MEMORANDUM

No 31/2001

Public- and private-good values of statistical lives: Results from a combined choice-experiment and contingent-valuation survey

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ISSN: 0801-1117

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This series is published by the
University of Oslo
Department of Economics

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November 2001

Abstract

We present a stated-preference study where values of statistical lives (VSL) are derived both as public and private goods, and we distinguish between three different death causes, heart disease, environmentally related illnesses and traffic accidents. 1000 randomly chosen individuals in Norway were faced a three-part valuation procedure: 1) pairwise comparisons (conjoint analysis), 2) combined contingent-ranking and contingent-valuation of willingness to pay (WTP) for public projects to reduce overall population mortality risk, and 3) WTP for individual treatment reducing own mortality risk from heart disease. Parts 1-2 comprise all three death causes, and indicate public-good VSL in the range 3-6 million USD, with heart disease deaths in the lower part of this range, environmental causes in the upper part, and traffic accidents in-between. Part 2 also permits a splitting up of VSL into motives (self-motivated and altruistic), and indicates that about 30 % of total public-good WTP is self-motivated. Part 3 provides a self-motivated (private-good) VSL figure for heart disease in the range 1-1.5 million USD, close to the self-motivated share of VSL from part 2. We find high consistency between values derived, and indications that private- and public-good VSL may differ subtantially, as well as VSL by death cause. Under pairwise comparisons in part 1 we find complete insensitivity of VSL to risk magnitude (or "scope"), in contrast to existing literature. The more complex choices under part 2 by contrast imply considerable scope sensitivity.

Key words: value of statistical lives; public goods; stated preference methods; altruism
JEL classification: H41, H42, I18, D64.

Introduction

The value of statistical life (VSL) is essential in many contexts involving public decision making, e.g. with regard to priorities in the health sector and determination of environmental and safety standards, and with enormous potential economic implications.[1] Rational public policy requires awareness of the ratio of benefits to costs of carrying out mortality-reducing projects, which in turn requires knowledge of the magnitude of VSL. The need for reliable VSL estimates is magnified by the observation that different public programs imply widely differing implicit VSL values (i.e. different costs to society of saving lives under the different programs); see e.g. Morrall (1986) and Tengs (1995) for the U.S.. Economists have suggested two main ways of deriving VSL values, through revealed preferences (RP), or through stated preferences (SP) based on surveys or experiments. While most early work on VSL was based on RP methods (in particular socalled hedonic wage studies springing from ideas developed by Rosen (1974)), there has over the last 20 years or so been a gradual shift in favor of using SP methods; see e.g. Viscusi (1993) for an early overview.

A number of SP studies of VSL exist in the literature. Most apply contingent valuation (CV), originally developed for environmental-good valuation. Early such VSL studies are Gerking, de Haan and Schulze (1988) for job safety, and Jones-Lee (1989) for road safety. More recent studies are McDaniels (1992), Jones-Lee, Loomes and Phillips (1995), Beattie et.al. (1999) and Persson et.al. (2001) (road safety), Johannesson et. al. (1993) and Johannesson, Johansson and Löfgren (1997) (clinical measures to prevent heart disease), and Smith and Desvousges (1987), Krupnick and Cropper (1992) and Krupnick et.al. (2000, 2001) (environmental health risk). Choice experiments, or conjoint analysis (CA), is a related but slightly less direct SP technique with a shorter history of application to VSL. Many researchers today tend to favor of CA on grounds that this technique facilitates verification of the multiattribute property of the utility function, where VSL may be one of several attributes valued.[2] Relevant VSL studies involving CA are Viscusi, Magat and Huber (1991) who consider motor vehicle accident risk;[3] Ryan and Hughes (1997) who value antenatal care; Johnson et.al. (1998) who value general life-extending projects conditional on activity level;

[1] This is documented by Murphy and Topel (1999), who calculate (using a 5 million USD VSL figure) that the annual gains in longevity over the 1980-1990 period valued almost 3 trillion USD, or about half of average private consumption over the period.
[2] See e.g. Ryan for a discussion.
[3] See Viscusi (1992, 1993) for further discussions of these and other related studies.

and Subramanian and Cropper (2000) who derive relative VSL values tied to different environmental health programmes.

One reason for popularity of SP methods is that VSL estimates derived in "good" SP studies appear as more stable than those from hedonic wage studies. Virtually all the SP studies cited (and several others) yield central estimates of VSL in the range 3-5 million (1990) USD. Incidentally, this figure turns to be strikingly close to our main estimates derived below, for Norway, related to heart disease and traffic accident risk.

Another reason for preferring SP over RP methods, so far less discussed but central in our application, lies in the public-good property of the concept of VSL. So far basically all SP approaches to VSL have dealt with private-good aspects only, which in our view may be misleading. Our study incorporates VSL valuation both for public projects to reduce mortality risk, and for individual private risk reductions.

There are several potential problems with the SP approach to VSL. The most focused of these is sensitivity of VSL to the assumed magnitude of risk, or "scope", whereby average stated willingness to pay (WTP) figures per statistical life from stated preference studies have been observed to depend strongly on the magnitude of mortality risk to be valued.[4] Hammitt and Graham (1999) find that, for CV studies of VSL up until the time of their survey, all studies exhibited either strong sensitivity to scope, or that the overall WTP associated with a given project is entirely independent of the risk to be valued.[5] The consequence is (often strongly) declining estimates of VSL when relevant risk increases, in contrast to predictions from standard economic theory. A separate set of problems in assessing VSL relates to altruism, which in turn is tied to the distinction between VSL as a public versus private good as noted above. WTP to reduce mortality risks may clearly involve individuals' valuation of others' death risk reduction, both family members and third persons. Such values may not (fully) be reflected in individuals' WTP for own mortality risk reduction. A central issue is how such values should be counted when deriving VSL figures to be applied in cost-benefit analyses. To our knowledge no empirical study to date has addressed such aspects of altruism and their implication for private- and public-good VSL valuation, in a common framework. A

[4] The terminology in this area is not totally clear. In the following we will use "magnitude of assumed mortality risk" and "scope" interchangeably, as is used by several authors, e.g. Hammitt, Liu and Lin (2000). Here also, "insensitivity (of VSL) to scope" throughout corresponds to the natural null hypothesis under fully rational preferences.

[5] To this author's knowledge, the only recent previous study which seems to successfully avoid this problem is Corso, Hammitt and Graham (2001), who rely on a sophisticated set of visual aids to help respondents to better grasp the issue or probability of death, and changes in this probability.

third set of problems is related to VSL values possibly differing by cause of death. Few existing SP studies have attempted to derive VSL values for several different death causes simultaneously, with the same set of respondents.

The study reported here sets out to deal simultaneously with these three sets of problems. In our survey VSL was elicited in three different ways. The first was a set of pairwise conjoint choices, where two projects to be compared differed in only on pair of attributes at the time; in one case this pair was the numbers of lives to be saved, and the project cost. The second elicitation procedure involved three steps, as follows: 1) a more complex, incomplete ranking procedure, where respondents were asked to rank two out of four projects which differed in four dimensions, two of which were the numbers of lives saved and its cost; 2) a question whether or not they were willing to pay the cost of their preferred project; and 3) eliciting WTP for this project. Our third main procedure was to elicit respondents' individual WTP for an individual treatment which was assumed to reduce mortality from heart disease, by prolonging the respondent's own life by one year with probability one per cent.

The issue of "scope" effects (i.e. whether or not VSL varies with magnitudes of assumed risk) is central to parts 1 and 2 of the elicitation procedure. In part 1, VSL estimates are simply derived from money-life tradeoffs, implying that respondents value additional lives saved (equivalent to reductions in general mortality risk), and for different magnitudes of risk reduction. Part 2 also tests for scope effects by letting subjects value mortality risks more directly, but through a more complex CR procedure where projects differ in four attributes, among them risk reduction and cost. Part 3 has no test for scope, since all respondents here face one given risk reduction. A main purpose of this part was rather one of "calibration" of the VSL level, to those from parts 1 and 2.

The survey also considered variations in VSL by three specified causes of death, heart disease, environmentally-related causes, and traffic accidents, which were embedded in the choice combinations under parts 1 and 2. In part 3 (dealing with private treatment) heart disease was the only specified cause. Part 2 moreover split up VSL into three valuation motives, namely pure self motivation (or motivation based only on the value of increased expected lifetime for oneself), value attached to concern for own family, and value attached to other motives. Such a splitting up sheds light on the altruism issue mentioned above, by identifying "purely self-motivated" and "altruistic" parts of total VSL for a representative individual. Part 3 by contrast provides information only on purely self-motivated WTP. A

strength of this study, relative to previous ones in the literature, is its ability to compare VSL across contexts, whereby individuals are asked questions that differ widely, in nature and context, making it possible to derive several, presumably independent, value-of-life estimates for each individual.

While dealing with a wide range of issues, a number of methodological problems are still not answered in a satisfactory way by our study. Among these are problems of interpreting stated answers as "true" WTP values for statistical lives, and validity issues involved in using CV and CA approaches in this context. In the final section below we discuss such issues and their implications for future research.

2. The survey

The survey was conducted in the summer of 1995 by the survey firm ACNielsen Norway. Following extensive pretesting, with focus groups and test interviews, approximately 1000 individuals selected randomly from all of Norway were interviewed in person, and asked questions related to this survey only.[6] On average, interviewers were rejected once for each interview obtained. The resulting set of interviewed individuals had somewhat lower average age and higher average income than the population averages. Average age of interviewed persons was 40.5 years, while the population average (for persons above 18) is 46 years. Average household income in the sample was 245 000 NOK, while the population household average at the time was 211 000 NOK. The latter discrepancy is largely due to average size of households being larger in the sample (3.0) than in the population (2.2), and that larger households have higher incomes (the amount of income per family member is somewhat lower in the sample than in the population). In other respects (e.g. gender and geographical distribution) the sample is largely representative. One may fear self-selection bias whereby individuals uninterested in life valuation issues or have particularly low valuations are more likely than others to reject being interviewed. The more specific objectives were however hidden at the start of the survey, as persons are told that the topic of the interview is issues of more general public concern. Only later, when the respondent has accepted to be interviewed, is the VSL issue raised. Respondents were then also given some background information on

[6] W must also stress that the questionnaire used in the survey itself was developed over a two-year period, involving a large number of persons in addition to the author. Among the most important persons involved were Olvar Bergland, Rune Elvik, Bente Halvorsen, Ståle Navrud and the ACNielsen staff.

different tasks of the public sector and possible programs for reducing overall mortality in the population. This design may have helped to minimize such self-selection problems.

Valuation procedure 1, Q2a-Q2d, was intended to measure respondents' preferences when faced with pairwise comparisons of different hypothetical projects designed to save lives on a national scale in Norway, which differ in only two dimensions at a time. In all comparisons, one dimension was the number of lives saved by the project. The other dimension was, respectively, the number of years before the project becomes effective (before the reduction in mortality actually takes place); the cause of death (where assumed possible causes were cardiac disease, environmentally related causes, and traffic accidents); the age group of the persons saved; and the cost of the projects. For the last comparison an introduction was given to remind respondents of their budget condition and that consumption of other goods and services would be reduced if positive payments were expressed. In a final question in this series (Q2e), respondents were asked whether they were actually willing to pay the implied cost of the preferred project under Q2d.

Q2a-Q2e helped prepare respondents for the more complex set of questions in part 2, but also give valuable information on preferences. Note that VSL estimates are here derived from marginal risk changes added on to differing "baselines", which largely circumvents the scope problem discussed above. Also "risk-risk" tradeoffs between different death causes give a good basis for relative valuation of VSL related to these causes. Perhaps most importantly, the pairwise tradeoffs involved are simple and easy to grasp by respondents.

