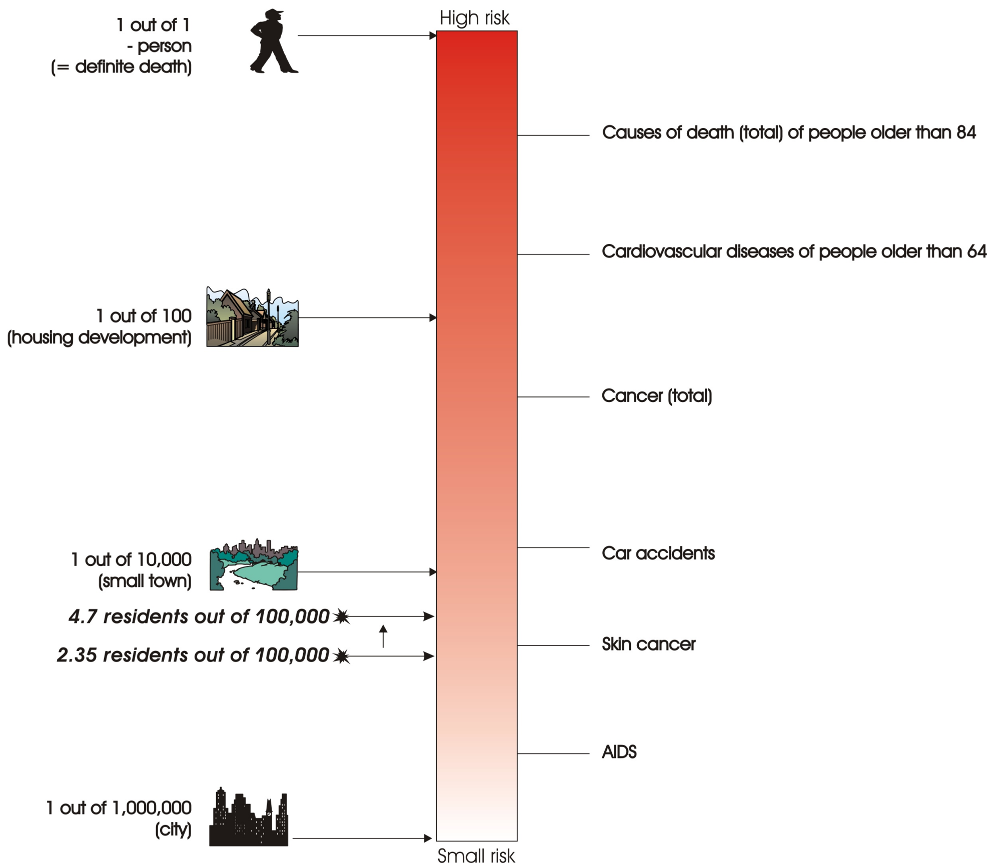


Figure 1: Causes of deaths in Tyrol in the year 2002

Depending on the answer to this initial question, the respondent was asked whether she would also pay € 5/10/20 to avoid the risk increase if the first bid was accepted, or € 1.3/2.5/5 if the first bid was rejected.[6] If the interviewee answered "no - no" or "do not know - no" she was asked whether she would be prepared to pay any positive amount. In the event of a negative reply interviewees were also asked why they refused to contribute.[7] Of the zero WTP responses, answers indicating a general refusal of payments for protection against natural hazards or stating that it was the government's responsibility to care about the protection

[6]Answers from an open-ended pretest were used to define the range of the bid vector.

[7]A "do not know" category was accepted as a response.

of citizens were classified as protest responses. This definition applies to 177 (100) out of 953 (634) answers in the fall (winter) sample. The payment vehicle "insurance premium" was used since Austrian respondents are familiar with monthly premiums to be paid in other (health) risk-related markets (voluntary and obligatory health insurance). Moreover, the obviously negative attitude of respondents towards taxes can be avoided. Hackl and Pruckner (2005) and Olsen, Kidholm, Donaldson and Shackley (2004) discuss the advantages of insurance premiums over alternative payment vehicles.

Several questions preceded the payment question to familiarize respondents with the topic and the good to be valued. First, the respondents' comprehension of the probability concept was tested.[8] Second, the interviewees were introduced to the notion of mortality risks and subsequently asked how many people they thought died on average in an avalanche per year. And finally, they were given information about the actual annual risk of dying in an avalanche in Tyrol. Moreover, in winter particularly the media address the issues by reporting current avalanche accidents and by informing residents and tourists about the actual danger of avalanches so that they can take reasonable precautions.

Respondents showed little difficulty answering the valuation question – only 43 respondents from the fall sample and 25 from the winter sample did not answer the payment question. Several plausibility checks did not reveal any problems regarding comprehension of the valuation scenario. In addition, based on their interactions with respondents, the interviewers reported few, if any, respondent difficulties.[9]

[8] 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.

[9] Prior to the implementation of the survey studies, the questionnaire was pretested by 200 economics and management students at the University of Innsbruck (Austria).

## 2.3 Risk characteristics and individual attitudes in risk valuation

Information was collected not only about socio-economic variables, but also on risk-related attitudes and behavior to test for internal validity of WTP. Furthermore, the implementation of two waves allows analysis of changes over time. We investigate whether the occurrence of avalanches in winter influences stated WTP and test such influences by including a time dummy and interaction terms with specific risk characteristics (e.g. voluntariness, subjective risk estimates). The sampled risk-related factors are:

- *Risk perception*: To help them visualize the risk, respondents were presented with a risk ladder (see Figure 1).[10] The bottom and top of this graph indicate the lowest and highest risk (= death), respectively. Different mortality risks, such as cancer, AIDS or car accidents are plotted along this logarithmic scale to show the relative magnitudes of different risks. Moreover, the dimension of the risks is stated as the number of affected persons in differently sized populations. Before they were presented with the current avalanche risk, respondents were asked to draw a bar where they thought the average risk of dying in an avalanche would be. The corresponding variable *percept* ranges between 0 (= lowest risk) and 131 (= death) and denotes the distance from the bottom to the self-plotted line, measured in millimeters on the scale. The variable represents the individual risk assessment of avalanches in relation to other mortality risks. Although the respondents receive identical information about the current baseline risk and the future change in risk, the subjective baseline risk assessment may influence individual WTP. We expect an increase in WTP with a higher assessment of the average avalanche risk.

