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On the joint valuation of averting fatal and severe injuries in highway accidents

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Abstract

Introduction: To evaluate the benefits of road transport safety projects, planners need the monetary value of averting fatal and severe injuries. Usually, contingent valuation and risk-risk studies have been used. The contexts posed by both survey techniques do not represent the choice situation a driver faces when having to choose among alternative routes with different levels of safety. *Method:* We set up a stated choice web page survey in which individuals had to choose between two routes for a hypothetical trip between two cities; thus implicitly revealing their preferences for safety both in terms of reducing the number of fatal victims and of severely injured victims. *Results:* For Chilean routes we were able to estimate approximate values of US$300,000 and US$140,000 for a reduction in one fatality and one severely injured victim, respectively. *Impacts:* Our evidence could be valuable for road planners in other developing nations.

Keywords: Road safety; Value of risk reductions; Stated choice surveys; Web survey

1. Introduction

From a subjective point of view, the two most feared outcomes of a road crash are to die or to become a severely injured victim. Not surprisingly, current road project appraisal practice in most industrialized countries gives those two outcomes the highest economic values; fatalities being more valued than severe injuries. Advanced micro-economic practice attempts to value individual preferences for better safety by finding the willingness to pay (WTP) for an averted death and/or an averted severely injured victim; in some cases the value of preventing a slightly injured victim has also been sought.

Conventional practice to elicit WTP values for preventing both fatalities and severe injuries comprises the use of contingent valuation (CV) and risk-risk trade-offs methods[1] (Jones-Lee, Loomes, & Philips, 1995; Jones-Lee, O'Reilly, & Philips, 1993). CV basically involves a trade-off between money and risk expressed as a tiny probability. Usually a question is posed to a respondent asking for his/her willingness to pay to buy some special safety devise designed to reduce *only* the likelihood of a particular outcome of a road crash (e.g., the likelihood of becoming a fatal victim or the likelihood of suffering, for example, a head concussion). This safety device is not useful for reducing the likelihood of two or more, but only one out of a group of mutually exclusive trauma outcomes.

The risk-risk trade-off, on the other hand, demands the respondent to exchange the risk of one likely trauma outcome of a road crash for another one. Usually the respondent has to assume he/she is already a road accident victim suffering a particular trauma; then he/she is offered the alternative of a medical intervention that, with probability p, will return him/her to the health state before the crash and, with probability 1-p, he/she will end up in a health state worse than the current hypothetical one—this state is usually death. The respondent has to state the value of p that will make him/her undertake medical intervention. Hence, it is possible to "chain" different risks with the risk

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[1] Risk-risk trade-offs are also called Standard Gamble or Chain Approach.

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considered in the CV survey, allowing the researcher to monetize risks other than that considered in the CV exercise.[2] The reader may ask why not use the CV to put a monetary value on all types of risk. The reason for not doing so is that money-risk trade-offs are deemed unstable, so researchers would rather avoid the overuse of CV. Sometimes the fatality risk is monetized in the CV survey (Jones-Lee et al., 1993) and sometimes a non-fatal risk is directly monetized (Carthy et al., 1998). In the last case, the risk-risk trade-off is used to indirectly put a monetary value to the reduction of the fatality risk. The decision of which risk should be monetized in the CV experiment is up to the researcher's preferences.

The authors believe that although the above methods may work as a first empirical approximation, they do not address the issue under analysis in its proper dimension. First, the road safety schemes an authority wants to evaluate are of a public-good nature. It is about reducing a public risk; that is, a risk that displays no-rivalry in consumption since the benefits of the scheme accrue to all drivers on that particular stretch of road. The safety device considered in the contingent valuation approach is a private good, not a public one.[3] Second and more important, a road safety scheme is about decisions on *ex ante* risk management, in the sense of what can be done to prevent road crashes or to mitigate the impact of a road crash. However, the risk-risk trade-off is akin to a post-trauma alternative medical treatment, associated with decisions to be taken after the accident has occurred.[4] This information should be more relevant for health insurance companies than for public road agencies.

