Valuing lives saved from environmental, transport and health policies: A meta-analysis of stated preference studies

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Abstract

It is increasingly common to include estimates of value of statistical life (VSL) into analyses of proposed policies that affect people's mortality risks. While such VSL estimates have often been derived using revealed preferences methods, for example comparing wage differentials between risky and non-risky jobs, such methods may be inappropriate to assess the value of very different environmental, health and transport risks affecting the general population. Environmental pollution, for example, typically, affects the younger or the older part of the population the most (rather than male workers in their prime years) and mortality results from long-term pollution exposure and exacerbation of pre-existing medical conditions (rather than accidental deaths in the workplace). The wage-risk studies also face the problems of separating between actual and perceived risks and other factors that cause variation in wages. Therefore, a growing body of research use stated preference methods instead (contingent valuation or choice modelling) asking people directly or indirectly for their willingness to pay (WTP) to reduce such risks. We take stock of this literature and conduct, to our knowledge, the first meta-analysis of stated preference studies only from all over the world, seeking to explain the variation in stated preference VSL estimates based on differences in socio-economic characteristics (age, income, gender, health status, etc.), study designs (including the way risk changes are displayed), characteristics of risk (type and size of risk, baseline risks, latency etc) and other variables derived from the studies and from other available statistics. We not only investigate whether VSL conforms with standard theoretically and empirically derived expectations, but attempt to probe deeper into how people's stated values vary with characteristics of risks, controlling for methodological differences between studies. Results are potentially important both to our understanding of how people perceive and value risk changes and as a contribution to more reliable use of VSL estimates for cost-benefit analysis.

Keywords: Value of statistical life, meta-analysis, stated preference, risk

JEL classification: H41, Q51, I18

Introduction

Impacts on mortality tend to dominate estimates of the benefits of environmental policies (for air pollution, see e.g. US EPA 1999, European Commission 1999, Friedrich and Bickl 2001, Watkiss et al. 2005). Available estimates of how the public at large, in different circumstances, value a prevented fatality – or a statistical life – varies significantly. This can strongly influence whether or not the estimated benefits of a given policy measure exceed the cost of that measure. Gaining a better understanding of what explains the differences in available estimates of Value of a Statistical Life (VSL) can hence be of vital importance for policy-making. Cost-Benefit Analysis (CBA) is increasingly used in project and policy evaluations in OECD countries, e.g. in the USA and Australia (where CBAs are termed Regulatory Impact Assessments), the UK, and the Nordic countries. The European Commission conducts CBAs for all new EU directives, and the World Bank and the regional development banks in Asia, Africa and Latin America use CBAs in their project evaluations. Most of the applications have been in the transportation, environment (including water and sanitation) and energy sectors. Since many of these projects and policies save human lives, and CBAs aims at comparing social costs and benefits on a monetary scale, it is necessary to have a VSL estimate; or rather place a monetary value on reductions in the risk of dying. Within the environmental sector, the US Environmental Protection Agency and DG Environment of the European Commission have taken a leading role in using VSL estimates in their CBAs. If we do not value changes in mortality risks, e.g. as is the case in the health sector[1], they will be valued anyway *implicitly* through the decisions we make. However, such implicit values tend to vary a lot depending on the level of information among the

[1] Cost-utility analysis (CUA), a special case of cost-effectiveness analysis, is typically used. In health impact assessments, CUA estimates the ratio between the cost of a health-related intervention and the benefit it produces in terms of the gained number of years lived in full health by the beneficiaries.

decision makers, political processes and other aspects of the decisions on which they are based (see for example the review of such implicit values in the USA by Morrall 2002).

Thus, *explicit* values derived from non-market valuation techniques based on revealed preferences (RP) (e.g. hedonic wage – HW or avertive costs – AC) or stated preferences (SP) (contingent valuation – CV; or choice modelling – CM) will yield more consistent values and efficient allocation of scarce resources across sectors. Since HW studies comparing wage differentials between risky and non-risky jobs may not be appropriate to assess the value of very different mortality risks from transportation, environmental and health policies which affect the general population, the meta-analysis (MA) we conduct here is based solely on the growing stock of stated preference studies SP studies on adult mortality risks. Thus, we limit the scope of the analysis, compared to previous MAs of VSL which usually include either just HW or both HW and CV studies (e.g. Mrozek and Taylor 2002, Viscusi and Aldy 2003, de Blaeij et al. 2003 Kochi et al. 2006), in order to gain a lower degree of heterogeneity (inconsistency) in the VSL estimates and be able to account for and explain these differences. Doing separate meta-analyses for HW and SP studies was also a clear recommendation of the US EPA expert group reviewing the use of MA to synthesize VSL estimates (US EPA 2006).

MA can be a powerful quantitative tool for reviewing the literature when we limit the scope of the analysis. We will use it to show how, and explain why, VSL vary with different characteristics of the SP valuation methodology employed, characteristics of the change in mortality risk and socio-economic characteristics of the respondents. Our results are primarily descriptive in terms of explaining how people value risks. When assessing how society should value risks, other concerns than efficiency, e.g. equity, must also be taken into account. The main aim of this paper is to assess how various policy-relevant factors impact on VSL. More specifically, the paper aims at:

1. Explaining to what extent VSL estimates depend on whether the mortality risk is caused by environmental pollution, transportation and non-environmental health risks, and – in the case of environmental mortality risks – which environmental media (air, water, soil, noise, etc.) are affected.
2. Assessing whether and how VSL depend on the degree of voluntarism in the change in the risk involved, whether the given risk reduction represents a private or a public good, the size of the baseline risk and the size of the risk change valued
3. Assessing to what extent the design of the stated preference study that the VSL estimate is derived from influences its magnitude; including whether willingness-to-pay (WTP) or willingness-to-accept (WTA) compensation was asked, what sort of SP techniques was used, the payment vehicle, size and type of sample (general population or people with a specific illness), etc. The impact on VSL of socio-economic factors, such as income and age, will also be assessed.

The paper is organised as follows: Section 2 outlines the theory of mortality risk valuation, and provides a brief overview of non-market techniques used to estimate VSL, and the main factors affecting the magnitude of VSL. Section 3 describes the protocol and literature search process used for compilation of the data set, on which the MA is based. The second part provides a brief descriptive overview of the VSL literature, in terms of methods used, geographical distribution, main types of risks valued, etc. Section 4 discusses the meta-regression analysis – the quantitative part the

MA – and provides the results from the first illustrative runs of the meta model and discusses some next steps in the refinement of the MA. Finally, section 5 provides some preliminary conclusions and policy implications of how characteristics of the mortality risk, valuation methodology and population affect VSL.

Theory and methods of valuing VSL

Risk reductions and value of statistical life

This section provides the definition of the Value of a Statistical Life (VSL). First, WTP is defined as the maximum amount that can be subtracted from an individual's income to keep his or her expected utility unchanged, in exchange for a given risk reduction. Individuals are assumed to derive well-being, or utility, from the consumption of goods. To derive the WTP for a risk reduction, let U(y) denote the utility function expressing the level of well-being produced by the level of consumption y when the individual is alive. Further let R denote the risk of dying in the current period, and V(y) the utility of consumption when dead (*e.g.* the utility derived from leaving bequests). Expected utility is expressed as EU=(1-R)·U(y)+R·V(y). This expression is simplified to EU=(1-R)·U(y) if it is further assumed that the utility of income is zero when the individual is dead. The VSL is a summary measure of the WTP for a mortality risk reduction, and a key input into the calculation of the benefits of policies that save lives. The mortality benefits are computed as VSL×L, where L is the expected number of lives saved by the policy. The VSL is the marginal value of a reduction in the risk of dying, and is therefore defined as the rate at which the people are prepared to trade off income for risk reduction:

$$(1)\quad VSL = \frac{\partial WTP}{\partial R}$$

where R is the risk of dying. The VSL can equivalently be described as the total WTP by a group of N people experiencing a uniform reduction of 1/N in their risk of dying. To illustrate, consider a group of 10,000 individuals, and assume that each of them is willing to pay €30 to reduce his, or her, own risk of dying by 1 in 10,000. The VSL implied by this WTP is €30/0.0001, or €300,000. The concept of VSL is generally deemed as the appropriate construct for *ex ante* policy analyses, when the identities of the people whose lives are saved by the policy are not known yet. As shown in the above-mentioned example, in practice VSL is computed by first estimating WTP for a specified risk reduction ΔR, and then by dividing WTP by ΔR.

How do people value mortality?

Mortality is most often valued in terms of VSL, which is the rate at which people are prepared to trade off income for a reduction in their risk of dying. There are two basic non-market valuation approaches suggested for identifying the WTP for mortality risk reductions of an individual. Firstly, the Hedonic Wage (HW) method, which is a RP method, analyses actual behaviour in the labour market. If a person is working in a job with above-average mortality risk, then he or she will require a higher wage to compensate for this risk. By observing the wage premium, we can see what value the person attaches to that risk. One drawback of hedonic wage studies is that they provide estimates of VSL only for a small segment of the population. A second shortcoming is that these studies value current risk of accidental death, whereas environmental hazards, such as asbestos or PCBs, are likely to cause death after a latency period, with cause of death being e.g. cancer or chronic respiratory illness. The wage-risk studies also face the problems of separating between actual and perceived risks and other factors that cause variation in wages

Secondly, Stated Preference (SP) studies explicitly ask individuals how much they would be willing to pay for (or willing to accept to compensate for) a small reduction (increase) in risk. The SP methods can be divided into *direct* and *indirect* approaches. The direct Contingent Valuation (CV) method is by far the most used method, but over the past few years, the indirect approach of Choice Modelling (CM) has gained popularity. The main difference between these two approaches is that the CV method typically asks the respondent for their WTP for a public program that would reduce their mortality risk directly; as an open-ended maximum WTP question or as a dichotomous choice (referendum; yes-no) approach. CM on the other hand, asks the respondents a series of choices between health risks with different characteristics and monetary costs. The main appeal of SP methods is that, in principle, they can elicit WTP from a broad segment of the population, and can value causes of death that are specific to environmental hazards. The main drawback of the SP method is that it is hypothetical, so that the amounts people say they are willing to pay may be different from what they actually would have been willing to pay faced with the given situation.

Another approach to valuing both mortality and morbidity risk is the Avertive Cost (AC; or self-protection) approach. Here, expenditures people make to reduce either the probability of a bad outcome or severity of the bad outcome are usually assumed, under certain plausible conditions, to be a lower bound on the *ex ante* value people assign to reduced risks to life and limb. However, recent analysis (Shogren and Stamland 2005) find that VSL estimated from this method is not in general a lower bound on the population average WTP for mortality risk reduction. Situations arise in which these expenditures are upper bounds, and situations exist when this "lower bound" is a severely deflated lower bound. The economic circumstances describing these situations, unfortunately, only partly depend upon things we can observe and correct for, *e.g.* the fraction who purchase self-protection and the price-setting in the market for self-protection. The impacts of these observable factors are tangled with the impacts of elements we cannot directly observe, *e.g.* the heterogeneity of both skill to cope with risk and risk preference among people. Thus, more research is still needed to define and broaden the case where one can at least say whether self-protection expenditures are a lower bound of true value, or one is confident of the direction of the bias of a biased (*i.e.* relatively invalid) value (Bishop 2003).

