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Consistency in preferences for road safety: An analysis of precautionary and stated behavior

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ABSTRACT

This study analyzes stated willingness to pay (WTP) for traffic safety, the use of traffic safety equipments, and the consistency between the two. Using data from a Swedish contingent valuation study we find that the estimated value of a statistical life (VSL) based on the respondents' rear-seatbelt usage is similar to the estimate found using the respondents' stated WTP. However, when estimating VSL based on the respondents' use of bicycle helmets we find a significantly higher VSL; the VSL from bicycle-helmet usage is 7 times higher than the estimate based on seatbelt usage. Moreover, we do not find any strong relationship between risk perception and usage, or individual stated WTP and usage. Hence, the main conclusion, based on our analysis, is that stated and observed WTP are not consistent.

1. Introduction

Individuals face many risks to their health in their daily lives. Some are voluntary like engaging in risky sport activities, for instance skiing, but most are involuntary since they are part of activities undertaken to live a normal life; the food choices that we make can have short and/or long term effects on our health level, and traveling choices on how to get to and from our workplace, school, families and friends, etc, will affect our accident risk. In this paper we are interested in the latter, i.e. traffic accident risk. More specifically, we are interested in individuals' behavior and preferences for road safety.

To influence their health and accident risks individuals can, in principle, choose two approaches; choosing safer activities or by taking precautionary behavior. This is true in general and also for accident risk in the traffic environment. For instance, by choosing what mode to use to travel from A to B, e.g. train, car, or by bike, and under what conditions, e.g. time of day, and weather, the traveler can influence the risk level he will be exposed to. Moreover, individuals can also choose to take precautionary behavior by investing in safety, like choosing a safer car model, or deciding to use safety equipment. In this study we are interested in the latter. We will in our analysis examine individuals' rear-seatbelt and bicycle-helmet usage. We will not, however, only examine usage but also use the information from observing this behavior to derive monetary values for safety, and moreover, examine how observed relate to stated preferences.

However, due to market failures, such as externalities and that individuals may not be well-informed about the risk levels they face, public safety interventions are necessary. Benefit-cost analysis has proven to be a powerful tool to guide policy makers in their resource allocations. It requires, though, that benefits and costs are available in a common metric, which is usually money. Since no market prices exist for "traffic safety" analysts have to rely on non-market evaluation techniques to obtain monetary values. These can broadly speaking be classified as being either revealed- (RP) or stated-preferences (SP) methods. The former refers to methods where actual market behavior is used to reveal individual preferences. Our example above with the choice of a safer car is an example of the RP approach where the price premium of the safer car reflects the car owner's willingness to pay (WTP), i.e. preferences, for safety (Andersson, 2005; Atkinson & Halvorsen, 1990). The second approach, i.e. SP, is instead, as the expression suggests, based on the individuals' stated decisions. In this approach a hypothetical market is created in which respondents are asked how they would choose in a given situation, or their willingness to pay (WTP) for a given risk reduction (or alternatively their willingness to accept (WTA) as compensation to forgo the risk reduction). Both approaches have their strengths and weaknesses; the RP approach is based on actual behavior but market data may not be available or information on

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individuals' choice alternatives may not be available to the analyst, whereas the SP approach offers flexibility and full information on the choice alternatives, but is based on hypothetical decisions.

The aim of this study is to examine the consistency of the implied value of safety from observed behavior with the same individuals' stated WTP in an SP study. This question was analyzed in Hakes and Viscusi (2007) and Svensson (2009) and this study replicates their approach. Whereas Hakes and Viscusi found evidence of a consistent behavior Svensson found no such evidence. Hence, as a result of this conflicting evidence it is of interest to examine this question again using a different population. Moreover, whereas Hakes and Viscusi only examined seatbelt usage we also examine bicycle-helmet usage, and compared with Svensson, who examined several safety equipments using Swedish data, we also have information on the individuals' risk-perception. In line with Svensson we estimate two VSLs based on actual behavior, but whereas Svensson estimated for front-seatbelt usage we estimate for rear-seatbelt usage. We use data from a Swedish contingent valuation (CVM) study and in addition to estimate VSL the objectives are to examine: (i) self-protective behavior and individual characteristics, and (ii) the consistency between implied and stated VSL.

The following section first describes the theoretical model of the VSL and then the empirical findings in the literature. We thereafter present the survey used to obtain our data. In the result section we explore relationships between usage and stated WTP by first focusing on the results from the SP questions and then on the values from the actual behavior. Finally we discuss our findings and draw some conclusions.