  Table 2 shows the individual assessment of the average risk of being killed in an avalanche in Tyrol. The winter sample evaluates

[10] The layout of Figure 1 is based on the results of Corso, Hammitt and Graham (2001).

this risk as significantly higher (at a 1 percent level) than the respondents in the fall sample. Even though the mean of winter respondents is higher than in fall (26.61 vs. 23.23), it still underestimates the true risk of fatal avalanche accidents (30). Several studies (Hanley, Shogren and White 1997, Viscusi 1990) find that people overestimate small risks. Although the risk level for deadly avalanches is comparably small (1/42,500), the overestimation hypothesis cannot be supported by our data.

**Table 2: Perception of average avalanche risk**

| | **Fall** | **Winter** |
|---|---|---|
| Observations | 922 | 628 |
| Median | 20.00 | 22.00 |
| Mean | 23.23 | 26.61 |

- *Subjective avalanche risk (lowrisk)*: In addition, respondents were asked how they estimate their subjective risk of dying in an avalanche as compared to the average risk. When respondents state a below-average personal risk we expect a lower WTP, as this group might suppose any benefit from prevention of avalanche risks to be lower.

  Table 3 summarizes the responses concerning the personal risk of dying in an avalanche. Shanteau and Ngui (1989) point out that people tend to believe they are inviolable and therefore underestimate their vulnerability to specific risks. While the proportion of those who estimate their personal risk to be higher (equal) than the average is smaller (higher) in the winter sample, the percentages for the category "lower" is almost the same in both waves. Analogous to Slovic, Fischhoff and Lichtenstein (1982), it can be argued that reports about avalanche accidents may provide indirect confirmation of lower personal risk: if those who initially regarded themselves as highly endangered are not affected by the reported events, they may infer that greater confidence is warranted and reduce their risk estimates.

**Table 3: Assessment of individual risk compared to average risk**

| | Fall | | Winter | |
|---|---|---|---|---|
| **Individual risk** | **Freq.** | **Percent** | **Freq.** | **Percent** |
| higher | 76 | 7.97 | 34 | 5.36 |
| equal | 166 | 17.42 | 139 | 21.92 |
| lower | 672 | 70.51 | 448 | 70.66 |
| missing | 39 | 4.09 | 13 | 2.05 |
| Total | 953 | 100.00 | 634 | 100.00 |

- *Skiing (skiing)*: Skiers are expected to show a higher WTP as they benefit especially from avalanche protection.

- *Risk aversion*: Seven different questions in the survey instrument capture individual behavior in risky situations. Respondents were asked whether they (1) wear seat belts when they travel by car, (2) use sun screen, (3) wear cycle helmets, (4) gamble, (5) would prefer a high-risk lottery to a lower-risk one, (6) would defend an unpopular opinion, and (7) would pass a friend's/team mate's work or idea off as theirs. The answers to these questions (e.g. always, mostly, sometimes, never), reflecting the frequency of such behavior, are subsequently transformed into values from 0 to 3 for each question, with 0 representing a risky and 3 a risk-averse behavior. Hence, the variable *riskaversion* ranges between 0 (risk loving) and 21 (risk averse).[11]

  Eeckhoudt and Hammitt (2004) examine the influence of financial risk aversion on WTP for a reduction of mortality risks. They find that the relationship between risk aversion and the VSL is ambiguous in many cases and depends on the characteristics of

[11] (Almost) everyone is either a driver or front seat passenger, so that all individuals are confronted with wearing seat belts in a car or not. In Austria, bikes are frequently used as means of transportation and for sporting activities (e.g. mountain biking). Again, the question of wearing cycling helmets seems to be relevant for the vast majority of respondents. Descriptive statistics confirm this supposition: 1,580 (1,418) out of 1,587 individuals answered the question on whether or not they wear seat belts (cycling helmets).

the utility function which are held constant (when risk aversion changes), as well as on the assumptions about marginal utility for wealth conditional on death. The authors show the ambiguity of the aversion effect particularly in the case of a partial reduction of mortality risks, i.e., depending on the local concavity of the utility function, risk aversion may either lead to an increase or a decrease in WTP. We examine the influence of risk aversion on prevention of avalanche risk (1/42,500) specifically.

- *Preferences for alternative protective measures:* Respondents were asked whether they value alternative protective measures, for example against fatal car accidents, air pollution, food poisoning, rockfalls, floods, and radiation as more/equal/less important than measures against avalanches, even if these different measures would save the same number of people. A lower WTP is anticipated as the respondents prefer alternative protective measures.

  Table 4 shows that in both sub-samples more than 50 percent of respondents would prefer protection against fatal car accidents. Moreover, for most risk categories the percentages of those who prefer alternative measures are higher in the fall sample as compared to the winter respondents. Interviewees are apparently more concerned about avalanche protection in winter, a fact that may be attributed to the frequent occurrence of avalanches in this period. The two important categories which do not comprise natural hazards are included in the regression analysis: traffic risks and food poisoning. We create a dummy variable *impalter* indicating preferences for alternative protective measures. It takes a value of 1 if respondents value mitigating car accidents and food poisoning as more important than protective measures against avalanches.

- *Personal experience of avalanches (famexp)*: We asked the respondents whether they or their dependents had been affected by avalanches in the past, as in this case we assume a stronger concern and therefore higher WTP to prevent avalanche risks among these individuals.

**Table 4: Importance of alternative protective measures compared to avalanche risks**

| | Traffic Accidents % | Air Pollution % | Food Poisoning % | Rockfall % | Flood % | Radiation % |
|---|---|---|---|---|---|---|
| **Fall** | | | | | | |
| more | 63.69 | 34.63 | 24.45 | 25.81 | 22.67 | 16.16 |
| equal | 31.48 | 48.79 | 40.61 | 63.27 | 57.40 | 41.24 |
| less | 3.15 | 13.64 | 31.37 | 8.29 | 16.37 | 39.14 |
| missing | 1.68 | 2.94 | 3.57 | 2.62 | 3.57 | 3.46 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Winter** | | | | | | |
| more | 50.63 | 37.07 | 21.14 | 20.50 | 16.09 | 11.20 |
| equal | 44.01 | 47.63 | 41.96 | 61.51 | 57.10 | 40.38 |
| less | 4.10 | 13.72 | 34.23 | 13.88 | 23.19 | 44.32 |
| missing | 1.26 | 1.58 | 2.68 | 4.10 | 3.63 | 4.10 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

- *Origin of deadly avalanches*: The questionnaire provides information as to who or what is seen as responsible for avalanche accidents. Respondents were asked whether they think that avalanches are always/mostly/seldom/never caused by humans, by nature or by acts of God/fate. We create two dummies, *anthropogen* and *natural*, which indicate whether the respondents regard avalanches as being caused by humans or occurring naturally. The dummy is one if the respondents state that avalanches are always caused by humans (nature), and zero for the categories mostly/seldom/never. According to Sunstein (1997), who points out that the voluntariness of risk exposure may be connected with who is seen as responsible for deadly avalanches, the variables *anthropogen* and *natural* are interpreted as indicators of voluntary and manageable risks. Those who state that people themselves are responsible for fatal avalanche accidents probably assume that individuals can choose their level of exposure to that risk. Hence, the probability of affirmative answers from this group may be expected to be lower.