Several factors may affect VSL estimated using SP techniques:

i) Age dependency

From theory, the relationship between people's WTP to reduce risk of dying and their age, is ambiguous. This is because even if people have fewer years left to live when they are older, they may consider those years more precious. Therefore, whether there is a "senior death discount" for older people's VSL, is largely an empirical question. The first study to address the issue of age dependency of VSLs was Jones-Lee (1989), which examined individuals' WTP for reducing the risk of serious motor vehicle accidents. Based on a central VSL of €4 million at age 40, the relationship between VSL and age was found to have an inverted U-shape. Other supporting evidence for a pattern of VSL declining with age is found in Desaigues and Rabl (1995) and Krupnick *et al*. (2000). Johannesson and Johansson (1996) used the CV method to look at the WTP of different respondents aged 18-69 for a device that will increase life expectancy by one year at age 75. The found an increasing WTP with age – though criticism has been levelled at this study on the basis of its elicitation method and small sample size. This pattern relating to age has also been found in a CV study by Persson and Cedervall (1991). Pearce

(1998) concludes on the basis of a review of the literature that the evidence, such that it is, seems to favour a case for a slow decline of VSL with age. A recent review by Krupnick (2007) concludes that there is limited evidence to adjust VSL by age.

ii) Latency

The related issue of futurity of impact (from latent and chronic mortality air pollution effects) has, to our knowledge, only been empirically estimated in a few studies, e.g. Alberini *et al*. studies in North America, (Alberini *et al.*, 2001) and the NewExt study (Alberini *et al*. 2004). These studies show that future risk changes are valued lower than immediate risk changes in both the US and Canada, resulting in internal discount rates of 4.6% and 8% respectively. Corresponding numbers for France, Italy and the UK were 5, 6 and 10 %, respectively. This result corresponds to other studies in economics where people tend to value future benefits lower than immediate benefits (*i.e.* they have a positive rate of time preference).

iii) Health Status

Regarding a relationship between *health status* and VSL, the CV evidence is very limited and inconclusive. The principal studies that have explored this linkage are Johannesson and Johansson (1996) who found that WTP values declined with poorer health status, whilst Krupnick *et al*. (2000) found no significant evidence of a relationship.

iv) Context and degree of voluntariness

The relationship between WTP and *context* is similarly underdeveloped in terms of primary CV studies. The main studies, by Jones-Lee and Loomes (1993, 1995) and Covey *et al* (1995), reported in Rowlatt *et al.* (1998), consider the road transport accident VSL in relation to those for underground rail accident risks, food risks, risks to third parties living in the vicinity of major airports and domestic fire risks. The perceived involuntariness of the underground rail risk attracted a 50% premium on the road VSL, whilst a 25% discount is attached to the risk of a domestic fire. The latter result was thought to reflect the high degree of voluntariness or controllability in this context. No evidence was found to support an adjustment to the road accident VSL for scale of the accident (*i.e.* in the case of the underground accident or residents´ proximity to airports contexts). A more recent study by Chilton *et al.* (2002) found that people's risk preferences in different hazard contexts (railway, domestic fire, public fire) were less pronounced than has been suggested by the value differentials that are currently implicit in public decision-making. However, the balance of the limited evidence suggests context relating to voluntariness is likely to be important in determining WTP though a strong conclusion cannot be drawn, nor VSL adjusted for *e.g.* air pollution exposure to account for a high degree of involuntariness.

v) Magnitude of risk change

A point to be observed when using the CV method for eliciting WTP for a reduction in mortality risk is how sensitive the resulting VSL estimates are to magnitude of the risk change. Economic theory suggests that WTP for mortality risk reductions should be increasing with the magnitude of risk reduction, and be approximately proportional to this magnitude (when the baseline risk of death is small), assuming that risk reduction is a desired good. For example, if a reduction in annual mortality risk is valued at a certain amount of money, then a larger reduction in risk should be valued at a larger amount of money. In addition, the difference between the values should be proportional to the difference in risks, ignoring the income effect. Hammitt and Graham (1999) discuss why stated WTP is often not sensitive to variation in risk magnitude. One possible reason they argue, based on the review of several CV studies, is that respondents might not understand probabilities or lack intuition for the changes in small probabilities of mortality risk. Another possibility relates to the fact that respondents might perceive their subjective mortality risk changes as different from the objective risk presented in the CV scenario. As a consequence, stated WTP would not be proportional to the amount of risk reduction the respondents were provided in the CV scenario, but should be proportional to changes in perceived risk. It is also acknowledged in the literature that there are other relevant dimensions than the risk level which defines the "scope" to people, *e.g*. the "dread" related to certain types of risks.

A test of the sensitivity of WTP to the magnitude of the risk change can be performed by asking each respondent to state their WTP for two or more mortality risk reductions. This is often termed "internal scope test", as opposed to the "external scope test", where typically each respondent is asked for his/her WTP for one risk reduction only. Then WTPs for the small and large risk reductions are compared across respondents. Internal scope tests are more likely to be successful because respondents base their response to a WTP questions for a specific risk reduction on their previous answers in terms of WTP for risk reductions. Thus, they anchor their answers on their previous responses, and this enforces some degree of internal consistency. Alberini *et al*. (2001) find that WTP for risk reductions varies significantly with the size of the reduction in the Canadian application of the CV survey instrument. Mean WTP for an annual reduction in risk of death of 5 in 10,000 in this case was about 1.6 times WTP for an annual risk reduction of 1 in 10,000, showing sensitivity to the size of the risk reduction, but not strict proportionality. This means that VSL values will be higher when based on WTP for the smaller risk reductions.

vi) Order of mortality risks valued

Krupnick (2004, p. 32) notes that the European applications of the Krupnick *et al.* (2002) survey used the 5 in 1,000 risk change in 10 years (which is equivalent to a 5 in 10,000 annual risk change), but did not ask the 1 in 1000 WTP question first, as was done in the US and Canada. Based on the results in the two latter countries, he predicts that the implied VSLs for this smaller risk change would be 2-3 times larger than for the 5 in 1000 risk change.

Survey of VSL studies and compilation of meta-dataset

Data compilation

The aim of the compilation of the data for the meta-analysis has been to be as comprehensive as possible in (at least) two dimensions: Within the boundaries chosen, we have tried to include as many original valuation surveys as possible, and we have tried to extract as much comparable information as possible from the studies – regarding the sample surveyed, the risk change that the sample valued, the method used in the surveys, etc. *A priori*, the aim was to cover *all* stated preferences-based valuation studies that provide one or more VSL estimates – or sufficient information so that we could calculate the implied VSL values. We have included information about studies published in academic journals and books, studies prepared for various ministries or other public institutions, studies issued as discussion papers or similar from research institutes, etc., and studies forming part of PhD thesis, etc. (As it would be an impossible task to get a close-to-complete coverage, we have, however, *not* included studies (only) forming part of Master thesis, etc.)

The analysis focuses on VSL estimates stemming from stated preferences studies in an environment, health or traffic context.[2] We have focused on surveys where the respondents have been asked to place a value on a change in (a private or public) risk to themselves (or their household). This means, *inter alia*, that we have *not* included surveys where parents have been asked to value a change in the risks facing their children. Some of the surveys included do also include estimates of changes in morbidity risk – the risks of getting ill – but most of them only focus on mortality risk changes. A separate variable in the dataset reflects whether a morbidity estimate is also collected in the survey, but the present meta-analyses focuses only on valuations of changes in mortality risks.

The hunt for relevant surveys started with a number of searches in the EVRI database, operated by Environment Canada. We have also looked carefully in the reference lists of previous meta-analyses and in each of the valuation studies that have come to light. In addition, similar searches have been made in the databases of a number of scientific publishers, such as ScienceDirect IngentaConnect, Cambridge Journals, etc., covering a large number of scientific journals. We have *not* excluded any survey due to it being "too old" – and the oldest survey we have found was published in 1973. In order to make the estimates comparable over time and between countries, we adjust the estimates expressed in national currency to national 2005 price levels, using the consumer price index, and convert all estimates into USD, using purchasing power-

2 The distinction between the environment and health categories are not always obvious, in part because some health risks are caused by an environmental problem – *e.g.* air or water pollution. In the classifications made here, we have focused on whether or not an *explicit* reference to an environmental problem was made in the valuation-question posed to the sample. If that was not the case, the survey is classified as being "health-related". This is, for example, the case with some well-known surveys using a questionnaire developed by Alberini, Krupnick, *et al.*, which in several cases refer to environmental problems in the titles of the papers presenting the surveys.

adjusted exchange rates (PPPs).[3] Other than price developments, improvements in the survey methods, etc., over time could make it difficult to compare estimates prepared at different points in time. The meta-analysis takes a number of factors in this regard into account, through variables reflecting the elicitation method used, the type of visual aid being used (if any) to help explain the magnitude of the risk changes to the sample, etc. Annex 1 provides an overview over the studies that have been included in the preliminary meta-analysis presented in this paper, and Annex 2 gives an overview of estimates on a country-by-country basis. Most of the studies present not just one, but several different VSL estimates – based, for example, on sub-samples with different age or income, different magnitudes of the risk-changes valued, different risk contexts (environment, health, and traffic), different assumptions made about the distribution of WTP values collected from each person asked, etc. We have included as many estimates as possible from any given study – generally with some variations in the explanatory variables from estimate to estimate. Annex 3 provides some information of the different VSL estimates that have been included in the analyses thus far. Figure 1 provides an illustration of how the accumulated number of studies providing original VSL estimates in the different risk contexts has increased over time.[4]

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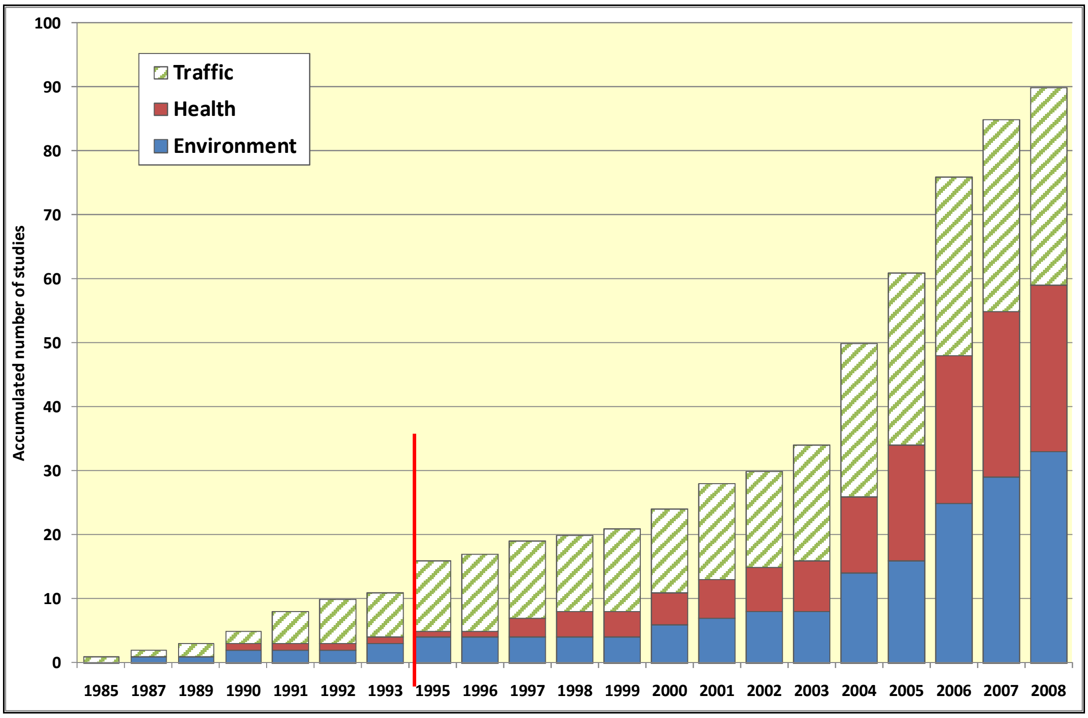
[3] The PPPs are taken from the World Bank's International Comparison Program, 2008 edition. From this publication, we have taken PPP estimates based both on all of GDP and on only Actual Individual Consumption, AIC. For most countries, these two different PPP measures are very similar, but for some countries – *e.g.* some developing countries – the differences are considerable. The analyses presented in this paper are based on the AIC-related PPPs.

[4] There is a certain bias in the graph, as some studies have been published in several versions, *e.g.* first as a discussion paper, later on as an article in a journal. The graph only takes into account the *last* available version of each study. Studies that provide VSL-estimates in different risk contexts have been counted several times.