2. The value of a statistical life

2.1. Theoretical model

The expression of the value of a statistical life (VSL) refers to the population mean of the marginal rate of substitution between mortality risk and wealth.[1] The theoretical expression is derived in a state-dependent expected utility framework where the individual is expected to maximize his utility (Jones-Lee, 1974; Rosen, 1988). Let p denote the baseline mortality risk and $u_s(w)$, $s \in \{a,d\}$, the state dependent utility of wealth (w) where the states are either alive (a) or dead (d). The individual is then assumed to maximize the following expression,

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

We assume that the utility functions are twice differentiable and we adopt the standard assumptions that the utility of wealth is larger if alive than dead, the marginal utility of wealth is also larger if alive than dead and nonnegative, and that individuals are weakly risk averse to financial risks, i.e.

$$u_a > u_d, u'_a > u'_d \geq 0, \text{ and } u''_s \leq 0. \tag{2}$$

The expression for the VSL is obtained by totally differentiating Eq. (1) and keeping utility constant,

$$\mathrm{VSL} = \left.\frac{\mathrm{d}w}{\mathrm{d}p}\right|_{\text{EU constant}} = \frac{u_a(w) - u_d(w)}{pu'_d(w) + (1-p)u'_a(w)}, \tag{3}$$

which is the standard expression for the MRS(w, p). It is straightforward to show that under the properties of (2), VSL is positive and increasing with w and p (Jones-Lee, 1974; Pratt & Zeckhauser, 1996; Weinstein, Shepard, & Pliskin, 1980).[2]

Eq. (3) is the VSL for "true" marginal changes in WTP (or WTA) and mortality risk. In this study, as in many studies using the SP approach, we deal with discrete changes, though. That is, in the SP survey used to obtain stated WTP respondents are asked about a finite change in the probability of death and the RP data used refer to situations where they take the decision to either use the safety device or not. Let Δw and Δp denote finite changes in wealth and risk and Eq. (3) is given by,

$$\mathrm{VSL} = \frac{\Delta w}{\Delta p}. \tag{4}$$

The expression in Eq. (4) is an approximation of the true marginal WTP and reveals that Δw should be near-proportional to Δp, a necessary (but not sufficient) condition for WTP from CVM-studies to be valid estimates of individuals' preferences (Hammitt, 2000). We use this theoretical prediction in our validity test of the respondents' stated WTP in our empirical analysis. We run two tests on scale sensitivity (Corso, Hammitt, & Graham, 2001): (i) a weak test where we examine whether WTP is increasing, and (ii) a strong test where we examine whether WTP is proportional to the size of the risk reduction.

When analyzing observed behavior we are studying discrete choices where an individual will use a safety device only if the benefits of using it are larger than the costs. Hence, by rearranging Eq. (4) it can be shown that,

$$\Delta w < \mathrm{VSL} \times \Delta p, \tag{5}$$

i.e. estimates from data on self-protection and averting behavior will provide a lower-bound estimate of the WTP of those using the safety device. Note, however, that it will provide an upper-bound for the non-users (consumers) of the device. Thus, it is unclear what is the average VSL when self-protection and averting behavior are discrete.

2.2. Empirical evidence from observed and stated choices

Today the WTP approach is well established but before it became widely accepted among economists as the appropriate evaluation method another approach dominated. That approach is usually referred to as the human capital approach in which the "value of life" is the value of the individual's market productivity, a value assumed to be reflected by the individual's earnings (Mishan, 1982). The value of human capital is calculated as the individual's present value of future expected earnings and it has two major drawbacks: (i) it assigns a zero value to non-market production implying that, e.g. unemployed and retired persons have a value equal to zero, and (ii) it does not reflect individual preferences for safety. Attempts to also incorporate non-market earnings have been made (Keeler, 2001; Max, Sung, Rice, & Michel, 2004), but it does not solve the main objection against the approach, i.e. the estimates do not reflect preferences, and it has therefore today been almost completely abandoned and replaced by the WTP approach.

Since the seminal papers on the WTP approach in the 1960s and early 1970s (Drèze, 1962; Jones-Lee, 1974; Mishan, 1971; Schelling, 1968) there has been a huge amount of work on the evaluation of health risks, both theoretical and empirical. In this brief review we are interested in the latter and two areas in which there is a vast

[1] This is true under the standard assumption in the literature that the marginal rate of substitution between mortality risk and wealth and the personal change in risk is uncorrelated. For a discussion see, e.g. Jones-Lee (2003).

[2] The assumption of weak risk aversion, i.e. $u''_s \leq 0$, is sufficient but not necessary for VSL to be increasing with w.