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Value of statistical life and cause of accident: A choice experiment

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Abstract

The purpose of this study is to compare value of statistical life (VSL) estimates for traffic, drowning and fire accidents. Using a choice experiment in a mail survey of 5000 Swedish respondents we estimated the willingness to pay for risk reductions in the three accidents. In the experiment respondents were asked in a series of questions, whether they would choose risk reducing investments where type of accident, cost of the investment, the risk reduction acquired, and the baseline risk varied between questions. The VSLs for fire and drowning accidents were found to be about 1/3 lower than that for traffic accidents. Although respondents worry more about traffic accidents, this alone cannot explain the difference in VSL estimates. The difference between fire and drowning accidents was not found to be statistically significant.

Key words: Stated preferences, statistical life, risk, traffic, fire, drowning, choice experiment.

JEL classification: D60, D81, R41

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1. Introduction

Governments regularly implement policies in various sectors in order to prevent or reduce inhabitants' risk of injury and death. A number of studies have shown that there are considerable differences in the size of society's investments in life-saving interventions in different areas. When examining the cost-effectiveness of these interventions across sectors, both Ramsberg and Sjöberg (1997) and Tengs et al. (1995) found substantial variations in the implied values of life. Ramsberg and Sjöberg (1997) examined investments in areas such as medicine, road safety and fire protection in Sweden, and found that the mean cost per life saved is more than 40 times higher than the median cost per life saved. Tengs et al. (1995) studied a number of interventions in the US and found, for example, that that median intervention cost for toxin control is 66 times the median medical intervention cost.

Two different conclusions can be drawn from these findings. One is that the allocation of resources in the public sector is not cost efficient because the implied-life values based on these investments is not a mirror of public policy preferences. Another conclusion is that the public sector has correctly perceived individual preferences for the value of statistical life (VSL) across different domains. A basic premise for the latter to be true is that individuals have different preferences for different domains. Results from studies that have compared the relationship between the context of risk and the willingness to pay (WTP) to reduce or avoid the risk have yielded mixed results. In the transport sector, Jones-Lee and Loomes (1995) found that the WTP for a reduction of risk for the London Underground Railway was 50% higher than that for road accidents. Carlsson et al. (2004) found that people are willing to pay twice the amount for a risk reduction for air transport than with road transport. Savage (1993) found considerable differences in the relative WTP for reducing risk in the hazard contexts domestic fires, stomach cancer and road and aviation accidents. Hammitt and Liu (2004) examined the effects of disease type and latency on WTP to reduce environmental risks of chronic, degenerative disease. Their results include that the WTP to reduce the risk of cancer is approximately one-third larger than that of a similar chronic, degenerative disease. Also, the estimated WTP to reduce the risk of lung disease due to industrial air pollution is twice as large as the WTP to reduce the risk of liver disease due to contaminated drinking water.

Other studies have found less variation across contexts. Viscusi and Aldy (2003) found no differences between the WTP to reduce cancer risks and traffic risks, while Vassanadumrongdee and Matsouka (2005) found that the VSL for traffic accidents and air pollution are similar. Chilton et al. (2002) studied individuals' preferences for safety programs that reduce the number of deaths in four contexts: railways, domestic fires, fires in public places, and roads, and found small differences between the contexts. Magat, Viscusi, and Huber (1996) found that the median respondent was indifferent between reducing the risk of terminal lymph cancer and reducing automobile death, but that the morbidity component of curable lymph cancer were evaluated as 58 percent as large as the loss from a fatal automobile accident.

In Sweden, the VSL studies conducted have mainly focused on traffic accidents (Persson and Cederwall, 1991; Persson et al., 2001; Hultkrantz et al., 2006; Svensson, 2006). The question is whether it is appropriate to use these estimates when performing cost-benefit analyses for public operations that reduce the risk of other accident types. Therefore, the main purpose of this study is to extend estimates of VSL in Sweden to the accident domains of drowning and fire. Also, we wish to compare these estimates with the corresponding figures for traffic accidents. We compare the WTP to reduce the risk of death from three accident types: fire, drowning and traffic accidents. This is done with a survey-based choice experiment sent out to a random sample of the Swedish population.[1] In the experiment respondents are asked in a series of questions whether they would choose risk reducing investments for the three accident types. The cost of the investment, the risk reduction acquired and the baseline risk varied between questions.