Figure 1 Accumulated number of studies providing VSL estimates in different risk contexts (no studies in 1994, indicated by "red line")

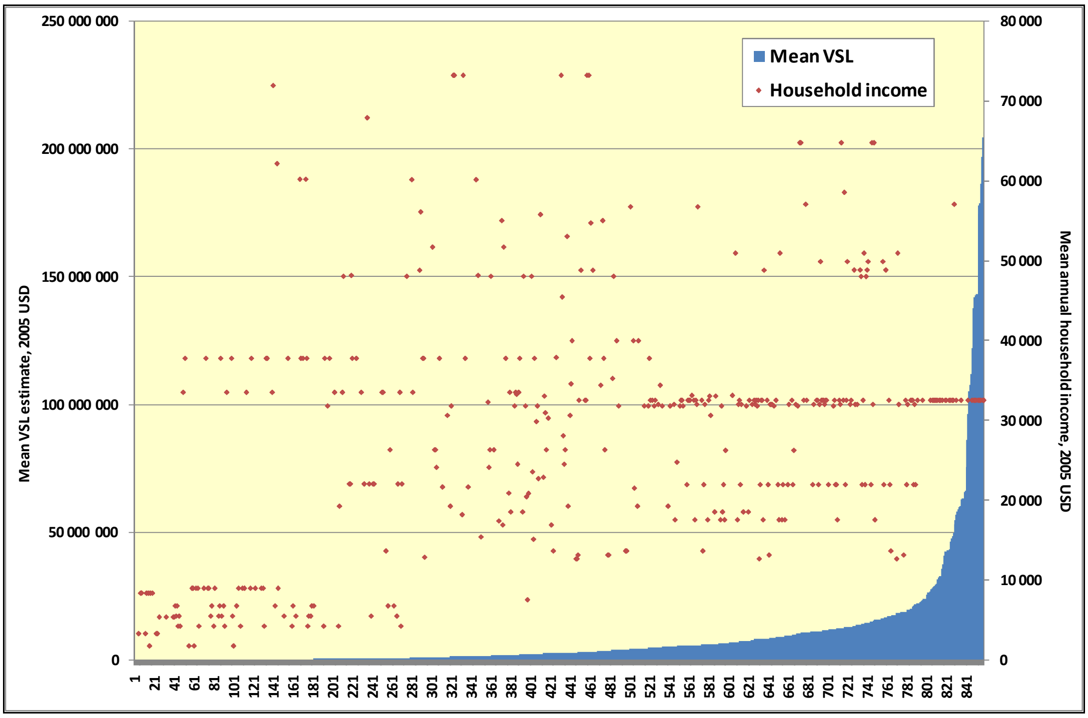


Up until 2003, at least half of all available stated preferences VSL-studies had been elaborated in the context of changes in a traffic-related risk. Since 2004, however, the number of studies providing VSL-estimates in an environmental or health context has increased significantly, and as of 2008, the accumulated number of studies providing VSL estimates in the three risk contexts we consider is roughly similar.

Characteristics of the VSL data

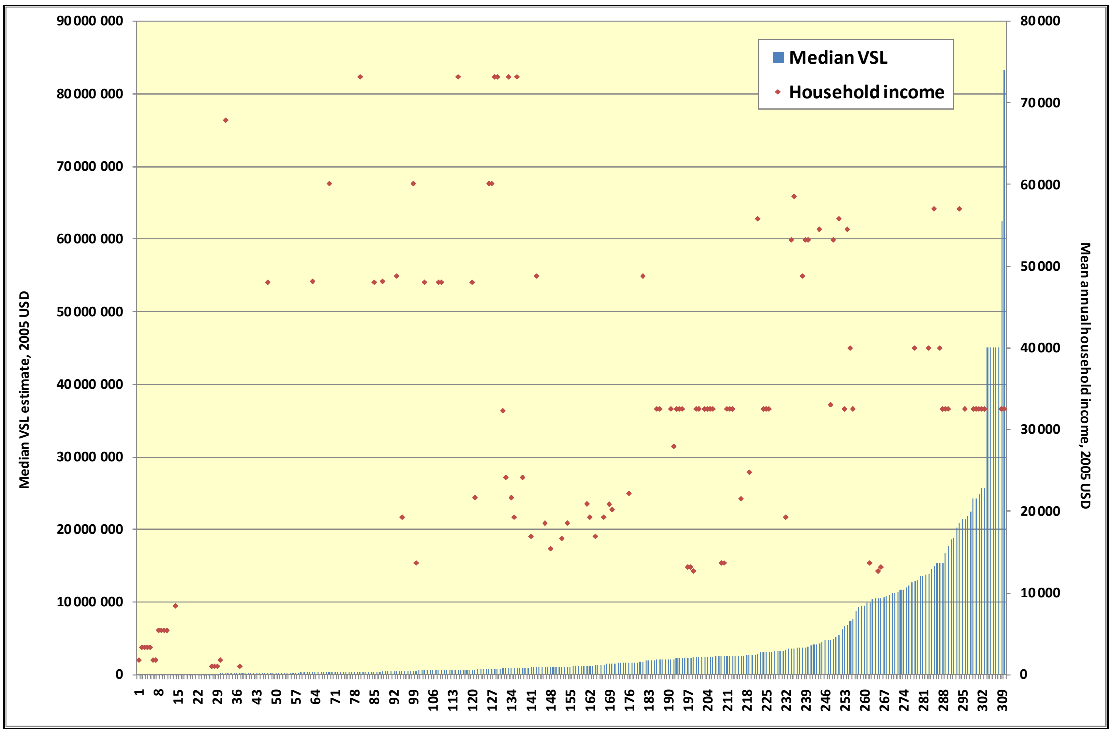
This section provides some further description of the VSL estimates that have been used in the present preliminary meta-analysis. Figure 2 shows all the 860 estimates of mean VSL estimates (left axis), sorted in increasing order, and the related *mean* annual household income of the persons in the given (sub-)sample, for which the VSL estimate applies (right axis). Not surprisingly, many of the lowest VSL estimates have been found in (sub-) samples with low household income. The *median* of the mean VSL estimates is about 2.9 million 2005 USD (PPP corrected, using PPP exchange rates based on Actual Individual Consumption) – which is well within the range found in many other VSL meta-analyses.

Figure 2 Mean VSL estimates and mean household income



To get a clearer view of the major bulk of the VSL estimates, in Figure 3, the highest *and* the lowest 5% of the VSL estimates have been deleted – or "trimmed" away.

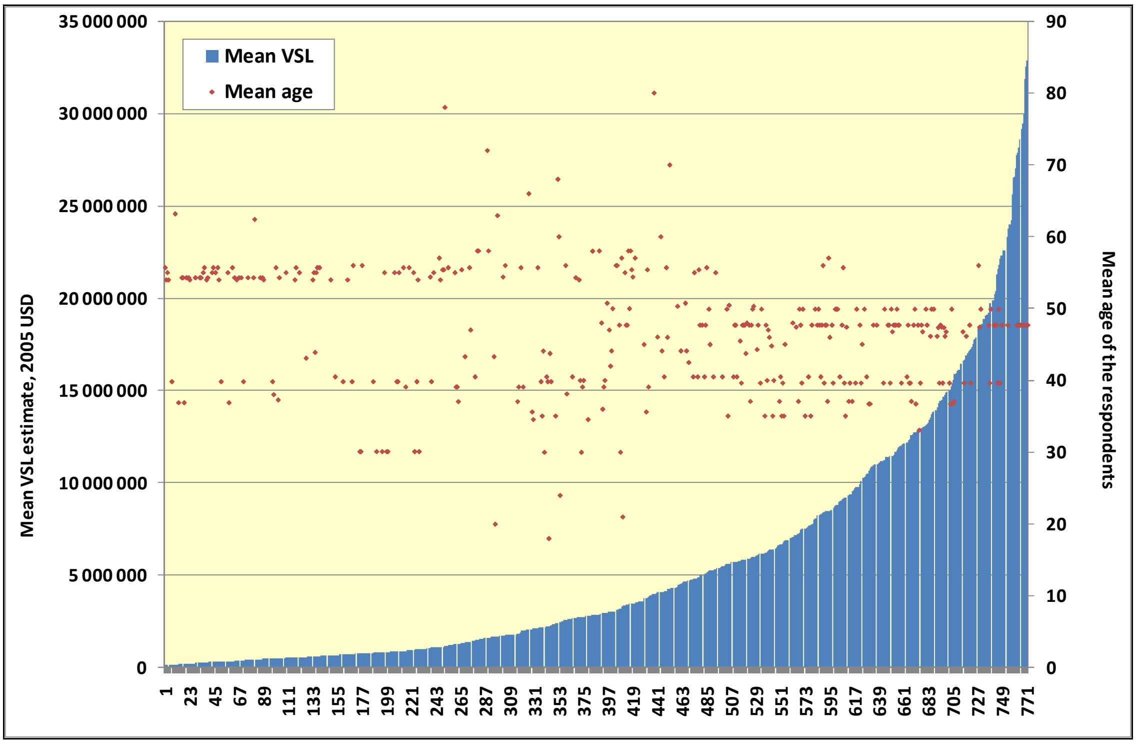
Figure 3 Mean VSL estimates and mean household income, trimmed



The median of the (trimmed) mean VSL estimates made in an (explicitly) *environmental* context is (also in the untrimmed case) 4.7 million 2005-USD – considerably higher than when estimates from all the three risk contexts (environmental, health and traffic) are included. The median of the (trimmed) mean VSL-estimates elicited in a traffic context is 4.8 million 2005-USD. The median of the (trimmed) VSL estimates in a health context is 1.2 million 2005-USD (as always, PPP-corrected; using AIC-based PPP exchange rates) – lower than in the two other risk contexts.

Figure 4 illustrates trimmed mean VSL-estimates across all three risk contexts and the average *age* of the persons in the (sub-)samples. The figure hardly reveals a clear age-pattern in the VSL-estimates, something the MA will investigate further.

Figure 4 Mean VSL estimates and mean age, trimmed



What determines VSL? Some preliminary meta-regression results

Meta-regression analysis

The previous section gave a descriptive overview of the data. To discern patterns in the data more formal statistical analysis is required. Meta-regression is a type of meta-analysis that uses quantitative statistical techniques to analyse how the so-called effect-size, in our case estimates of VSL (or WTP), vary with a set of explanatory variables derived based on information from studies[5]. Definition and coding[6] of the variables depend on theoretical expectations, previous empirical results and the availability of necessary information in studies (which tends to be a problem). The trade-off in meta-analysis – which is also apparent in our case – is between the ideal number of explanatory variables and the number of studies that will actually report the necessary

[5] ”Study” is a publication of some kind where results are reported, which is different to the term ”survey” used to descirbe a ”field application” of a questionnaire.

[6] By ”coding” we mean that information from studies expressed as numbers or as text is transformed into variables for statistical analysis. Typically, much of the information is coded as binary (0-1) variables – see table below.

information. Too many variables lead to a dataset full of holes, while too few will lead to much unexplained variation. One solution to this problem is to run different meta-regressions for different subsets of the data and for different sets of explanatory variables.

The explanatory variables are typically of three main types: (1) characteristics of the good and context in which it is valued; (2) characteristics of the methods applied in the different studies, and (3) characteristics of the population asked to value the good. In addition, meta-analysts sometimes include variables that cover quality dimensions of the studies or other types of variables. For many variables there are *a priori* expectations of relationship with VSL, while others are typically more explorative. We will discuss the main variables in the next section. Each study typically reports more than one estimate of WTP and/or VSL, for example estimated using different methods, different risk levels etc. A key issue in meta-regression analysis related to the choice and definition of coded variables, is to decide which and how many estimates to include in the analysis from each study. The coded variables help explain variation in the data, *e.g.* that certain types of risk go together with higher VSL, that certain methods give lower VSL etc. For research, meta-regression helps better understand how people value risks, both to confirm/reject hypotheses from the literature and to detect new patterns that warrant more research. It also serves as a summary, or synthesis, of state-of-knowledge in an area, *i.e.* as a quantitative literature review. For policy, meta-regression analysis is useful to derive a range of plausible value estimates that can be used for example in cost-benefit analysis under different circumstances.