The opposite is expected for those who consider avalanches to be a natural phenomenon. If they assume that risk exposure is not voluntary and/or not manageable protective measures against avalanches should become more valuable, inducing a positive influence on the probability of a "yes" answer. These arguments are in line with Walker et al. (1999), who discuss the importance of "moral responsibility" for damage in the individual valuation process. The authors find higher WTP values for undoing damage caused by natural events compared to anthropogenic damage when someone else can be blamed for the loss. Cookson (2000), Lesser, Dodds and Zerbe (1997), Slovic et al. (2000), and Sunstein (1997) have examined these hypotheses too. For example, Lesser et al. (1997) argue that the possibility of a choice between different risk levels considerably influences the individual risk valuation. If no option is available and risk-averse people face a given and uniform risk level, they state a higher WTP for a risk reduction in comparison to situations where they can choose the extent of risk exposure.

In contrast, Kahneman et al. (1993) predict a higher (lower) WTP for anthropogenic (natural) events according to the "outrage effect". This argument challenges the economic interpretation of WTP as a measure to reveal economic preferences. However, another economic explanation may be provided for such impacts: effectiveness considerations may influence the individual valuation process. Respondents may consider protective measures against forces of nature as ineffective and a waste of money, whereas, in cases of human failure and/or human misbehavior, risk prevention seems to be feasible and reasonable.

Table 5 shows that 37 percent of respondents in the winter sample think that humans always cause deadly avalanches, whereas this proportion is significantly lower (32 percent) in the fall. This may be explained by the fact that in the winter of 2004/2005 each of the

25 fatal avalanche accidents occurred out of the way of the pistes on the land, i.e. neither on traffic routes nor in residential areas.[12]

**Table 5: Perceived origin of deadly avalanche accidents**

| | Nature | | Humans | | Fate | |
|---|---|---|---|---|---|---|
| | **Freq.** | **Percent** | **Freq.** | **Percent** | **Freq.** | **Percent** |
| **Fall** | | | | | | |
| always | 328 | 34.42 | 308 | 32.32 | 142 | 14.90 |
| mostly | 367 | 38.51 | 524 | 54.98 | 178 | 18.68 |
| seldom | 208 | 21.83 | 102 | 10.70 | 365 | 38.30 |
| never | 34 | 3.57 | 5 | 0.52 | 243 | 25.50 |
| missing | 16 | 1.68 | 14 | 1.47 | 25 | 2.62 |
| Total | 953 | 100.00 | 953 | 100.00 | 953 | 100.00 |
| **Winter** | | | | | | |
| always | 206 | 32.49 | 236 | 37.22 | 99 | 15.62 |
| mostly | 247 | 38.96 | 352 | 55.52 | 112 | 17.67 |
| seldom | 146 | 23.03 | 33 | 5.21 | 242 | 38.17 |
| never | 23 | 3.63 | 4 | 0.63 | 170 | 26.81 |
| missing | 12 | 1.89 | 9 | 1.42 | 11 | 1.74 |
| Total | 634 | 100.00 | 634 | 100.00 | 634 | 100.00 |

# 3 WTP for risk prevention

The aim of this study is to calculate and analyze individual WTP for risk variation which can be introduced in a cost-benefit analysis (CBA). In the underlying valuation process the risk increase can be avoided by maintaining existing protective measures. Risk-averse individuals perceive prevention of risk as an improvement in their welfare. Hence, their WTP to obtain the less risky status should be non-negative. A WTP distribution which only allows zero or positive values therefore seems appropriate. The Weibull and the log-normal are common distribution functions for positive WTP values (Alberini 2004, Haab and McConnell 1997)

[12] Even though the two categories “nature” and “fate” appear to be similar, perception of fateful or “act of God” events seems to be dominated by indefinable and divine forces.

and are used to estimate mean and median WTP. Our empirical analysis is based on a double-bounded dichotomous choice format (DBDC). The underlying specification reads as:

$$WTP_i^* = \mathbf{X_i}\beta + \epsilon_i \tag{1}$$

with $WTP_i^*$ representing the latent individual WTP for the prevention of an increase in risk and $\mathbf{X_i}$ is the vector of individual socio-economic and risk-related attributes. $\beta$ is the vector of coefficients to be estimated, and $\epsilon_i$ denotes the error term. In a DBDC format we use the following dummy variables to capture the sequence of "yes(y)" and "no(n)" answers for individual $i$:

$$\begin{aligned} d_i^{yy} &= 1 \text{ if } WTP_i^* \geq B_i^H; \\ d_i^{yn} &= 1 \text{ if } B_i^I \leq WTP_i^* < B_i^H; \\ d_i^{ny} &= 1 \text{ if } B_i^L \leq WTP_i^* < B_i^I; \\ d_i^{nn} &= 1 \text{ if } WTP_i^* < B_i^L; \end{aligned} \tag{2}$$

where $B_i^H$, $B_i^I$, $B_i^L$ represent the higher, the initial, and the lower bid an individual is confronted with. A maximum likelihood procedure is used to estimate the coefficients in the WTP function. In the likelihood function each response is represented with its probability

$$\begin{aligned} &Pr(\mathbf{X}_i\beta + \epsilon_i \geq B_i^H)^{d_i^{yy}} * Pr(B_i^I \leq \mathbf{X}_i\beta + \epsilon_i < B_i^H)^{d_i^{yn}} * \\ &Pr(B_i^L \leq \mathbf{X}_i\beta + \epsilon_i < B_i^I)^{d_i^{ny}} * Pr(\mathbf{X}_i\beta + \epsilon_i < B_i^L)^{d_i^{nn}} \end{aligned} \tag{3}$$

which is equivalent to

$$\begin{aligned} &[1 - F(B_i^H;\tau)]^{d_i^{yy}} * [F(B_i^H;\tau) - F(B_i^I;\tau)]^{d_i^{yn}} \\ &*[F(B_i^I;\tau) - F(B_i^L;\tau)]^{d_i^{ny}} * F(B_i^L;\tau)^{d_i^{nn}} \end{aligned} \tag{4}$$

where $F(\bullet)$ denotes the cumulative distribution function (cdf) and $\tau$ the parameter vector to be estimated. In accordance with Cameron and