There are a number of reasons why we may expect different values for fire and drowning accidents compared to traffic. Firstly, there are several differences in the characteristics of people who die from the various causes. In Sweden a higher proportion of people older than 45 years die in drowning and fire accidents than in

[1] Most stated preferences studies have used CVM to estimate VSL, but there are a growing number of studies that employ the choice experiment (CE) method. The main advantage of CE compared to CVM is that we can obtain a valuation of several attributes and of several levels of each attribute. Tsuge et al. (2005) used a CE to compare VSL for accidents, cancer and heart disease. Similarly, Van Houtven et al. (2008) used a CE to compare VSL for (traffic) accidents and stomach cancer. Rizzi and Dios (2006) utilized a CE to estimate a value of fatal risk reduction for traffic accidents. Alberini et al. (2007) used a CE to estimate VSL for mortality risk reductions delivered by contaminated site remediation policies.

traffic accidents, while for teenagers, the probability of dying in a traffic-accident is greater than for the rest of the population (Swedish Rescue Agency, 2007). Secondly, there are significant gender differences in the affected population. Four times more men than women die in drowning accidents, while the corresponding figures for fire and traffic accidents are 3 respectively 2.5 times higher mortality rates for men. Thirdly, differences in the baseline risk may also affect WTP for the three accident types. In Sweden the mortality rate from traffic accidents is four times greater than from fire and drowning. Finally, WTP to reduce risk may be influenced by the risk characteristics of the different accident contexts. Psychologists have found a number of attributes that determine the risk attitudes and perceptions (e.g. Slovic, 1987) associated with various risk characteristics. Among them are voluntariness, controllability and dread of the risk. While an exact definition of these attributes is not straightforward, it is reasonable to believe that people have different risk attitudes when it comes to the three accident risks (for a discussion see Sunstein, 1997, 2004). Subramanian and Cropper (2000) let respondents choose between environmental health programs and other health and safety programs and found that both the number of lives saved and qualitative risk characteristics are significant in explaining program choices. They also found that that the risk characteristics severity, personal exposure and controllability have a significant effect on people preferences to life saving programs while voluntariness did not. Savage (1993) found that WTP increases with the perceived dread of the risk but declines with familiarity. Chilton et al. (2006) found that the dread effect varies between different accidents with drowning considered to be worse than domestic fires and traffic accidents. The categorizing itself could also have an effect due to availability heuristics bringing some accidents more readily to mind or external effects where some accidents are perceived to affect society more.

Using a choice experiment in a mail survey of 5000 Swedish respondents we estimated the willingness to pay for risk reductions in fire, drowning and road traffic accidents. We found the average VSL to be 13.2 million SEK for fire accidents, 12.6 for drowning accidents, and 20.0 million SEK for road traffic accidents.[2] The

[2] 1 US dollar ≈ 6,50 SEK at the time of the survey (fall 2007).

difference between fire and drowning accidents was not found to be statistically significant.

The remainder of the paper is organized as follows: section 2 provides a description of the choice experiment design and the econometric model. The results from the study are presented in section 3 followed by a discussion in section 4.

2. Design of the choice experiment

The willingness to pay estimates for risk reductions were obtained using a choice experiment (CE)[3] with a rather simple design where respondents were never required to make direct trade-offs between the causes of accidents. Instead, they made nine repeated choices, three for each accident type. In each choice situation, they had to choose whether or not they would take a certain preventive measure, for a given cost, that would reduce their mortality risk for a given accident type. The baseline risk for each choice situation was given to the respondent, but it varied between situations.

Table 1. Attributes and attribute levels

Accident type	**Fire, drowning**	**Road traffic**
Baseline risk	8 or 16 in 60000	16 or 32 in 60000
Risk reduction	2, 4 or 6 in 60000	2, 4 or 6 in 60000
Cost for 2 in 60000	200, 700, 1200, 1700 SEK	200, 700, 1200, 1700 SEK
Cost for 4 in 60000	400, 1100, 1800, 2500 SEK	400, 1100, 1800, 2500 SEK
Cost for 6 in 60000	600, 1400, 2200, 3000 SEK	600, 1400, 2200, 3000 SEK

