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The value of a statistical life in Sweden: A review of the empirical literature

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ABSTRACT

Recent focus on cost-benefit/socio-economic assessment of government "life-saving" programmes within public health, pharmaceutics, transport, and civil contingencies has spurred a wave of empirical research on the value of a statistical life (VSL) in Sweden. This paper provides an overview of the received evidence from a range of studies in one country and over a relatively short time period. A literature search was conducted in Econlit, Pubmed, Google Scholar and in bibliographies of published papers. Twelve studies on VSL with a total of 48 VSL estimates, published with data from Sweden from 1996 onwards, were identified. Among all estimates VSL varies from 9 to 1121 million SEK (€0.9–121 million). Based on a set of additional quality inclusion criteria, as used also in a recent global review of VSL studies, the sample is restricted to 9 studies with a total of 29 VSL estimates with VSL varying from 9 to 98 million SEK (€0.9–10.6 million). The raw mean among these estimates is 34.6 million SEK (€3.7 million) and the median is 23 million SEK (€2.5 million). Currently, official authorities in Sweden recommend a VSL of 22 million Swedish kronor (€2.4 million). We also point out important concerns regarding validity of these estimates: primarily the problem that VSL is significantly related to the size of the mortality risk reduction showing significant scale insensitivity, in contrast to theoretical assumptions but in line with previous empirical findings.

1. Introduction

Several Swedish government authorities use cost-benefit analysis (CBA) to make trade-offs between public expenditure and effects of public programmes on mortality risks. Since the early 1980s, the Swedish Transport Administration has used explicit economic values for prevention of fatalities and injuries from road and rail accidents, and for mortality and morbidity effects of air pollution in the planning of transport infrastructure investments and traffic policies (such as speed limits). Likewise, but more on a case-by-case basis, the Swedish Civil Contingencies Agency and the Environmental Protection Agency conduct cost-benefit analyses of policies and investments that involve health and health risk effects.

In a CBA all the relevant benefits and costs of a proposed policy are expressed in monetary terms (discounted to present value if necessary). If the monetized benefits are larger than the monetized costs, the policy is said to increase societal economic efficiency/welfare. In CBA the economic parameters of policies and programmes affecting health and mortality risks are intended to reflect tax payers' willingness to pay for public health-enhancing efforts. The key parameter is the value of a statistical life (VSL), i.e. the value of preventing a fatality. In CBA within the transport sector and in accident prevention within others sectors, other health related values, such as values

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of preventing different kinds of injuries and health benefits from reduction of air pollution, are derived as proportions of the VSL. In Sweden, VSL has also been used in the decision making process for subsidization of medical technologies; for example, one (out of a few) suggested threshold values of the maximum accepted cost per a quality-adjusted life year (QALY) gained is based on the VSL [1].[1]

The increased use of VSL in public sector planning and policy-making in Sweden has spurred a wave of empirical research in recent years. As a result, there is a unique cluster of empirical VSL estimates from different studies, to some extent based on different methods, in one country within a time span of 14–15 years.

The purpose of this study is to provide an overview of the main results of these studies. It is hoped that this may synthesize future research on methodological improvements in the field, and provide insight into policy making. Using studies from all over the world, a recent meta-analysis of VSL estimates commissioned by the OECD was based on a set of studies carried out between 1985 and 2009 (including two Swedish studies) [2,3]. In contrast, our study focuses on studies conducted in one country and over a shorter time period. Since public preferences are context-dependent and change over time, we argue that we to a larger degree avoid the possible confounding problems connected to multi-country comparisons and the use of data from a longer time period.

The rest of this paper is structured in the following way. In Section 2 we introduce the concept of the value of a statistical life and the main approaches to empirically estimate VSL. Section 3 contains an overview of studies estimating VSL in Sweden from the year 1995 onwards. A discussion of the empirical estimates and policy-relevant weaknesses with these estimates concludes the paper in Section 4.

2. The value of a statistical life

2.1. The marginal willingness to pay for a mortality risk reduction

Up until the 1960s the standard approach to estimate the value of prevented fatalities was the human capital approach that "values life" by future production potential, calculated by summing all future income streams of the "saved individual" to a present value (using an appropriate discount rate). This does not take into account lost leisure and other non-market activities, risk aversion and preferences for life and health per se.

Hence, a relevant economic approach using the willingness to pay (WTP) approach was developed initially by Dreze [4] and further elaborated by e.g. Schelling [5] and Jones-Lee [6]. In the WTP approach VSL is a measure of the population mean marginal rate of substitution between mortality risk and wealth. This can be illustrated using an atemporal model within an expected utility framework. It is assumed that individuals face and maximize an expected utility function in a certain period, as seen in Eq. (1), where w, p, and $u_s(w)$, $s \in \{a, d\}$, denote wealth, baseline probability of death, and the state-dependent utilities, respectively, with subscripts a and d denoting being alive or dead [7].

$$\mathrm{EU}(w, p) = pu_d(w) + (1-p)u_a(w) \tag{1}$$

Totally differentiating Eq. (1) with expected utility held constant gives us the marginal WTP for a mortality risk-reduction, i.e. the value of a statistical life (VSL).

$$\mathrm{EU}(w, p) = pu_d(w) + (1-p)u_a(w) \quad \mathrm{VSL} = \left.\frac{dw}{dp}\right|_{\text{EU constant}} = \frac{u_a(w) - u_d(w)}{pu'_d(w) + (1-p)u'_a(w)} \tag{2}$$

In Eq. (2) prime denotes first derivative. Under the reasonable assumptions (which are standard in the literature) that $u_a(w) > u_d(w)$, $u'_a(w) > u'_d(w) \geq 0$ and $u''_s(w) \leq 0$ for $s \in \{a, d\}$, it can be shown that VSL is positive and increasing in wealth (w) and baseline mortality risk (p) [8–10]. VSL increases with wealth since a higher wealth is associated with a higher utility if alive and lower expected utility decrease for a given level of resources used to reduce mortality risks. VSL also increases with baseline risk since with a higher baseline mortality risk it is more likely that resources used to reduce mortality risks will "come from" the state of death (low cost).[2]

In a health policy context it is also of relevance how VSL varies with age and health status. However, there are no clear results from the literature on these relationships. It has been shown that the effect of health status on VSL is ambiguous since there are effects affecting both the numerator and denominator in Eq. (2) [10,12]. Regarding age and VSL it has been shown theoretically that VSL may show different patterns with respect to age using different (but all plausible) assumptions. Many authors argue that most empirical results support the view that VSL declines with age or has an "inverted U-shape" with regards to age, i.e. increases up to ages around 40–45 after which it decreases [13–15].

2.2. Empirical approaches: how to empirically estimate VSL

VSL can be estimated with the WTP approach using either experimental or observational data, i.e. either from decisions made by subjects in contingent valuation (CV)/choice experiments (CE) involving trade-offs between money and health risk, or from observation of behaviour in real life choice settings. While randomized experimental data is often preferred to observational data due to (usually) clearer identification, this is not necessarily so in the context of this literature since it is difficult to conduct experiments involving a real money trade-off with risk (although there are a few such studies [16]). Hence, subjects participating in health risk CV and CE studies are usually asked to make hypothetical choices. Hypothetical choice experiments are used in the stated preference (SP)

[1] Where VSL was used to derive the willingness to pay for a QALY by dividing VSL with the (discounted) quality-adjusted expected life-expectancy.

[2] The so-called "dead-anyway effect" [11].