A meta-regression can show that VSL to reduce certain types of risk (*e.g.* related to environmental pollution) is higher than for other types of risk (*e.g.* traffic accidents).

This may be an argument that such risks should be valued higher in CBA. Or, VSL may be lower among the older part of the population. However, the step from a given finding in a meta-regression analysis to the use of the results in practical policy is a contentious one and one that needs careful consideration – both for ethical and methodological reasons. The US EPA, for example, has had an ongoing and intense discussion of these issues over the last few years.

To model the relationship between VSL and the explanatory variables we can specify a meta-model that captures *j* risk context characteristics X, *k* study or methodological characteristics M, and *q* socio-economic characteristics, S, of the sample population. Mean VSL estimate (in USD 2005) *m* from study *s*, VSL_{ms}, can then be defined as[7]:

(2) $$VSL_{ms} = \beta_0 + \beta_X X_{ms}^{j} + \beta_M M_{ms}^{k} + \beta_S S_{ms}^{q} + e_{ms} + u_s$$

where, β_0, β are constant term and parameter vectors for the explanatory variables, and e_{ms} and u_s are random error terms for the measurement and study levels, respectively. Using meta-regression for benefit transfer (MA-BT) involves estimating (5) based on previous studies, and inserting values for X, P and S for the policy situation of interest (for example an environmental policy likely to reduce the mortality risk of an elderly population) and choosing values for M (typically average of the meta-data, "best-practice" values or sample from a distribution). Ideally, most of the variation in VSL estimates should be explained by measurable risk characteristics and socio-economic variables, not by different valuation methods applied. However, in practice, unfortunately this is often not the case in MA studies.

[7] It is generally not recommended to use the median VSL in the meta-regression analysis, so mean VSL is used as left-hand side variable here.

There are many ways a point estimate, a range or a distribution of VSL values can be derived from the estimated meta-regression model (see *e.g.* Mrozek and Taylor 2002 for one example).

The simplest approach to estimating the meta-model in (2), which has been used in several MA studies, is to treat all WTP observations as independent replications and hence assume that study level error is zero. A more advanced approach is to apply a Huber-White robust variance estimation procedure to adjust for potential heteroskedasticity and intercluster correlation – caused by the fact that the error terms related to estimates both from the same study and between studies are likely to be correlated. There are also other, more advanced, techniques used in the literature that will be explored later.

Variables coded in the meta-dataset and how they affect WTP for risk reduction

Section 2 discussed how a number of factors of variables may influence on the size of VSL. Some of these variables are derived from theory, others from empirical studies and yet others from more explorative hypotheses without firm theoretical grounding. Based on the comprehensive coding protocol used for the VSL studies (see Annex 4 for the full range and definition of coded variables), we chose the most central of these variables to be transformed into dummy variables and other variables useable for entering in on the right-hand side of equation (5). Too detailed and many variables, will as mentioned, lead to missing data in the regressions and can also lead to over-specification of the model (too many explanatory variables compared to the number of observations). In Table 1 below, we have defined the variables we intend to use in the meta-regression analysis. The variables in bold are the ones we have included in this preliminary run of the models. More thorough analysis will be left for the next version of the paper, where all the variables in the table (including different ways of combining detailed categories into separate dummy variables) will be explored.

We have indicated in the right column the expected sign of the relationship between the variable and VSL. Most variables are dummies (*i.e.* binary, 0-1). The dummy coefficient measures the effect of "switching on" one variable compared to a situation where all dummies are zero. For example, using the three categories of risk: health, environment and traffic, we code one dummy for health and one for environment, leaving traffic as the "hidden variable" we compare with. If there is a positive coefficient on "environment", it means that such risk is valued higher than traffic risks. Similar with the health dummy compared to the traffic risk. Some of the relationships have been discussed in section 2. In this first run of the model, we hypothesize that not only the baseline risk and the risk change may matter, but also the type of risk (environment, health, traffic), whether the risk is voluntary, the period of the risk change, whether cancer and suffering have been mentioned in the survey, whether the risk is a private or a public good, whether certain types of risk display devices have been used in the survey and so forth. The range of explanatory variables describing the risk valuation context is fairly comprehensive and should cover most of the relevant context dimensions. We also include a range of methodological variables. It is known in the literature that dichotomous choice (Yes-No) CV typically give higher values (among others due to so-called "yea saying") than open ended CV questions, that voluntary donations give lower values (since people free ride), the survey mode influences results (though sometimes in unexpected ways) etc. Further, the higher the response rate in the survey, all else equal, the lower will the WTP values be since the survey has managed to capture more of the less interested respondents (*i.e.* reducing self-selection problems). It is also important whether people have been asked for WTP for a risk reduction or

WTA for a risk increase, which typically is much higher (among others because it is not bounded by income). Finally, we include socio-economic, time and spatial variables. Higher income is likely to yield higher VSL. The age-VSL relationship is, as discussed previously, ambiguous. It is likely that VSL varies between countries or at least regions (OECD vs Non-OECD). More recent surveys are often found in the literature to give higher values for environmental goods than older surveys so year of survey is therefore included as a variable here. One reason for this result is that environmental goods are becoming scarcer (and that people are becoming wealthier – not measured by income – and also care more about the environment). It is unclear if this reasoning translates directly to mortality risks as it is a different good.

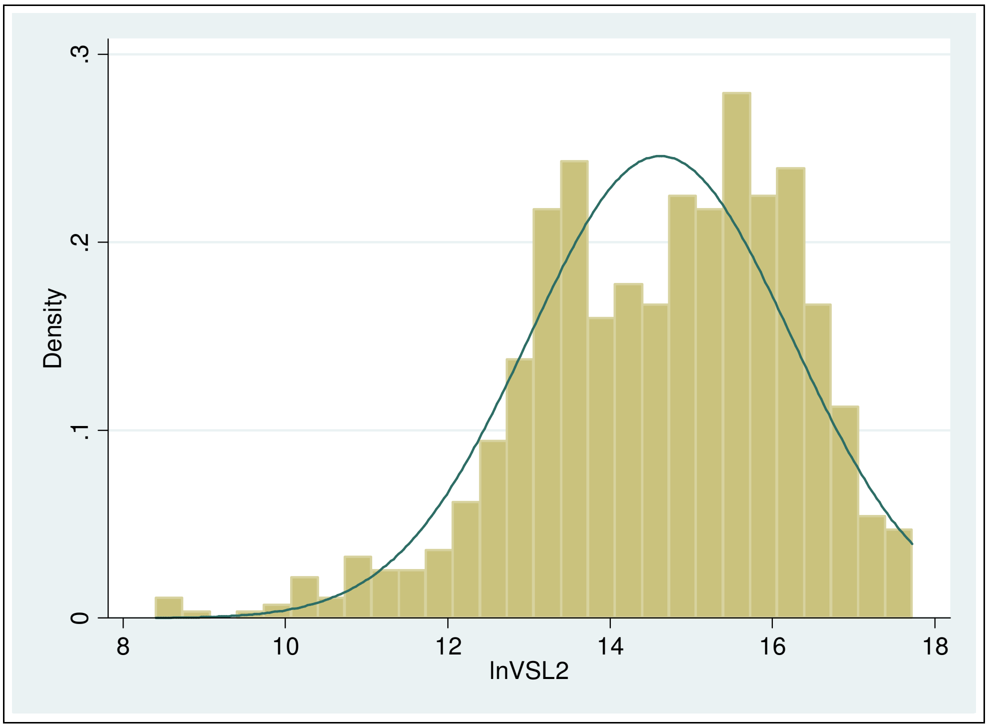
Table 1 Meta-analysis variables and expected relationships with VSL

Variable	Description	Sign
Dependent variable		
LnVSL	**Natural logarithm of VOSL in USD 2005 (mean, annual WTP divided by annual risk change)**	**….**
LnWTP	Natural logarithm of annual (> 1 year) mean WTP as reported in study in USD 2005, PPP	….
Risk valuation context variables:		
Baserisk	**Continuous: Ex ante (baseline) mortality risk (risk of "dying anyway")**	**+**
Rchange	**Continuous: Change in mortality risk on an annual basis (normalised per year from study info)**	**0/-**
Rincr	**Binary: 1 if WTP to avoid an increase in mortality risk; 0 if WTP for risk reduction**	**+**
Year1	Binary: 1 if risk change for 1 year or shorter, 0 if > 10 years (incl. life-time or forever)	?
Year510	Binary: 1 if risk change for 5 or 10 years, 0 if > 10 years (incl. life-time or forever)	-
Private	**Binary: 1 if private good (risk affects only the individual asked or her household), 0 if public good**	**+**
Environ	**Binary: 1 if environment-related risk change, 0 if traffic-related (by definition acute)**	**+?**
AcuteEn	Binary: 1 if the environment-related health risk is acute, 0 if traffic-related	+?
ChEnLat1	Binary: 1 if the environment-related health risk is chronic and latent, 0 if traffic-related	+?
ChEnLat0	Binary: 1 if the environment-related health risk is chronic, but not latent, 0 if traffic-related	+?
Env(name)	EnvAir, EnvWater, EnvHazard, EnvWaste, EnvNoise, EnvRadi, EnvFood, EnvOther. Sub-categories of Environ. Binary: 1 for each environ. risk vehicle ("EnvRadi" means radiation)	+/-
Health	**Binary: 1 if unspecified health risk reduction, 0 if traffic-related (by definition acute)**	**-**
AcuteHe	Binary: 1 if the health-related risk is acute, 0 if traffic-related	-?
ChHeLat1	Binary: 1 if the health-related risk is chronic and latent, 0 if traffic-related	-?
ChHeLat0	Binary: 1 if the health-related risk is chronic, but not latent, 0 if traffic-related	-?
Grid1k	Binary: 1 if a 1000 square grid was used in risk explanation, 0 if oral/written or no explanation.	-
Grid10k	Binary: 1 if a 10 000 square grid was used in risk explanation, 0 if oral/written or no explanation	
OtherVis	Binary: 1 if other visual tools (life exp. graph, 10k grid, risk ladder etc) used, 0 if oral/written or no	
Control	**Binary: 1 if the risk is voluntary (can be controlled/avoided by individual), 0 if involuntary**	**-**
Specific	**Binary: 1 if survey includes a description of degree of suffering; 0 if more abstract**	**+**
Cancer	**Binary: 1 if reference to cancer risk in survey; 0 if otherwise**	**+**
Methodological variables:		
CE	Binary: 1 if contingent ranking or conjoint ranking, 0 if dichotomous choice CV	?
CVOE	Binary: 1 if open-ended max WTP contingent valuation question, if dichotomous choice CV	-
ElOther	Binary: 1 if other elicitation format than CVOE or CE; 0 if dichotomous choice CV	-?
Individ	**Binary: 1 if WTP is stated as an individual; 0 if stated on behalf of household**	**-**
Month	Binary: 1 if WTP was stated per month (and converted to annual WTP), 0 if otherwise	+
Lump	Binary: 1 if WTP was stated as a one-off lump sum, 0 if otherwise	+
Donation	**Binary: 1 if payment vehicle used donation, 0 if otherwise (*e.g.* tax)**	**+**
WTA	**Binary: 1if Willingness to accept compensation for a risk increase, 0 if WTP for risk reduction**	**+**
Telephone	**Binary: 1 if telephone survey, 0 if otherwise (*i.e.* mail, web)**	**+**
F2f	**Binary: 1 if face-to-face interview survey, 0 if otherwise**	**-**
RespHigh	Binary: 1 if response rate was > 65 per cent, 0 if between 50 and 65 percent	-
RespLow	Binary: 1 if response rate was > 50 percent, 0 if between 50 and 65 percent	+
Nonpara	**Binary: 1 if WTP was estimated using non-parametric (typically WTP lower-bound), 0 otherwise**	**-**
Source	Binary: 1 if VSL was given in the study, 0 if calculated by us	+/-
Socio-economics, time and space:		
NonOECD	Binary: 1 if survey was conducted outside OECD, 0 if OECD	-
National	**Binary: 1 if survey was country-wide, 0 if other (*i.e.* sub-national geographical area)**	**?**
LnYear	**Continuous: Natural log of year of data collection. Range 1 (19xx, year of survey) to 16 (20xx).**	**+**
LnIncome	**Continuous: Natural log of mean annual income USD 2005, PPP-adjusted**	**+**
LnAge	**Continuous: Natural log of mean age of sample**	**+/-**
Subpop	Binary: 1 if survey of general population, 0 if special group (*e.g.* older population, ill etc)	?
Study quality variables:		
Journal	**Binary: 1 if study published in a journal, 0 if otherwise**	**+**
LowSamp	Binary: 1 if sample had less than 150 useable responses; 0 if otherwise	?

