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Estimating the willingness to pay and value of risk reduction for car occupants in the road environment

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ABSTRACT

In recent years there has been a re-focus on the valuation of a statistical life from the ex post or human capital method to an ex ante willingness to pay (WTP) approach. This is in part a recognition that we may have been undervaluing the cost of fatalities and injuries to society associated with crashes, but also a strong belief in the need to focus on establishing the amount, ex ante, that individuals are willing to pay to reduce the risk of exposure to circumstances that might lead to death or degree of injury on the road network. This study has developed a framework in which to identify the degree of preference heterogeneity in willingness to pay by individuals who are drivers or passengers in cars to avoid being killed or injured. A stated choice experiment approach is developed. The empirical setting is a choice of route for a particular trip that a sample of individuals periodically undertakes in Australia. The particular trip is described in enough detail to provide the respondent with a familiar market environment, providing all the relevant background information required for making a decision. Mixed logit models are estimated to obtain the marginal (dis)utilities associated with each influence on the choice amongst the attribute packages offered in the stated choice scenarios. These estimates are used to obtain the WTP distributions for fatality and injury avoidance, which are then aggregated to obtain estimates of the value of risk reduction (VRR), of which the fatality class is also known as the value of a statistical life (VSL).

1. Introduction

An important conceptual advance in the state of practice of road safety valuation was achieved in the 1980s by valuing road safety according to subjective preferences rather than by using the heavily criticised *human capital* (*HC*) approach (see Jones-Lee and Loomes, 2003 for a review). The *HC* approach rests on accounting principles: the benefit of avoiding a premature death is given by the present value of the income flow the economy could lose in that case (Ashenfelter, 2006). More appropriately, the *value of risk reductions* (VRR) – initially known as the *value of a statistical life* (VSL) where the focus has historically been predominantly on fatalities[1] – is based on subjective preferences, and defined as the amount of money that individuals are willing to pay for reducing the risk of their premature death or of injury, while performing a certain risky activity. The focus on the VRR in contrast to the *HC* value has empirically yielded higher benefits for risk avoidance, and hence the social net benefit of safety policy measures has increased in countries such as the UK, USA, Sweden and New Zealand, where the ex ante WTP approach has been progressively implemented as the only approach that can elicit individuals' preferences

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[1] Given the continued common use of the phrase VSL, we will also use it herein to be equivalent to VRR.

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(predominantly through the application of contingent valuation methods – see de Blaeij et al. (2003)), prompting many road safety interventions, otherwise not socially profitable, in the developed world. In the Australian context, this *HC* approach remains in place, with substantially lower estimates of VRR than other western economies.

The VRR *(or the specialised* VSL*)* for road contexts was estimated originally using contingent valuation (CV), standard gamble or the chain method (Viscusi et al., 1991; Jones Lee et al., 1993; Beattie et al., 1998; Carthy et al., 1998), but the approach, in general, was criticised by specialists in human behaviour (Fischhoff, 1991, 1997) and economics (Hausman, 1993; Diamond and Hausman, 1994). In those original studies people were confronted with situations expressing risk as very small probabilities, and needing a trade-off between risk and money to arrive at a monetary value.[2] This kind of simulated context may not bear upon actual choices of trip route selection where individuals have to consider a bundle of attributes describing each alternative (i.e., travel time, toll, and safety associated with each route alternative).

Ortúzar and Rizzi (2000), Ortúzar and Rizzi (2001) and Rizzi and Ortúzar (2003) were the first proponents of a different approach based on the Stated Choice (SC) technique'; this was later followed by de Blaeij et al. (2002) in the context of a Dutch study interested in testing the new approach. In a SC survey, individuals are asked to choose among different alternatives, the attribute levels of which vary according to a statistical design aimed at maximising the precision of the estimates. As such, SC allows the analyst to mimic actual choices with a high degree of realism, and for this reason most experts believe that it is an appropriate elicitation method for the valuation of intangibles (McFadden, 1998; Louviere et al., 2000). The approach has also been applied by de Blaeij et al. (2002), Iragüen and Ortúzar (2004) and Hojman et al. (2005) and is the starting position for the current study.

This paper develops an ex ante willingness to pay (WTP) model as input into the calculation of the value of a statistical life in the context of a fatality and three classes of injury (defined below) in the road environment for occupants of cars. New surveys have been undertaken in late 2007 in New South Wales to obtain WTP distributions, which are then combined with secondary data on the recent history of fatalities and injuries as well as exposure (measured in kilometres), to obtain estimates of VRR.

2. The value of fatal and injury risk reductions

Assume a route is used by N users. If person n travels more than once in a reference period, say m_n times, this gives rise to m_n pseudo-members with a total population of $N = \sum_{n=1}^{N} m_n$, observations, i.e., the individuals of a population. This population exactly amounts to the flow on a route in a given period (say a year).[3] We define a route as a path connecting one origin–destination pair. A trip on a route provides a level of dissatisfaction given by a deterministic indirect utility function $V = V(r, c, t)$, where r stands for risk of a fatal accident or class of injury, c for the cost of travel and t for the travel time on a route; there could be more attributes, of course. The injury classes studied are:

- *Severe permanent injury* (or serious) (*SI*), defined as an injury that requires hospitalisation for a long period and results in some permanent disability.
- *Injuries requiring hospitalisation* (*HI*), defined as an injury that requires hospitalisation but there is a full recovery.
- *Minor injury* (*MI*), defined as an injury that requires some medical treatment but no hospitalisation.

Jones-Lee (1994), focussing only on fatality, formally defined the VRR as the value of avoiding one expected death, and this corresponds to the population (or sample) average of the marginal rate of substitution between income and risk of death for person n (MRS_n) plus a covariance term that accounts for possible correlation between WTP and reduced risk (δr_n).[4]

$$MRS_n = \frac{\partial V_n/\partial r}{\partial V_n/\partial c | V = \overline{V}}, \tag{1}$$

$$\text{VRR} = \frac{1}{N}\sum_{n=1}^{N} MRS_n + N\text{cov}(MRS_n, |\delta r_n|). \tag{2}$$

In empirical work, it is typically assumed that there is no correlation between WTP and δr in the population. Then, Eq. (2) simplifies to Eq. (3), below, and to estimate the VRR it is sufficient to have a good estimate of the *MRS*. This assumption would be correct, for example, if δr were the same for every individual.

$$\text{VRR} = \frac{1}{N}\sum_{n=1}^{N} MRS_n. \tag{3}$$

The *MRS* can be interpreted as an implicit value for the own life, and averaging it over all individuals travelling on the route yields the VRR. The *MRS* clearly depends on personal risk perceptions according to the functional form of V_n. The same anal-

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[2] Some of these studies posed a risk – risk trade-off. However, in order to arrive to a monetary value a risk – money trade off is necessary, sooner or later.

[3] Bear in mind though that a population is a stock variable whereas a flow is not.

[4] $\text{cov}(MRS_n, \delta r_n) = \sum_n MRS_n \delta r_n - \frac{1}{N}\sum_n MRS_n \frac{1}{N}\sum_n \delta r_n$.