For fire and drowning accidents the baseline risk was either 8 or 16 in 60 000, while for road traffic accidents it was either 16 or 32 in 60 000. The attribute risk reductions had three levels 2, 4 and 6 in 60 000. The levels of the cost attribute varied with the size of the risk reduction (see Table 1). In total there are 24 different combinations of baseline risk, risk reduction and cost. These combinations were randomly blocked into eight survey versions. Thus, each respondent was required to answer a total of nine

[3] In a CE respondents make repeated choices between alternatives. The alternatives are described by a number of attributes, and the levels of the attributes are varied among the choice sets. For overviews on the CE method, see for example Alpizar et al. (2003) and Louviere et al. (2000).

choice situations consisting of three choice sets, one for each accident type. An example of a choice situation is shown in Figure 1.

Figure 1. Example of a choice situation

Imagine that your risk of dying in a road traffic accident during the following 10 years is 32 in 60000. You have the opportunity of taking an accident preventive measure that will reduce your risk of dying by 2 in 60 000. This measure will cost you 1200 kronor.

Your risk reduction is 2 in 60 000	
Your risk if you do not take the preventive measure	32 in 60 000
Your risk if you take the preventive measure	30 in 60 000
Single expense incurred	1200 kronor

Would you be willing to pay for the risk reducing measure?

☐ Yes ☐ No

We took a number of steps in order to design a questionnaire that was comprehensible, plausible and meaningful to the respondent. We used a number of focus groups in the development of the survey and conducted a small pilot study (200 questionnaires). The final questionnaire consists of three parts. The first part has two sections where the first concerns the respondents current risk behavior and the second respondents' experiences and attitudes with regard to traffic, fire and drowning. The primary purpose here was to provide us with a picture of each individual's exposure and attitude to risk generally and the three accidents types specifically. The second part of the survey consists of the choice experiment questions while the third concerns questions regarding the respondent's socio-economic status. The purpose of the survey was briefly explained in the introduction to the choice experiment, followed by a description of accident risk. There are approximately 6 million adults in Sweden, and since the survey only concerned risks for adults we used this as our starting point. Approximately 60 adults die in fire accidents in Sweden every year, making the average risk 600 in 6 million in ten years. Thus, we expressed this risk as 6 in 60 000; for a full description of the risk and scenario see the Appendix. In order to reduce hypothetical bias, a short cheap talk script was introduced (Cummings and Taylor., 1999) just before the nine choice sets in part two.

Econometric model

Each respondent was required to answer nine valuation questions, three for each cause of accident. In the econometric analysis we analyze the three accident causes separately. We estimate simple panel random effects binary probit models, where the dependent variable is equal to one if the respondent would take the action to reduce the risk. The independent variables include the level of the risk reduction and the cost of the action. In addition, we interact the risk reduction variable with a dummy variable, which is equal to one for the high baseline risk (16 in 60,000 for fire and drowning and 32 in 60,000 for road traffic accidents). In addition we include a number of socio-economic and risk attitude characteristics that interact with the risk reduction variable. In general, we assume that an individual *k* takes action to reduce the risk if her willingness to pay (WTP_{ki}) for the situation described in choice set *i* is higher, or equal, to the proposed cost (t_i). The willingness to pay function is specified as:

$$WTP_{ki} = \gamma x_i + \beta z_k + \varepsilon_{ki},$$

where x_i is a vector of attributes, z_k is a vector of covariates, γ and β are the corresponding parameter vector and ε_{ki} is an error term. The probability of a yes response to a certain bid, t_k, is

$$P[Yes] = P[WTP_{ki} > t_i] = P[\gamma x_i + \beta z_k + \varepsilon_{ki} > t_i] = P[\varepsilon_{ki} > t_i - \gamma x - \beta z_k]$$

Since a respondent answers several choice sets, an assumption of independence among responses is questionable since it is likely that the responses are correlated. Following Butler and Moffitt (1982), we therefore specify the error term as:

$$\varepsilon_{kt} = u_k + v_{kt};\ u_k \sim N(0, \sigma_u^2);\ v_{kt} \sim N(0, \sigma_v^2),$$

where u_k denotes the unobservable individual specific effect and v_{kt} denotes the remainder disturbance. The components of the error term are thus independently distributed and we have that the correlation between the errors is:

$$Corr[\varepsilon_{kt}, \varepsilon_{ks}] = \rho = \frac{\sigma_u^2}{\sigma_u^2 + \sigma_v^2}$$

This is a random effects binary probit model. Since the model has to be normalized, the coefficient of the cost coefficient is the inverse of the scale parameter (Cameron, 1988). We use this to recover the marginal WTP for a risk reduction, which is then simply the ratio between the coefficient of the risk reduction attribute and the coefficient of the cost coefficient.