Some very preliminary results

Since the current meta-analysis is work in progress and by nature iterative (new studies are still being added, initial results lead to recoding and revisions of dataset to obtain a more in-depth understanding etc), we only present a few examples of a very preliminary trial run of the models here. For example, we have not yet made any assessment of how many estimates should be included from each study and whether some studies should be excluded by some quality criteria. We have also chosen a fairly simple econometric specification. However, that does not mean that the models do not already give us hints to patterns and trends in the data. Since the distribution of VSL estimates is highly skewed (as shown in the previous section), we use a natural log transformation (see Figure 10 below showing a better approximation to the normal distribution), necessary for the econometric analysis. We also log transform the other continuous variables in Table 1 above, as this transformation gives a better fit to the data. The coefficients on risk (risk change and baseline risk) can be interpreted as "risk elasticities", one percent reduction in risk changes the VSL by a percentage magnitude indicated by the estimated coefficient. As discussed previously, this coefficient should in theory be close to zero, as a risk change of x% should lead to an increase in WTP by (roughly) the same percentage, leaving VSL unchanged. In the following we present some preliminary results from four model runs.

Figure 5 Transforming the VSL estimates using natural log creates a more normal distribution.



1. All explanatory variables marked in bold (except Income and Age). Double log better fit than semilog. VSL>0

Linear regression

Number of clusters (Survey) = 21

Number of obs	= 359
F(12, 20)	= .
Prob > F	= .
R-squared	= 0.8110
Root MSE	= .74059

lnVSL2	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnBaserisk	-.0126518	.0701663	-0.18	0.859	-.1590161	.1337125
lnRchange	**-.7734261**	**.0902361**	**-8.57**	**0.000**	**-.9616552**	**-.585197**
Rincr2	-.3233651	1.644919	-0.20	0.846	-3.754607	3.107877
Private2	**2.883365**	**.5087549**	**5.67**	**0.000**	**1.82212**	**3.944609**
Environ2	1.505023	1.449121	1.04	0.311	-1.517791	4.527837
Health	.5366792	.8993716	0.60	0.557	-1.339377	2.412736
Control2	**-4.37662**	**.9714229**	**-4.51**	**0.000**	**-6.402973**	**-2.350268**
Specific2	**4.358427**	**1.145647**	**3.80**	**0.001**	**1.968649**	**6.748205**
Cancer2	-.1707363	.453428	-0.38	0.710	-1.11657	.7750979
Indiv2	-.4644053	1.189886	-0.39	0.700	-2.946464	2.017653
Donation2	-8.70e-12	7.57e-12	-1.15	0.264	-2.45e-11	7.09e-12
WTA2	.8690477	1.472213	0.59	0.562	-2.201935	3.94003
Telephone	-.0409298	.4369223	-0.09	0.926	-.9523338	.8704741
F2f	**-2.291368**	**.9542381**	**-2.40**	**0.026**	**-4.281873**	**-.3008618**
Nonpara2	**-.8207634**	**.232274**	**-3.53**	**0.002**	**-1.305278**	**-.3362483**
lnYear	**-1.060433**	**.3784423**	**-2.80**	**0.011**	**-1.84985**	**-.2710162**
_cons	12.35181	2.350833	5.25	0.000	7.448058	17.25556

The first model includes all the bold variables from Table 1, except income and age. Significant variables at the 10 percent level or better are indicated in bold in the result tables. We focus on the signs of the coefficients (*i.e.* the direction of the relationships), rather than their size in this first model runs. Since some data are missing for the full range of variables, there are around 359 observations used in this estimation. The model explains around 81% of the variation in the data (R-squared of 0.811), which is high. It means that the 81% of the variation in the VSL estimates is explained by the variables we have chosen. The risk change is statistically significant and negative, meaning that the higher the risk change, the lower is the VSL. This is, as mentioned in Section 2, because people are not sufficiently sensitive to the risk change size (so WTP increases relatively less than the risk change, lowering VSL). Further, people value risks that affect themselves or their household significantly higher than public risk changes (variable Private), as expected. People do also consider it less valuable to reduce risks they (think they) can control (*i.e.* voluntary) compared involuntary risk (variable Control), *e.g.* related to air pollution, also as expected. If there is mention of suffering specifically in the survey, VSL is significantly higher (variable Specific). However, cancer risks are not valued higher than other risks, somewhat unexpectedly. Face-to-face surveys give lower VSL values, which is hard to explain, as the opposite is usually found, due to what is called social desirability bias. It is a positive result for policy analysis that the method of data collection does not seem to influence VSL results significantly. The year variable is significant, but with a different sign than expected. However, one possible reason for this could be that more stringent and prudent risk communication tools have been developed over time, resulting in more accurate (and lower) estimates. Non-parametric methods yield significantly lower VSL, as expected, since such methods typically give a lower-bound estimate. It is worth noting that the risk type (*i.e.* environment and health *vs.* traffic) does not seem to give significantly different VSL values. This contrasts with the description of the data in section 3, where health risks were found to give lower VSL. This issue will be investigated in further analyses of the data.

2. Same as 1 except with income and age (NB! Few observations)

Linear regression

Number of obs = 162
F(10, 14) = .
Prob > F = .
R-squared = 0.9506
Root MSE = .41351

Number of clusters (Survey) = 15

lnVSL2	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnBaserisk	.0730925	.0962513	0.76	0.460	-.1333459	.2795309
lnRchange	**-.6844895**	**.0649067**	**-10.55**	**0.000**	**-.8237005**	**-.5452784**
Rincr2	**1.121694**	**.266366**	**4.21**	**0.001**	**.5503954**	**1.692992**
Private2	-1.888537	1.391776	-1.36	0.196	-4.873599	1.096525
Environ2	1.270521	1.772568	0.72	0.485	-2.531259	5.072301
Health	.758362	1.604483	0.47	0.644	-2.682911	4.199635
Control2	(dropped)					
Specific2	**7.728185**	**1.726126**	**4.48**	**0.001**	**4.026013**	**11.43036**
Cancer2	(dropped)					
Indiv2	1.742813	3.082884	0.57	0.581	-4.869315	8.35494
Donation2	(dropped)					
WTA2	(dropped)					
Telephone	-.2436873	1.572993	-0.15	0.879	-3.617421	3.130046
F2f	**-4.305286**	**1.789464**	**-2.41**	**0.031**	**-8.143304**	**-.4672682**
Nonpara2	**-.7034048**	**.2458412**	**-2.86**	**0.013**	**-1.230682**	**-.1761278**
lnYear	**-4.12661**	**.5794193**	**-7.12**	**0.000**	**-5.369341**	**-2.883879**
lnAge	-3.363068	6.306278	-0.53	0.602	-16.88869	10.16255
Lnlnchhld2	-.0982454	.0795644	-1.23	0.237	-.2688941	.0724034
_cons	35.48201	27.60143	1.29	0.219	-23.71718	94.68119

This model includes all bold variables in Table 1, to investigate the relationship also with age and income. It must be interpreted with caution, as many observations have been dropped due to missing information for the age and income variables (as discussed previously, do not studies report this information to the extent we could wish for). Income is not significant in this model, nor is age. Meta-analyses often find insignificant relationships between socio-economic variables and effect-sizes, a common weakness. The specification of the age variable used here may be too simple to capture this complex relationship. Further analysis will look closer into the effect of income and age, and other socio-economic variables and indicators. The income variable is important in using the model for policy analysis (*e.g.* transferring VSL estimates), as income is the typical variable used for scaling VSL up or down when transferred between countries.

3. Same as 1, except dropped baseline risk (since many observations are missing) (859 observations of VSL>0, so around 320 obs are dropped due to missing data) (dropping also the lnRchange variable increases obs to 761, but R2 drops to 34%)

```
Linear regression                                      Number of obs =     521
                                                       F( 14,     33) =       .
                                                       Prob > F       =       .
                                                       R-squared      =  0.7370
Number of clusters (Survey) = 34                       Root MSE       =  .87637
```

lnVSL2	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnRchange	**-.8027025**	**.0817061**	**-9.82**	**0.000**	**-.9689348**	**-.6364702**
Rincr2	-.0697039	.517181	-0.13	0.894	-1.121917	.9825087
Private2	**.8139256**	**.3269978**	**2.49**	**0.018**	**.1486435**	**1.479208**
Environ2	**1.834951**	**.518217**	**3.54**	**0.001**	**.7806306**	**2.889271**
Health	.8931772	.6409428	1.39	0.173	-.4108307	2.197185
Control2	**-1.711249**	**.7006963**	**-2.44**	**0.020**	**-3.136827**	**-.2856719**
Specific2	**3.664488**	**.7599028**	**4.82**	**0.000**	**2.118454**	**5.210522**
Cancer2	.3586526	.2462635	1.46	0.155	-.1423742	.8596794
Indiv2	-.8152141	.5111964	-1.59	0.120	-1.855251	.2248227
Donation2	-.4522882	.3183503	-1.42	0.165	-1.099977	.1954005
WTA2	**1.004432**	**.4888057**	**2.05**	**0.048**	**.0099492**	**1.998914**
Telephone	-.1004327	.3832856	-0.26	0.795	-.880233	.6793676
F2f	**-2.094869**	**.6890448**	**-3.04**	**0.005**	**-3.496742**	**-.692997**
Nonpara2	**-.6026257**	**.2547555**	**-2.37**	**0.024**	**-1.12093**	**-.0843218**
lnYear	**-1.077675**	**.3603737**	**-2.99**	**0.005**	**-1.810861**	**-.344489**
_cons	11.91971	1.330844	8.96	0.000	9.212087	14.62733

To increase number of observations with full information compared to model 1, we dropped the baseline risk level variable, which in any case in theory should not influence VSL values much at the low risk levels we are investigating here. This increases the number of observations to 521. The explained variation is still high, at 73%. The coefficients are fairly robust compared to model 1. In this model, it is worth noting that environment-related risks have significantly higher VSLs than either traffic risks or non-environment-related health risks. The robustness (*i.e.* results do not change much depending on different number of observations and of explanatory variables) of results and the direction of the relationships (*i.e.* many as expected) give us some confidence that the SP studies have validity and can be used for policy analysis.

However, more investigations need to be carried out to find models that can be reliably used to predict VSL estimates for use in different policy situations.

