Research in Transportation Economics 43 (2013) 62–70

Contents lists available at SciVerse ScienceDirect

Research in Transportation Economics

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

Paradoxes of rationality in road safety policy

Rune Elvik

Institute of Transport Economics, Gaustadalléen 21, NO-0349, Oslo, Norway

ARTICLE INFO

Article history:
Available online 10 January 2013

JEL Codes:
D61
D71
R41

Keywords:
Cost–benefit analysis
Road safety policy
Rationality
Paradox
Valuation

ABSTRACT

Rationality is an ideal for transport safety policy. As developed within normative welfare economics, rationality denotes the efficient use of safety measures based on cost–benefit analyses that include all relevant impacts of the measures. Efficiency in the technical sense of the term provides a perfectly clear and precise guideline for policy priorities. Nevertheless, some choices that are guided by cost–benefit analysis may strike us as paradoxical or counterintuitive. A paradox of rationality refers to any situation in which conflicting choices can both be defended as rational. This paper discusses a number of choices that may seem paradoxical. The first involves the choice between options that have identical impacts on safety, but in which these impacts are valued differently. The second deals with the tendency for preference reversals to occur when preferences for the provision of safety are aggregated. The third discusses the inability of conventional measures of willingness-to-pay to reflect the intensity of preferences. The fourth concerns the tendency for policy choice to favour the rich at the expense of the poor when willingness-to-pay is not adjusted for the marginal utility of money. A fifth situation refers to the fact that a policy option that looks attractive ex ante may fail an ex post compensation test because utility functions depend on health state. There is a potential conflict between individual and collective rationality with respect to the costs and benefits of some road safety measures. When developing a road safety programme, a set of road safety measures whose benefits exceed the costs when considered as stand-alone measures could have benefits smaller than cost when combined in a programme consisting of all the measures. Finally, there is a potential conflict between efficiency and negotiated consensus as mechanisms of resource allocation in the public sector. The sources of the paradoxes and ways of avoiding them are discussed. Some of the paradoxes can be avoided if changes in risk are valued in terms of a fixed price per unit of risk rather than according to a non-linear demand function.

1. Introduction

"One kind of optimism, or supposed optimism, argues that if we think hard enough, are rational enough, we can solve all our problems" (Simon, 1983; page 3). Rationality is a widely supported ideal of public policy; yet the implementation of this ideal to road safety in terms of a policy based on cost–benefit analysis remains controversial (Ackerman & Heinzerling, 2004; Hauer, 1994, 2011). There is evidence that actual policy priorities for safety are not always perfectly rational. Tengs et al. (1995) examined more than five hundred life-saving interventions and found that the cost per life-year saved varied enormously between these interventions. A subsequent analysis (Tengs & Graham, 1996) found that efficient priorities, i.e. marginally spending the same amount per life-year saved in all interventions, had the potential of saving about 60,000 lives per year in the United States. Despite this, it is not obvious that efficient priority setting in safety policy can be easily implemented. To use cost–benefit analysis as a means of setting efficient priorities, one needs a monetary valuation of life-saving. The values currently found in the literature vary enormously (Hauer, 2011; Lindhjem, Navrud, Braathen, & Biausque, 2011) and do not seem to reflect well-ordered preferences (Loomes, 2006; Sugden, 2005).

There is a large literature (for an overview, see e.g. Slovic, 2000) showing that risks and changes in them are not always correctly perceived; risks that are wrongly perceived as large may get disproportionate attention in public policy and more may be spent on controlling them than on controlling larger risks that are perceived as minor. Moreover, the possibility that people do not value all lives equally cannot be ruled out (Johansson-Stenman & Martinsson, 2008). Hence what looks like inefficient or even haphazard policy priorities could in principle reflect a complex preference structure that does not assign the same value to the reduction of all types of risk or to the saving of all lives.

E-mail address: re@toi.no.

0739-8859/$ – see front matter
http://dx.doi.org/10.1016/j.retrec.2012.12.008

One can even imagine that the huge differences between safety programmes with respect to the implied value of saving a life are entirely consistent with a well-behaved demand function. When the valuation of life implied by regulatory decisions is reviewed, it is typically found that the implicit value of life is high when the risk regulated is low. Conversely, the implicit value of life tends to be low when the risk is high (Viscusi, 1996). As will be shown later in this paper, such a pattern could be consistent with individual demand for safety. The objective of this paper is to examine some implications of basing priorities for safety strictly on individual demand for it. It is not suggested that current safety policy is actually based on individual demand as interpreted in this paper, nor is it suggested that official guidelines for cost–benefit analysis call for providing safety strictly according to the demand for it (see, for example, HM Treasury, 2005).