James (1987), let $\alpha_i = \mathbf{X_i}\beta/\sigma$ and $\gamma = -(1/\sigma)$.[13] Substituting the corresponding cdf of the log-normal distribution for $F(\bullet)$ in (4) and combining it with (2) leads to the following log likelihood function:

$$LogL_{logn} = \sum_{i=1}^{N} \left\{ \begin{array}{l} d_i^{nn} \ln[\Phi(\alpha_i + \gamma\ lnB_i^L)] + \\ d_i^{yy} \ln[1 - \Phi(\alpha_i + \gamma\ lnB_i^H)] + \\ d_i^{yn} \ln[\Phi(\alpha_i + \gamma\ lnB_i^H) - \Phi(\alpha_i + \gamma\ lnB_i^I)] + \\ d_i^{ny} \ln[\Phi(\alpha_i + \gamma\ lnB_i^I) - \Phi(\alpha_i + \gamma\ lnB_i^L)] \end{array} \right\} \tag{5}$$

where $\Phi(\bullet)$ denotes the cumulative density for the log-normal. Under the assumption of a Weibull distribution $F(WTP_i^*) = 1 - \exp(-(B_i^\bullet/\lambda_i)^\rho)$ with shape parameter $\rho$ and scale parameters $\lambda_i$ the log likelihood function can be written as:[14]

$$LogL_{weib} = \sum_{i=1}^{N} \left\{ \begin{array}{l} d_i^{nn} \ln[1 - \exp(-(\frac{B_i^L}{\lambda_i})^\rho)] + \\ d_i^{yy} \ln[\exp(-(\frac{B_i^H}{\lambda_i})^\rho)] + \\ d_i^{yn} \ln[\exp(-(\frac{B_i^I}{\lambda_i})^\rho) - \exp(-(\frac{B_i^H}{\lambda_i})^\rho)] + \\ d_i^{ny} \ln[\exp(-(\frac{B_i^L}{\lambda_i})^\rho) - \exp(-(\frac{B_i^I}{\lambda_i})^\rho)] \end{array} \right\} \tag{6}$$

Depending on the chosen distribution function, mean and median WTP are calculated (Model 1) as:

$$\begin{aligned} mean_{logn} &= \exp[-(\tfrac{\alpha_i}{\gamma}) + 0.5\ (\tfrac{1}{\gamma})^2] \\ median_{logn} &= \exp[-(\tfrac{\alpha_i}{\gamma})] \end{aligned} \tag{7}$$

$$\begin{aligned} mean_{weib} &= \lambda_i \Gamma(\tfrac{1}{\rho} + 1) \\ median_{weib} &= \lambda_i [-ln(0.5)]^{\frac{1}{\rho}} \end{aligned} \tag{8}$$

with $\Gamma(\bullet)$ representing the Gamma function. Those respondents who accepted neither the initial nor the lower bid were subsequently asked

[13] $\sigma$ represents the standard deviation of the log-normal.

[14] In the Weibull variant the error term follows the Type I extreme value distribution. Hence, the scale parameter varies across individuals: $\lambda_i = exp(\mathbf{X_i}\beta)$.

whether they would be willing to pay any positive amount. This allows a distinction to be made between the two sub-groups: respondents whose WTP is definitely zero and individuals with a positive WTP that falls below the lower bid. Utilizing this information we estimate a second model (Model 2) with mean and median WTP being calculated as the weighted sum of the mean and median for sub-group 1 with zero WTP (mean = median = 0) and for the group of respondents with positive WTP, again following the log-normal and the Weibull distribution. Descriptive results from the surveys can be used directly to estimate the weighted welfare measures: 48.5 percent (49.4 percent) state a positive WTP in the fall (winter) sample. Multiplying these percentages by the mean WTP of this group (positive WTP statements) of respondents, we get mean values which account for the significant number of observable zero responses. Thus, "spike models" that assign some positive probability to zero WTP (spike at 0) represent a more appropriate approximation of the true WTP distribution.

The following Table 6 illustrates the sequence of answers to the WTP questions.[15] As expected, both the fall and the winter sample show a decrease (increase) in the number of positive (negative) responses for increasing bids. However, the proportion of "yes-yes" statements in the winter sample is always slightly lower than in the first wave. The percentages in the last row of Table 6 show that the observed differences between the two sub-samples are modest.

The estimation of mean WTP is based on the answers of 953 respondents in fall and 634 persons in winter. First, only the bid structure, a constant term, and the period dummy *winter* are included as explanatory variables, which means that WTP within the yy, yn, ny and nn groups is the same for each respondent. The corresponding means and medians are listed in Table 7. Depending on the chosen model and on the distribution function, mean (median) WTP for protective measures varies between 3.60 € and 6.17 € (0 € and 1.71 €) per month. Moreover, the results show that mean and median WTP is lower in winter as compared

[15]The first (second) letter indicates the response to the initial (following) question. yn means a positive "yes" answer is followed by a negative "no" reply.

**Table 6: Response sequence to payment questions**

| initial bid | Fall | | | | | Winter | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | yy | yn | ny | nn | Tot | yy | yn | ny | nn | Tot |
| 2.5 | 54 | 74 | 36 | 148 | 312 | 45 | 53 | 22 | 145 | 265 |
| | 17.3 | 23.7 | 11.5 | 47.4 | 100.0 | 17.0 | 20.0 | 8.3 | 54.7 | 100.0 |
| 5.0 | 34 | 55 | 39 | 201 | 329 | 18 | 26 | 30 | 109 | 183 |
| | 10.3 | 16.7 | 11.9 | 61.1 | 100.0 | 9.8 | 14.2 | 16.4 | 59.6 | 100.0 |
| 10.0 | 21 | 48 | 33 | 210 | 312 | 9 | 37 | 20 | 120 | 186 |
| | 6.7 | 15.4 | 10.6 | 67.3 | 100.0 | 4.8 | 19.9 | 10.8 | 64.5 | 100.0 |
| Total | 109 | 177 | 108 | 559 | 953 | 72 | 116 | 72 | 374 | 634 |
| | 11.4 | 18.6 | 11.3 | 58.7 | 100.0 | 11.4 | 18.3 | 11.3 | 59.0 | 100.0 |

to the fall period; however, the differences are not statistically significant. As was mentioned before this may be associated with a changing influence of specific risk characteristics over time – an issue to be discussed in detail in the next section.