Part 2 comprises the sets Q3-Q4. Q3a-Q3b faced respondents with a more complex choice problem. Here four different projects were presented, which differed in four different aspects, namely the number of lives saved, the number of years before life savings occur, the cause of death, and the cost of the project to ones own household. In Q3a respondents are asked which of these projects is preferred first, and in Q3b which is preferred second, among the four. Altogether 56 combinations of attributes were used in the survey, which were rotated using a procedure designed to vary and span out the given domain of variation of attribute, in optimal ways.[7] The sets of choice alternatives included 34 possible choices to select heart disease, and 11 choices each to select either environmental causes or traffic accidents. This may have biased the selection process in making respondents choose heart projects too often. We

[7] The combinations were chosen by an iterative optimizing procedure in SAS called OPTEX, applying an A-optimality criterion; see also Montgomery (1984) and the SAS user manual. I am grateful to Bente Halvorsen and Olvar Bergland for help with designing the optimization procedure related to Q4.

however wanted to emphasize heart projects, both in view of Q7 as explained below, and since this is the overwhelmingly most common death cause among the three included in the study. The numbers of lives to be saved nationally in each project varied from 50 to 500. None of the environmental nor traffic accident projects had numbers exceeding 100, out of concern for realism. The assumed time until effect of project varied from 1 year to 25 years.

In Q4a respondents were asked whether their household would be willing to pay the cost implied by the chosen project (i.e., the monetary cost to the household which was part of the attribute combination for the project). In Q4b they were asked what is their maximum willingness to pay (WTP) for this particular project, aided by a payment card showing figures from 0 to 10000 NOK. The set Q4a-Q4b comprises a single-bounded binary choice with open-end follow-up WTP using a payment card, where WTP is tied to the preferred project from Q3a. Note that the valued project is self-selected and not random, something which in principle may lead to bias; se below.

Valuation procedure 2 provides more VSL information than procedure 1, since WTP is elicited from each respondent. Procedure 2 is however more complex to respondents, thus creating cognitive problems of focusing on the mortality risk-money tradeoff crucial for VSL estimation. We come back to this in section 4 below.

Those who stated zero WTP in Q4a were asked Q5a-Q5g to determine whether they could be interpreted as "protest bidders". Those who expressed positive WTP in Q4a were asked Q6a-Q6c in order to check validity, in particular whether the amount stated actually would be paid if real payment was required.

In Q6d, individuals with positive WTP in Q4a were asked to distribute their total valuation between four different motives: 1) reduced risk of own premature death, 2) reduced risk of premature death for individuals in ones nearest family, 3) reduced risk of premature death for other individuals in society, and 4) other motives. Respondents were asked to distribute a total of 10 points among these motives, corresponding to shares of total WTP. Q6 concludes the section on valuing public programmes in the survey.

The questions Q7a-Q7d were designed to elicit respondents' WTP for particular treatments designed to prolong the lives of individuals, either only oneself or the population in general. We choose to present only on the first of these, Q7a, which comprises valuation

procedure 3 and in the following is denoted Q7.[8] Here respondents were faced with the possibility of purchasing a particular (hypothetical) treatment not provided by the public health care system, and which, if purchased, was assumed to have the effect of prolonging the respondent's life by one year, with probability one percent. The treatment in question was related to cardiac disease (which is likely to be perceived as a realistic possible cause of death, for all individuals). The purpose of such a question was to seek an estimated of VSL as a purely private good, to be confronted with the public-good VSL estimates found from Q2-Q6. While there might in principle be some "anchoring" from Q2-Q6 to to Q7, at least the objects for valuation are radically different for the two approaches.

The next section of the questionnaire was devoted to standard background variables and other relevant questions, such as whether ones car has particular safety equipment; the frequency of use of seatbelt when driving; the amount of smoking; the amount of exercise; and whether the respondent or others in the near family has experienced either cancer; serious cardiac disease; serious lung disease; death or serious injury in traffic accident.

The final section contained debriefing questions to respondent and interviewer, to obtain a tentative measure of "precision" with which answers were provided, where "low ability to answer" is associated with low precision. As stressed e.g. by Bates (1994), Mazzotta and Opaluch (1995), DeShazo and Fermo (1999), Swait and Adamowicz (1999) and Sælensminde (2000), erratic and imprecise valuations due to questionnaire complexity and respondent fatigue may lead to biased and imprecise estimation results, and better results can be obtained when correcting for such factors.

Overall, the questionnaire was complex and quite long (it took about 40 minutes to complete on the average), and demanding. It is best described as a combined indirect and direct SP study. Q2a-Q2d and Q3a-Q3b comprise indirect SP questions, Q2e and Q4a are direct binary-choice SP questions, while Q4b and Q7 are direct open-ended SP questions. Table 1 sums up the main features of its implied valuation procedure. In the table, CE and CR are indirect SP questions, while the rest are direct SP questions. When discussing the results below we will concentrate on questions yielding an economic value concept. We see that Q2e and Q4a yield discrete-choice WTP answers, in terms of yes or no answers to respective binary choices, while Q4b and Q7 yield open-end WTP answers.

[8] There are several reasons for focussing on only the first among this group of questions. One is that, as it turned out, the first question was the most carefully thought through in the group and most easily perceived by

A valuable feature of our survey was the high level of interest in the questions displayed by the respondents, and the relative facility with which the most difficult questions (in valuation parts 1 and 2) apparently were handled. Only about 4 % of respondents appeared to be "uninterested" in the topics of the survey, and only about 20 % claimed to have trouble conducting the rankings in parts 1 and 2.

Table 1: Overview of main features of choice questions included in the survey

Question	Type of question	Involves monetary valuation	Inclusiveness of value elicited
Q2a	CE	No	
Q2b	CE	No	
Q2c	CE	No	
Q2d	CE	Yes	
Q2e	DC-CV	Yes	Public risk
Q3a	CR	Yes	
Q3b	CR	Yes	
Q4a	DC-CV	Yes	Public risk
Q4b	OEPC-CV	Yes	Public risk
Q7	OE-CV	Yes	Individual risk

Explanation of symbols: CE = choice experiment, CR = contingent ranking, DC-CV = discrete choice contingent valuation, OEPC-CV = open-ended contingent valuation with payment card (follow-up), OE-CV = open-ended contingent valuation.

Tables 2-3 contain summary tables for key debriefing questions in the survey, asked to respondents (table 2) and interviewers (table 3). By far most respondents find questions easy to answer at least most of the time. A problem in part 2 is obviously that some of the attributes included were not much focussed (this in particular applies to numbers of lives). Interviewers' reactions are also mostly positive in indicating a high degree of interest and understanding among respondents.

respondents. Another reason was that there appeared to be a considerable fatigue effect setting in for many respondents at the point where the question set Q7 was being posed.

Table 2. Summary tables for categorical variables

Question	Answer category	Number of respondents
18a: Easy to answer, part1	Every time	343
	Most of the time	545
	Most of the time not	125
	None of the times	44
	Unknown	24
	No answer	12
18b: Easy to answer, CR	Yes	711
	No	188
	Unknown	99
	No answer	4
18c: Decisive attribute, CR	Number of lives saved	14
	Cost	684
	Cause of death	316
	Time before effect	241
	Unanswered	391
18d: Satisfactory answers, CV in part 2	Both	670
	Only the first	48
	Only the second	10
	None	175
	Unknown	92
	No answer	7
19: Felt you understood the questions	Always	585
	Almost always	362
	As a rule not	32
	Unknown	16
	No answer	7

Table 3a. Interviewer reactions

Question	Answer category	Number of respondents
20: Degree of interest shown by respondent	Great	681
	Some	272
	Small	37
	Unanswered	12
21: Did respondent appear to understand questions	Yes	681
	Mostly	261
	Occasionally	46
	Rarely	7
	Unanswered	7

Table 3b. Interviewer reactions (cont.)

Question	Number yes	Number no	Number unanswered
22a: Respondent had difficulty with rankings in Q2	190	780	32
22b: Respondent had difficulty with rankings in Q3	200	773	29
22c: Respondent had difficulty with WTP questions	241	728	33
23: Others present during interview	301 (great influence=10, some influence=36)	689	12

3. VSL as a public good: Results from choice experiment questions (part 1)

We now analyze key aspects of part 1 of the valuation procedure, involving answers to Q2a-Q2e. We focus on pairwise tradeoffs between lives and death causes (Q2b), lives and money cost (Q2d), and the follow-up DC-CV question concerning acceptance of preferred

project (Q2e).[9] None of the questions under part 1 yields direct WTP values. The data however permit inference of such values, given particular assumptions about respondents' utility functions, choice sets and decision-making process. The resulting WTP derivations can be done in a number of ways depending on assumptions e.g. concerning error-term distributions. To fix ideas, assume that respondents' utility from choosing a particular project can be written on the form

$$u_{ij} = \alpha x_j + \beta z_i + \varepsilon_i, \qquad (1)$$

where i indexes individuals with a vector z_i of characteristics , j indexes projects with a vector x_j of characteristics, u_{ij} is individual i's utility from a project with characteristics vector x_j, α and β are parameter vectors, and ε_i is a random error term. (1) implies a simple linear utility assumption, common in the standard random utility model, see e.g. Adamowicz, Luoviere and Williams (1993), Hanemann and Kanninen (1997), Halvorsen (1997, 2000), and Roe, Boyle and Teisl (1999). Provided that the error terms are Weibull distributed, a binary variable, describing the choice of project where two project attributes vary, is logistically distributed, and the choice variable can be estimated by a logit model; see McFadden (1973), Ben-Akiva and Lerman (1985), Greene (1993, chapter 21).

Provided that the logit model applies, deriving a monetary VSL involves three steps. The first step is to estimate an average tradeoff between lives and costs, from answers to 2d. Such an estimation yields an average VSL estimate (intuitively, it yields an estimate of how much the cost of the project must increase in order for an average respondent to stay on the same utility level, when one additional person is saved, regardless of cause of death).

The two first lines of table 4 contain results from such calculations, based on logit model estimations. Averages for VSL are here estimated at 47.2 and 46.2 million NOK respectively (given 2 million households and assuming that individual answers represent household WTP).[10] Alternative procedures may incorporate e.g. other assumptions about respondents'

[9] We thus ignore in our presentation the choice experiments in Q2a and Q2c, involving tradeoffs with respect to time until effect of project (i.e. discounting), and age groups in which lives are saved (with implications e.g. for translating VSL figures into QALYs), due to space concerns. These results are presented in separate documents.

[10] We will throughout this section and the next stick to this interpretation of WTP at the individual level. We take this as a conservative approach since the WTP answer provided was assumed to "take into consideration the household's entire income". Alternatively one could have assumed that each individual only represents himself or herself when providing a WTP figure to Q4b. This would have given higher overall valuations, but there would then be a greater danger of double counting; see also the concluding section.

utility functions and error term distributions. A simple alternative is to estimate linear or log-linear probability functions, under both Q2b and Q2d. Although the linear and log-linear probability models have somewhat shaky foundations e.g. in terms of their distributional properties (see Greene (1993), pp 672-674), they may be useful when predicted probabilities are on the whole well inside the unit interval. In our case the linear specification works quite well, when we include a specification under Q2d where the probability of acceptance is a function of cost per life saved by the project. These results are given in line 3 of table 4. Under the preferred specification we then find almost exactly the same average VSL as in the logit case, namely 46.6 million NOK.