4. Same as 3 except, excluding 5% highest and 5% lowest VSL

```
Linear regression                                      Number of obs =     492
                                                       F( 14,     31) =       .
                                                       Prob > F       =       .
                                                       R-squared      =  0.7317
Number of clusters (Survey) = 32                       Root MSE       =   .7529
```

lnVSL2	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnRchange	**-.7084481**	**.0777462**	**-9.11**	**0.000**	**-.8670126**	**-.5498837**
Rincr2	-.9793218	.7124742	-1.37	0.179	-2.432423	.473779
Private2	**.9877909**	**.343358**	**2.88**	**0.007**	**.2875076**	**1.688074**
Environ2	**2.171961**	**.4844169**	**4.48**	**0.000**	**1.183986**	**3.159935**
Health	.2078238	.5607449	0.37	0.713	-.9358231	1.351471
Control2	-.5704325	.4741283	-1.20	0.238	-1.537424	.3965585
Specific2	**2.606442**	**.6229182**	**4.18**	**0.000**	**1.335992**	**3.876892**
Cancer2	.4686639	.2901803	1.62	0.116	-.1231628	1.060491
Indiv2	-.4649099	.5320039	-0.87	0.389	-1.549939	.6201192
Donation2	-.4156219	.2952511	-1.41	0.169	-1.01779	.1865466
WTA2	.9613176	.7528642	1.28	0.211	-.5741592	2.496794
Telephone	.2080393	.3493851	0.60	0.556	-.5045363	.9206149
F2f	-.5263052	.4651938	-1.13	0.267	-1.475074	.4224639
Nonpara2	**-.6581931**	**.2378214**	**-2.77**	**0.009**	**-1.143233**	**-.1731531**
lnYear	-.3980739	.3030041	-1.31	0.199	-1.016055	.2199071
_cons	9.611926	1.109396	8.66	0.000	7.349298	11.87455

This model takes out the 5% highest and lowest VSL estimates. Results are fairly robust, though some variables are no longer significant (*e.g.* lnYear and F2f). This means that the very high and very low VSL observations have only had limited impact on the results we found using model 1 and 3.

Next steps in the meta-regression analysis

As mentioned, the meta-analysis is work in progress. The following important factors will be considered in the next revision of the model:

- Additions of some more studies, cf. the list in Annex 1.
- The number of studies to include, based on some sort of screening based on quality or reliability of estimates.

- The number of estimates to include from each study. Here, attempts will be made to weigh estimates by their reliability (typically the inverse of their standard error, if available in the study, or as a proxy, sample size)
- Model runs where different subsets of the data (*e.g.* only environmental risks) are included, and where the range of explanatory variables vary (*e.g.* the full list of variables in the table above, and alternative groupings and coding of those variables).
- Different ways to represent the risk characterization in the model (*e.g.* classifying risk changes into categories of "low", "medium", "high", or as squared), to understand better the relationship with VSL.
- Classify the age variable into different categories, as the age-VSL relationship may be difficult to discern using the current model specification.
- Use WTP as left-hand side variable in the meta-regressions.
- More advanced econometric specifications of the model to account for the panel structure of the data.
- Sensitivity analysis (which some of the bullets will be part of) and investigation of the influence of outlier estimates.
- Regional and/or country differences

The main point of these bullets is to derive models that are as robust as possible in explaining variation in VSL, in order to, if possible, derive a suggested range of VSL estimates to be used for policy purposes – depending on national circumstances and other aspects of the context at hand. Further, even though our preliminary model results have shown interesting and robust patterns, in accordance with theory and what we expected, more analysis needs to be carried out to increase our confidence in the models. However, the preliminary model runs give us a degree of confidence in the validity of the VSL data generated by the SP literature, and a good basis to investigate estimates for policy.

Preliminary conclusions and next steps in meta-analysis

We have constructed a database of stated preference studies; primarily contingent valuation studies which ask people their willingness-to-pay (WTP) to reduce their risk of dying prematurely from environmentally related mortality risks, transportation risks or a health conditions (without specifying the cause of death). The economic value of a prevented fatality, or the Value of a Statistical Life (VSL), can then be calculated from their WTP responses. An example: If people state a mean WTP of 50 € per year to reduce their annual risk of dying from 10 in 10.000 to 5 in 10.000, VSL can be calculated at 50 € x 2.000 (to get from a probability of 5 in 10.000 to a probability of 10.000 in 10.000, which is equal to a probability of dying equal to 1, *i.e.* death) = 100.000 €.

Based on this database of SP studies, we have performed a meta-analysis (MA) in order to explain how VSL vary with differences in study designs (including the way risk changes are displayed), characteristics of risk (type and size of risk, baseline risks, latency etc), socio-economic characteristics (age, income, gender, health status, etc.) and other variables derived from the studies and from other available statistics. Our first illustrative runs of the MA model show that the variables included in the model explain a large part (80 % or more) of the variation in VSL estimates, but results are mixed even though many variables show the expected sign (positive or negative) in terms of influencing the estimated VSL.

People value risks that affect themselves or their household higher than public risk changes. People do also consider it less valuable to reduce risks they can control (*i.e.* voluntary) compared involuntary risk (*e.g.* mortality risk from driving your car as opposed to being exposed to air pollution). If there is mention of suffering specifically in the survey, VSL is higher. This lends support to the practise of adding a dread and suffering premium to VSL (*e.g.* lung cancer deaths caused by air pollution). We find that the higher the risk change that is valued, the lower is the VSL. This is because people are not sufficiently sensitive to the size of the risk change (meaning that WTP increases relatively less than the risk change, thus lowering VSL) and because the income constraint becomes more binding when people are asked to express their WTP for larger risk changes. The year the survey was conducted has an impact on VSL, but with a different sign than expected. However, one possible reason for this could be that more stringent and prudent risk communication tools have been developed over time (*e.g.* using grid cell diagrams – see annex 4) resulting in more accurate (and lower) VSL estimates. In one of the model runs we find that environmentally related mortality risk is valued higher than either traffic risks or non-environment-related health risks, while we do not find this in other runs.

Among the results we find harder to explain, and for which further analysis is needed, is that face-to-face surveys (as opposed to mail surveys) give lower VSL values, age has no effect on VSL, and income has no effect on VSL. We will also look closer into how VSL estimates vary between regions /countries, and conduct sensitivity analyses to shed light on how different definitions of the variables, specification of the models, econometric approaches, etc. influence VSL.

These preliminary results clearly show that MA can be a useful tool to improve our understanding of how people perceive and value risk changes internationally, and a contribution to more reliable use of VSL estimates for cost-benefit analysis (CBA) of programs involving environmentally related mortality risks.

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Annex 1: Overview over studies included in the meta-analysis

Title	Year	Country	Risk context
Adamowicz, Dupont & Krupnick -- Willingness to Pay to Reduce Community Health Risks from Municipal Drinking Water: A Stated Preference Study	2006	Canada	Environment
Adamowitz *et al*. -- Valuation of Cancer and Microbial Disease Risk Reductions in Municipal Drinking Water – An Analysis of Risk Context Using Multiple Valuation Methods	2007	Canada	Environment
ADB -- The Cost of Road Traffic Accidents in Malaysia	2005	Malaysia	Traffic
Aimola -- Individual WTPs for Reductions in Cancer Death Risks	1998	Italy	Health
Alberini & Chiabai -- Urban Environmental Health and Sensitive Populations: How Much are Italians Willing to Pay to Reduce Their Risks?	2006	Italy	Health
Alberini *et al* -- The Value of a Statistical Life in the Czech Republic: Evidence from a Contingent Valuation Study	2005	Czech Republic	Health
Alberini *et al*. -- Does the value of a statistical life vary with age and health status: Evidence from the US and Canada	2005	US, Canada	Health
Alberini *et al*. -- Public Preferences for Contaminated Site Cleanup	2007	Italy	Environment
Alberini, Hunt & Markandya -- Willingness to pay to reduce Mortality Risks: Evidence from a Three-Country Contingent Valuation Study	2006	UK, France, Italy	Health
Alberini, Scasny & Braun Kohlova -- The Value of a Statistical Life in the Czech Republic: Evidence from a Contingent Valuation Study	2005	Czech Republic	Health
Andersson & Lindberg -- Benevolence and the value of road safety	2008	Sweden	Traffic
Andersson -- Willingness to pay for road safety and estimates of the risk of death: Evidence from a Swedish contingent valuation study	2007	Sweden	Traffic
Bhattacharya, Alberini & Cropper -- The value of mortality risk reductions in Delhi, India	2007	India	Traffic
Buzby, Ready & Skees -- Contingent Valuation in Food Policy Analysis: A Case Study of a Pesticide-Residue Risk Reduction	1995	USA	Environment
Carson & Mitchell -- Public preferences toward environmental risks: The case of trihalomethanes	2006	USA	Environment
Carthy *et al*. -- On the Contingent Valuation of Safety and the Safety of Contingent Valuation -- Part 2 -- The CV-SG “Chained” Approach	1999	UK	Traffic
Chanel & Luchini -- Monetary values for air pollution risk of death: A contingent valuation survey	2008	France	Environment
Chilton *et al*. -- DEFRA -- Valuation of Health Benefits Associated with Reductions in Air Pollution	2004	UK	Environment
Chilton *et al*. -- Estimating a Value of a Life Year Gained from Air Pollution Reduction: A comparison of Approaches	2004	UK	Environment
Choi, Lee & Lee -- Determining the Value of Reductions in Radiation Risk Using the Contingent Valuation Method	2001	Korea	Environment
Cookson -- Incorporating psycho-social considerations into health valuation: An experimental study	2000	UK	Health
Corso, Hammit & Graham -- Valuing Mortality-Risk Reduction: Using Visual Aids to Improve the Validity of Contingent Valuation	2001	USA	Traffic
de Blaeij -- Value of a Statistical Life in Road Safety	2003	Netherlands	Traffic
Desaigues & Rabl -- Reference Values for Human Life: An Econometric Analysis of a Contingent Valuation in France	1995	France	Traffic
Desaigues *et al*. -- Final Report on the monetary valuation of mortality and morbidity risks from air pollution	2007	9 EU countries	Environment
Desaigues *et al*. -- Monetary value of Life Expectancy Gain due to Reduced Air Pollution: Lessons from a Contingent Valuation in France	2007	France	Health
Gibson *et al*. -- The Value of Statistical Life and the Economics of Landmine Clearance in Developing Countries	2007	Thailand	Health
Giergiczny -- Value of a Statistical Life – case of Poland	2006	Poland	Health
Guo, Haab & Hammitt -- Contingent Valuation and the Economic Value of Air-Pollution-Related Health Risks in China	2006	China	Environment
Guria *et al*. -- The WTA Value of Statistical Life Relative to WTP Value: Evidence and Policy Implications	2005	New Zealand	Traffic
Guria *et al*. -- The New Zealand Values of Statistical Life and of the Prevention of Injuries	2003	New Zealand	Traffic
Gyrd-Hansen *et al*. -- Willingness-to-pay for a statistical life in the times of a pandemic	2007	Norway	Health
Hakes & Viscusi -- The rationality of automobile seatbelt usage -- The value of a statistical life and fatality risk beliefs	2004	USA	Traffic
Hammitt -- Risk Perceptions and Food Choice -- An Exploratory Analysis of Organic- Versus Conventional-Produce Buyers	1990	USA	Environment
Hammitt & Graham -- Willingness to Pay for Health Protection: Inadequate Sensitivity to Probability?	1990	USA	Health

