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Are estimates of the value of a statistical life exaggerated?

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ABSTRACT

The magnitude of the value of a statistical life (VSL) is critical to the evaluation of many health and safety initiatives. To date, the large and rigorous VSL research literature has not explicitly accommodated publication selectivity bias (i.e., the reduced probability that insignificant or negative VSL values are reported). This study demonstrates that doing so is essential. For studies that employ hedonic wage equations to estimate VSL, correction for selection bias reduces the average value of a statistical life by 70–80%. Our meta-regression analysis also identifies several sources for the wide heterogeneity found among reported VSL estimates.

1. Introduction

Estimates of the value of a statistical life (VSL) are used extensively in cost-benefit analyses (CBA) of public health and safety projects worldwide.[1] Examples of such public health and safety projects include: transport safety, occupational health and safety interventions, environmental protection, rehabilitation programmes, and public health initiatives (Ashenfelter, 2006). However, CBA is often based upon VSL estimates that differ widely, even after one adjusts for regional differences, exchange rates and year. In order to make sense of this heterogeneity, researchers have turned to meta-regression analysis (Stanley, 2001). Meta-regression analysis allows researchers to account for many other dimensions of heterogeneity such as differences in average worker income, the circumstances of the risk of death, and observable variations in the econometric models and methods used to estimate VSL.

Commencing with Liu et al. (1997), numerous meta-analyses of VSL estimates have been undertaken, the most recent being Bellavance et al. (2009), Lindhjem et al. (2010) and US EPA (2010). Other meta-analyses of VSL estimates include Day (1999), Miller (2000), Bowland and Beghin (2001), Dionne and Michaud (2002), Mrozek and Taylor (2002), De Blaeij et al. (2003), Viscusi and Aldy (2003), Kochi et al. (2006), Dekker et al. (2008) and Kluve and Schaffner (2008). While not all of these meta-analyses provide an overall VSL estimate for policy analysis, they all attempt to make sense of the wide disparity among VSL estimates. These 'quantitative' and systematic reviews of VSL suggest that differences between estimates are, of course, partly due to sampling error, but also due to data differences (e.g. different countries, time periods, and groups of workers analysed) and methodological choices (e.g. the specification of the wage regression and the choice of the fatality risk variable) made by the researcher.

To date, little consideration has been given to the possibility that the selection bias inherent in choosing which results to report may also be contributing to the observed differences found among VSL estimates. Existing meta-analyses have assumed implicitly that the reported VSL estimates are a representative sample, thereby valid and unbiased inferences can be drawn from their averages.[2] In

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[1] VSL is a measure of the marginal rate of substitution between income and fatality risk. It is not a measure of the value of a single *actual* life. Rather, it is the aggregation of the value of the marginal willingness to pay for infinitesimal risk reductions for different people that are aggregated to a single *statistical* life (Cameron, 2010).

[2] Lindhjem et al. (2010) raise the issue of non-random sample bias but do not formally model or correct for it. Dionne and Michaud (2002) also raise the issue and include the year of publication as an attempt to control for selection effects. Hwang et al. (1992, p. 855) hypothesize that: "studies that find insignificant and wrong-signed values of compensating wage differentials have a more difficult time getting published". The US EPA (2006, p. 18) also noted the issue of the: "exclusion or failure

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particular, they assume that there is no preference to report statistically significant fatality risk coefficients and positive VSL estimates. However, if the available VSL estimates are a truncated and/or a selected sample, then any average, weighted or simple, will lead to a biased estimate of VSL.[3] Typically, such truncated or skewed samples result in *inflated* averages and potentially to faulty inference (De Long and Lang, 1992; Card and Krueger, 1995; Roberts and Stanley, 2005).

In this paper, we ask whether reported VSL estimates are a reflection of publication selection and, if so, how practically important is the resulting bias. Our paper has three aims. First, we wish to make users of VSL estimates – researchers, meta-analysts and policy makers – aware of the issue of publication selection bias and its potential effects on inference. Second, we offer more accurate estimates of VSL for use in CBA. Third, we identify more fully the heterogeneity among VSL estimates and thereby provide revised estimates of key elasticities, such as the income elasticity of VSL.

Section 2 discusses how publication selection might bias estimates of VSL. Section 3 modifies the existing meta-regression model used in prior meta-analyses and uses the modified framework to detect and correct publication selection bias. Section 4 discusses the selection bias corrected meta-regression results. Policy implications are discussed in Section 5. Section 6 concludes the paper. The economic theory underpinning VSL, measurement and estimation issues and limitations are not presented in this paper, as these have been discussed extensively in several other studies (e.g. Viscusi, 1978, 1993).

2. How publication selection biases the value of a statistical life

We use the data from the recent meta-analysis by Bellavance et al. (2009) to illustrate the importance of publication selection.[4] Their comprehensive search uncovered 39 hedonic wage equation estimates of VSL from 37 studies that provided comparable estimates of VSL. The simple average value of VSL from these studies is $9.5 million (in $US 2000).

