Transportation Research Part F 31 (2015) 112–123

Contents lists available at ScienceDirect

Transportation Research Part F

journal homepage: www.elsevier.com/locate/trf

# Asymmetric preferences for road safety: Evidence from a stated choice experiment among car drivers

Stefan Flügel [a,b,*], Rune Elvik [a], Knut Veisten [a], Luis I. Rizzi [c], Sunniva Frislid Meyer [a], Farideh Ramjerdi [a], Juan de Dios Ortúzar [c]

[a] Institute of Transport Economics (TOI), Gaustadalleen 21, NO-0349 Oslo, Norway
[b] School of Economics and Business, Norwegian University of Life Sciences (NMBU), P.O. Box 5003, NO-1432 Ås, Norway
[c] Department of Transport Engineering and Logistics, Pontificia Universidad Católica de Chile, Casilla 306, Cod. 105, Correo 22, Santiago, Chile

ARTICLE INFO

*Article history:*
Received 16 February 2014
Received in revised form 27 February 2015
Accepted 3 April 2015
Available online 29 April 2015

*Keywords:*
Road safety
Prospect theory
Stated preference
Asymmetric preferences

ABSTRACT

Recent research has proposed fitting responses from discrete choice experiments to asymmetric value functions consistent with prospect theory, taking into account respondents' reference points in their valuation of choice attributes. Previous studies have mainly concentrated on travel time and cost attributes, while evidence regarding road safety attributes is very limited.

This paper investigates the implicit utility of a road safety attribute, defined as the number of casualties per year in alternative car trip choices, when safety improves or deteriorates. Using appropriate statistical tests we are able to reject symmetric preferences for losses and gains in the level of safety and estimate a sigmoid value function that exhibits loss aversion and diminishing sensitivity. This adds an interesting psychological dimension to the preference of road safety. Possible implications of this finding for policy making are discussed.



## 1. Introduction

The economic valuation of changes in road safety, or fatality and injury risk in road transport, constitutes a key input to policymaking on how much to spend on road safety. The monetary valuation of road safety is often referred to as the value of preventing a statistical fatality or the value of a statistical life (VSL). VSL is the population mean of the marginal rate of substitution (MRS) between wealth and mortality risk; that is, the monetary value of a "small" mortality risk change that aggregated over the population would amount to the prevention (or the increase) of one statistical death (Schelling, 1968; Mishan, 1971). Similarly, values of preventing injuries of different severity, can also be established (Jones-Lee, 1974; Jones-Lee, Loomes, & Philips, 1995; Hojman, Ortúzar, & Rizzi, 2005).

An extensive literature exists regarding the economic valuation of preventing fatalities and injuries (Viscusi & Aldy, 2003, Rizzi & Ortúzar, 2006; Lindhjem, Navrud, Braathen, & Biausque, 2011). Most studies have applied stated preference (SP) methods (Carson & Louviere, 2011) that have their theoretical underpinning in standard neo-classical economic theory. However, recent research has proposed fitting responses from discrete stated choice (SC) experiments to a value function proposed by prospect theory (Kahneman & Tversky, 1979; Thaler, 1980, see also Malul, Rosenboim, & Shavit, 2013), taking

* Corresponding author at: Institute of Transport Economics (TOI), Gaustadalleen 21, NO-0349 Oslo, Norway. Tel.: +47 415 20 576.
*E-mail addresses:* sfl@toi.no (S. Flügel), re@toi.no (R. Elvik), kve@toi.no (K. Veisten), lir@ing.puc.cl (L.I. Rizzi), sfm@toi.no (S.F. Meyer), fra@toi.no (F. Ramjerdi), jos@ing.puc.cl (J.D. Ortúzar).

http://dx.doi.org/10.1016/j.trf.2015.04.001
1369-8478/

into account respondents' reference points in their valuation of choice attributes and allowing for asymmetric preferences. De Borger and Fosgerau (2008) applied SC data but only with trade-offs between travel time and money and tested for reference-dependent preferences. They found that "loss aversion plays an important role in explaining responses; moreover, participants were found to be more loss averse in the time dimension than in the cost dimension"; they also found "evidence of asymmetrically diminishing sensitivity" (p 101). Hjorth and Fosgerau (2012) present a similar SC study, also finding that the value function was consistent with prospect theory, exhibiting loss aversion for both travel time and cost. Ramjerdi, Flügel, Samstad, and Killi (2010) found the same evidence in the Norwegian Value of Time Study. Masiero and Hensher (2010, chap. 2) found that their Swiss SC data on freight transport were much better explained when allowing for asymmetric preferences, a steeper utility function for losses than for gains; and found that loss aversion was significant for all three attributes (punctuality, time and cost). Many of these empirical studies seem to give support for an asymmetric value function (and loss aversion) as proposed by prospect theory regarding travel time and travel cost. Evidence regarding road safety attributes is very limited.

