

The application of contingent valuation surveys to obtain willingness to pay data in road safety research: methodological review and recommendations

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Abstract

Willingness to pay is increasingly utilized in cost-benefit analysis research in road safety. In other fields of research such as environmental and health policy evaluations, contingent valuation (CV) surveys have been developed and widely used as a method to elicit people's willingness to pay for the products being evaluated. Many authors have provided methodological critiques on CV surveys, which have been shown to be subject to various forms of biased responding such as hypothetical bias, starting-point bias, and strategic response bias. Various ways to control for these biased responses exist including the design of the survey and statistical analyses. Furthermore, different results have been found depending on the elicitation methods used (e.g. open-ended question versus referendum format; ex-ante valuation versus ex-post valuation), and the ways in which the context of the product provision is described and the product framed (e.g. private product versus public product) for the same product being valued. These methodological critiques are relevant to the use of CV method in road safety research that intends to elicit willingness to pay for road safety products. Furthermore, employing evidence-based survey designs and question forms are critical to obtain the best possible willingness to pay data in road safety research. The current paper presents the methodological limitations of CV surveys identified in previous research and offers best practice recommendations for CV survey designs in road safety based on the CV methodological literature.

Key words: willingness to pay; contingent valuation; survey design; bias

1. Introduction

The contingent valuation method is a survey-based approach for eliciting consumers' monetary valuations (willingness to pay) for a policy measure. Willingness to pay (WTP) is widely used in cost-benefit analyses in the fields of environmental economics, health economics and increasingly in transport economics. There are a number of potential advantages over other methods of economic evaluation. First, WTP is based on the utilitarian principle that underlies welfare economic theory in which benefits are deemed to be based on consumer preferences (Olsen and Smith 2001). Second, WTP approach imposes no restriction on the attributes people can place a value on, allowing a more comprehensive valuation of benefits than other approaches that strictly quantify the value of health

outcomes only (e.g. quality adjusted life years (QALYs), incremental cost-effectiveness ratios (ICERs)). Another advantage of WTP is its unit of measurement being the same as that of costs, enabling questions of allocative efficiency to be directly addressed (Olsen and Smith 2001). Recent literature on economic evaluation in road safety shows increasing interest in the use of WTP as a measure of road safety benefits (Andersson 2007, Andersson and Lindberg 2009, Hensher *et al.* 2009, Svensson and Johansson 2010).

A measure of WTP seeks individuals' valuation of an intervention in terms of the amount of money that individuals are willing to pay for it (Gafni 1990, Diener *et al.* 1998). It is implemented predominantly through contingent valuation (CV) surveys in which individuals of a representative sample of the population at risk are directly asked to value in monetary terms a hypothetical reduction in risks of their own and possibly other people's resulting from an intervention (de Blaeij *et al.* 2003, Svensson and Johansson 2010). While CV surveys have been widely implemented in the fields of environmental and health economics to value a wide range of matters such as forest preservation (Lockwood *et al.* 1993), medical, surgical, and pharmaceutical interventions for respiratory diseases and cardiovascular diseases (Diener *et al.* 1998), many authors have also provided methodological critiques on CV surveys applied in those fields. These methodological critiques are relevant to the use of the CV method in road safety research that intends to elicit WTP for road safety intervention products. Researchers attempting to obtain the best possible WTP data in road safety research must be cognisant of the previously identified CV methodological issues to ensure best practice applications of the CV surveys in road safety research.

The WTP values have practical use in terms of understanding the value the community places on road safety policy/interventions and thereby providing information on acceptability or the extent of the need to promote an effective intervention to the community. Strictly speaking CV surveys are typically employed to value products with no market transactions (e.g. clean air) and revealed preference method (where the value data is obtained from real/hypothetical market transactions) is preferred to value products for which market transactions are possible. However, the prices charged for road safety measures such as training, that are provided and potentially heavily subsidized by government, may not necessarily reflect their 'market value'. Consequently stated preference studies may be useful in deriving shadow prices for such goods.

The present paper aims to identify the key issues highlighted in the long-time environmental and health economics literature on the contingent valuation method and how they have been addressed, and to provide recommendations for the application of contingent valuation in road safety economic evaluations. While this paper offers recommendations for CV survey design in road safety research, discussion on the use of WTP values to calculate the value of statistical life (VOSL) is beyond the scope of this paper.

2. Addressing the methodological problems in the road safety CV applications

WTP values are explicitly intended to reflect preferences, perception and attitudes toward risk of those affected by the decisions to implement the policy measure, and hence it is natural that WTP for a product differ among different situations (de Blaeij *et al.* 2003). However, CV surveys must be designed

in a manner which allows the real respondent factors such as individual differences in income, risk, and attitudes to be distinguished from the methodological factors that influence the WTP estimates. The ample methodological research on CV surveys particularly in the environmental and health economics literature (e.g. (Kartman *et al.* 1996, Klose 1999, Frew *et al.* 2003) has provided clues to the ways in which the common methodological problems encountered in CV surveys (see Table 1 for summary) can be circumvented or managed in the CV design and analyses. Many of the recommended CV designs tackle two or more of the potential methodological issues, hence the information is organized by each design and/or analysis strategy.