2.1. Plotting publication selection

Fig. 1 displays the 39 estimates of the value of a statistical life (VSL), calculated from the coefficients of a variable that represents the probability of death in hedonic wage equations.[5] This so called 'funnel' plot is a graph of the precision (measured as the inverse of the standard error, SE) of these VSL estimates against their magnitudes in 2000 US dollars.

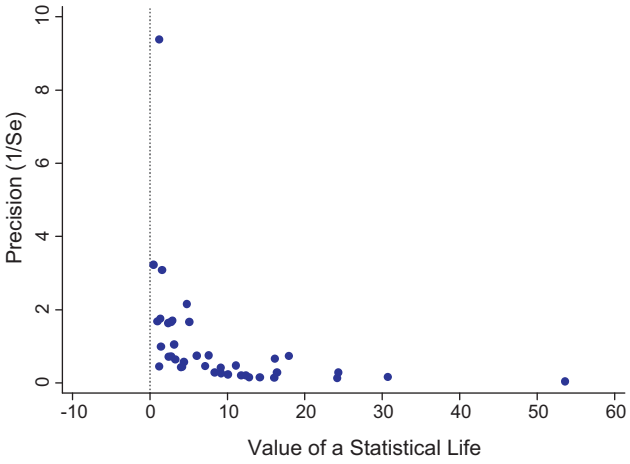

Fig. 1. Funnel plot of the value of statistical life (2000 US $m). *Source*: Bellavance et al. (2009).

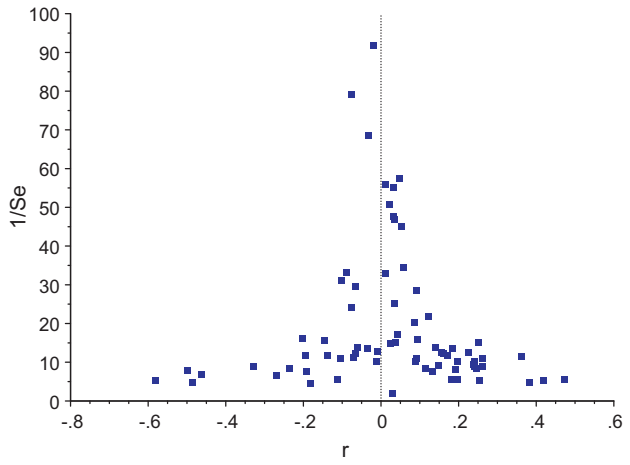

Fig. 2. Funnel plot of union-productivity partial correlations (r). *Source*: Doucouliagos and Laroche (2003).

In the absence of publication selection bias, a funnel plot should resemble an inverted funnel, similar to Fig. 2.[6] If each reported VSL is estimating the underlying 'true' value plus or minus sampling error and/or random heterogeneity, then this graph will be symmetric. Of course, known heteroscedasticity will make the distribution more widely scattered at the bottom where SE is relatively large than at the top where SE is small. Nonetheless, elementary sampling theory guarantees that the distribution will be symmetric unless, of course, there is directional selection.[7] Fig. 1 shows, however, that reported VSL estimates are clearly highly skewed,

to report models or subpopulation results that did not reach significance or did not conform to expectations . . .". However, none of these studies provide any formal tests or correction for publication bias in the VSL literature. The only exception is Day (1999), who uses an incorrect test of publication bias based on a meta-regression model of the logarithm of the reported t-value and the log of the square root of its sample size. The fit of Day's (1999) meta-regression model is so poor that it accepts both the hypothesis that the value of a statistical life is zero and also that there is no publication selection. This logarithm meta-regression test of publication bias has been shown to be invalid (Stanley, 2005, 2008; Doucouliagos and Stanley, 2009). More appropriate meta-regression models of publication selection are discussed in detail in Section 3.

[3] This is also true for 'fixed' and 'random-effects' weighted averages. Simulations show that these conventional meta-analytic summaries are quite vulnerable to publication selection (Stanley and Doucouliagos, 2007; Stanley et al., 2010).

[4] In Section 4.4 we look also at other meta-analyses. Our central focus is on Bellavance et al. (2009) because they offer the most recent published meta-analysis using wage-risk studies. US EPA (2010) has recently used Bellavance et al. (2009) database as the basis for their meta-analysis.

[5] We use their largest dataset. Little changes if the smaller dataset of 32 observations is used. See Bellavance et al. (2009) for a more complete description of the search criteria used to identify these studies, the calculation of VSL, its standard error, and the variables that were coded for each derived estimate.

[6] Fig. 1 plots VSL estimates whereas Fig. 2 plots partial correlations (r). The choice of the measure of a comparable effect should not affect the distribution's symmetry. To be sure, we have also converted all the reported VSL estimates to partial correlation coefficients and found them to be similarly highly skewed and asymmetric. These partial correlation results are available at (www.deakin.edu.au/meta-analysis).

[7] Systematic heterogeneity could also cause asymmetry to a funnel graph, and meta-analysts always allow for this possibility. In Fig. 3, below, we filter out identified systematic heterogeneity but still find considerable asymmetry and hence publication selection bias. In Section 4.2 we explicitly model potential systematic heterogeneity using a multiple meta-regression analysis (MRA). Yet, here too, there remains strong evidence of asymmetry and selection.