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Valuation of road safety effects in cost–benefit analysis

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ABSTRACT

Cost–benefit analysis is a common method for evaluating the social economic impact of transport projects, and in many of these projects the saving of human lives is an issue. This implies, within the framework of cost–benefit analysis, that a monetary value should be attached to saving human lives. This paper discusses the 'Value of a Statistical Life' (VoSL), a concept that is often used for monetising safety effects, in the context of road safety. Firstly, the concept of 'willingness to pay' for road safety and its relation to the VoSL are explained. The VoSL approach will be compared to other approaches to monetise safety effects, in particular the human capital approach and 'quality adjusted life years'. Secondly, methods to estimate the VoSL and their applicability to road safety will be discussed. Thirdly, the paper reviews the VoSL estimates that have been found in scientific research and compares them with the values that are used in policy evaluations. Finally, a VoSL study in the Netherlands will be presented as a case study, and its applicability in policy evaluation will be illustrated.

1. Introduction

In the field of traffic and transport the saving of human lives is an issue in many policy decisions. An integral assessment must then be made of invested resources, the saving of lives, and other effects of an intervention. This means that a value is attached to the saving of human lives, be it implicitly or explicitly. In a cost–benefit analysis (CBA) this is explicitly done by attaching a monetary valuation to the safety effects. This enables weighing the saving of human lives against other effects and costs. The valuation of human lives in Euros is necessary for CBAs which are often carried out or even are compulsory in many countries. Such a valuation does not only take someone's production capacity ('human capital') into account, but also appraises immaterial aspects such as joy of life, health and the prevention of sorrow, pain, and distress.

In addition to the use in a CBA there is a second reason to monetise human losses: this type of damage is an important item in the total costs as a consequence of road crashes. Information about road safety costs is a useful input for the preparation and assessment of the national road safety policy. The total road safety costs can also be used for a comparison with the costs of other social problems like the safety costs of modes of transport other than road traffic, other types of unsafety (e.g. unsafe work), congestion, or the environmental damage caused by road transport. Furthermore, it gives us insight in the possibilities for cost reduction and it can be used for prioritizing policy targets. Studies of the social costs of road crashes in various countries show that human losses are a substantial part of the total costs: a share of 50 to more than 75% of the total costs is no exception (e.g. Elvik, 2000).

This paper discusses the 'Value of a Statistical Life' (VoSL), a concept that is often used for monetising safety effects, in the context of road safety. Firstly, the concept of 'willingness to pay' for road safety and its relation to the VoSL are explained. The VoSL approach will be compared to other approaches to monetise safety effects, in particular the human capital approach and 'quality adjusted life years'. Secondly, methods to estimate the VoSL and their applicability to road safety will be discussed. Thirdly, the paper reviews the VoSL estimates that have been found in scientific research and compares them with the values that are used in policy evaluations. Finally, a VoSL study in the Netherlands will be presented as a case study, and its applicability in policy evaluation will be illustrated.

2. The concept 'Value of a Statistical Life'

In order to value safety effects in monetary terms, including human costs, the concept of the Value of a Statistical Life (VoSL) was developed and is now used in several countries. This 'statistical human life' can be illustrated by the following example. The chance of a fatal crash of, for instance, 7 per 100,000 inhabitants means that,

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statistically, each year 7 out of every 100,000 people will die in a road crash. A decrease from 7 to 4 road deaths per 100,000 means that 3 of every 100,000 'statistical lives' are saved. To determine the monetary value of this decrease in the crash rate, the welfare economic concept 'willingness to pay' is used. This is the maximum amount that people are prepared to pay for a given decrease in crash rate. This concept originates from the economic welfare theory and makes it possible to put a price on a specific risk reduction and hence on the saving of statistical lives. Suppose that people are prepared to pay € 60 for a crash rate reduction from 7 to 4 per 100,000. It then follows that 100,000 people are collectively prepared to pay € 60 × 100,000 = € 6 million. The VoSL is then € 6 million/3 statistical lives saved = € 2 million per statistical life. Note that the VoSL is not about valuing a specific individual life, but about the value of the decrease in crash rate. Most people would 'give anything' not to die. In the concept 'willingness to pay', people make a trade-off between crash rate and money. Every day people make decisions in which, unconsciously or not, they make such a trade-off. Take for example, choosing food, choosing driving speed, choosing whether to install a smoke detector or not, or choosing whether or not to smoke.

The total value of the prevention of a road death consists of more components than just the VoSL. Evans (2001) has analysed these components. He distinguishes between the valuation by the individual members of society (consumers) and the valuation by society as a whole. The VoSL expresses what individuals are willing to pay for reducing the risk of death. The VoSL consists of two parts: a material and an immaterial part. The immaterial part (everything that has no (market) price) represents the loss of joy of life and the value of pain, sorrow and distress of the casualties and their relations, also called 'human losses'. The material part, which is formed by all the utility that can be acquired by market transactions, consists of the loss of consumption in the life years lost: the 'no longer being able to consume'. Discounting is used to calculate its present value. The assumption is that people are willing to pay to lower their risk of loss of joy of life, of pain, sorrow and distress, and of the loss of future consumption.