We have also run logit and linear estimations of tradeoffs between costs and lives where the absolute numbers of lives saved in the preferred project is used as an additional explanatory variable for project acceptance. This implies controlling for "scope" effects on average VSL valuations. When there are scope effects on VSL, the probability of accepting a project, for given cost and life difference between the project accepted and not accepted, is reduced when the number of lives saved by the preferred project increases. We find no such effect in either case. The coefficients on absolute life number are in fact positive (but not significant), implying that the estimated VSL values are, if anything, increasing in risk magnitude.

The second step involves estimating relationships between numbers of lives and cause of death from answers to Q2b. This gives an estimate of the number of lives that must be saved from one cause of death, for respondents to be indifferent to saving one life from another cause of death. Both logit and log-linear estimations were used to determine such tradeoffs.[11] Using a logit specification we find that respondents are, on the average, indifferent between 2.19 lives saved from heart disease and one life saved from environmental causes; and between 1.19 lives saved from heart disease and one life saved from traffic accidents. These coefficients are given in the first line of table 5. Assuming that 46.4 million NOK is the "correct" average VSL from step 1, individual-cause VSL are now given in the second and third lines of table 5, where calculations differ by the weights to individual causes used to

[11] The logit relation estimated was constructed such that numbers of lives to be saved from each of the causes, in the project chosen and that not chosen, were the explanatory variables for the probability of accepting the project. The log-linear relation was constructed such that the ratios of numbers of lives to be saved in the two alternative projects specified (a and b) was used as explanatory variable for the probability of accepting a, together with dummy variables representing types of lives to be saved in projects a and b. This gives estimates of tradeoffs between causes of death and relative numbers of lives which leave respondents indifferent.

derive the average VSL.[12] The derived values are approximately 32 or 37 million NOK for heart disease, 38 or 44 million for traffic accidents and 70 or 81 million for environmental causes, depending on weighting of individual causes. Deriving this tradeoff from a log-linear regression, the weights are 1.51 and 1.04 heart disease deaths, for each death respectively from environmental causes and traffic accidents, given in the next line of table 4. Still using the 46.4 million NOK value for an average VSL, the respective valuations (corresponding to those under the logit specification) are now about 39 and 42 million NOK for heart disease, 41 and 44 million NOK for traffic accidents, and 59 and 64 million NOK for environmental causes. These figures are given in the last two lines of table 5.

Table 4. Estimated WTP per household per life saved from Q2d, alternative specifications

Estimated relationship	Estimated WTP	z statistic on lives	z statistic on cost	Pseudo R-squared
Logit without background variables	23.6	8.9	-3.6	0.073
Logit with background variables	23.1	8.9	-3.7	0.075
Linear with background variables	23.3	9.6	-3.6	0.095

It is also possible to use answers to the binary-choice question Q2e for correcting the estimates derived from steps 1-2. We have however run logit and linear regressions of the answers to Q2e, and find no systematic relationship between acceptance in Q2e and absolute amount to be paid, for given amount per life saved by each project. This indicates no major reason for adjusting the figures in table 5 upward or downward, on such a basis.

The sizes of these coefficients should however be viewed with some caution. Standard errors on coefficients in the logit and linear estimations are largely in the range ¼ - 1/8 of their values, and the weights used to calculate cause-specific values in addition have sizeable standard errors (in particular, the weights attached to traffic accident deaths and heart disease

[12] In the first line, the weights are equal (=1/3) to each. In the second line, weights are equal to the fractions of individual who choose the respective cause in their preferred project in the following Q3, namely 0.62 to heart disease, 0.16 to environmental causes and 0.22 to traffic accidents. The latter type of calculation here gives the higher overall figures.

deaths are in neither case statistically different, as seen from table 5). This implies relatively high, and ambiguous, standard errors on total figures. Thus many totals in the left-hand column, and most of the individual cause-specific values, do not differ significantly. The table must be taken to indicate the order of magnitude of values in this part of the study.

Table 5. Calculated VSL, different causes, using average WTP figures from table 3

Type of relationship	Heart disease	Traffic accidents	Environmental causes
Relative weights derived from logit	1	1.19 (0.7)	2.19 (6.2)
Estimated VSL using logit, equal weights	31.8	37.8	69.6
Estimated VSL using logit, different weights	37.0	44.2	80.7
Relative weights derived from loglinear relation	1	1.04 (0.3)	1.51 (3.4)
Estimated VSL using log-linear, equal weights	39.2	40.8	59.2
Estimated VSL using log-linear, different weights	42.5	44.3	64.2

(Figures in parentheses: z test statistics for test different from 1)

Our pairwise tradeoffs between lives and death cause can be compared to those from another recent study, Subramanian and Cropper (2001), who conduct a telephone survey to find tradeoffs between lives saved from environmental (air and water) cleanup programs to those from general public health programs (which would be most similar to our heart disease mortality reduction programs). They find values similar to ours, with coefficients corresponding to those in the first line of table 5 in the range 1-2.5 (derived as preferences of the median respondent).[13]

The VSL valuation procedure in this section goes some way toward resolving problems of scope raised in previous literature. We find no sign of reduced VSL values when the

[13] They however find indication that there is a significant share of respondents with seemingly lexicographic preferences, i.e. who seem to prefer environmental programs regardless of the ratio of lives saved, which in case would contribute to a higher average preference for environmental programs. This could in principle be the case also here, but we have no way of testing for this (since we only ask one pairwise tradeoff question).

assumed mortality risk changes by more, over a rather wide range of risk levels. Whatever (weak) discovered effect implies that VSL is greater for large than for small risk changes.

4. VSL as a public good: Combined CR-CV survey questions (part 2)

We now turn to the valuation procedure implied by Q3-Q4 of the survey. As noted in section 2, this procedure consists of three steps. The first step involves contingent ranking (CR). Four different projects, each differing in four attributes (cost, number of lives saved, cause of death, and time until project has effect), are compared by each respondent, and the first and second are ranked. Secondly, respondents are asked whether they accept their first-ranked project. Finally, they are asked to state their WTP for the preferred project. The last two steps correspond to a dichotomous-choice question with an open-ended follow-up WTP question using a payment card, a mechanism familiar from the CV literature (Carson (1985), Hanemann, Loomis and Kanninen (1991), Cameron and Quiggin (1994), Hanemann and Kanninen (1996)).

The analysis of this data is done in two different ways. The first is done by Bente Halvorsen (see Halvorsen (2000) and Halvorsen and Sælensminde (1998)), who considers the two first steps only, and estimates logit models determining criteria for the first-ranked project choice, and the DC-CV answer in step 2.[14] From these estimations average values for the tradeoffs between money and numbers of lives saved, and between money and cause of death, can be calculated. Estimations are done in four versions, as nested and non-nested logit estimations, and for each assuming either a common or choice-specific utility structure for each choice implied by the two steps. Halvorsen finds statistical evidence in favor of the nested models, and we here present results based on these, in table 6. The first line of the table gives results from the common-structure model, and the second line from the specific-structure model, where in the latter case we use the money-lives tradeoff from the CR procedure in step 1.[15]

[14] These estimation procedures are reported in detail in Halvorsen (2000).

[15] It here turns out that the money-life tradeoff for step 2 in isolation becomes rather meaningless; too much attention is here directed to the money dimension (in the form of the yes-no answer to the particular payment to be made here). This property of the answers also accounts for the higher average money value per life saved in

Table 6. Average VSL estimates based on Halvorsen's (2000) nested logit model estimations, using answers to Q3 and Q4a, million NOK

Model applied	Heart disease	Traffic accidents	Environmental causes	Average VSL
Common utility structure	20.2	29.2	38.6	25.2
Choice-specific utility structure	20.6	61.4	94.2	41.4

Average estimated VSL differs somewhat between the two models: the figure is 25 million NOK under a common utility structure, and 41 million NOK assuming that the utility structure differs between the two choices (in steps 1 and 2) and using the money-lives tradeoff implied by the first step only.[16] We see that the estimate for heart disease deaths is almost identical in the two cases, while there are larger discrepancies for traffic accident and environmentally caused deaths, particularly for the latter.[17]

The second approach uses the answers to Q4b directly, where WTP of the chosen project is elicited directly.[18] Table 7 sums up some important results based on these data, which are based on simple sample averages across chosen project types. The right-hand column in table 7 shows average VSL related to chosen project where cause of death is heart disease, environmental causes, and traffic accidents respectively. Individuals are as noted valuing only their preferred project, and numbers in the first column are numbers of persons preferring projects of each of the three types. 612 respondents preferred a project saving lives from heart disease, 162 environmental causes and 221 traffic accidents. We here correct for

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the choice-specific than in the common-utility case, since the former only embeds this tradeoff for step 1, while the latter estimates the tradeoff as an average for the two steps.

[16] In the same way as under valuation procedure 1, reported in section 3 above, we also throughout this section assume that each respondent answers on behalf or his or her household, and that there are 2 million households in the relevant population universe.

[17] Note that relative tradeoffs between money and lives were not estimated directly for each of the different causes. Instead constant shifts in utility, due to traffic accident and environmental deaths relative to heart disease deaths, were estimated. These shifts were then used for deriving additional money values associated with an average project, when the project saves traffic accident or environmental lives instead of heart disease deaths, which in turn were converted into values per life. Ambiguities and uncertainties with respect to model specification may here account for the diverging values between the two approaches. Note also that VSL estimates based on the non-nested logit models (which are rejected in favor of the nested ones) are almost identical to those reported here.

[18] A third approach to Q4, pursued by Halvorsen and Sælensminde (1998), is to estimate logit models directly based on answers to Q4a. Traditionally such estimation tends to yield higher average WTP estimates than OE-CV type questions implied by Q4b. Here the authors find such differences to be significant (but they are reduced when corrections are made for heteroscedasticity in the distribution of responses, and for some other possible biases). We thus feel it "prudent" to base direct WTP estimations on Q4b rather than Q4a.

"time until effect of project" (part of the survey design) to arrive at present-value figures.[19] The right-hand column of table 7 is found using calculated averages for WTP per life saved in the preferred project. Population figures, in the right-hand column, are then arrived at by multiplying by 2 million (assuming 2 million households, and that each individual answers on behalf of his or her household as presumed).

These figures imply that average VSL varies from 36.1 million NOK for heart disease deaths, to 53.8 and 62.6 million NOK for traffic accident or environmentally caused deaths. Average VSL over all respondents is 44.6 million NOK. Comparing these figures with those found from the conjoint choices under Q2, in section 3 above, they are similar both for overall averages and for the relative values for the three causes of death. A general pattern is that average VSL is very close to 45 milllion NOK (5 million USD at current exchange rate).[20] Another pattern is that cause-specific values vary from a low of about 35 million NOK (with heart disease, and in one case traffic accidents, in the low end), to a high of about 80 million NOK (where environmental causes are associated with the highest WTP). This variation is well in line with figures in table 6, derived under Halvorsen's procedure.

The right-hand column of table 7 gives theoretically unbiased VSL figures for the individual death causes only when respondents are indifferent with respect to the three types of projects. Otherwise positive self-selection bias should occur, since the project for which a value is expressed, is the one preferred among the three. Such bias is potentially greater for environmental and traffic deaths, since the population fractions behind these values are relatively small (implying that many with potentially lower valuation are not expressing any such value). On the other hand a comparison of relative figures in table 7 to those in table 6 (where such biases should not occur) indicated that this problem, if at all present, is minor.

Q4b was followed by a question (Q6d) splitting total VSL up into three motivations, described in the three first columns of table 7. On average approximately 30 % of total VSL is stated to be due to concern for ones own life, about 50 % other family members' lives, and about 20 % other persons or motives. The self-concern fraction is rather stable across death causes, while "other family members" have a high share of total value for traffic accidents (and low for environmental causes), and "other (altruistic) concerns" have a higher share of total WTP for environmentally-caused deaths.