**Table 7: Mean and median WTP in € per month: bid and constant**

| | Weibull | | | Log-normal | | |
|---|---|---|---|---|---|---|
| | Fall | Winter | Diff.[a] | Fall | Winter | Diff.[a] |
| Observations | 953 | 634 | | 953 | 634 | |
| Mean – Model 1 | 4.67 | 4.36 | 0.31 | 6.17 | 5.66 | 0.51 |
| | (0.30) | (0.34) | (0.43) | (0.56) | (0.57) | (0.57) |
| Mean – Model 2 | 3.85 | 3.60 | 0.25 | 4.28 | 4.05 | 0.23 |
| | (0.18) | (0.20) | (0.27) | (0.25) | (0.27) | (0.31) |
| Median – Model 1 | 1.64 | 1.53 | 0.11 | 1.71 | 1.57 | 0.14 |
| | (0.13) | (0.14) | (0.15) | (0.12) | (0.13) | (0.16) |
| Median – Model 2 | 0 | 0 | 0 | 0 | 0 | 0 |

[a] Difference between fall and winter values.
Standard errors (delta method) in parentheses.

# 4 Time dependence of WTP and the VSL

Table 8 depicts the full model regression results for the Weibull and log-normal WTP distribution and provides a short description of all the variables included. The focus of the empirical analysis is on the influence of socio-economic characteristics on WTP and on the effect of risk-related attributes and changes in these over time. Time dependence of valuations is captured by including a dummy *winter* for the February 2005 subsample and several interaction terms of risk-specific characteristics with this seasonal dummy.

It can be seen that the influence of the variables is quite robust for the different distribution assumptions. The coefficients for age *age*, education level *alevel*, assessment of avalanches as a natural event *natural*, preference for other protective measures *impalter*, and whether a person is of normal weight *normalweight* show significantly negative signs. The negative coefficient of *impalter* meets expectations as it indicates a lower WTP for those who prefer alternative protective measures over protection against avalanches. A reasonable explanation for the negative impact of education is that highly educated people may believe that they could reduce their individual risk at low cost by avoiding dangerous areas.[16] The negative coefficient on *natural* (significant in the Weibull model) supports the validity of the aforementioned effectiveness hypothesis. Individuals may suppose that effective reduction of avalanche risks is not possible in the case of natural events.[17] This assumption is strengthened by the positive and significant impact of *anthropogen*. Respondents seem to be willing to support the prevention of man-made risks, which is also in line with the "moral responsibility" hypothesis if it is assumed that involved persons feel responsible for the loss or damage occurring (Walker et al. 1999).

The variables *female*, *lnincome*, *famexp*, *percept*, and *skiing* show a significantly positive influence. Women state a higher WTP. The same

[16] See Alberini, Cropper, Krupnick and Simon (2004).

[17] If we pool the "natural" and "fateful" events and include the corresponding dummy – which is one if respondents think that avalanches are always caused by nature or are always an act of God – the effect is still negative but no longer significant.

is true for skiers and people who have had personal experience of avalanches. Moreover, the affirmation of payment increases with an increase in income[18] and with a higher risk perception. Other positive and significant variables are: whether a person volunteers *volunteer*, whether a person faces risks at work *jobrisk*, and whether a respondent gets regular exercise *weeklysport*.[19]

The positive sign of *lowrisk* is unexpected at first glance. It shows that people are willing to support protective measures even if they assess their personal risk of dying in an avalanche as below average. However, both the positive sign of *volunteer* and *lowrisk* may indicate the importance of altruistic preferences.[20]

The most surprising result is the negative (although statistically not significant) coefficient of the winter dummy. As was seen before in Table 7 the salience of avalanche accidents in winter and the associated media coverage do not cause an exogenous shift in willingness to pay; the observed differences between the two waves can rather be explained by a change in risk characteristics over time.

Our data allow us to gain deeper insight into which variables may cause the observed variation in WTP between the periods. The coefficient of the interaction term *perceptw* reveals that the positive impact of risk perception is more pronounced in winter. Whereas the variable indicating whether avalanches are regarded as anthropogenic events *anthropogen* shows a positive sign, its interaction with the period dummy *anthropogenw* is significantly negative. In other words, the occurrence of avalanche accidents in winter causes a change in respondents' attitudes towards self-responsiveness. This strengthens the psychological view that (deadly) avalanches – when seen as anthropogenic events – are being im-

[18] As the indicator variable for missing income *missincome* depicts, the effect of income on WTP is significantly lower for those respondents who refused to provide information about their personal income.

[19] The variables *jobrisk*, *normalweight* and *weeklysport* are introduced to test for the "background risk hypothesis" (Eeckhoudt and Hammitt 2001). Eeckhoudt and Hammitt (2001) find that if the marginal utility of bequest is positive and high competitive risks (background risks) occur, WTP for reducing a specific mortality risk is smaller due to lower benefits from risk reduction when respondents still face a high remaining risk level.

[20] The interaction term *lowriskvol* is significantly negative. People seem to be willing to volunteer or to pay for socially desirable projects, but do not support both.

**Table 8: Estimated Coefficients for the DBDC model (Weibull and Log-normal)**

Dependent variable: bid interval

| | ***WEIBULL*** | | ***LOG-NORMAL*** | |
|---|---|---|---|---|
| **Variable** | ***Coef.*** | ***Std. Err.*** | ***Coef.*** | ***Std. Err.*** |
| *winter* | 0.013 | 0.263 | −0.006 | 0.275 |
| *age* | −0.007** | 0.003 | −0.007** | 0.003 |
| *female* | 0.119 | 0.095 | 0.162* | 0.098 |
| *lnincome* | 0.240*** | 0.092 | 0.210** | 0.093 |
| *missincome* | −0.209** | 0.097 | −0.189* | 0.100 |
| *alevel* | −0.295*** | 0.101 | −0.400*** | 0.107 |
| *housemember* | 0.045 | 0.028 | 0.029 | 0.025 |
| *volunteer* | 0.556*** | 0.189 | 0.574*** | 0.184 |
| *famexp* | 0.344*** | 0.116 | 0.385*** | 0.114 |
| *percept* | 0.009*** | 0.003 | 0.008*** | 0.003 |
| *lowrisk* | 0.320** | 0.146 | 0.266* | 0.152 |
| *lowriskvol* | −0.541** | 0.227 | −0.612*** | 0.226 |
| *anthropogen* | 0.300** | 0.126 | 0.298** | 0.128 |
| *natural* | −0.226* | 0.122 | −0.204 | 0.127 |
| *skiing* | 0.241* | 0.128 | 0.252* | 0.134 |
| *riskaversion* | 0.021 | 0.018 | 0.030 | 0.019 |
| *missaversion* | 0.220 | 0.261 | 0.240 | 0.271 |
| *impalter* | −0.363** | 0.151 | −0.274* | 0.158 |
| *perceptw* | 0.009** | 0.005 | 0.010** | 0.004 |
| *anthropogenw* | −0.546*** | 0.192 | −0.508** | 0.197 |
| *naturalw* | 0.193 | 0.195 | 0.220 | 0.202 |
| *impalterw* | −0.138 | 0.253 | −0.109 | 0.269 |
| *lowriskw* | −0.104 | 0.206 | −0.148 | 0.211 |
| *skiingw* | −0.383** | 0.187 | −0.370* | 0.193 |
| *jobrisk* | 0.167* | 0.098 | 0.206** | 0.101 |
| *normalweight* | −0.263*** | 0.096 | −0.248** | 0.099 |
| *nosmoke* | −0.140 | 0.095 | −0.097 | 0.098 |
| *weeklysport* | 0.372*** | 0.099 | 0.382*** | 0.104 |
| *constant* | −1.245* | 0.725 | −1.694** | 0.741 |
| *Observations* | 1508 | | 1508 | |
| $Wald - \chi^2(28\text{df})$ | 140 | | 157 | |
| *Log Likelihood* | -1626 | | -1636 | |