For society as a whole two other components determine the value of the prevention of a road death: net production loss and medical costs (e.g. Alfaro, Chapuis, & Fabre, 1994; Persson & Odegaard, 1995). Individuals do not include these costs in their valuation of risk reduction, because these costs are borne by others. Table 1 gives a schematic presentation of the total costs of a road death.

Gross production loss can be estimated by using the human capital approach. In this approach the (loss of) productive capacity of a human being is valued. Although the human capital approach and the willingness to pay approach are sometimes considered to be alternatives for valuing human lives saved, it should be noted that they estimate different cost components and that the two approaches are complementary. The willingness to pay approach includes both a material component (consumption loss) and an immaterial component (human losses) while the human capital approach is restricted to material losses (gross production loss). However, both approaches include an estimate of consumption loss. To avoid double counting, consumption loss should be deducted from the VoSL, which results in 'human losses', or from gross production loss which results in net production loss.

In health care evaluations 'quality adjusted life years' (QALYs) are often used as a measure for the benefits of interventions (e.g. Drummond, Sculfer, Torrance, O'Brien, & Stoddard, 2005). The benefits are then expressed in the number of healthy life years gained, which is calculated by a reduction of the number of life years lost due to early death and the number of years someone lives with a disability, weighted for their severity. Based on the relation between QALYs and the costs, interventions can then be prioritized in a cost-utility analysis. However, this does not answer the question of whether an investment is socially profitable. A CBA, on the other hand, does give an answer, and is also a more suitable method when there are effects with several dimensions. This is for example the case in CBAs of traffic and transport projects that weigh the effects on mobility, environment, travel times, and safety against each other and against the costs.

QALYs can also be used in cost–benefit analyses. The number of QALYs saved by a (road safety) measure then needs to be converted into a monetary valuation. This can be done by determining the willingness to pay for a QALY lost or gained. A 'stated preference' or 'revealed preference' method can be used for this. Using QALYs in a CBA has the advantage that both fatalities and injuries can be valued using the same willingness to pay estimate. In valuing fatalities, this raises the question whether there is a difference between valuing human lives and valuing life years saved. Theoretically, there should be no difference between the Value of a Statistical Life at a certain age and the (discounted) value of the remaining (statistical) life years (VoSLY) at that age. This would for example mean that, if the VoSL increases with age, the value of a life year should also increase with age.[3] Hammit (2007) addresses this issue and concludes that empirical studies into the relation between both VoSL and VoSLY and age yield conflicting results. He concludes that additional studies are required to enable drawing conclusions.

3. Valuation methods and their applicability to road safety

Various methods have been developed to measure 'willingness to pay'. The two most important groups of methods are revealed preference (RP) and stated preference (SP) methods. RP methods value risk reductions based on actual behaviour, for example on how much money people actually spend on safety provisions, while SP methods use questionnaires in which people, directly or indirectly, are asked about how much they are willing to pay for safety provisions. Theoretically, RP methods are better than SP methods because RP methods are based on the actual spending of incomes, and SP methods on what people say they will do. A major problem of SP methods is of course that their real behaviour may be different. However, applicability of RP methods to road safety is limited. For example, the purchase of an airbag is usually not a separate choice, because it is part of a set of accessories. Moreover, the purchase and use of many safety devices, such as seatbelts, are obligatory. Another limitation is that RP methods assume that people are capable of correctly assessing the risks that they take and the risk reduction of purchasing a particular device. However, the risks and the changes in risk of fatal crashes are very small. It is well known that people are hardly capable of assessing them correctly. SP research provides people with information about limited risks and risk changes in such a way that they are better capable of assessing them adequately. This is not possible with RP methods, which limits its applicability. The scope of SP methods is also broader because they do not depend on the availability of data about peoples' actual choice behaviour. SP methods have been used for the valuation of safety, but also for valuation of travel time, natural resources and pollution.

In a meta-analysis de Blaeij, Florax, Rietveld, and Verhoef (2003) show that, after correction for other study characteristics, SP estimates of the VoSL generally are somewhat higher that the RP estimates, but that their dispersion is large in both categories. However, the literature does not agree on this. Kochi, Hubbell, and Kramer (2001), for example, have, in the context of work accidents, compared studies of the VoSL which had been done based on 'contingent valuation' (SP) with those based on 'hedonic wage

[3] There is evidence that the VoSL increases at younger ages and decreases at older ages, resulting in an 'inverted U' curve (Hammit, 2007).