[19] This implies that we are using the discount rates implicit from choices between projects with different times until effect. In the survey these discount rates were generally small, on the order of 1 per cent.

Table 7. Relationships between preferred project in terms of type of life saved, WTP, and motivations for payment, from answers to Q4, averages across respondents. Million NOK per VSL.

Type of lives saved	Concern for own life	Concern for other family memers	Other (altruistic) concerns	Total
Heart disease (612 respondents)	11.3 (31 %)	19.5 (54 %)	5.3 (14 %)	36.1
Environmental causes (162 respondents)	18.8 (30 %)	23.8 (40 %)	21.0 (33 %)	62.6
Traffic accidents (221 respondents)	14.2 (26 %)	33.2 (62 %)	6.6 (12 %)	53.8
Total (995 respondents)	11.8 (29 %)	21.4 (53 %)	7.0 (18 %)	44.6

To our knowledge this is the first VSL study where total WTP is split up into motivations in the way done here. An obvious reason for this is that virtually all studies to date consider VSL as a purely private good where such a splitting-up would not be well defined. We will claim that such splitting up is of considerable principal and practical interest, in view of possible differences when deriving VSL as a private and a public good, and of principles for including altruistic values in cost-benefit studies, as will be discussed in the final section below. We will stress that we found no indication that the question requesting such a splitting up was more difficult, or yielded more arbitrary answers, than other questions implied by our CV instrument.[21] The split-up figures in table 7 require interpretations, in terms of differences between private- and public-good VSL, secondly, how to interpret the "purely altruistic" element of VSL, and thirdly, what is behind differences in overall stated VSL for the three death causes. Such issues are elaborated in the final section.

[20] Using OECD's PPP conversion index for 2000, which was 10.8 NOK/USD, the corresponding figure is about 4 million USD.

[21] There was no debriefing question directed at how respondents perceived or understood Q6b. This issue was however communicated in detail by the test sample and focus group, and through discussions with interviewers after the survey. In the view of interviewers, the splitting-up-into-motives question generally appeared to be one of the easiest for subjects to answer. One should still of course be careful in interpreting such answers, in the same way as for other CV administered survey questions.

Table 8 describes linear and log-linear OLS relationships between WTP in Q4b, and the respondent's household income, age and gender, in addition to two project-specific variables, time until effect of project and the number of lives saved by project, and correcting for death cause.[22] In the last log-linear relationship the project cost per life saved in Q4a is also used as explanatory variable. This variable is highly significant and enters with coefficient 0.45, implying a significant anchoring effect on the cost in the initial dichotomous choice (a doubling of the initially stated amount increases the VSL value by 45 %).[23] We also see that the log coefficients to number of lives saved by project are high in both relationships, -.634 and -.721 respectively: a doubling of the number of lives saved by a project raises the value of the project by only about 30 - 40 %.

Table 8. Impact on WTP per life in Q4, of key background and design variables. NOK per respondent per life saved (in linear relationships).

Variable	Linear OLS	Log-linear OLS	Log-linear OLS
Environmental cause	6.25**	0.21*	0.20*
Traffic accidents	3.23	0.05	0.025
Household income	$1.09*10^{-5}$**	0.175**	0.166**
Age	-0.074	-0.261**	-0.0064**
Gender (f=1)	3.33*	0.06	0.04
Time until effect	-0.21	-0.04	-0.04
Number of lives	-0.053**	-0.634**	-0.720**
Cost per life in Q3			0.450**
Constant	30.0		
Adjusted R-squared	0.095	0.146	0.202

* = significantly different from zero at level 10 %
** = significantly different from zero at level 5 %

This result indicates relative sensitivity of VSL to scope in this part of the survey (while in part 1, by contrast, there was complete insensitivity to scope). This is in line with existing

[22] A large number of other specifications, with respect to functional form, assumptions about properties of the error terms (such as robust estimation to correct for heteroskedasticity), and including other explanatory variables, were attempted in the estimations. I ended up with these specifications, as none of the other alternatives attempted turned out to improve precision or explanatory power more than only marginally. In particular, the "number of children" variable, the educational variables, and the variables representing health and health concerns, all turned out (rather disappointingly) not to yield improvement nor statistically significant effects on valuations. The same applied to the variables representing health problems such as the previous experience heart disease (for oneself or in the family), pulmonary disease, cancer or traffic accidents, by oneself or someone in the near family.

[23] Still however the initial amount explains quite little of the total variance on final WTP amounts in Q4b; the adjusted R-squared for the overall relationship is still only 0.2 in this case.

research, as surveyed in Hammitt and Graham (1999) and Krupnick et.al. (2000), and is troublesome for VSL estimation. The scope problem in part 2 can most likely be explained by lack of respondents' attention to numbers lives saved, in WTP questions Q4a and Q4b. A propensity to utilize simplified decision criteria in complex choice situations such as the current one, demonstrated by Sælensminde (2000), here has the consequence that estimated total WTP is relatively insensitive to project size. This is underlined by Halvorsen's (2000) analysis of Q4a reported above, where she found high emphasis on cost relative to number of lives, and this effect is likely reinforced in Q4b. For the values based on answers to Q2 and Q3, involving direct tradeoffs between lives and costs, the scope problem appears to be far less important.

A question is whether one ought to correct for differences in average project size, when deriving VSL separately for heart disease, environmental causes and traffic accidents. One argument against this is that "natural" projects involving reduced numbers of heart disease deaths are bound to be (substantially) larger than projects involving lives saved on the road or from environmental causes. While the number of cardiac deaths in Norway is about 19 000 per year, the number of road accident deaths is only about 300. It would be out of line to suggest a project that reduces mortality from traffic accidents by, say, 200 lives per year, within a 5-year span, while a similar mortality reduction for heart disease is fully realistic. For environmentally caused deaths the issue is more complex since nobody knows exactly how many current deaths are caused this way. The Norwegian State Pollution Control Authority has suggested that air pollution could be a factor behind up to 500-1000 premature deaths annually in Norway, related to pulmonary diseases, heart disease, and cancer of the lungs and respiratory system.[24] Moreover, approximately half of all cancer deaths have today no known statistical causes; many of these could be induced by environmental factors.

Increasing the time until the project has effect, as part of the project design, is found to have little impact on estimated VSL in this part of the study. In no case is the time variable significant when considered as common for the entire sample in table 8. The log-linear relationship here implies a time variable in logs, i.e. a hyperbolic relationship with time. This fits better than the constant-discounting relationship which was also attempted.[25]

[24] Pope et.al. (1995) has similarly estimated that the Clean Air Act in the U.S. has led to about 180 000 statistical deaths avoided (annually?), mostly in older age groups.

[25] With constant discounting, the implicit annual rate of discounting is estimated at approximately 0.5 %, but is not significantly different from zero. Indications of hyperbolic discounting are found here by introducing time

Log-log relationships imply household income elasticity of around 0.17, and age elasticity of about –0.26, both highly significant.[26] The income elasticity is small but not uncommon in such studies. The age elasticity is rather high (a doubling of the respondent's age, say from 25 to 50 years, of from 40 to 80 years, implies a reduction in WTP of 26 %, everything else equal; and the WTP of a 20 year old with given income and gender is 52 % higher than that of an 80 year old).[27]

A possible problem with the figures derived for each of the three causes of death in tables 7-8 is potential self-selection bias due to endogenous choice of project type. Put otherwise, each of the three types of life is valued only by those respondents who most prefer this particular project, among the project choices available (which were four for each respondent). While no formal corrections for such bias has been made here, the problem must be kept in mind and will be considered further in section 5 below.[28]

Consider now factors behind the motivations for value expressed in Q4b. For the selfishly motivated value, there are two main differences from the results for total valuation. First, when correcting for other (design and background) variables, avoiding traffic accident deaths is now associated with lower average WTP than avoiding heart disease deaths (where the difference is statistically significant for the linear relationship), while the comparison of such values between heart disease and environmental causes is now less clear. Overall, the self-motivated part of VSL is no lower for heart disease deaths than for the other two causes. Secondly, self-motivated WTP increases more with age and income than total WTP (the estimated income elasticity is now 0.25), and falls more with age: a doubling of age (from, say, 20 to 40, or from 30 to 60 years) now reduces the self-motivated WTP by 76 %.

5. VSL as a private good: Analysis of CV question on individual treatment

We now turn to the third main part of our survey, namely individual WTP for a private treatment for heart disease which is presumed to prolong the respondent's life by one year,

squared in such a relationship, which turns out to yield a positive (although not significant) coefficient, such that the absolute value of the discount rate falls with the time horizon until the project has effect.

[26] Note that the coefficient to age in the right-hand column is associated with one-year, and not relative, age increases.

[27] I tried out other specifications but found no significant deviations from a steadily falling WTP with respondents' age. This is somewhat different e.g. from Krupnick et.al. (2000) who found reductions in WTP only in advanced age groups.

with probability one per cent. Heart disease potentially affects everyone, although clearly with different (subjective) probabilities.[29] Individual medication and treatment, outside of the public health system and subject to individual payment, is also a familiar issue to Norwegians, although to different degrees. A potential problem with this part of the survey is that not all Norwegians are used to actually paying for treatment, and some may be hostile to such payment. This may result in protests, possibly in the form of (incorrectly) stated zero WTP values. This issue is considered more closely below.

The valuation question posed here was more elementary than those in parts 1 and 2, in only providing one point estimate of WTP, for one particular specified risk. Our goal here was rather limited, to obtain one estimate on the valuation of human life "independent" of the estimate obtained in the earlier parts of the survey. This is a point estimate of VSL as a private good, to be compared with the (more comprehensive sets of) public good VSL estimates from previous parts of the survey. A defense of our instrument is that it involves an easily comprehensible probability, 1 percent, of extending ones life by one year, where one does not state at what stage of ones life the extension will take place. We will argue that this is no less realistic nor more difficult to understand than alternatives used in the literature (e.g. by Johannesson et. al. (1997) and Krupnick et. al. (2000), where life extensions are assumed to occur for certain or at particular stages of life).

Each individual's own-motivated VSL can her be derived as the WTP answer in Q7, multiplied by 100 (to obtain the statistical value of one additional year of life), and again by an assessed (subjective) number of remaining years of lifetime, T.[30] To derive an operational value of T we make two alternative, and rather opposite, assumptions. The first is simply that T = 40 for all adults in the sample. (Since the average age of respondents is 40.5 years, this implies that respondents on the average expect to live until the age of 80.5 years.) The second is that T is given by T(a) = 75 – 0.75*a, where a is the respondent's age. With the latter assumption, T(20) = 60, T(40) = 45, T(60) = 30, T(80) = 15. The former assumption on average underestimates remaining lifetimes of youngsters and overestimates those of old

[28] I have run estimations using Heckman's (1978, 1979, 1990) two-step correction procedure for selection bias, with littie success; estimates were erratic with large standard errors and often with wrong signs.

[29] Most types of medical treatment and medication in Norway is today subject to some individual payment, although largely at prices much below cost in the public system. Hospitalization is free in the public system, while there exist medical clinics and hospitals where patients pay in full.