Title	Year	Country	Risk context
Hammitt & Liu -- Effects of Disease Type and Latency on the Value of Mortality Risk	2004	Chinese Taipei	Environment
Hammitt & Zhou -- The Economic Value of Air-Pollution-Related Health Risks in China: A Contingent Valuation Study	2005	Chinese Taipei	Environment
Hojman, Ortúzar & Rizzi -- On the joint valuation of averting fatal and severe injuries in highway accidents	2005	Chile	Traffic
Hultkrantz, Lindberg & Andersson -- The value of improved road safety	2006	Sweden	Traffic
Itaoka *et al*. -- Age, Health, and the Willingness to Pay for Mortality Risk Reductions: A Contingent Valuation Survey in Japan	2005	Japan	Health
Johannesson, Johansson & O'Conor -- The Value of Private Safety Versus the Value of Public Safety	1996	Sweden	Traffic
Johannesson, Johansson & Löfgren -- On the Value of Changes in Life Expectancy: Blips Versus Parametric Changes	1997	Sweden	Health
Jones-Lee, Hammerton & Philips -- The Value of Safety: Results of a National Sample Survey	1985	UK	Traffic
Kidholm -- Assessing the value of traffic safety using the contingent valuation technique: The Danish Survey	1995	Denmark	Traffic
Krupnick *et al*. -- Age, Health and the Willingness to Pay for Mortality Risk Reductions: A Contingent Valuation Survey of Ontario Residents	2002	Canada	Health
Krupnick *et al*. -- The Willingness to Pay for Mortality Risk Reductions in Shanghai and Chongqing, China	2006	China	Health
Krupnick, Zhang & Adamowitz -- The Role of Altruism in the Valuation of Community Drinking Water Risk Reductions	2008	Canada	Environment
Lanoie, Pedro & Latour -- The Value of a Statistical Life : A Comparison of Two Approaches	1995	Canada	Traffic
Leiter -- The Influence of Age and Competitive Risks on Monetary Valuation of Prevented Mortality Risks	2007	Austria	Environment
Leiter & Pruckner -- Dying in an Avalance -- Current Risks and Valuation	2006	Austria	Environment
Leiter & Pruckner -- Proportionality of Willingness to Pay to Small Risk Changes -- The impact of attitudinal factors in scope tests	2006	Austria	Environment
Liu *et al*. -- Valuation of the risk of SARS inTaiwan	2005	Chinese Taipei	Health
Mahmud -- Contingent Valuation of Mortality Risk Reduction in Developing Countries: A Mission Impossible	2006	Bangladesh	Health
Maier, Gerking & Weiss -- The Economics of Traffic Accidents on Austrian Roads: Risk Lovers or Policy Deficit	1989	Austria	Traffic
McDaniels -- Reference Points, Loss Aversion, and Contingent Values for Auto Safety	1992	USA	Traffic
McDaniels, Kamlet & Fischer -- Risk Perception and the Value of Safety	1992	USA	Traffic
Miller & Guria -- The Value of Statistical Life in New Zealand	1991	New Zealand	Traffic
Morris & Hammitt -- Using Life Expectancy to Communicate Benefits of Health Care Programs in Contingent Valuation Studies	2001	USA	Health
New Ext -- New Elements for the Assessment of Ecternal Costs from Energy Technologies	2004	9 EU countries	Environment
O'Conor & Blomquist -- Measurement of Consumer-Patient Preferences Using a Hybrid Contingent Valuation Method	1997	USA	Health
Ortiz, Markandya & Hunt -- Willingness to Pay for Mortality Risk Reduction Associated with Air Pollution in Sao Paulo	2003	Brazil	Health
Perreira & Sloan -- Living Healthy and Living Long : Valuing the Nonpecuniary Loss from Disability and Death	2004	USA	Traffic
Persson *et al*. -- The Value of a Statistical Life in Transport: Findings from a New Contingent Valuation Study in Sweden	2001	Sweden	Traffic
Riddel & Shaw -- A theoretically-consistent empirical model of non-expected utility: An application to nuclear-waste transport	2006	USA	Environment
Rizzi & Ortúzar -- Stated preference in the valuation of interurban road safety	2003	Chile	Traffic
Schwab Christe -- The valuation of human costs by the contingent method: The Swiss case	1995	Switzerland	Traffic
Smith & Desvousges -- An Empirical Analysis of the Economic Value of Risk Changes	1987	USA	Environment
Soguel & van Griethuysen -- Evaluation contingente, qualité de l'air et santé : Une étude en milieu urbain	2000	Switzerland	Environment
Strand -- Public- and private-good values of statistical lives : Results from a combined choice-experiment and contingent-valuation survey	2004	Norway	All 3
Tonin, Turvani & Alberini -- The Value of Reuse and Reducing Cancer Risks at Contaminated Sites	2008	Italy	Environment
Tsuge, Kishimoto & Takeuchi -- A Choice Experiment Approach to the Valuation of Mortality	2005	Japan	Health
Vassanadumrondgee & Matsuoka -- Risk Perceptions and Value of a Statistical Life for Air Pollution and Traffic Accidents: Evidence from Bangkok, Thailand	2005	Thailand	Environment,

			Traffic
Viscusi, Magat & Huber -- Pricing environmental health risks: Survey assessments of risk-risk and risk-dollar trade-offs for chronic bronchitis	1991	USA	Traffic
Wang & Mullahy -- Willingness to pay for reducing fatal risk by improving air quality: A contingent valuation study in Chongqing, China	2006	China	Environment
Williams & Hammitt -- A Comparison of Organic and Conventional Fresh Produce Buyers in the Boston Area	2000	USA	Environment
Zhang *et al*. -- Altruistic Values for Drinking Water Quality Improvements	2006	Canada	Environment
Zhu -- Valuation of life -- A study using discrete choice analysis	2004	Norway	All 3
Additional studies that will be included in further analyses	**Year**	**Country**	**Risk context**
Acton -- Evaluating Public Programs to Save Lives -- The Case of Heart Attacks	1973	USA	Health
Blomquist -- Self-Protection and Averting Behavior, Values of Statistical Lives, and Benefit Cost Analysis of Environmental Policy	2004	Sweden	
Chestnut *et al*. -- Economic Valuation of Mortality Risk Reduction -- Stated Preference Approach in Canada -- 2004	2004	US, Canada	Health, Traffic
Chestnut *et al*. -- Economic valuation of mortality risk reduction -- A stated preferences approach	2004	US, Canada	Health, Traffic
duVair & Loomis -- Household's Valuation of Alternative Levels of Hazardous Waste Risk Reductions: An Application of the Referendum Format	1993	US	Environment
Geurts, van der Veen & Wierstra -- Willingness-to-Pay for reducing risk of flooding -- Testing for temporal stability and scope validity	2002	Netherlands	Environment
Muller & Reutzel -- Willingness to Pay for Reduction in Fatality Risk -- An Exploratory Survey	1984	USA	Traffic
Person & Cedervall – The Value of Risk Reduction: Results of a Swedish Sample Study	1991	Sweden	Traffic
Philips, Russel & Jones-Lee -- The Empirical Estimation of Individual Valuation of Safety -- Results of a National Sample Survey	1989	UK	Traffic
Zhai -- Public Preference and Willingness to Pay for Flood Risk Reduction	2006	Japan	Environment
Zhai & Suzuki -- Effects of Risk Representation and Scope on Willingness to Pay for Reduced Risks -- Evidence from Tokyo Bay, Japan	2008	Japan	Environment

Annex 2: Table overview of number and sixe of VOSL study estimates by sector risk and country

(VSL numbers in million 2005-USD, PPP corrected using AIC-based exchange rates)

	Number of mean VSL surveys			Number of mean VSL estimates			Env. mean VSL estimates			Health mean VSL estimates			Traffic VSL estimates		
Country	**Env.**	**Health**	**Traffic**	**Env.**	**Health**	**Traffic**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
Austria	1	0	1	34	0	8	6 664	2 128	15 903	…	…	…	12 516	2 101	40 857
Bangladesh	0	1	0	0	4	0	…	…	…	5	4	7	…	…	…
Brazil	0	1	0	0	32	0	…	…	…	15 760	2 821	35 717	…	…	…
Canada	1	1	1	46	11	2	13 400	6 493	20 601	1 572	796	3 581	2 951	2 116	3 786
Chile	0	1	3	0	14	16	…	…	…	1 024	178	2 295	663	265	2 130
China	2	3	0	1	124	0	24	24	24	535	17	1 716	…	…	…
Chinese Taipei	1	2	0	8	48	0	2 126	924	3 883	11 672	5 255	22 147	…	…	…
Czech Republic	0	1	0	0	12	0	…	…	…	2 735	731	5 447	…	…	…
Denmark	0	0	1	0	0	6	…	…	…	…	…	…	13 649	8 998	17 540
France	2	1	1	20	43	12	1 803	768	3 027	2 272	188	9 787	8 576	268	26 494
India	0	0	1	0	0	18	…	…	…	…	…	…	46	21	98
Italy	2	3	0	7	25	0	3 885	1 432	6 341	3 687	502	12 642	…	…	…
Japan	0	2	0	0	31	0	…	…	…	1 380	505	4 091	…	…	…
Korea	1	0	1	1	0	1	5 726	5 726	5 726	…	…	…	3 511	3 511	3 511
Malaysia	0	0	1	0	0	4	…	…	…	…	…	…	1 194	700	1 705
Netherlands	0	0	1	0	0	29	…	…	…	…	…	…	3 419	1 492	6 426
New Zealand	0	0	2	0	0	96	…	…	…	…	…	…	31 222	682	206 474
Norway	1	2	1	6	9	6	7 288	1 491	10 480	4 623	690	8 502	6 095	2 680	12 188
Poland	0	1	0	0	3	0	…	…	…	785	190	1 710	…	…	…
Sweden	0	1	4	0	14	21	…	…	…	4 510	2 783	5 530	4 289	1 567	10 259
Switzerland	0	0	1	0	0	1	…	…	…	…	…	…	13 257	13 257	13 257
Thailand	1	1	1	2	2	2	1 539	1 380	1 699	605	582	629	1 571	1 295	1 847
United Kingdom	1	2	3	2	11	34	170 100	143 241	196 962	12 705	652	63 268	20 802	652	112 035
United States	2	1	4	8	3	15	59 736	5 402	137 775	1 358	1 096	1 747	23 948	4 731	65 809

The table will be updated when additional surveys have been included. The estimates have not yet been screened in any way (*e.g.* based on quality or by other criteria).

Annex 3. Overview over VSL estimates included in the analysis.

Number of surveys with mean VSL estimates >0	63
Number of mean VSL estimates >0	860
Mean value of mean VSL estimates >0, 2005 USD, AIC-PPP	9,643,300
Max value of mean VSL estimates >0, 2005 USD, AIC-PPP	206,473,500
Min value of mean VSL estimates >0, 2005 USD, AIC-PPP	4,450
Number of surveys with median VSL estimates >0	33
Number of median VSL estimates >0	311
Mean value of median VSL estimates >0, 2005 USD, AIC-PPP	4,577,100
Max value of median VSL estimates >0, 2005 USD, AIC-PPP	83,291,300
Min value of median VSL estimates >0, 2005 USD, AIC-PPP	3,765
Number of surveys with mean or median VSL estimates >0	67
Number of surveys with mean, private WTP VSL estimates >0	49
Number of mean, private WTP VSL estimates >0	554
Mean value of mean, private WTP VSL estimates >0	5,967,000
Max value of mean, private WTP VSL estimates >0	137,775,400
Min value of mean, private WTP VSL estimates >0	4,450
Number of surveys with median, private WTP VSL estimates >0	27
Number of median, private WTP VSL estimates >0	206
Mean value of median, private WTP VSL estimates >0	3,394,000
Max value of median, private WTP VSL estimates >0	21,816,400
Min value of median, private WTP VSL estimates >0	3,765
Number of surveys with mean, public WTP VSL estimates >0	19
Number of mean, public WTP VSL estimates >0	255
Mean value of mean, public WTP VSL estimates >0	10,088,000
Max value of mean, public WTP VSL estimates >0	196,963,000
Min value of mean, public WTP VSL estimates >0	87,800
Number of surveys with mean, private, environment WTP VSL estimates >0	6
Number of mean, private WTP VSL estimates >0	31
Mean value of mean, private WTP VSL estimates >0	16,863,200
Max value of mean, private WTP VSL estimates >0	137,775,400
Min value of mean, private WTP VSL estimates >0	767,800
Number of surveys with mean, public, environment WTP VSL estimates >0	8
Number of mean, public, environment WTP VSL estimates >0	148
Mean value of mean, public, environment WTP VSL estimates >0	9,201,700
Max value of mean, public, environment WTP VSL estimates >0	196,963,000
Min value of mean, public, environment WTP VSL estimates >0	87,800
Number of surveys with mean, private, health WTP VSL estimates >0	21
Number of mean, private, health WTP VSL estimates >0	347
Mean value of mean, private, health WTP VSL estimates >0	4,400,000
Max value of mean, private, health WTP VSL estimates >0	35,717,000
Min value of mean, private, health WTP VSL estimates >0	4,450
Number of surveys with mean, public, health WTP VSL estimates >0	5
Number of mean, public, health WTP VSL estimates >0	43