To our knowledge, only Rizzi and Ortúzar (2003) presented a test for reference dependency and loss aversion involving road safety. They found only weak indication of differences between valuations of safety gains and safety losses. De Blaeij and van Vuuren (2003) presented a prospect theory approach to road safety valuation, analysing the form of the utility function for safety losses based on a very small pilot sample, but did not assess loss aversion.

This paper contributes to the limited literature on reference dependency and loss aversion in discrete choice experiments involving road safety (or casualty risk) by utilizing a large dataset (Veisten, Flügel, Rizzi, Ortúzar, & Elvik, 2013). The dataset is also rich in the sense that the reference levels are person specific, pivoted to an actual trip described by the respondent (while Rizzi & Ortúzar, 2003 used a common "pseudo-reference point", ibid, p. 17).

The remainder of the paper is arranged as follows: The next section presents some relevant theory regarding value functions. The third section describes the survey, the design of the choice experiments (CE), and the loss aversion hypothesis applicable to our data. The fourth section provides the results of our analysis. These results are discussed and conclusions drawn in the last section.

## 2. Theoretical background

Kahneman and Tversky (1979) proposed an alternative value function to the one assumed in expected utility theory, the prospect theory-based value function which models the changes in utility level (i.e. marginal utility) associated with equal-sized losses and gains as asymmetric. More precisely, their value function was (1) defined in terms of changes from a reference point, (2) it was concave for gains and convex for losses (decreasing marginal values for gains and for losses), and (3) it was steeper for losses than for gains (loss aversion). Fig. 1 displays this *S* shaped asymmetric value function.

The functional form of such a value function can be rather simple. Departing from a linear and symmetric value function, $V = \beta_0 + \beta * X$, a modification to: $V = \beta_0 + \beta_{loss} * Loss^{\lambda} + \beta_{gain} * Gain^{\lambda}$, allows for more flexibility and would be consistent with prospect theory if:

(1) $Loss = \begin{cases} X_{ref} - X & if\ X_{ref} > X \\ 0 & else \end{cases}, Gain = \begin{cases} X_{ref} - X & if\ X_{ref} < X \\ 0 & else \end{cases}$
(2) $\lambda < 1$ and
(3) $|\beta_{loss}| > |\beta_{gain}|$.

These three conditions correspond to the three characteristics described above (reference point ($X_{ref}$) dependent utility, diminishing sensitivity and loss aversion). Hence, prospect theory implies that answers to valuation questions in SP surveys will depend on the reference point, which, in the case of safety would be the current level of safety. When asked about the compensation needed to offset a reduction in safety, the valuation function would be in the domain of losses and display loss aversion, which is akin to the so called *endowment effect* (Thaler, 1980; Bateman, Munro, Rhodes, Starmer, & Sugden, 1997). Prospect theory, proposing asymptotic preferences for road safety, adds an interesting psychological dimension to modelling human travel behaviour, compared to traditional neo-classical economic assumptions of preferences that are the same, in absolute terms, for gains and losses. Prospect theory expands neo-classical theory by arguing for different preferences and mind-sets depending on the endowment, that is, the current level of road safety that the individual holds when facing a safety change.

In psychology and marketing literature loss aversion is explained by at least four components (Paraschiv & L'Haridon, 2008): (1) the neural component, that losses and gains are processed in different primary areas of the brain; (2) the affective component, that persons are (emotionally) attached to what they possess; (3) the cognitive component, acknowledging that the cognitive progress prior to transactions differs between cession/selling and receiving/buying; and (4) the conative component, explaining loss aversion by negative feelings connected to giving up a possession (independent of the degree of emotional attachment). The literature underlines that the conative ("possession") component does not have to be strictly related to "real endowment" but can also apply to "mental endowment" (Ariely & Simonson, 2003). This latter aspect is important in our context as road users do not literally own/possess the existing level of road safety (see also the discussion in Section 5).