The next section develops a framework for analysis. Based on that framework, the subsequent sections of the paper present a number of hypothetical policy choices in which arguments can be given against basing the choice on cost–benefit analysis. These hypothetical choices are not intended as examples of real policy choices, but have been framed to highlight situations that may be felt as dilemmas. Some of the choices that are discussed can be interpreted as paradoxes of rationality, i.e. situations in which conflicting choices can both be defended as rational.

2. Framework for analysis

Analysis relies on the assumption that individual preferences for the provision of safety can be represented by means of a demand function based on the size of the risk reduction. It has furthermore been assumed that utility increases as a function of income, but the marginal utility of income declines monotonically (i.e. throughout the entire range of income). Finally, it has been assumed that individual utility functions depend both on income and on health state. Health state (at a given level of income) can be represented as a continuous quality-of-life variable that takes on the value of 1 in perfect health and 0 in death. Health state refers not just to the presence or absence of disease, but to what extent an individual experiences life in general as good and joyful.

2.1. Willingness to pay for improved road safety

The assumptions made regarding individual demand for improved safety are based on the results of a meta-analysis reported by Lindhjem et al. (2011). They found that the value of a risk reduction which corresponds to reducing the expected number of fatalities by one (the value of a statistical life, VSL) could be modelled in terms of the following function:

$$\text{Ln}(\text{VSL}) = 7.451 - 0.761 \cdot \ln(\text{change in risk})$$

For a change in risk of 1 in 1,000,000 (0.000001) this becomes:

$$\text{Ln}(\text{VSL}) = 7.451 - 0.761 \cdot \ln(0.000001)$$
$$= 7.451 - 0.761 \cdot (-13.8155) = 17.9646$$

By taking the exponential function of this, the estimated value of a statistical life becomes 63,376,490 US dollars (2005). Since VSL is obtained as the marginal rate of substitution between income and risk, mean willingness to pay for a risk reduction of 1 in 1,000,000 can be estimated as:

$$\text{WTP} = \text{VSL} \cdot \text{risk change} = 63,376,490 \cdot 0.000001 = 63.38$$

The demand function is:

$$\text{WTP} = 63.376 \cdot \text{X}^{0.239}$$

In this function, X denotes the size of the change in risk, which is usually stated per 100,000 or per 1,000,000. Marginal willingness-to-pay is the first derivative of the demand function, which is:

$$\text{Marginal WTP} = 15.147 \cdot \text{X}^{-0.761}$$

The resulting values for WTP and VSL are shown in Table 1.

It is seen that willingness to pay increases as the size of the risk reduction increases but not in proportion to the size of the risk reduction. Marginal willingness to pay shows the additional amount paid per additional unit of risk reduction. The value of a statistical life is obtained by dividing willingness to pay by the risk reduction, for example 109.88/0.00001 = 10,988,241. It can be seen that while willingness to pay increases as a function of the size of the risk reduction, the value of a statistical life declines as a function of the size of the risk reduction. The function assumed for willingness to pay implies the demand function shown in Fig. 1. The shape of the demand function which has been assumed resembles the typical shape of almost any demand function.

2.2. Utility as a function of income and health state

As far as the utility of income and health state is concerned, the utility functions proposed by Kornhauser (2001) will be used as the starting point for analysis. For perfect health, Kornhauser proposed the following utility function with respect to income:

$$\text{Utility} = 5 + 5 \cdot \ln(w + 1)$$

The letter w denotes income, and ln is the natural logarithm. For death, Kornhauser assumed the following utility function:

$$\text{Utility} = \ln(w + 1)$$

It was stated earlier that the utility of health (on the 0–1 quality of life scale) equals 0 when a person is dead. It is, however, still conceivable that a positive utility of income exists, as a result, for example of bequest motives.

Utility in a state of reduced health can be represented by varying the constants, for example:

$$\text{Utility} = 3 + 4 \cdot \ln(w + 1)$$

This function yields a utility level of approximately 78% of the utility of income in perfect health.

The three utility functions listed above are illustrated in Fig. 2.

The functions may seem to be very flat. However, the utility function for perfect health closely resembles a function that can be fitted to US data describing the relationship between income and points scored for happiness (Frey & Stutzer, 2002) and may therefore be regarded as quite reasonable. The interpretation of

Table 1
Willingness-to-pay for reduced road accident fatality risk and implied value of a statistical life.

Risk reduction (per million)	Willingness to pay (US dollars 2005)	Marginal willingness to pay	Value of a statistical life (US dollars 2005)
1	63.38	15.15	63,376,490
5	93.11	4.45	18,621,386
10	109.88	2.63	10,988,241
15	121.06	1.93	8,070,914
20	129.68	1.55	6,484,020
50	161.43	0.77	3,228,583
100	190.51	0.46	1,905,146
200	224.84	0.27	1,124,202