3. Results

The mail survey was conducted between September and October 2007 using a random sample of 5000 individuals aged between 20-75 years selected from the Swedish census registry. Those who did not respond were sent two reminders with a fortnight's interval. A total of 2058 individuals returned the questionnaire, of which roughly 1900 were available for analysis, due to non-responses to various questions. Table 2 reports the descriptive statistics for our sample. Comparing the descriptive statistics of the sample with the national statistics for these two years, we find that the shares of women and of those who have at least three years of university education are significantly higher in our sample than in the population as a whole. The distribution across age groups is, however, representative.[4]

[4] One thousand samples were bootstrapped by randomly drawing observations with replacement as many times as there are observations in the original sample. By using the percentile method and a 95 % confidence interval, it can be shown whether the means significantly differ from each other at the 5 % significance level.

Table 2. Descriptive statistics of attributes and variables

	Description	Mean	Stdv.
Attributes			
Risk reduction	Units of risk reduction	4.00	1.633
High baseline risk	= 1 if high baseline risk	0.50	0.50
Cost	Cost in 1000 SEK	1.40	0.84
Household characteristics			
Male	= 1 if male respondent	0.471	0.499
Has no partner	= 1 if respondent does not have a partner	0.295	0.456
Has children	= 1 if at least one child lives in the household	0.376	0.485
Age in years	Respondents age in years (scaled by 10)	4.65	1.48
Income	Equivalence scaled income in 10,000 SEK.[a]	1.578	0.771
University education	= 1 if respondent has university education	0.340	0.474
Apartment block	= 1 if respondent lives in an apartment block	0.384	0.487
Large city	= 1 if respondent lives in a large city	0.217	0.413
Medium sized city	= 1 if respondent lives in a medium sized city	0.187	0.390
Uses car	= 1 if respondent drives a car regularly	0.863	0.344
Uses seatbelt	= 1 if respondent uses a seatbelt in the back seat	0.758	0.429
Smoke detector	= 1 if at least one smoke detector in the household	0.916	0.277
Bad experience Fire	= 1 if respondent has had a bad experience	0.066	0.249
Bad experience Drowning	= 1 if respondent has had a bad experience	0.081	0.273
Bad experience Road traffic	= 1 if respondent has had a bad experience	0.280	0.449

a. In order to compare income among households we use an equivalence scale. The scale assigns the first adult the value of 1, the second adult 0.58; all other adults are set at 0.61, and each child at 0.48.

In addition to standard socio-economic characteristics, we include some measures of respondents' risk behavior and experiences of the three accident types. Following the approach of Subramanian and Cropper (2000) the respondents were asked about their views regarding the characteristics of the three accident types. Table 3 reports the results from the questions regarding the issues of control and worry for the risk of the three causes of accident.

Table 3. Control and worry about the risk, mean values, standard deviations in parentheses.

Variable	Question	Fire	Drowning	Road traffic
Controllability	I can control the risk (1 = Disagree, 10 = agree)	7.13 (2.50)	7.44 (2.55)	6.26 (2.57)
Worry	I worry about the risk (1 = Disagree, 10 = agree)	2.75 (2.36)	2.58 (2.23)	4.45 (2.87)

The respondents largely believe that they can control the risks, but to a lesser degree for road traffic accidents. The reason for this is most likely that the risk that someone else causes the accident is higher for road traffic. While they do not worry about the risks to any large extent, there is a clear difference between road traffic accidents and the other causes in that they worry more about road traffic accidents. Our original intention was to include a direct question relating to the respondents dread of dying by the three accident causes. However, in the focus groups sessions we found that people had difficulties in answering the question due to the range of scenarios that were possible. For example, the dread associated with dying in a domestic fire varies substantially depending on whether the victims die in their sleep or if they are awake and trapped in the flames.