[30] We will argue that it is in our context incorrect to discount future years of life. The reason is that individuals, when valuing increased expected lifetime, may be taken to already have done the proper discounting (e.g. if death is expected in 20 years in the absence of treatment, the effect valued is one having effect in 20 years).

persons, and tends to underestimate average remaining lifetimes, thus on the whole yielding "conservative" figures. The latter assumption corresponds more closely to true average survival functions at today's mortality rates, both on average and across age groups (the average value of T(a) in the entire sample is 44.5). Since we do not know how individual subjective assessments of T are made, two alternative assumptions may be useful.[31]

An issue of concern is whether zero WTP expressed in Q7 should be viewed as a "true zero" or not.[32] From section 4 we have information on self-motivated WTP for reduced heart disease mortality, from those individuals who there preferred heart disease projects. If this expressed value was positive, the "true" WTP ought arguably to be positive also for Q7.

Table 9. Relationship between numbers of respondents with positive WTP figures in the own-motivate part of Q4b, and Q7, and preferred project in Q3.

Type of project in Q4b	Positive WTP in Q7	Positive own-motivated part of Q4b, zero Q7	Zero own-motivated part of Q4b, and Q7	Total
Heart disease	280	286	53	619
Environmental causes	71	69	22	162
Traffic accidents	82	112	27	221
Total	433	467	102	1002

Table 9 shows that more than half of the respondents (57 %) state zero WTP to Q7. Most of these stated positive own-motivated WTP in Q4b. This may invite two different approaches to the treatment of zeros in Q7. One (conservative) approach is to treat these as true zeros. Another (less conservative) approach is to assume that individuals with positive own-motivated WTP to heart-disease projects in Q4b have true positive WTP also to Q7. This concerns 286 individuals, who are consequently moved from zero to positive WTP in

[31] Some information does exist about individuals' longevity expectations, at least for the U.S., from the U.S. Health and Retirement Survey. In analysing different "interview waves" from this data set, Smith et.al. (2001), find a rather close correspondence between longevity expectations and actual longevity. This speaks for using our second alternative that corresponds rather closely to actual average age-dependent life expectations. In our context there is however the additional issue of whether individuals actually incorporated explicit, age-dependent, longevity expectations in their own VSL assessments. If they do not, the first alternative may appear to be more reasonable.

[32] There was no particular debriefing question directed at respondents who stated zero in Q7. One could here of course attempt to utilize answers from the debriefing question Q5 directed at zero-WTP respondents in Q4, We have not gone into this here.

Q7. Imputing these from regressions against available background variables assesses their WTP values in Q7.[33]

Our approach yields four different estimates of average WTP in Q7, namely 1) estimates using 40 years expected lifetime and all actual zeros, b) estimates using decreasing remaining lifetime and all actual zeros, c) 40 years expected lifetime and imputed zeros, and d) decreasing remaining lifetime and imputed zeros. These calculations are given in table 10.

Table 10 also shows how average WTP in Q7 varies with project choice in Q3. We find a strong tendency for individuals who chose heart disease projects in Q3, to have higher WTP in Q7 than others. Most interestingly, those choosing environmental projects in Q3 have far lower valuations than others in Q7.[34] Recall that respondents who chose environmental projects in part 2 had greater overall average VSL than others, but no greater own-motivated parts of VSL.

Average WTP figures for the group who chose heart projects in Q3, 8.7 and 10.1 million NOK per life saved respectively (depending on remaining-life calculation), are here close to the corresponding figure derived from Q4 (i.e. the self-motivated part of total WTP there), 11.3 million NOK.

Table 10. VSL from reduced own risk of heart disease death, based on answers to Q7 (individual treatment), by project choice in Q3, and by assumption about remaining subjective life years, real and imputed values for zero answers to Q7. Million NOK.

Grouping according to preferred project in Q4	40 years remaining, real zeros	Decreasing remaining life, real zeros	40 years remaining, imputed zeros	Decreasing remaining life, imputed zeros
Heart disease	8.7	10.1	12.7	19.5
Environmental causes	3.3	3.5	3.5	5.0
Traffic accidents	5.5	9.3	8.4	12.3
Average across all respondents	7.0	8.6	10.0	15.2

[33] While such an approach is "less conservative", it by no means provides an upper bound on the MWTP values from Q7, in particular since also many of those choosing other than heart disease projects may have incorrectly answered zero to Q7.

[34] It turns out that the fractions of positive WTP answers to Q7 were almost identical for environmental and heart-disease project selectors; the entire difference in average WTP between these groups were then due to lower averages among positive environmental-project respodents relative to heart-disease-project respondents.

For results using imputed values, the way in which the imputation is done (i.e. the set of explanatory variables used in calculating imputed values) matters little, and we report only one set of valuation figures, in the two right-hand columns in table 10. The average value now increases from 8.7 to 12.7 million NOK per life, for individuals who prefer heart projects and when the expected remaining lifetime is 40 years, and more dramatically, from 10 to 19.5 million NOK assuming a declining remaining lifetime. By construction of the imputed variable, essentially the whole increase in valuation is due to increases for those preferring heart projects. Thus overall average valuations increase by less, from 7.8 to 10 million under 40 years remaining, and from 8.7 to 15.2 million with declining remaining lifetime.[35]

The figures in the right-hand columns of table 10 are likely to embed biases in different directions. The imputation procedure almost certainly overestimates WTP in Q7 for those individuals whose values are imputed. (Even though you state zero to Q7, stating something positive to the self-motivated portion of Q4, however small, "forces" your value in Q7 to abide by average valuation to Q7 in the rest of the population). More likely, zero stated WTP in Q7 indicates a lower true value than the respective population mean. On the other hand, no correction is done for those who stated zero in Q7 and positive to the self-motivated part of Q4, and preferred either an environmental or traffic accident project, in all 181 respondents.

We have also studied the answers to Q7 in more detail and find positive income and negative age effects on WTP, but these are on the whole weak and insignificant.

Since there were no debriefing questions following Q7, and no scope tests are possible, it is difficult to know exactly how well this question worked. It only gives (rather rough) point estimate of a purely private-good VSL, for one particular risk level. A weakness is obviously the high share that responded zero, and where we have no clue to the reasons why. It is still in my opinion interesting that central private VSL figures appear to be very close to purely private fractions of total VSL in the public-good parts 1 and 2 above.

[35] We have also studied the answers to Q7 in more detail, and find positive income and negative age effects, which however both are insignificant.

6. Conclusions and discussion

6.1 Summary of main results

The three parts of the survey, reported in sections 3-5 above, have together given us several different estimates of VSL in Norway, related to different concepts of VSL. Our results indicate that a public project to save one statistical life in Norway today is associated with an average WTP per household of about 10-25 NOK, or a total VSL in the range 20-50 million NOK (about 2.5-6 million USD at today's exchange rate of 1USD = 9 NOK).[36] Parts 1-2 of our valuation procedure also provide information on VSL for each of the three possible death causes considered. Here environmental causes imply the highest VSL, and heart disease the lowest, with traffic accidents in between the other two. We find a high degree of consistency between parts 1 and 2, both for overall VSL, and relative values for the three death causes. The most noticeable difference is that traffic-accident-caused deaths has a somewhat lower value relative to heart-disease-caused deaths in part 1.

Part 2 also splits total WTP up by motives. Here slightly less than one third of total VSL is found to be motivated by pure self interest, slightly less than one half by concerns for the rest of ones family, and the rest (about 25 %) by "altruistic" concerns, as averages over all respondents. The "purely self-motivated" VSL when the death cause is heard disease is about 10 million NOK when derived from part 2. From part 3 we obtain a purely private-good VSL estimate, in terms of respondents' own willingness to pay for treatment to prolong their own lives. The average VSL from part 3 is approximately 10 million NOK, or somewhat higher to the extent that some of the zero bidders in part 3 are protest bidders. This is very close to the average privately motivated part of total VSL, from part 2.

While information on environmental and traffic accident deaths is provided only in parts 1 and 2, VSL of reduced heart-disease risk is covered by all three parts of the survey. Table 11 sums up the different estimates of heart disease VSL, 1-2 from the choice experiments in part 1 (previously reported in table 5, using the more conservative equal-weights alternatives); 3-4 from CR and DC-CV questions Q3 and Q4a in part 2 (reported in table 6), 5 from OE-CVM question in Q4b (reported in table 7); and 7-8 from the individual treatment question Q7 in part 3, (reported in table 10). Line 6 in table 11 is constructed by adjusting figures in Line 5

downward, assuming that total values of heart disease lives among individuals who chose other projects in part 2, are proportional to self-motivated valuations of heart disease lives in part 3.

Table 11. Relationship between total WTP for one heart disease death avoided in the population, and type of question asked (in present value terms).

Type of calculation	Total value	Own motivated
1. Part 1, logit life-cause tradeoff	31.8	9.9
2. Part 1, log-linear life-cause tradeoff	39.2	12.2
3. Part 2, CR and DC-CV sequence, common utility	20.2	6.3
4. Part 2, CR and DC-CV sequence, specific utility	20.6	6.4
5. Part 2, OE-CV, pref. Heart project	36.1	11.3
6. Part 2, OE-CV, average	28.4	8.9
7. Part 3, Q7 averages (actual zeros)		7.8, 40 years 8.7, declining lifetime
8. Part 3, using imputed values for single zeros		10.0, 40 years 15.2, decl. Lifetime

Table 11 also distinguishes between total value and self-motivated value. Calculations 1-6 provide both, while calculations 7-8 provide only own-motivated values. The figures display striking similarities. Excluding calculations involving imputed values, estimates of average own-motivated VSL for heart-disease deaths vary from a minimum of 6.5 million NOK (calculation 3) to a maximum of 11.3 million NOK (calculation 4) (with imputed values the upper limit is moved upward, to 15.2 million NOK). When considering total VSL related to heart disease, central figures are also close, ranging from 20 million NOK in relation 3, to 39 million NOK in relation 2. An interesting feature is the similarity between items 1-6 and

[36] This is also quite close to the PPP adujsted exchange rate used by the OECD, as averages over the 1995-200 period, see OECD (2001).

items 7-8, in spite of the extreme difference in method by which the data were collected in these two cases.

Table 12 sums up our estimates of "total VSL" for each of the three death causes, from parts 1-2. Relevant figures for the two other death causes derived from part 1 (corresponding to relations 1-2 in table 11) are found from table 2. The figures in lines 3-4 are derived from the tradeoffs implied by the rankings in Q3, while figures in lines 5-6 are derived from the valuation procedure from WTP answers to Q4b. In line 6, figures in line 5 are adjusted down for all causes, proportionately to the downward adjustment for heart disease deaths, as found from the equivalent calculations in table 11 (relations 5-6).

Table 12. Overall assessment of VSL for different death causes. Million NOK.

Relationship in table 7	Heart disease	Traffic accidents	Environmental causes
1	31.8	37.8	69.6
2	39.2	40.2	59.2
3	20.2	29.2	38.6
4	20.6	61.4	94.2
5	36.1	53.8	62.6
6	28.4	42.4	49.3

6.2 Validity of our analysis

A range of factors impact on validity of the above analysis. Four factors are a) the correctness of our concept of a statistical life, b) the way in which we handle altruistically expressed valuations, c) the unbiasedness of results obtained from our CV and CA/CR surveys, and d) statistical and sampling problems in deriving "correct" valuation figures from our survey data. Each factor raises problems of interpretation and substance, which go beyond the scope of the present paper. Some discussion is still in place.

In attempting to define the concept of a statistical life a number of issues arise. Focussing on VSL as a private good, Bleichrodt and Quiggin (1999) and Johansson (2000, 2001) argue that this in part depends on the whole (optimal) consumption path of the individuals experiencing risk changes, over the whole horizon over which such risk changes are relevant. An easily interpretable concept is then obtainable only when consumption is constant over

this horizon.[37] Such issues would mainly apply to part 3 and not parts 1-2, where the object for valuation is VSL as a public good, essentially in the form of an "immediate life saved". A question is if the critique applies even to part 3. Respondents in the survey would then have to consciously take into consideration the fact the their consumption profile over time may increase or decrease up to the time of likely death, which may seem far fetched.