If WTP values are required for appraising road safety projects we believe stated choice methods are a superior elicitation approach (de Blaeij, 2002; Hjalte, Norinder, & Trawen, 2000; Iragüen & Ortúzar, 2004; Rizzi & Ortúzar, 2003). This technique places the respondent in the correct context, for example, having to choose between two routes with different levels-of-service (i.e., travel time, toll, number of fatalities, and number of severely injured victims). This way, people implicitly reveal WTP not only for safety improvements, but also for travel time savings, probably the most important trip attribute. We believe the quota of increased realism afforded by the approach is necessary to uncover the value people actually place on safer roads. Our approach also avoids the problem of *embedding* (Sælensminde, 2003), since both the reduction of fatalities and severely injured victims are valued, together with travel time, in an integrated framework where the individual is always conscious of his/her budget constraint.

As a caveat, stated choice is not without problems. As with CV, the hypothetical nature of the choice scenarios is the main disadvantage of stated preference surveys. The article will not discuss the reasons giving rise to these shortcomings, since they are extensively discussed in the literature (Freeman, 1993; Louviere, Hensher, & Swait, 2000). However, the authors strongly believe that stated choice surveys outdo conventional CV surveys with respect to increasing realism.

This paper represents a further development of the stated choice approach for safety valuation as an alternative to CV and risk-risk approach. It also produces the first Chilean evidence on the value of preventing severely injured road victims and adds new evidence on the value of preventing road fatalities, considering both problems in an integrated fashion. The rest of the paper is organized as follows. The next section briefly presents the theory of safety valuation. This is followed by a section that describes the experimental design, a section that provides a summary of basic statistics, a section that explains the modeling activities undertaken and also includes a comparison of our results with those of related studies. Finally, the remainder of the paper summarizes the conclusions.

2. The value of road safety

The community demand for a public good is given by the summation of the WTP for it by each individual (WTP_j). In this study, the public good is the avoidance of a fatality;[5] this value is also known as the *value of risk reductions* (*VRR*). It can be shown (Jones-Lee, 1994; Rizzi & Ortúzar, in press) that this value is equivalent to:

$$VRR = \sum_{j=1}^{N} WTP_j = \frac{1}{N}\sum_{j=1}^{N} MRS_j + N\ \mathrm{cov}(MRS, |\delta r|) \tag{1}$$

where cov(•,•) stands for the covariance[6] between *MRS* and reduced risk, δr; MRS_j is the marginal rate of substitution between income and risk; WTP_j is the marginal rate of substitution between income and number of fatalities, so $\mathrm{WTP_j}/\delta r_j = MRS_j$.

In empirical work it is assumed that there is no correlation between WTP and δr, so Eq. (1) simplifies to Eq. (2):

$$VRR = \frac{1}{N}\sum_{j=1}^{N} MRS_j, \tag{2}$$

[2] Basically, this is done as follows. First, calculate a money-risk of mortality (r_m) trade-off, $\Delta\$/\Delta r_m = I$; second, estimate a risk of mortality-risk of a given severe injury (r_{sv}) trade-off, $\Delta r_m/\Delta r_{sv} = II$; finally, multiply I * II to obtain $\Delta\$/\Delta r_{sv}$.

[3] Indeed, this could be corrected by substituting a public good for the private good, and this critique would loose substance.

[4] The importance of post-trauma medical attention, which constitutes a very important element of a road safety policy, should not be neglected since many lives are saved this way.

[5] The same procedure is used for defining the value of avoiding one severely injured victim.

[6] $$\mathrm{cov}(MRS_j, \delta r_j) = \sum_j \frac{MRS_j \delta r_j}{N} - \sum_j \frac{MRS_j}{N}\sum_j \frac{\delta r_j}{N}$$