We will now consider the responses of the choice experiment. A description of the raw responses is given in Table A1 in the appendix; note that this is not the order of the choice sets in the actual surveys.[5] Firstly, we find that the share of yes responses is almost always decreasing in the level of the cost. Secondly, there is a higher share of yes responses for the low baseline risk level for all three causes of accidents, the implication of which is that respondents are more likely to invest to reduce the risk at the low baseline risk. Table 4 reports the results of the different binary panel probit models. We estimate two models for each accident type, one excluding the socio-economic characteristics and another where the socio-economic characteristics interact with the risk reduction variable. For the interaction variables we report the marginal effect on the marginal willingness to pay for a one unit reduction of the risk. In the table we also report the average marginal willingness to pay for a one unit reduction of the risk.

[5] 493 respondents stated 'yes' in all choice sets and 313 respondents stated 'no' in all choice sets.

Table 4. Marginal effects estimated random effects probit models, p-values in parentheses. Dependent variable is equal to one if the respondent is willing to pay for the risk reduction.

		Fire		Drowning		Road traffic	
Constant		0.166	0.169	0.070	0.071	0.147	0.149
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Risk reduction		0.043	-0.007	0.043	0.007	0.048	0.021
		(0.000)	(0.699)	(0.000)	(0.712)	(0.000)	(0.073)
Risk reduction × High baseline risk		-0.007	-0.007	-0.011	-0.011	-0.008	-0.008
		(0.001)	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)
Cost		-0.182	-0.190	-0.178	-0.182	-0.140	-0.138
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Rho		0.805	0.792	0.808	0.802	0.832	0.822
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
			Δ WTP		Δ WTP		Δ WTP
Risk red ×	Male		-17.81		-13.52		-44.14
			(0.369)		(0.511)		(0.082)
Risk red ×	No partner		-76.02		-46.12		-83.18
			(0.001)		(0.066)		(0.006)
Risk red ×	Has children		16.61		12.27		19.88
			(0.494)		(0.632)		(0.527)
Risk red ×	Age		87.61		95.03		77.63
			(0.031)		(0.033)		(0.145)
Risk red ×	Age squared		-9.16		-10.95		-9.91
			(0.041)		(0.028)		(0.092)
Risk red ×	Income		46.02		52.25		89.80
			(0.001)		(0.000)		(0.000)
Risk red ×	University education		3.30		-19.07		16.49
			(0.879)		(0.396)		(0.563)
Risk red ×	Apartment block		-86.88		-70.34		-98.07
			(0.000)		(0.003)		(0.001)
Risk red ×	Large city		-7.44		22.08		14.76
			(0.768)		(0.406)		(0.661)
Risk red ×	Medium city		-1.00		6.95		74.56
			(0.970)		(0.804)		(0.026)
Risk red ×	Uses car		35.26		-5.76		87.20
			(0.290)		(0.863)		(0.025)
Risk red ×	Uses seatbelt		-54.75		-41.36		-37.00
			(0.021)		(0.092)		(0.208)
Risk red ×	Smoke detector		-70.79		-9.49		-77.17
			(0.045)		(0.804)		(0.096)
Risk red ×	Bad experience		74.33		-9.77		19.28
			(0.036)		(0.789)		(0.480)
Risk red ×	Controllability		3.84		4.85		1.90
			(0.316)		(0.229)		(0.692)
Risk red ×	Worry		10.41		14.32		19.05
			(0.009)		(0.001)		(0.000)
Mean marginal WTP, low baseline (standard error)		238.00	239.15	241.90	240.45	354.71	360.40
		(14.83)	(14.90)	(15.54)	(15.56)	(17.96)	(18.11)
Mean marginal WTP high baseline (standard error)		199.05	202.02	181.94	181.17	296.18	305.26
		(17.23)	(17.00)	(17.78)	(17.78)	(20.03)	(20.15)
No. of individuals / obs.		1888 / 5628		1874 / 5578		1914 / 5676	
Pseudo R2		0.19	0.18	0.20	0.19	0.21	0.20