A more important issue is in our opinion that of VSL as private versus public good, which is important for our study but plays only a small role in the empirical literature. Possible altruistic motivations behind VSL then become crucial. Part 2 of our survey in principle provides information on such motivations by splitting total VSL into three value components, pure self interest, the rest of ones close family, and other persons or causes. An important principal question is whether the two latter parts of total VSL should be included in a definition of total (public-good) VSL. This issue has been subject to analysis in the theoretical literature. Some authors argue that at least the first should generally be included, in particular since elicited WTPs are interpreted as household values. Jones-Lee (1992) defines "pure paternalism" as altruism within a family, which shares a common budget, and where a single decision maker in the household has authority to make all its spending decisions. In such a case the marginal rate of substitution, between the public good to be valued and the bundle of other goods (i.e., money) is the same for all family members, when viewed by the member of the family conducting the valuation. Jones-Lee then shows that the total valuation expressed by a family decision maker (i.e., the sum of the expressed self-motivated and family-motivated values) correctly represents the household's total valuation of the public good (here, VSL).[38] A related issue is whether values attached to other family members should be added to purely selfish motivations when deriving VSL as a public good. Harbaugh (1999) argues that altruism exhibited toward own children should be included, since children will not themselves meaningfully express own WTP of "correct" magnitude. This leads to discrepancy between true" private-good and public-good VSL, thus making this distinction meaningful and important.

[37] A number of other issues also impact on private VSL values, such as initial death risk and financial risk and the degree of risk aversion; see e.g. Pratt and Zeckhauser (1996), Eeckhoudt and Hammitt (2000, 2001) for further discussion.

[38] By the same token, consequently, Jones-Lee's argument goes against adding up all household members' valuations including those altruistically motivated our of concern for other household members. This would lead to double counting even when such altruistic motives are paternalistic. See also Quiggin (1998), who also argues in favor of using the household WTP concept.

We must here note that the concept of ones "close family" is not made precise in our study, and may comprise also persons not sharing a common household budget. Thus in particular, also singles can be assumed to have a "close family". About one fourth of the sample consists of singles, and these turns out to have "family" VSL valuations not significantly different from those of respondents in multiperson households. Such valuation should be treated formally in the same way as value given to outside persons, discussed in the following.

The second type of altruism is directed toward persons outside of ones own "close family", which represents about 20 % of total stated VSL in part 2 of our survey. The issue of whether or not to include such value components in VSL valuation turns out to depend at least in part on whether the altruism thus expressed is nonpaternalistic or paternalistic. Nonpaternalistic altruism implies that individuals attach value to other individuals' general level of utility. Borgstrom (1982) has demonstrated that including such values then leads to double counting and should be avoided in a social benefit calculation of VSL. Paternalistic altruism has been studied by Jones-Lee (1991) and Johansson (1994) in the context of VSL, and e.g. by Lazo, McClelland and Schulze (1997) for more general public goods. In such cases altruistic value is attached to other individuals' consumption of the public good being valued, and not to general utilities of these. The inclusion of altruistically expressed values is then more legitimate, since marginal rates of substitution are affected. The same principle should apply for "close family" valuation, which does not concern persons sharing a common budget, as discussed in the previous paragraph.

We have few indications about the predominant type of altruism (nonpaternalistic or paternalistic) exhibited toward "other persons", in our study or other similar surveys eliciting VSL. Whenever paternalistic altruism dominates (respondents attach "considerably more" weight to other persons' survival probabilities than to their general consumption), it may be legitimate to include altruistically expressed values as part of "true" VSL. Elicitation of VSL as a purely private good may then be misleading in public policy contexts where mortality risk reductions almost always are of the public good kind. In our study we find large apparent differences between VSL elicited as private versus as public goods. While not conclusive, our results should provoke further research on this issue.[39]

[39] Note that the much larger altruistic component attached to saving lives from environmental causes than from other causes, may imply that saving such lives imply a particularly large paternalistic component, whereby it is particularly valuable to save the lives of others in this particular manner.

The second major new issue addressed in our study is that of comparing VSL values according to death causes, and in combination with motives for valuation. We will emphasize three main possible factors behind different expressed VSL for different death causes in our study.[40] First, the manner in which death occurs (and any possible suffering up until point of death) can be associated with different ex ante disutilities.[41] Secondly, mortality reductions may be viewed as provided jointly with other public goods. Thirdly, a (paternalistic) altruistic component can vary systematically between death causes, i.e., individuals' WTP to avoid deaths of other individuals may vary systematically between causes. All three factors may be relevant in explaining high values attached to environmental deaths, relative to the two other causes included. Environmentally caused deaths may involve greater perceived individual suffering, greater disamenities in terms of low overall environmental quality levels, and a greater paternalistically-motivated component of altruistic valuation. The VSL values for traffic accident deaths are higher than those for heart disease deaths, but not by much; effects on average remaining lifetimes may here have played a role. Our data are not rich enough to separate out all these issues; more research is here clearly needed.

Note that our study has not gone deeply into the issue of valuing remaining life years (e.g. in terms of QALYs; se Nord (1999)) as opposed to lives. An example of this type of problem is that expected remaining lifespan for deaths avoided from traffic accidents likely are far higher than those for deaths avoided from environmental or heart disease (see e.g. Cropper and Simon (1994) for discussion in the environmental risk context). In our survey respondents were given no information on possible differences in expected lifetimes between death causes. It is then an open question whether any such differences were perceived, when WTP figures were stated for the different projects involved.

The final major topic is general validity of the VSL elicitation mechanisms in parts 1-3 of our survey. This is a complex issue and one that cannot be answered exhaustively here. The most important types of criticism would be those raised against the contingent valuation procedures, in parts 2 and 3, since these form the core of our VSL valuation exercise. Four points are here particularly important. First, one needs to check for consistency of answers by individuals across different questions. Secondly, the issues of scope and sequencing are

[40] We are here disregarding the issue of remaining statistical life years for persons killed by the different causes, which may play a role but which at least was not focused in the survey.

[41] A related issue is clearly the degree of subjective control exhibited by the individual, over the particular death risks at stake. Such control may be perceived as high for drivers in the case of traffic accident death, and for

important. Thirdly, possible starting point biases should be controlled for. Fourth, internal validity must be checked for, in particular if valuation figures are in correspondence with predictions from economic theory, in particular when it comes to background variables. See e.g. Carson, Flores and Meade (2001) for discussion of factors.

A particularly serious issue is raised by a common finding that total expressed VSL values as derived from SP studies are (often extremely) sensitive to magnitudes of risk changes, what is commonly called "scope". In part 1, assessed VSL is found as an average over all individuals facing different risk reductions. We here find little difference between VSL estimates given large and small risk reductions, implying essentially no (externally tested) sensitivity of VSL to scope. This gives hope for optimism for future use of pairwise-choice experiments as a basis for VSL valuation from the comparison of public programmes. By contrast, when WTP figures are derived from absolute and relative valuation of more complex projects, involving four attributes one of which is the number of lives saved, sensitivity to scope is much greater. Here a doubling of the number of lives saved in a project reduces the average implied VSL estimate by around 60-70 %. An issue appears be the complexity of the choice situation in this case, making respondents use simplified decision making procedures giving priority to particular attributes (the decision process tends to be lexicographic; see Sælensminde (2000)). This speaks against using complex decision procedures in VSL derivation. Clearly, more research is required to derive the potential strengths and weaknesses of such elicitation mechanisms.

In checking our results for validity we have run regressions of stated WTP against a number of background variables. We find among other things that income has a significantly positive effect on VSL, while age has a significantly negative effect, both to be expected a priori. We however find no significant relationship with many other key variables, such as occurrence of own illness or activities.[42] .

6.3 Implications

What are the overall implications of our results for "correct" VSL assessment in general, and in Norway in particular? First, departing from the "standard" VSL measure in the

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smokers in the case of heart disease death, but may for all be perceived as very small for environmentally caused deaths (where even the mode of death is generally uncertain).

literature, namely as a purely private good, the most likely VSL figure from our study appears to be in close to 1 million USD, which is clearly lower than values traditionally used in the U.S. context (where a standard figure appears to be 5 million USD, see e.g. Murphy and Topel (1999)), but well in accordance e.g. with similar values recently obtained for Canada, by Krupnick et.al. (2000), probably the most thorough, comparable, study in the recent literature.[43] Moreover, the private VSL assessment from our study does not differ much by "type" of life saved. We however argue that in most contexts involving public policy, VSL must be viewed as a public good. Then VSL values derived from our study may be considerably higher, possibly up to 4-5 million USD depending on assumptions about the inclusion of valuation components with intrafamily and altruistic motivations, and in addition differ more by death cause. Overall figures are then more in line with commonly used U.S. figures. One must then however remember that they are derived in a manner quite different from the traditional way, and that it may be inappropriate to include (all) altruistic values in such a calculation.

Overall, the most encouraging results from our study are clearly those from pairwise CA comparisons in part 1, where no scope effect is found in assessment of public-good VSL. This points toward the possibility for deriving stable VSL values to be derived from SP studies, also in future studies, and underlines the need for further research in this area. Such research should involve other designs than the one used here, where we have relied on one random population sample that was interviewed only once, and where the risk changes valued were entirely hypothetical. Preferably, future studies should involve follow-up studies where particular sets of individuals are familiarized with the choice situation and where, if possible, actual payments are made, for actual individual or collective risk changes.

[42] This is in line with results from another recent study, Krupnick et.al. (2000), who however find some positive effect of own cancer illness on WTP.

[43] See also Johnson et.al. (1998), who obtain an average (undiscounted) value of extending respondents' lifetime by one year beyond "normal" life expectancy, given minimal activity restrictions, equal to 14 000 Canadian dollars (CAN), using CA techniques. Given 3 % discounting by the average (42-year-old) respondent up to a life expectancy of 78 years, this is equivalent to a discounted present-value (private-good) VSL of around 0.7 million CAN.

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Appendix 1: Survey questionnaire.

Part One: Presentation and registration

Good afternoon/morning, my name is <YOUR NAME> and I work for <THE NAME OF THE OPINION AGENCY>. On commission from researches we interview people concerning their opinions about different issues in our society. This interview is voluntary and it will not be possible to trace individuals based on their responses after the interview. The questionnaire will take approximately thirty minutes. If we ask you any questions you do not want to answer, just tell us, and we will proceed with the interview.

A) TO THE INTERVIEWER:

IT IS VERY IMPORTANT THAT THE RESPONDENT IS NOT GIVEN ANY INFORMATION ABOUT THE SUBJECT/TOPIC OF THE QUESTIONNAIRE AT THIS STAGE. IF THE RESPONDENT ASKS ABOUT THE TOPIC, JUST TELL HIM: We interview people about their preferences towards different issues, as education, health services, unemployment and protection of the environment.

DID YOU HAVE TO READ THIS? YES / NO

B) TO THE INTERVIEWER:

IF THE RESPONDENT INSISTS ON KNOWING MORE, SAY: The reason I am not telling you more about the topics in this survey before we start the interview, is that I want you to make up your mind while I am giving you various information about these topics.