Mean value of mean, public, health WTP VSL estimates >0	5,085,100
Max value of mean, public, health WTP VSL estimates >0	63,268,000
Min value of mean, public, health WTP VSL estimates >0	177,800
Number of surveys with mean, private, traffic WTP VSL estimates >0	24
Number of mean, private, traffic WTP VSL estimates >0	176
Mean value of mean, private, traffic WTP VSL estimates >0	7,138,200
Max value of mean, private, traffic WTP VSL estimates >0	65,809,000
Min value of mean, private, traffic WTP VSL estimates >0	21,100
Number of surveys with mean, public, traffic WTP VSL estimates >0	10
Number of mean, public, traffic WTP VSL estimates >0	63
Mean value of mean, public, traffic WTP VSL estimates >0	15,700,000
Max value of mean, public, traffic WTP VSL estimates >0	112,035,000
Min value of mean, public, traffic WTP VSL estimates >0	267,600

Annex 4. Description of dataset variables and definitions

Type of info	Column name	Additional information on the cell contents Classification categories used are listed in red
	Estimate variation	
Country information	Country	
	GDP per capita 2005 USD, PPP	
	Actual individual consumption per capita 2005 USD, PPP	
	Life expectancy, 1972	Numbers for 1970-1975 are assumed to be valid for 1972.
	Life expectancy, 2005	
	Life expectancy, collection year	Estimated based on interpolation between 1972 and 2005 figure.
	Human development index, 2005	
	Human development index, collection year	Calculated in the sheet "HDI data", interpolation between data for 1970, 1975, 1980, … 2000, 2005 in UNDP Human Development Index report 2008
Location	Location	
	Location category	Country-wide; Large (>1,000,000); Medium (100,000-1,000,000); Small (<100,000); Rural; Other; Not known
	SurveyID	The term "survey" refers to a given "field application".
	Questionnaire ID	This field keeps track of different studies using the same questionnaire
	Study Title	
	Publication Year	
	Collection Year	
	Estimate value year	In some studies, the VSL numbers are expressed in a value other than the collection year's
	Currency used	
	Price adjustment factor; study year to 2005	Using Consumer Price Index of the respective countries
	Exchange rate -- Nat curr. - $, PPP corrected, GDP	PPP for all GDP
	Exchange rate -- Nat curr. - $, PPP corrected, AIC	PPP for Actual Individual Consumption -- excludes e.g. investment and export parts of GDP
Author 1	Last Name	
	First Name	
	Institution	
	Email	
Author 2	Last Name	
	First Name	
	Institution	
	Email	
Author 3	Last Name	
	First Name	
	Institution	
	Email	
Author 4	Last Name	
	First Name	
	Institution	
	Email	
	Other Authors	

	Study Reference	
	Publication status	Journal; Book; Discussion paper; Conference paper; Doctorate thesis; Other. -- Kvalitetsindikator.
	Reference web-link	
	Risk category	Environmental; Traffic; Health. "Environment" only if environment explicitly mentioned in the survey, otherwise Health. "Traffic" is normally obivous
	WTP or WTA	WTP; WTA -- Green font in the cell for the least common alternative
	Risk increase or decrease?	Increase; Decrease
	If Environment: medium	Air; Water; Hazardous waste; Noise; Radiation; Food; Other
	Private vs. Public good	Private; Public (Private=individual or household, but not public at large)
	Survey approach	Telephone; Mail; Face-to-face; Self-administrated without PC; Self-administrated with PC; Web-based (e.g. a pre-established panel), Other
	Elicitation method	CV - open; CV - cards; CV - bids (Much like dicho, but with many bidding rounds); CV - dicho; Conjoint analysis; Contingent ranking; Other
	If CV - dicho: Single-or double-bounded?	Single; Double; Single+Open; Double+Open (In the +-options, the VSL estimate based on both dichtomous responses and an open-ended question)
	Risk change explanation	Written explanation; Oral explanation; Risk ladder; 1000 square grid; 100,000 square grid; LE graph; Other visual tool; Other; None
	If not traffic: Acute vs. Chronic	Acute (The risk change concerns an accute episode); Chronic (The risk-change has a lasting character)
	If Chronic: Degree of latency	Latent (The risk-change appears after a certain time); Not latent (The risk-change appears immediately)
	If Latent: Risk reduction after # years	
	Risk controllability	Voluntary (The interviewee has a direct control over the risk change -- e.g. can buy a product or not); Involuntary
	Individual or household WTP	Individual (The WTP is only the interviewed persons WTP); Household (The WTP is the WTP of all the members of the household)
	Abstract or specific	Abstract; Specific (Includes a description of the degree of suffering involved);
	Response rate info	
	Response rate category	High; Medium; Low; No info
	Total sample size	
	Sub-sample Size	The number of (valid) response used to estimate VSL /WTP -- but there could be some uncertainty of whether invalid responses always are excluded
Risk information	Baseline risk -- original	Baseline risk expressed as "5 out of 1,0000", or similarly
	Baseline risk -- normalised	Baseline risk expressed as a decimal number
	Risk change	
	Risk change -- normalised (per year)	
	Risk reduction period	1 year; 10 years; Other period (e.g. lifetime of car); Lifetime; Forever
	If "Other period": How long?	Number of years
	Assumed life expectancy gain	Number of months
WTP type	WTP number	1; 2; 3; Higher; 1&2; Other; Not known (Whether the WTP estimate is based on the first, second, … valuation question)
	WTP per what?	Monthly for rest of life; Monthly over a period; Yearly for rest of life; Yearly over a period; One-off; Other
	If over a period: WTP period	Number of years
	If other: What?	
WTP estimates	Mean -- Nat curr.	
	Mean -- 2005$ GDP-PPP	
	Mean -- 2005$ AIC-PPP	
	St. err -- Nat curr.	
	St. dev -- 2005$ GDP-PPP	
	St. dev -- 2005$ AIC-PPP	
	Mean / St.dev	Mean value divided by the standard error
	Median -- Nat curr.	
	Median -- 2005$ GDP-PPP	
	Median -- 2005$ AIC-PPP	
	St. err -- Nat curr.	
	St. err -- 2005$ GDP-PPP	
	St. err -- 2005$ AIC-PPP	
	Median / St.dev	Median value divided by the standard error

Voly estimates	Based on mean WTP -- Nat. curr	
	Based on mean WTP -- 2005$ GDP-PPP	
	Based on mean WTP -- 2005$ AIC-PPP	
	St.err -- Nat curr.	
	St. err -- 2005$ GDP-PPP	
	St. err -- 2005$ AIC-PPP	
	Based on median WTP -- Nat. curr	
	Based on median WTP -- 2005$ GDP-PPP	
	Based on median WTP -- 2005$ AIC-PPP	
	St.err -- Nat curr.	
	St. err -- 2005$ GDP-PPP	
	St. err -- 2005$ AIC-PPP	
VSL estimates	Based on mean WTP -- Nat. curr	
	Based on mean WTP -- 2005$ GDP-PPP	
	Based on mean WTP -- 2005$ AIC-PPP	
	St.err -- Nat. curr	
	St. err -- 2005$ GDP-PPP	
	St. err -- 2005$ AIC-PPP	
	Based on median WTP -- Nat. curr	
	Based on median WTP -- 2005$ GDP-PPP	
	Based on median WTP -- 2005$ AIC-PPP	
	St.err -- Nat. curr	
	St. err -- 2005$ GDP-PPP	
	St. err -- 2005$ AIC-PPP	
Zeros	% WTP=0 -- All	All zero responses in per cent of the total sample
	% WTP=0 -- Protest	Protest zero responses in per cent of the total sample
	Protest 0s included in WTP estimate?	Yes; No
Confidence and understand	Degree of confidence in the WTP indicated	High; Normal; Low: Not known (Subjective degree of confidence in the respnse given)
	% of sample with high confidence	
	Under-standing of "risk" etc.	High; Normal; Low: Not known
	% of sample failing probability test	
	% of sample with good risk under-standing	
	Overall vs. adjusted WTP	Overall; Adjusted. (Indicates if certain types of responses have been excluded from the sample) Should not be given much emphasise
	Adjustment details	
	Parametric vs. non-parametric	Parametric; Non-parametric (Main method used to estimate the WTP/VSL)
	If CV-dicho: Estimation method	More details on estimation method for CV-dicho studies
	If CV-dicho: Distributional assumptions	
Bids presented to the sample	Lowest value presented, overall -- Nat curr	These fields could perhaps give an indication of whether the WTP expressed depends on the "bids" presented to the respondents -- but this is of relevance only for risk changes of a comparable magnitude.
	Lowest value presented, overall -- 2005$ GDP-PPP	
	Lowest value presented, overall -- 2005$ AIC-PPP	
	Highest value presented, overall -- Nat curr	
	Highest value presented, overall -- 2005$ GDP-PPP	
	Highest value presented, overall -- 2005$ AIC-PPP	
	Lowest 1st value presented -- Nat curr	
	Lowest 1st value presented -- 2005$ GDP-PPP	
	Lowest 1st value presented -- 2005$ AIC-PPP	
	Highest 1st value presented -- Nat curr	
	Highest 1st value presented -- 2005$ GDP-PPP	
	Highest 1st value presented -- 2005$ AIC-PPP	

Payment	Payment vehicle	Price of product (i.e., a specific product); Cost of living (i.e., prices in general); Tax; Donation; Road toll; Other
	Payment vehicle -- Details	
	Sampling criterion	Indicates if the total sample aim at specific parts of the total population, e.g. certain age categories.
Annual income	Mean, household -- Nat curr.	Normally pre-ttax income, i.e. gross income -- but there could be some exceptions (the papers often lack details on this)
	Mean, household -- 2005$ GDP-PPP	
	Mean, household -- 2005$ AIC-PPP	
	Household st.dev. -- Nat curr.	
	Household st.dev. -- 2005$ GDP-PPP	
	Household st.dev. -- 2005$ AIC-PPP	
	Median, household -- Nat curr	
	Median household -- 2005$ GDP-PPP	
	Median household -- 2005$ AIC-PPP	
	Mean, individual / per capita -- Nat curr.	The information here is not necessarily always comparable -- sometimes it reflects income of only the respondent, sometimes the average income of all the persons in the household
	Mean, individual / per capita -- 2005$ GDP-PPP	
	Mean, individual / per capita -- 2005$ AIC-PPP	
	Individual / per capita st.dev. -- Nat curr.	
	Individual / per capita st.dev. -- 2005$ GDP-PPP	
	Individual / per capita st.dev. -- 2005$ AIC-PPP	
	Median, individual / per capita -- Nat curr	
	Median, individual / per capita -- 2005$ GDP-PPP	
	Median, individual / per capita -- 2005$ AIC-PPP	
	Sample income compared to country average	High; Normal; Low; Not known -- "Normal" = national average +/- 5%.
Age structure of th	Mean	
	Median	
	St. dev.	
	Mini-mum	
	Maxi-mum	
	% less than 40 years	
	% 40-60 years	
	% more than 60 years	
Health situation of	"Objective" health status	High; Normal; Low; Not known (For a representative nation-wide sample, it is Normal. It is Low if an estimate only includes e.g. persons with cancer)
	% with cancer	
	% with heart disease	
	% with lung disease	
	% with high blood pressure	
	% with any preceeding illness	
	% having been hospitalied recently	
	% self-assess being in very good health	
Additional sample	% women	
	% married	
	Number of persons in household -- Mean	
	Number of persons in household -- St.dev	
	Years of schooling	
	Schooling St. dev.	
	% 12 years schooling or more	There could be some variation from study to study whether those with exactly 12 years are included -- they should be so.
	% less than 12 years schooling	There could be some variation from study to study whether those with exactly 12 years are included -- they should not be so.
	Reference to cancer risk	Yes; No (Have the respondents somehow been made to think specifically about cancer risks, due to the particular risk change to be valued, or otherwise?)
	Also morbidity estimate	Yes; No (Did the survey also include questions regarding changes in morbidity risks?)
	External scope test passed	Yes; No (Split-sample test where people asked about different magnitude of risk changes give significantly different answers) -- Not addressed in all studies)
	Internal scope test passed	Yes; No (Did respondents have a significantly higher WTP for a larger risk change than for a small one?) -- Not addressed in all studies)
	Saved as	