The cost and risk reduction parameters are all statistically significant in the models without socio-economic characteristics. However, we find that the interaction term between the dummy variable for high baseline risk and the risk reduction variable is negative. Thus, respondents' willingness to pay for a risk reduction is lower when the baseline risk is high (for fire and drowning 16 in 60,000 and for road traffic 32 in 60,000). Previous evidence regarding the relationship between baseline risk and VSL is mixed. For example, Persson et al. (2001) and De Blaeij et al. (2003) found a positive relationship between VSL and baseline risk. Viscusi and Aldy (2003) and Aldy and Viscusi (2007) found the relationship to be convex while Mrozek and Taylor (2002) found a concave relationship. Our result differs in that the relationship between VSL and baseline risk is in fact negative. Studies we are aware of with similar results are Persson and Cedervall (1991) and Guria et al. (2003); see also Smith and Desvousges (1987).

In all the models, the constant is significant, indicating that there are other factors than the risk reduction and the cost that also affect the choices. The estimated correlation between the error terms ρ is strong and significant in all models. This means that we cannot reject the random effects model in favor of a more restrictive model with no correlation between the error terms. In the model with additional covariates it is not useful to interpret the sign and size of the risk reduction parameter directly. We therefore focus on interpreting the sign and size of the interaction terms. For the interaction variables we report the marginal effect for the marginal willingness to pay for a one unit reduction of the risk. This should be related to the average marginal WTP. For fire and drowning accidents the average marginal WTP is around 240 SEK for the low baseline, and for road traffic accidents it is almost 360 SEK.

We find that respondents without a partner are less willing to pay for a risk reduction, in the case of fire accidents the WTP for a respondent without a partner is almost 18 SEK lower. Neither the presence of children in the household nor gender has a significant effect on the WTP. Since we include both age and age squared, and both variables are significant, this implies an inverted U-shaped relationship between age and WTP. The turning point for fire accidents is almost 48 years. The corresponding figures for drowning and road traffic accidents are approximately 43 and 39 years respectively. As expected, WTP is increasing in equivalence scaled income. The income elasticity is between 0.3 and 0.35 for fire accidents, between 0.35 and 0.46 for drowning accidents, and between 0.39 and 0.47 for road traffic accidents. Respondents living in apartment blocks were found to have a lower WTP, although their geographic area of residence has no significant effect. People who regularly drive a car have a higher WTP for a risk reduction for traffic accidents. However, the use of a seatbelt has no statistical significant effect on the WTP for traffic accidents. A negative effect on the WTP for a risk reduction for fire accidents was found when there were smoke detectors in the household. Of the three accident types, a significant effect on WTP was only exhibited in the case where the respondent has had a bad experience with fire accidents. The self reported degree of controllability is statistically insignificant in all three models, while the self reported degree of worry is positive and significant in all three models.

The main aim is to estimate the WTP for a risk reduction and the value of statistical life. At the bottom of Table 4, the marginal WTP values for the various models are reported. These are thus the WTP in SEK to reduce the risk by 1/60 000. However, it may be more revealing to look at the value of statistical life. We do this for the two different baseline risks, and we also estimate an average value for each cause of accident. Table 5 reports the results for the three accident types.[6] We only report the estimates for the model without covariates, but the results are similar for the model with covariates.

Table 5. Value of statistical life in SEK and USD, standard errors in parentheses.

	Fire		**Drowning**		**Road traffic**	
	SEK	USD	SEK	USD	SEK	USD
Average	13 231 000	2 205 000	12 643 000	2 107 000	19 965 000	3 327 000
	(893 000)	(149 000)	(933 000)	(156 000)	(1 069 000)	(178 000)
Baseline risk:	14 349 000	2 392 000	14 427 000	2 405 000		
8 / 60 000	(894 000)	(149 000)	(933 000)	(156 000)		
Baseline risk:	12 121 000	2 020 000	10 870 000	1 812 000	21 624 000	3 604 000
16 / 60 000	(1 020 000)	(170 000)	(1 067 000)	(178 000)	(1 087 000)	(181 000)
Baseline risk:					18 316 000	3 053 000
32 / 60000					(1 209 000)	(185 000)

The average VSL is estimated at 13.2 million SEK for fire accidents, 12.6 for drowning accidents, and 20.0 million SEK for traffic accidents. The difference between fire and drowning accidents is not statistically significant (using a two-sided t-test), while the difference between fire and drowning accidents, and traffic accidents

[6] The standard errors are calculated with the Delta method (Greene, 2000).

is significant. However, with this comparison both the cause of accident and the baseline risk varies. Because the baseline risk 16 in 60,000 was included for all accident causes, a direct comparison can be made. As can be seen in the table, the difference in VSL between fire and drowning accidents on the one hand, and traffic accidents on the other, is even larger when the baseline risk is the same. The VSL varies with the baseline risk and the differences between the low and high baseline are statistically significant (using two-sided t-tests) in all cases.