DID YOU HAVE TO READ THIS? YES / NO

Question 1

TO THE INTERVIEWER

a) How many houses did you visit where nobody was home before this? _____

b) In how many houses did the respondent refuse to be interviewed before this? _____

c) Year, month and time of the interview _____

d) Length of the interview, in minutes _____

e) Municipality number _____

f) Split A - N

Part two: Scenario description and discrete choice questions

The public authorities concern themselves with several tasks in Norwegian society. Some examples of such tasks are the public health service, road construction, aid to developing countries, fighting crime, preserving the nature, pollution control and reducing unemployment. In this survey, we primarily focus on topics concerning public health services, traffic safety, and some aspects of pollution control.

Every year, several people suffer a premature death due to various diseases and in traffic accidents. We want you to make up your mind about how important you feel it is for the government to take initiatives to prevent

such deaths. Some of these questions may be difficult to answer, but we hope you will answer as well and honestly as possible.

SHOW CARD I: "DESCRIPTION OF THE CURRENT SITUATION AND POSSIBLE ACTIONS"

Approximately 19 000 people die every year due to cardiovascular diseases, approximately 10000 people die of cancer, and approximately 300 die in car accidents. An unknown number of people die because different environmental problems, both indoors and outdoors, may trigger off, or worsen, diseases which cause a premature death. Some examples of such environmental problems are asbestos and paint products used by in the construction industry. We also know that environmental pollution may cause lung emphysema, lung cancer, and asthma.

People may to some extent reduce their own risk of such causes of death by changing their life style, move to a less polluted area, or drive more carefully. It is also possible for the government to initiate action to reduce the risk of dying from these causes. An increased priority given to the public health service, accompanied by initiatives to encourage people to change their diet and quit smoking may reduce the number of people suffering from cardiovascular diseases and cancer. Improved safety equipment in cars and various road safety initiatives, may reduce the number of people killed in traffic accidents. Research on health effects due to different matters that surround us may reveal whether some of them are dangerous, so the use of these substances may be regulated or banned. E.g., this was what happened when we discovered how dangerous asbestos was, which led to a ban on the use of asbestos.

Some of these governmental projects may reduce the risk that you, or someone in your nearest family, will suffer a premature death. Other projects may mainly affect other people's welfare. Some of these projects will start having an effect immediately, whereas other projects may take some time before they start saving lives. Some of these projects may also have an effect on the number of casualties and sick people, but we urge you to concentrate on the number of lives saved by the project.

Now, we are going to ask you some questions concerning your preferences towards governmental measures to reduce the number of people dying from cardiovascular disease, in traffic accidents, or from lethal diseases triggered off by environmental pollution.

Question 2

a) Suppose the government can choose between the following two projects, A and B, shown on this card:

HAND OUT CARD 1 - AND NOTE ON THE QUESTIONNAIRE (REMEMBER TO ROTATE)

The only aspects which distinguish the two projects are the time lag from when the project is initiated until it starts saving lives and the number of lives saved by the project. All other aspects of the projects are identical.

If project A is applied, it will take ____ (NOTE) years from the time when the project is initiated until it starts saving lives. After this time lag, the project will save ____ (NOTE) lives every year as soon as the project starts

to be effective. For project B it will take _____ (NOTE) years until it starts saving lives. After this, the project will save _____ (NOTE) lives every year to come.
Which one of these two projects do you prefer? *A / B*

TAKE BACK CARD 1

IF THE RESPONDENT HAS DOUBTS ABOUT THE NUMBER OF LIVES SAVED, ANSWER THAT THE NUMBER OF LIVES THE PROJECT WILL SAVE IS KNOWN.

IF THE RESPONDENT ASKS ABOUT OTHER FACTORS THAN THOSE MENTIONED IN THE PROJECT, ANSWER THAT THE TWO PROJECTS ARE EQUAL EXCEPT THESE TWO ATTRIBUTES.

b) Suppose the government can choose between the following two projects, A and B, shown on this card:

HAND OUT CARD 2 - AND NOTE ON THE QUESTIONNAIRE (REMEMBER TO ROTATE)

The only aspects which distinguish the two projects are the cause of death and the number of lives saved by the project. All other aspects of the projects are identical.
Project A will save ____ (NOTE) lives every year of persons who would otherwise have died from _____ (NOTE). Project B will save _____ (NOTE) lives every year of persons who would otherwise have died from _____ (NOTE).
Which one of these two projects do you prefer? *A / B*

TAKE BACK CARD 2

IF THE RESPONDENT HAS DOUBTS ABOUT THE NUMBER OF LIVES SAVED, ANSWER THAT THE NUMBER OF LIVES THE PROJECT WILL SAVE IS KNOWN.

IF THE RESPONDENT ASKS ABOUT OTHER FACTORS THAN THOSE MENTIONED IN THE PROJECT, ANSWER THAT THE TWO PROJECTS ARE EQUAL EXCEPT FOR THESE TWO ATTRIBUTES.

c) Suppose the government can choose between the following two projects, A and B, shown on this card:

HAND OUT CARD 3 - AND NOTE ON THE QUESTIONNAIRE (REMEMBER TO ROTATE)

The only aspects which distinguish the two projects are the age group affected and the number of lives saved by the project. All other aspects of the projects are identical.
Project A will save ____ (NOTE) lives every year in the age group _____ (NOTE). Project B will save _____ (NOTE) lives every year in the age group _____ (NOTE).
Which one of these two projects do you prefer? *A / B*

TAKE BACK CARD 3

IF THE RESPONDENT HAS DOUBTS ABOUT THE NUMBER OF LIVES SAVED, ANSWER THAT THE NUMBER OF LIVES THE PROJECT WILL SAVE IS KNOWN.
IF THE RESPONDENT ASKS ABOUT OTHER FACTORS THAN THOSE MENTIONED IN THE PROJECT, ANSWER THAT THE TWO PROJECTS ARE EQUAL EXCEPT FOR THESE TWO ATTRIBUTES.

READ:

Suppose that the government wants to finance the project by a general increase in direct and indirect taxes. This increase will be sufficiently large so the project does not come at the expense of other governmental tasks. This increase in taxes will lead to an increase in costs for you and your family. This implies that you get less money left to other purposes as travelling, food, cloths, car, savings etc., after all fixed costs are paid. Now, we want you to consider your personal costs due to the initiation of these governmental projects.

d) Suppose the government can choose between the following two projects, A and B, shown on this card.

HAND OUT CARD 4 - AND NOTE ON THE QUESTIONNAIRE (REMEMBER TO ROTATE)

The only aspects which distinguish the two projects are the annual cost for your family and the number of lives saved by the project. All other aspects of the projects are identical.
Project A will save ____ (NOTE) lives every year at an annual cost of_____ (NOTE) NOK for your family.
Project B will save _____ (NOTE) lives every year at an annual cost of_____ (NOTE) NOK for your family.
Which of these two projects do you prefer? *A / B*

IF THE RESPONDENT HAS DOUBTS ABOUT THE NUMBER OF LIVES SAVED, ANSWER THAT THE NUMBER OF LIVES THE PROJECT WILL SAVE IS KNOWN.
IF THE RESPONDENT ASKS ABOUT OTHER FACTORS THAN THOSE MENTIONED IN THE PROJECT, ANSWER THAT THE TWO PROJECTS ARE EQUAL EXCEPT FOR THESE TWO ATTRIBUTES.

e) Now, assume that the government will carry out the project you preferred in the last question, that is project _____ (NOTE). This project will cost your family _____ (NOTE) NOK in additional yearly expenses, because the project is financed by an increase in both direct and indirect taxes.
When you consider your household's annual income and fixed expenditures, are you willing to pay this cost so the government may effectuate this project?
Remember that this will leave you less money to buy i.e. food, clothing, shoes, travels, car use and savings. Yes / No / Don't know

TAKE BACK CARD 4

READ:

The projects we have considered until now have been equal except for two attributes. We are now going to consider projects where the number of lives saved, the cause of death, the time lag until the project starts saving lives, and your personal costs in relation to the project, vary.

Question 3:

Suppose the government has to choose between four different projects reducing the number of people suffering a premature death. The four different projects are described on this card.

HAND OUT CARD 5 - AND NOTE ON THE QUESTIONNAIRE (REMEMBER TO ROTATE)

The attributes which distinguish the four projects are the number of lives saved by the project, the annual cost for your family, the time lag until the project starts saving lives and the cause of death. For all other aspects the projects the projects are identical. We will give a short description of the four projects.

Project A: NOTE FROM THE CARD INTO THE QUESTIONNAIRE (REMEMBER TO ROTATE)

If the government chooses project A they will save ____ (NOTE) lives every year after a time lag of _____ (NOTE) years, who would otherwise have died of _____ (NOTE). The increase in the direct and indirect taxes necessary to finance this project will cost your family _____ (NOTE) NOK every year.

Project B: NOTE FROM THE CARD INTO THE QUESTIONNAIRE (REMEMBER TO ROTATE)

If the government chooses project B they will save ____ (NOTE) lives every year after a time lag of _____ (NOTE) years, who would otherwise have died of _____ (NOTE). The increase in the direct and indirect taxes necessary to finance this project will cost your family _____ (NOTE) NOK every year.

Project C: NOTE FROM THE CARD INTO THE QUESTIONNAIRE (REMEMBER TO ROTATE)

If the government chooses project C they will save ____ (NOTE) lives every year after a time lag of _____ (NOTE) years, who would otherwise have died of _____ (NOTE). The increase in the direct and indirect taxes necessary to finance this project will cost your family _____ (NOTE) NOK every year.

Project D: NOTE FROM THE CARD INTO THE QUESTIONNAIRE (REMEMBER TO ROTATE)

If the government chooses project D they will save ____ (NOTE) lives every year after a time lag of _____ (NOTE) years, who would otherwise have died of _____ (NOTE). The increase in the direct and indirect taxes necessary to finance this project will cost your family _____ (NOTE) NOK every year.

a) If the government must choose one of these projects, which one of these four projects do you prefer? *A / B* / C / D

b) If the government does not choose the project you ranked as the first best, which one of the three remaining projects do you prefer? *A / B* / C / D

IF THE RESPONDENT ASKS ABOUT THE COST, TELL HIM THAT THE COST MUST BE PAID/MET EVERY YEAR FROM THE POINT WHEN THE PROJECT IS INITIATED.

IF THE RESPONDENT HAS PROBLEMS UNDERSTANDING WHAT IS MEANT BY "TIME LAG ", EXPLAIN THAT THE PROJECTS ARE INITIATED NOW (AND THE PAYMENTS START NOW), BUT IT MAY TAKE SOME TIME FROM WHEN THE PROJECT IS INITIATED UNTIL IT STARTS SAVING LIVES.

EXAMPLE 1: IT MAY TAKE SOME TIME FROM A RESEARCH PROGRAM IS INITIATED UNTIL POTENTIAL CAUSALITIES BETWEEN ENVIRONMENTAL POLLUTION AND HEALTH EFFECTS ARE DISCOVERED, AND THESE CHEMICALS CAN BE BANNED OR REGULATED.

EXAMPLE 2: IT MAY TAKE A LONG TIME FROM WHEN A PERSON IS EXPOSED TO DANGEROUS CHEMICALS UNTIL HE BECOMES ILL. IT WILL THUS ALSO TAKE SOME TIME FROM WHEN THE BANNING OR REGULATION OF THE USE OF DANGEROUS CHEMICALS IS INITIATED UNTIL IT AFFECTS THE NUMBER OF LIVES SAVED.

Part three: Questions on the Willingness to Pay

Question 4:

Now, assume that the government will carry out the project you preferred in the last question. That is, project _____ (NOTE). The government will finance the project through an increase in both direct and indirect taxes that will cost your family _____ (NOTE) NOK in additional yearly expenses.

a) When you consider your household's annual income and fixed expenditures, are you willing to pay this cost so the government may achieve this project? Remember that this will leave you less money for i.e. food, clothing, shoes, travel, car use and savings.