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

| Variable | Description |
|---|---|
| *age* | Age of respondent in years. |
| *alevel* | Dummy = 1 if respondent has a university entrance diploma; 0 otherwise. |
| *anthropogen* | Dummy = 1 if respondent always regards avalanches as an anthropogenic event; 0 otherwise. |
| *famexp* | Dummy = 1 if respondent 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. |
| *lnincome* | Logarithm of personal monthly take home income; missing observations replaced by mean income. |
| *lowrisk* | Dummy = 1 if respondent assesses her personal risk of dying in an avalanche below average. |
| *lowriskvol* | Interaction term: lowrisk and volunteer. |
| *missincome* | Dummy = 1 if income is missing; 0 otherwise. |
| *missaversion* | Dummy = 1 if *riskaversion* is missing; 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. |
| *perceptw* | |
| *anthropogenw* | |
| *naturalw* | Interaction terms: risk characteristics and the period dummy. |
| *impalterw* | |
| *lowriskw* | |
| *skiingw* | |
| *riskaversion* | Respondent's behavior in risky situations. Ranges between 0 (risk lover) and 21 (risk averse); missing observations replaced by zero. |
| *percept* | 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. |
| *winter* | Dummy = 1 if the survey took place in February 2005; 0 otherwise. |

plicitly interpreted as voluntary and controllable risks, and this leads, as a consequence, to a reduced concern for their prevention. This also complies with the findings in Walker et al. (1999), who observe lower WTP to reduce damage if someone else can be made responsible for the loss. The interpretation seems appropriate, as all fatal avalanche accidents in the winter of 2004/2005 happened to occur out of the way of the pistes. Hence, respondents may think that the accidents could easily have been prevented by avoiding unsecured (ski) routes, and they are therefore less willing to spend money on avalanche protection. The same argument seems to be relevant even for skiers, as their interaction term *skiingw* in the Weibull regression indicates a significantly lower valuation for this group too. The coefficients of the remaining variables are not significant.

Mean and median WTP based on the full model can be seen in Table 9. In support of our previous findings, the welfare measures for the fall sample are again higher as compared to the WTP figures in the winter sample.[21] However, the difference is only statistically significant for Model 1.

**Table 9: Mean and median WTP in € per month: complete structure**

| | **Weibull** | | | **Log-normal** | | |
|---|---|---|---|---|---|---|
| | **Fall** | **Winter** | **Diff.**[a] | **Fall** | **Winter** | **Diff.**[a] |
| Observations | 903 | 605 | | 903 | 605 | |
| Mean – Model 1 | 7.99 | 4.54 | 3.45** | 10.02 | 5.38 | 4.64** |
| | (1.50) | (1.03) | (1.56) | (2.00) | (1.25) | (1.94) |
| Mean – Model 2 | 4.99 | 3.80 | 1.19 | 5.39 | 4.48 | 0.91 |
| | (0.73) | (0.68) | (0.85) | (0.82) | (0.83) | (1.00) |
| Median – Model 1 | 3.31 | 1.88 | 1.43** | 3.36 | 1.80 | 1.56** |
| | (0.63) | (0.43) | (0.64) | (0.64) | (0.41) | (0.64) |
| Median – Model 2 | 0 | 0 | 0 | 0 | 0 | 0 |

[a] Difference between fall and winter values; ** indicates statistical significance at the 5% level.
Standard errors (delta method) in parentheses.

These figures – to be used in the subsequent calculation of VSLs – represent conservative estimates as protesters have been included and

[21] The estimates refer to an average respondent with mean (mode) values being used for continuous (indicator) variables.

treated as if they had responded "no". As mentioned, protesters are those respondents who indicate a general refusal of payments or who express the government's responsibility for the protection of citizens.[22]

- The value of statistical life

The VSL is defined as the rate at which people are willing to exchange income for a reduction in mortality risks. It is calculated by dividing the annual mean or median WTP by the corresponding risk variation. As Table 9 shows, monthly mean WTP ranges between € 3.80 and € 10.02 and median WTP goes from € 0 to € 3.36, depending on the underlying WTP distribution and the time period. The equivalent WTP per year lies between € 46 and € 120 (mean values), and € 0 and € 40 (median values), respectively. The underlying risk variation is 1/42,500. Hence, mean (median) VSL is in an interval between € 2.0 and € 5.1 million (€ 0 and € 1.7 million).

A cursory comparison shows that these estimates lie within the range of VSLs found in other studies. For example, Alberini et al. (2005) estimate a mean VSL of € 2.9 million. Alberini, Hunt and Markandya (2004) calculate a value of € 2.3 million based on a three-country sample. Viscusi and Aldy (2003) review about 60 studies on mortality risk premiums based on labor data and report that the VSL ranges between € 3.4 and € 7.7 million. In two Austrian studies the VSL ranges from € 1.8 to € 4.9 (Maier et al. 1989) and from € 4.4 to € 7.4 (Weiss et al. 1986). These and further related studies are summarized in Table 10. Each study is based on a different valuation design (e.g. difference in risk variation, risk category, region, valuation method), so any attempt at more precise comparison may cause misleading inferences.

# 5 Conclusions

This paper discusses the influence of current risk events on WTP for prevention of a risk increase. In a CV study conducted in the Austrian

[22] As an alternative, the protesters could have been removed from the sample as part of the data cleaning process. In doing so, the calculated WTP figures would have increased.