The value of statistical life for traffic accidents is within the span of other recent Swedish estimates where several studies using contingent valuation methods with WTP-questions have arrived at values between 17 and 24 million Swedish kronor (Persson et al., 2001; Hultkrantz et al., 2006; Svensson, 2006). The figure is also in line with the current official recommended valuation of risk for road infrastructure investments in Sweden, 21 million SEK in 2001 (ASEK, 2008).

Why then do we find a difference between road traffic accidents on the one hand, and fire and drowning accidents on the other? Our econometric models do not provide a direct test of this, but they reveal some interesting differences. We found that people worry more about road accidents than the other accident types, and worry has a statistical significant impact on the WTP for risk reductions. In fact, worry has a larger impact on the WTP to reduce the risk for road accidents than for fire and drowning accidents. The effect of controllability is insignificant, so this cannot explain the difference in WTP between accident types. In order to see the impact of worry we estimate the value of statistical life using the same level of worry and the same baseline risk for all the accident types. The results are reported in Table 6. For simplicity, we use the average level of worry obtained for fire accidents, i.e. a level of 2.75.

Table 6. Value of statistical life in SEK for baseline risk 16/ 60 000 and the degree of worry equal to 2.75, standard errors in parentheses

	Fire	**Drowning**	**Road**
VSL in SEK for baseline	12 121 000	9 466 000	19 699 000
risk 16/60 000	(1 020 000)	(1 175 000)	(1 189 000)

Consequently, the difference in the degree of worry alone cannot explain the difference in VSL estimates. Thus, there are other factors associated with the causes of accidents that affect the estimates.

4. Discussion and conclusion

We have used a choice experiment to estimate the value of statistical life for three types of accidents: fire, drowning and road. If one accepts the view that VSL should vary across domains our conclusion is that the VSL's for fire and drowning accidents are about 1/3 lower than that for traffic accidents. These results are in contrast with for example Chilton et al. (2002) who concluded that "… people do not favour rates of trade-off between preventing deaths from different hazards that are greatly different from 1:1" (ibid, p. 225). In our study, people worry more about traffic accidents, and this increases the WTP for a risk reduction. However, the psychological effects of worry and controllability alone could not explain the difference in VSL between traffic and fire/drowning accidents. What other factors could explain the difference in VSL? Firstly, respondents might not have accepted our baseline risks. For example, they might believe that the risks associated with traffic accidents are larger, or that the risks associated with fire/drowning accidents are lower. Secondly, due to the higher actual baseline risk for traffic accidents, people might think more about traffic accidents, in particular compared with drowning accidents.

Another important, somewhat counter-intuitive result is that we find a negative relationship between VSL and baseline risk which implies that the individuals in our survey place a greater value on reducing a lower initial risk than a higher one. We have no straightforward explanation for this result. One hypothesis is that individuals may have a risk threshold, i.e. if a risk can be reduced below this level then the individual can disregard it to a large extent. Thus, further reducing an already low initial risk may afford the individual a greater utility (expressed in terms of less concern) than reducing a high baseline risk to above the threshold level. Another hypothesis is that individuals are concerned not only with absolute risk reduction, but also with relative risk reduction. For example, an individual with relative preferences would prefer a risk reduction from 8 to 4 rather than a reduction from 16 to 12 as the former case would reduce risk by half.

One may hold the belief that the public sector should use a single value of statistical life across all domains. This view could be based on ethical reasons i.e. "a life is a life", but also for administrative reasons: It is more practical to use one value across all public sectors instead of several different ones. However, this value should in an ideal world be calculated as a weighted measure across all domains. Using the value obtained from stated preference methods for traffic accidents in other public investments areas such as other accident types, environment, and health could lead to biased cost-benefit results. Clearly, there is a need for more studies in this area, since the empirical evidence is mixed.