Yes / No / Don't know

b) When you consider your household's annual income and fixed expenditures, what is the maximum cost you would be willing to pay so the government may achieve this project? Remember that this will leave you less money for i.e. food, clothing, shoes, travel, car use and savings. _____ NOK.

If you have any problems answering this question, this card may help you.

HAND OUT CARD 6

TAKE BACK CARDS 5 AND 6

Part four: Follow up questions.

- If the respondent gave a zero response to all WTP-questions, that is question 4 a) and b), proceed to question 5.
- If the respondent gave a positive respondent to at least one of the WTP-questions, either yes in 4 a) or a WTP greater than zero in 4 b), proceed to question 6.

Question 5

Now, I am going to ask you some questions concerning the reasons you do not want to contribute to such projects.

a) Is it because you believe the level taxes are high enough as they are, and you would not like them to increase? *Yes / No / Don't know*

b) Is it because, even if you feel these projects are important, you would want the governmental authorities to redistribute their current revenue and finance the project from other budget posts, i.e. from administration or culture? *Yes / No / Don't know*

c) Is it because you do not believe the money will be used on such projects, but on administration and other objects you do not want to increase? *Yes / No / Don't know*

d) Is it because you do not believe the projects will affect your or anyone in your nearest family's risk of suffering a premature death? *Yes / No / Don't know*

e) Is it because people can reduce their own risk by changing their lifestyle, and you do not believe that such project is a governmental task? *Yes / No / Don't know*

f) Is it because your household cannot afford to pay additionally to such projects, although you feel they are important? *Yes / No / Don't know*

g) Is it because you feel the projects are saving too few lives in comparison to the cost of the project? *Yes / No / Don't know*

PROCEED TO QUESTION 7

Question 6

i) In the last question you agreed to pay an increased amount in your annual taxes to initiate a governmental projects aiming to reduce the risk of suffering a premature death. Now, I want to ask you some question concerning the amount you agreed to. The project will increase both the direct and indirect taxes.

a) Did you feel that you reported an amount which was lower than what the project is really worth to you? *Yes / No / Don't know*

b) Did you agree to pay more than you actually want to pay to make sure the project is initiated? *Yes / No / Don't know*

c) Would you be displeased if you actually had to pay the amount you agreed to for the project? *Yes / No / Don't know*

ii) I am now going to ask you some questions concerning the reasons why you agreed to support the project.

HAND OUT CARD 7

On this card we have mentioned some possible reasons for supporting this project.

1) Reduce your own risk of suffering a premature death

2) Reduce you nearest family’s risk of suffering a premature death

3) Reduce other persons' risk of suffering a premature death

4) Other reasons

Imagine that you have 10 points to distribute among the four groups according to the importance of these causes when you decided upon which project to support. The more influential the reason, the higher the points score. How many points would you give each of the four causes? (Remember that the sum must equal 10)

1) Reduce your own risk of suffering a premature death _____ points

2) Reduce you nearest family's risk of suffering a premature death _____ points

3) Reduce other persons' risk of suffering a premature death _____ points

4) Other reasons _____ points

TAKE BACK CARD 7

We now want you to forget about all the previous projects.

Question 7

a) New and improved treatments for cardiovascular diseases will increase the average life expectancy. Assume that the government are considering initiating actions that would lead to an increase in your life expectancy by one year, with a probability of one percent. That is, the chance that you will enjoy this increase in life expectancy is 1:100. For the action to be initiated you would have to pay an own fee for the treatment.

How much are you willing to pay in own payments for the government to initiate this treatment? _____ NOK

b) Suppose an alternative action which would have an effect on all human beings, that is, all people would have a 1:100 change of increasing their life expectancy with one year. This project would be financed by an increase in taxes. How much are you willing to pay for this action? Or, what is the value for you that these actions are taken? Remember that others, including your own family, will enjoy this action. _____ NOK

c) New and improved treatments for cardiovascular diseases will increase the average life expectancy. Assume that the government are considering initiating actions that would lead to an increase in the life expectancy of all human beings of one year, with a probability of one percent. That is, the chance that you will enjoy this increase in life expectancy is 1:100. This action will be financed by an increase in taxes. How much are you willing to pay for the government to initiate this treatment? Remember that others, including your own family, will enjoy this action. _____ NOK

d) We want to know how much of the amount you agreed to is due to an increase in our own life expectancy with one year at a probability of one percent. What is the maximal amount you would be willing to pay for this action, when you only consider the effect it will have on you? _____ NOK

Part five: Social and Economical variables

We have now finished the most difficult part of the questionnaire and will proceed to some more general questions.

Question 8

What is you highest accomplished education? *Primary school / College / University.*

Question 9

What is your marital status? *Married, cohabiting / widow, widower / unmarred / divorced, separated.*

Question 10

a) How many cars does you family command? _____

b) How many km do your family drive annually? _____

c) How many km do you drive annually? _____

Question 11

a) How many children do you have? _____

b) How many of them are under the age of 18? _____

Question 12

Gender: *Male/ Female*

Question 13

How old are you? _____

Question 14

What is your main occupation? *Student /unemployed, senior citizen, on welfare / living at home / employed within the: .....*

Question 15

a) With annual gross income we mean the sum of salary (before taxes), social security (including unemployment insurance, retirement pensions, and disabled pensions), and other income that is tax liable. Approximately, what was your (personal) annual gross income in 1994? _____NOK

b) Approximately, what was you family's annual gross income in 1994? _____NOK

c) Approximately, what is your expected your personal annual gross income to be over the next 10 years? _____NOK

Part six: Information about personal risks

Question 16

We would like some information about what you already do to reduce your own risk of suffering a premature death.

a) Do you have a collision pillow or anti-lock brakes in your car? *Anti-lock brake / Collision pillow / Neither / Both.*

b) Do you use the seat-belt when you are driving? *Always / Usually / Seldom / Never*

c) Do you smoke? *Yes / No / Sometimes / Not answered*

d) Do you exercise? *Often / Sometimes / Seldom / Never*

Question 17

By our nearest family we mean our spouse/partner, children, and biological relatives until your grand parents (including aunts, uncles and cousins). Have you, or anyone in your nearest family ever suffered from any of these diseases?

a) Cancer: *I myself / others / no one / don't know.*

b) Cardiovascular disease: *I myself / others / no one / don't know.*

c) Lung emphysema, asthma, bronchitis or other serious lung diseases: *I myself / others / no one / don't know.*

d) Have you or any of your friends and family been in an serious car accident? *I myself / friends / relatives / no one / don't know.*

Part seven: Conclusion.

To end this questionnaire, we want to ask you some questions about what you thought of it. We are aware that several questions may be difficult to answer. Thus, we ask you to think carefully about how difficult you found these questions.

Question 18

a) In the first four questions, you were asked to choose one of two different projects. How often did you feel you could answer these questions, according to your opinions?

Every time / most of the times / few of the times / never / don't know.

b) Then, we asked you to choose the best and the second best of four different projects. Did you feel you could answer these questions according to your preferences?

Yes / No / don't know.

c) Was any of the four attributes decisive in your choice of project?

The number of lives saved / the cost / the time lag / the cause of death.

THE RESPONDENT IS ALLOWED TO CHOOSE MORE THAN ONE FACTOR

d) In the following two questions we asked you questions concerning your willingness to pay for the project you ranked as the first best. Did you feel that you could answer these questions according to your preferences? *Yes, both of them / only the first / only the second / neither*

Question 19

How often did you feel you understood the content of the questions we asked you?

Always / almost always / almost never / never / don't know

Thank you very much for taking your time to answer these questions.

Part nine: Questions to the interviewer

THIS PART IS TO BE ANSWERED BY THE INTERVIEWER AFTER THE INTERVIEW IS OVER.

IT IS VERY IMPORTANT THAT THIS PART IS ANSWERED AS HONESTLY AS POSSIBLE. WE ARE AWARE THAT THE QUESTIONNAIRE IS VERY LONG AND DIFFICULT TO ANSWER, AND EXPECT THE RESPONDENTS TO HAVE SOME PROBLEMS.

Question 20

How cooperative and interested in the subjects of this survey did the respondent appear to be? *Very interested / interested / not interested.*

Question 21

Did the respondent seem to understand and be able to answer the questions?

Yes / mostly / seldom / never

Question 22

a) Did the respondent have difficulties in ranking the projects in question 2? *Yes / no*

b) Did the respondent have difficulties in ranking the projects in question 3? *Yes / no*

c) Did the respondent have difficulties in stating their willingness to pay in question 3? *Yes/no*

Question 23

Was there anyone present other than the respondent during the interview? *Yes / no*

Question 24

If yes, how large effect on the respondents answers did this other person(s) have?

Large effect / some effect / little effect / no effect

The interviewer's name: _____

Appendix 2: Samples of cards used in the survey

Card I: Description of the current situation and possible actions.

Cause of death	Number of deaths per year in Norway	Possible action to reduce mortality
Cardiovascular Disease	19 000	Increased priority to the public health service, and initiatives to encourage people to change their diet and quit smoking.
Cancer	10 000	Increased priority to the public health service, and initiatives to encourage people to quit smoking.
Road Accident	300	Reduced taxation on security equipment in cars, and road safety measures.
Lethal Disease due To Environmental Pollution	?	Research on health effects due to different matters that surround us so the use of these substances may be regulated or banned.

Sample cards for parts 1 of the valuation procedure (Q2)

Card 1: Governmental projects to reduce the number of annual premature deaths.

Project A		**Project B**	
Number of lives saved:	100	Number of lives saved:	200
With effect from:	In 5 years	With effect from:	In 10 years

The only aspects which separate the two projects are the time lag from when the project is initiated until it starts saving lives, and the number of lives saved by the project.
All other aspects of the projects are identical.

Which one of these two projects do you prefer (A or B)?

Card 2: Governmental projects to reduce the number of annual premature deaths.

Project A		**Project B**	
Number of lives saved:	10	Number of lives saved:	100
Cause of death:	Cardiovascular disease	Cause of death:	Road Accident

The only aspects which separate the two projects are the cause of death and the number of lives saved by the project. All other aspects of the projects are identical.

Which one of these two projects do you prefer (A or B)?

Card 3: Governmental projects to reduce the number of annual premature deaths.

Project A	**Project B**
Number of lives saved: 50 Age: 0 - 18	Number of lives saved: 100 Age: 35 - 60

The only aspects which separate the two projects are the age and the number of lives saved by the project. All other aspects of the projects are identical.

Which one of these two projects do you prefer (A or B)?

Card 4: Governmental projects to reduce the number of annual premature deaths.

Project A	**Project B**
Number of lives saved: 100 Annual Cost in NOK: 2 500	Number of lives saved: 500 Annual Cost in NOK: 5 000

The only aspects which separate the two projects are the cost and the number of lives saved by the project. All other aspects of the projects are identical.

Which one of these two projects do you prefer (A or B)?

Sample card for part 2 of the valuation procedure (Q3)

Card 5: Governmental projects to reduce the number of annual premature deaths.

Project A		**Project B**		**Project C**		**Project D**	
Lives saved:	500	Lives saved:	200	Lives saved:	100	Lives saved:	50
Years:	25	Years:	25	Years:	5	Years:	1
Disease: CD		Disease: CD		Disease: TA		Disease: CD	
Cost:	2500	Cost:	1000	Cost:	5000	Cost:	1000

The only aspects which separate the four projects are the number of lives saved, the time-lag from the project is initiated until it starts saving lives, the cause of death, and the cost.
All other aspects of the projects are identical.