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The value of a statistical life: A meta-analysis with a mixed effects regression model

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ABSTRACT

The value of a statistical life (VSL) is a very controversial topic, but one which is essential to the optimization of governmental decisions. We see a great variability in the values obtained from different studies. The source of this variability needs to be understood, in order to offer public decision-makers better guidance in choosing a value and to set clearer guidelines for future research on the topic. This article presents a meta-analysis based on 39 observations obtained from 37 studies (from nine different countries) which all use a hedonic wage method to calculate the VSL. Our meta-analysis is innovative in that it is the first to use the mixed effects regression model [Raudenbush, S.W., 1994. Random effects models. In: Cooper, H., Hedges, L.V. (Eds.), The Handbook of Research Synthesis. Russel Sage Foundation, New York] to analyze studies on the value of a statistical life. We conclude that the variability found in the values studied stems in large part from differences in methodologies.

1. Introduction

More than ever before, our society must face numerous risks, notably in spheres such as health, the environment, natural disasters, transportation, as well as occupational safety. Cost–benefit analysis is a very popular project-evaluation tool for reducing these social risks. What the government has to do from a national perspective is to set up projects or regulations whose benefits will outweigh the costs of their implementation. It is usually quite easy to determine costs. But how is one to evaluate the benefits linked to protecting a human life?

Individuals are everyday making decisions that reflect the value they put on their health, life, and limb, whether when at the wheel of their car, smoking a cigarette, or working at a dangerous job. Risk evaluation is in some sort a matter of

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individual preference. Each individual, to some degree, chooses his optimal level of exposure to risk and the corresponding value of his life. The number of studies conducted on this topic since the 1970s is quite impressive. Many values of human life have been estimated with the help of several different methods. The wide variability of the results obtained makes it hard for governments to choose a value. In effect, the VSLs observed range from $0.5 million up to $50 million (US$ 2000).

The principal objective of this article is to help in understanding the source of this great variability in results. We thus wish to find out just how sensitive the values obtained empirically are to the population under study (average income, level of initial risk, race, sex, etc.). We shall also look to see whether the results obtained are influenced by differences in the methodologies of the studies. To attain these objectives we shall use meta-analysis, a statistical tool of growing popularity in the financial and economic literature.

The methodology selected for our meta-analysis is based on the mixed effects regression model (Raudenbush, 1994) which accounts for heterogeneity in different value estimations. We are the first to use this approach to analyze studies on the value of a statistical life and this is which distinguishes our research from other meta-analyses.

The next section presents the willingness-to-pay (WTP) approach. This section serves to clarify the concepts to be used in the meta-analysis. This approach is based on an individual's willingness to pay to reduce the risk of death. It is worth mentioning that we are here speaking of a completely anonymous member of society. To avoid any confusion, we use the term "value of a statistical life" (VSL). We shall at no time touch on any of the sentimental and ethical aspects that such an issue might engender. It is also imperative to understand that the value-of-statistical-life concept is not based on the value of the risk of "certain" death, but rather on the value of a variation in the risk of death (Viscusi, 2005).

Section 3 presents the meta-analysis tool. It offers a survey of some of the meta-analyses associated with the VSL to be found in the literature. It also discusses the different methodological issues associated with the estimation of a VSL. In the fourth section, we go on to give a descriptive analysis of the studies selected. The fifth section deals with the results of the meta-analysis, which are presented and analyzed in full. In conclusion, we summarize the main results and we discuss some potential extensions and implications for public decision-makers.

2. Theoretical model

Based on the willingness-to-pay (WTP) concept, the standard model for evaluating the VSL was formulated by Drèze (1962). It was subsequently popularized mainly by Schelling (1968), Mishan (1971), Jones-Lee (1976), and Weinstein et al. (1980).

The model stipulates that each individual is endowed with an initial wealth w and is subject to only two possible states of nature in relation to his existence, either to be alive (a) or to be dead (d). The probabilities associated with these states are respectively $(1-p)$ and p. The individual's well-being is represented by his expected utility:

$$EU(w) = (1-p)U_a(w) + pU_d(w), \tag{1}$$

where $U_a(w)$ and $U_d(w)$ represent, respectively, his state-dependent von Neumann–Morgenstern utility functions during his existence as well as at his death.

Intuitively, one may suppose that the individual will prefer life to death and that the utility drawn from his wealth will therefore be greater in state a than in state d. Thus we have the following inequality:

$$U_a(w) > U_d(w) \quad \forall w. \tag{2}$$

Wealth is the same in both states of nature, since it is supposed that the individual has access to an insurance market providing coverage for all financial and material losses (Dionne and Lanoie, 2004). The literature often proposes that the marginal utility drawn from wealth is greater in the state of survival than in the state of death:

$$U'_a(w) \geq U'_d(w) > 0 \quad \forall w. \tag{3}$$

This hypothesis comes from the intuition that the individual must necessarily profit more from increasing his wealth while he is alive rather than when he is deceased. It also implies that the optimal insurance plan does not cover all pain and suffering (Cook and Graham, 1977; Dionne, 1982). The individual has aversion to risk in both states of nature. This means that his marginal utility is strictly decreasing in both states:

$$U''_a(w), U''_d(w) < 0 \quad \forall w. \tag{4}$$

As mentioned above, willingness-to-pay corresponds to the amount a person is ready to pay to reduce his exposure to risk. In this model, it is a matter of asking what amount x of his initial wealth w the individual would be ready to pay to see his probability of death p reduced to p^*, while keeping his expected utility constant. So we need only find the value of x that satisfies this equality:

$$EU(w) = (1-p)U_a(w) + pU_d(w) = (1-p^*)U_a(w-x) + p^*U_d(w-x). \tag{5}$$