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Appendix

Translation of the description of risk scenario

Part 3. Questions on Risk Reduction

We will consider the risk for people between the ages of 18 and 70 years. There are currently 6 million people in this age group in Sweden. Although the number of people that die in accidents within this age group varies from year to year, we are still able to calculate the average risks based on statistics from different accident types.

For example: During a ten year period, 600 adults die in fire accidents in Sweden. We can then say that the average risk of dying in a fire accident is 600 in 6 million.
This is the same as saying that the average risk of dying in a fire accident is 6 in 60 000.

For road traffic accidents, the risk of dying during a ten year period is 35 in 60 000 while for drowning accidents the risk is 8 in 60 000.

We will now require you to answer a number of questions. In each question there is the possibility of taking a measure that will reduce your own personal risk of dying in a particular accident type.

In each question we assume that your current level of risk is given. This risk will vary between questions and you are only able to reduce this risk by taking the accident prevention measure. Please take this risk as given, even if you believe that you are able to influence this risk in some other way.

The accident prevention measure entails a given cost. It is your task to determine whether or not the risk reduction in each question is worth the cost. Please try to answer each question on the premise that the risk reduction is valid only for you personally and no one else, not even the members of your family.

Please regard that there are no "correct" answers, and only your own choices are relevant. The situations vary in type of accident, risk level before the measure is taken, the risk reduction and the cost to you.

An example is given on the following page.

Example

Imagine that your risk of dying in a fire accident during the following 10 years is 6 in 60 000. You have the opportunity of taking an accident preventive measure that will reduce your risk of dying by 5 in 60 000. This measure will cost you 1000 kronor.

Your risk reduction is 5 in 60 000	
Your risk if you do not take the preventive measure	6 in 60 000
Your risk if you take the preventive measure	1 in 60 000
Single expense incurred	1000 Swedish kronor

Would you be willing to pay for the risk reducing measure?

☐ Yes ☐ No

In the example you have the opportunity to take an accident preventive measure at a given expense.

- If your answer is Yes, then you are willing to pay a single sum of 1000 kronor for the measure. Your risk for dying in a fire accident will then be 1 in 60 000 for the duration of the following 10 year period. Your risk reduction is then 5 in 60 000
- If your answer is NO, then you consider 1000 kronor to be too expensive for reducing your risk by 5 in 60 000. Then your risk of dying in a fire accident will be 6 in 60 000 for the duration of the following 10 year period.

We require you to answer nine similar questions. Regard each question a new situation; i.e. you should consider each question independently as if you had not answered the earlier questions.

Experiences from previous studies have shown that peoples' responses do not always match with their actions in real life. For example it is common for people to state that they are willing to take a particular accident prevention measure, but later do not do so. We believe that this is partly because people do not consider the cost.

Table A1. Responses for each choice situation

Baseline	Risk reduction	Cost	Share yes fire	Share yes drowning	Share yes road
16 / 32	2	1700	0.38	0.29	0.44
16 / 32	2	1200	0.46	0.38	0.53
16 / 32	2	700	0.55	0.45	0.62
16 / 32	2	200	0.68	0.63	0.68
16 / 32	4	2500	0.40	0.33	0.54
16 / 32	4	1800	0.48	0.37	0.55
16 / 32	4	1100	0.57	0.44	0.61
16 / 32	4	400	0.75	0.65	0.78
16 / 32	6	3000	0.40	0.27	0.52
16 / 32	6	2200	0.49	0.39	0.55
16 / 32	6	1400	0.64	0.52	0.74
16 / 32	6	600	0.73	0.62	0.80
8 / 16	2	1700	0.47	0.36	0.53
8 / 16	2	1200	0.59	0.48	0.66
8 / 16	2	700	0.61	0.51	0.62
8 / 16	2	200	0.76	0.67	0.74
8 / 16	4	2500	0.37	0.30	0.49
8 / 16	4	1800	0.51	0.39	0.58
8 / 16	4	1100	0.61	0.49	0.65
8 / 16	4	400	0.80	0.71	0.78
8 / 16	6	3000	0.36	0.32	0.51
8 / 16	6	2200	0.45	0.38	0.62
8 / 16	6	1400	0.62	0.51	0.68
8 / 16	6	600	0.76	0.68	0.81