**Table 10: The value of statistical life (in 2005 €[a])**

| Authors | Country | Method | VSL |
|---|---|---|---|
| Alberini, Scasny and Braun Kohlova (2005) | Czech Republic | CV | € 2.86 m |
| Alberini, Hunt and Markandya (2004) | France/Italy/UK | CV | € 2.31 m |
| Alberini, Cropper, Krupnick and Simon (2004) | Canada | CV | € 0.77 - 3.05 m |
| Alberini, Cropper, Krupnick and Simon (2004) | U.S. | CV | € 1.28 - 4.01 m |
| Baranzini and Ferro Luzzi (2001) | Switzerland | Wage risk studies | € 5.02 - 6.3 m |
| European Commission (2000) | EU | different | € 0.72 - 3.11 m |
| Maier, Gerking and P. (1989) | Austria | CV | € 1.76 - 4.9 m |
| Persson, Norinder, Hjalte and Gralen (2001) | Sweden | CV | € 2.61 m |
| Spengler (2004) | Germany | Wage risk studies | € 1.69 m |
| Viscusi and Aldy (2003) | U.S. | Wage risk studies | € 3.41 - 7.68 m |
| Weiss, Maier and Gerking (1986) | Austria | Wage risk studies | € 4.41 - 7.35 m |

[a] Austrian values are converted into 2005 € using the domestic CPI (consumer price index) series (Statistics Austria). For indexation of VSLs for EU members the EICP (European Index of Consumer Prices) is applied. Conversions for non EU members are based on PPP (purchasing power parity) factors from the Penn World Table (Heston, Summers and Aten 2006), on the CPI-U deflator series, and on the Euro-Dollar reference rates from the European Central Bank.

federal state of Tyrol, individuals were asked in two waves (fall 2004 and winter 2005) to state their WTP for preventing an increase in the risk of dying in an avalanche. The question was worded as a double-bounded dichotomous choice format. Using an interval data model and assuming a Weibull and a log-normal distribution, WTP is estimated by a maximum likelihood procedure. Depending on the underlying distribution function of WTP, on the treatment of zero responses, and on included observations, mean VSL ranges between € 2.0 and € 5.1 million while median VSL goes from € 0 to € 1.7 million.

The occurrence of avalanches, associated fatalities, and media coverage of these seem to represent important factors in monetary risk valuation. We estimate the impact of new (implicit) information on WTP for prevention of deadly avalanches by comparing responses in the two periods. Descriptive analysis indicates higher perceived risk among the respondents in the winter sample. Furthermore, differences between the fall and the winter responses are observed with respect to the assessment of individual avalanche exposure, the perceived causes of deadly avalanches, and preferences for alternative protective measures. The inclusion of socio-economic and risk-specific characteristics in the regression model allows us to gain deeper insight into the process of individual risk valuation.

The magnitude of perceived risk reveals a significantly positive impact on WTP; in other words, although all respondents are provided with identical information about the baseline risk and the change in risk to be evaluated their subjective assessment of the average baseline risk has an influence on their monetary valuation. However, further risk-specific attributes exist which play a role in the valuation process. Personal experience of avalanches in the past, a lower personally sensed avalanche risk, and an individual's classification of avalanches as representing anthropogenic events induce a higher WTP, while characterization of deadly avalanche accidents as natural and existing preferences for other protective measures indicate a negative influence. Women tend to have a higher willingness to pay, and an increase in income also leads to higher WTP. Respondents' age and higher educational level reveal a negative impact.

The observation that WTP figures are lower in winter despite the fact that avalanches occur more frequently at that time seems surprising. One would have expected the occurrence of fatal avalanche events and associated media coverage in winter to considerably increase affirmative WTP responses in CV surveys. We control for changes in risk valuation over time by including a time dummy and different interaction terms. The variation in WTP over time can then be explained by the interaction of the period dummy with the variables indicating risk perception, whether avalanches are being characterized as anthropogenic, and whether a person is skiing. Hence, we infer that the presumed origin of risk matters, and that WTP tends to be lower when the risk is characterized as voluntary and controllable. The change in the influence of voluntariness and controllability of risk exposure over time are the main reasons for the lower WTP in winter.

These results show that WTP figures fluctuate between the time periods, but that this variation is not arbitrary. Our findings weaken any objections that their sensitivity to external influences, such as the salience of an event or the point in time of a survey, would invalidate WTP figures from CV studies as proper measures for individual economic preferences.

# References


Alberini, A. (2004), Robustness of VSL Values from Contingent Valuation Surveys, Nota di lavoro 135.2004, FEEM. http://www.feem.it/NR/rdonlyres/56421ED9-632A-4561-AB7E-C571A817DF80/1325/13504.pdf.

Alberini, A., Cropper, M., Krupnick, A. and 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., Hunt, A. and Markandya, A. (2004), Willingness to Pay to Reduce Mortality Risks: Evidence from A Three-Country Contingent Valuation Study, Nota di lavoro 111.2004, FEEM. http://www.feem.it/NR/rdonlyres/8904A715-57A3-4FDD-A7E9-52318537EEFF/1258/11104.pdf.

Alberini, A., Scasny, M. and Braun Kohlova, M. (2005), The Value of Statistical Life in the Czech Republic: Evidence from a Contingent Valuation Study, Working Paper presented at the 14th Annual Meeting of the EAERE in Bremen, Germany. http://www.webmeets.com/files/papers/EAERE/2005/24/alberini%20scasny%20EAERE%202005.pdf.

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

Baranzini, A. and Ferro Luzzi, G. (2001), 'The Economic Value of Risks to Life: Evidence from the Swiss Labour Market', *Swiss Journal of Economics and Statistics* **137**(2), 149–170.

Cameron, T. A. and James, M. D. (1987), 'Efficient Estimation Methods for "Closed-Ended" Contingent Valuation Surveys', *The Review of Economics and Statistics* **69**(2), 269–276.

Cookson, R. (2000), 'Incorporating psycho-social considerations into health valuation: an experimental study', *Journal of Health Economics* **19**, 369–401.

Corso, P. S., Hammitt, J. K. and 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.

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

Eeckhoudt, L. R. and Hammitt, J. K. (2004), 'Does risk aversion increase the value of mortality risk?', *Journal of Environmental Economics and Management* **47**, 13–29.

European Commission (2000), 'Recommended Interim Values for the Value of Preventing a Fatality in DG Environment Cost Benefit Analysis'. `http://europa.eu.int/comm/environment/enveco/others/recommended_interim_values.pdf`.

Haab, T. C. and McConnell, K. E. (1997), 'Referendum Models and Negative Willingness to Pay: Alternative Solutions', *Journal of Environmental Economics and Management* **32**, 251–270.

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

Hanley, N., Shogren, J. F. and White, B. (1997), *Environmental economics: in theory and practice*, Palgrave Macimillan, Hampshire.

Heston, A., Summers, R. and Aten, B. (2006), Penn World Table Version 6.2, Technical report, Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania. `http://pwt.econ.upenn.edu/`.

Huang, C. L. (1993), 'Simultaneous-Equation Model for Estimating Consumer Risk Perceptions, Attitudes, and Willingness-to-Pay for Residue-Free Produce', *The Journal of consumer affairs* **27**(2), 377–396.

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

Leiter, A. M. and Pruckner, G. J. (forthcoming), 'Proportionality of willingness to pay to small changes in risk – The impact of attitudinal factors in scope tests', *Environmental and Resource Economics* .

Lesser, J. A., Dodds, D. E. and Zerbe, R. O. (1997), *Environmental Economics and Policy*, Addison Wesley Longman, Reading.

Liu, J. T., Hammitt, J. K., Wang, J. D. and Tsou, M. W. (2005), 'Valuation of the risk of SARS in Taiwan', *Health Economics* **14**(1), 83–91.

Maier, G., Gerking, S. and P., W. (1989), 'The economics of traffic accidents on Austrian roads: Risk lovers or policy deficit?', *Empirica* **16**(2), 177–192.

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

Persson, U., Norinder, A., Hjalte, K. and Gralen, K. (2001), 'The Value of a Statistical Life in Transport: Findings from a New Contingent Valuation Study in Sweden', *The Journal of Risk and Uncertainty* **23**(2), 121–134.

Shanteau, J. and Ngui, M. L. (1989), 'Decision Making Under Risk – The Psychology of Crop Incurance Decisions'. `http://www.ksu.edu/psych/cws/pdf/insurance_paper90.PD`.

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

Slovic, P., Fischhoff, B. and Lichtenstein, S. (1982), Facts versus fears: Understanding perceived risk, *in* D. Kahneman, P. Slovic and A. Tversky, eds, 'Judgment under uncertainty: Heuristics and biases', Cambridge University Press, Cambridge, pp. 463–489.

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

Spengler, H. (2004), Kompensatorische Lohndifferenziale und der Wert eines statistischen Lebens in Deutschland, Darmstadt Discussion Papers in Economics 133, Institute of Economics, TU Darmstadt. `http://opus.zbw-kiel.de/volltexte/2005/2524/pdf/ddpie_133.pdf`.

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

Tversky, A. and Kahneman, D. (1982), Availability: A heuristic for judging frequency and probability, *in* D. Kahneman, P. Slovic and A. Tversky, eds, 'Judgment under uncertainty: Heuristics and biases', Cambridge University Press, Cambridge, pp. 163–178.

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

Viscusi, W. K. and Aldy, J. E. (2003), 'The Value of a Statistical Life: A Critical Review of Market Estimates Throughout the World', *The Journal of Risk and Uncertainty* **27**(1), 5–76.

Walker, M. E., Morera, O. F., Vining, J. and Orland, B. (1999), 'Disparate WTA–WTP disparities: the influence of human versus natural causes', *Journal of Behavioral Decision Making* **12**(3), 219–232.

Weiss, P., Maier, G. and Gerking, S. (1986), 'The Economic Evaluation of Job Safety – A Methodological Survey and Some Estimates for Austria', *Empirica* **13**(1), 53–67.

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

2008-11 **Andrea M. Leiter and Gerald J. Pruckner:** Dying in an Avalanche: Current Risks and their Valuation
2008-10 **Harald Oberhofer and Michael Pfaffermayr:** Firm Growth in Multinational Corporate Groups
2008-09 **Michael Pfaffermayr, Matthias Stöckl and Hannes Winner:** Capital Structure, Corporate Taxation and Firm Age
2008-08 **Jesus Crespo Cuaresma and Andreas Breitenfellner:** Crude Oil Prices and the Euro-Dollar Exchange Rate: A Forecasting Exercise
2008-07 **Matthias Sutter, Stefan Haigner and Martin Kocher:** Choosing the carrot or the stick? – Endogenous institutional choice in social dilemma situations.
2008-06 **Paul A. Raschky and Manijeh Schwindt:** Aid, Catastrophes and the Samaritan's Dilemma.
2008-05 **Marcela Ibanez, Simon Czermak and Matthias Sutter:** Searching for a better deal – On the influence of group decision making, time pressure and gender in a search experiment.
2008-04 **Martin G. Kocher, Ganna Pogrebna and Matthias Sutter:** The Determinants of Managerial Decisions Under Risk.
2008-03 **Jesus Crespo Cuaresma and Tomas Slacik:** On the determinants of currency crises: The role of model uncertainty.
2008-02 **Francesco Feri:** Information, Social Mobility and the Demand for Redistribution.
2008-01 **Gerlinde Fellner and Matthias Sutter:** Causes, consequences, and cures of myopic loss aversion - An experimental investigation. *Revised version forthcoming in Economic Journal.*

---

2007-31 **Andreas Exenberger and Simon Hartmann:** The Dark Side of Globalization. The Vicious Cycle of Exploitation from World Market Integration: Lesson from the Congo.
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. *Revised version accepted for publication in The Economic Journal.*
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. *Revised version forthcoming in "International Journal of Industrial Organization".*

2007-20 **Christiane Schwieren and Matthias Sutter:** Trust in cooperation or ability? An experimental study on gender differences*. Revised version published in Economics Letters 99 (2008): 494-497.*

2007-19 **Matthias Sutter and Christina Strassmair:** Communication, cooperation and collusion in team tournaments – An experimental study. *Revised version forthcoming in: Games and Economic Behavior.*

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. *Published in: Games and Economic Behavior, Vol. 62 (2008), pp. 417-435.*

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 published in: Canadian Journal of Economics, Vol. 41 (2008), 22-45.*

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**

2008-11

Andrea M. Leiter and Gerald J. Pruckner

Dying in an Avalanche: Current Risks and their Valuation

## Abstract

This paper examines the influence of implicit information on willingness to pay (WTP) values for prevention of the risk of dying in an avalanche. We present the results of a contingent valuation (CV) study carried out in Austria in two different periods (fall 2004 and winter 2005). The comparison of WTP results between the two waves allows identification of whether the immediate occurrence of avalanches and their attendant fatal accidents affect individual risk evaluations. Individuals state a lower WTP in winter despite the fact that avalanche accidents are predominant at that time. Personal responsibility for risk exposure and its associated voluntariness are the main reasons for the decrease in WTP from the fall to the winter period. Preferences for alternative protective measures (against car accidents and food poisoning) also lead to a decrease of WTP, while a higher risk perception and personal experience of avalanches reveal a positive influence. We conclude that the change in WTP across seasons is not arbitrary but can be explained by specific risk characteristics.

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