Table 1. Types and sources of methodological problems in CV surveys

Types	Sources
<p>Hypothetical bias and yeah-saying responses: Values offered in hypothetical survey contexts are significantly different from values offered in real market conditions (Blumenschein <i>et al.</i> 2001, Kennedy 2002). Yeah-saying responses refer to responding yes to a question without really meaning it.</p>	<ul style="list-style-type: none"> • Lack of relevant information provided to the respondents before eliciting their willingness to pay (List and Gallet 2001, Hultkrantz <i>et al.</i> 2006). • Close-ended WTP survey questions are not administered in a manner that encourages the respondents to seriously think about and respond to the questions (Arrow <i>et al.</i> 1993).
<p>Non-responses: Non-responses can include a genuine ‘don’t know’ responses or strategic refusal responses (Dalmau-Matarrodona 2001), which are distinct from genuine real zero valuations.</p>	<ul style="list-style-type: none"> • Lack of information provided to the respondents about the product and its implementation context (Arrow <i>et al.</i> 1993). • Open-ended WTP questions (Arrow <i>et al.</i> 1993).
<p>Strategic responses (protest zeros/free-riding): Respondents understand the WTP question and support the product provision but demonstrate their refusal to pay themselves by giving a nil response in the hope that someone else (e.g. government) will pay for the product (Carson <i>et al.</i> 2001).</p>	<ul style="list-style-type: none"> • Can be induced by the ways in which the product is framed in terms of private versus public with respect to provision and use. (Hultkrantz <i>et al.</i> 2006, Svensson and Johansson 2010, Pedersen <i>et al.</i> 2011).
<p>Scope and scale biases: WTP estimates being insensitive to changing health outcomes in terms of</p> <ul style="list-style-type: none"> • consequences (scope bias) <i>e.g.</i> minor injury versus serious injury, and • magnitude of risk reduction (scale bias) <i>e.g.</i> 5% versus 10% reduction (Beattie 1998, Olsen <i>et al.</i> 2004, Hultkrantz <i>et al.</i> 2006). 	<ul style="list-style-type: none"> • The product outcomes in terms of risks and uncertainty are not clearly communicated in the CV surveys (Carson <i>et al.</i> 2001, de Blaeij and van Vuuren 2003) • The valuation is sought for changes in small probabilities of risks (Jones-Lee <i>et al.</i> 1995). • When respondents value the product in terms of moral satisfaction from the act of giving or from contributing to what the respondents believe as a good cause (warm glow effect), rather than the product itself (Kahneman and Knetsch 1992, Baron and Greene 1996).
<p>Range bias: The final WTP estimate restricted by the range of values presented in the CV survey (Donaldson <i>et al.</i> 1997, Whynes <i>et al.</i> 2004).</p>	<ul style="list-style-type: none"> • The bid values presented in the payment card or bidding formats do not cover all the possible values for the product in practice.
<p>Starting point bias: The final response is influenced by the initial value presented in the bidding format (Boyle <i>et</i></p>	<ul style="list-style-type: none"> • The order of the bid presentations are the same across all survey respondents.

<p><i>al.</i> 1985, Silberman and Klock 1989, Frew <i>et al.</i> 2004).</p>	
<p>Oder bias: The same product is valued differently depending on the order in which the product was presented in the survey (Svensson and Johansson 2010).</p> <p><i>e.g.</i> Product A that can achieve a 5% risk reduction is more highly valued if it was presented before product B that can achieve a 10% risk reduction than if product A was presented after product B.</p>	<ul style="list-style-type: none"> • Valuing the more valuable good before the less valuable one may create a larger difference in valuations than vice versa because people perceive a loss as worse than an equal gain (prospect theory; (Kahneman and Tversky 1979). • Respondents may demonstrate the warm glow effect with the product that was presented first and the glow effect fades with subsequent presentation (Stewart <i>et al.</i> 2002).

2.1. Sampling

Because road safety measures often bear significant amenity value (e.g. protective clothing has aesthetics, comfort, branding, etc) in addition to their safety benefit, willingness to pay values generated across different products are likely to provide a wide range of implied VOSL valuations.

It may be useful to obtain WTP values for each road safety measure that is targeted for a specific group, rather than simply obtaining an overall WTP estimate for all road safety measures (de Blaeij *et al.* 2003). This may be particularly relevant for products that would only be used and paid by a particular group, particularly those who may have a role in the decision making process, for example relating to the use of motorcycle helmets and protective clothing. Respondents can value the same product differently because of their individual differences in the need and use of the product (Carson *et al.* 1999). For example, current patients/clients will value the product based on current use (use-value). Non-current use respondents may gain utility from knowing a service is available for their use in future given uncertainty (option value out of insurance motives), or from knowing that a service is available to other individuals to use (existence value out of moral satisfaction), or out of concern for the welfare of future generations (caring externality). What type of value is being estimated will depend on the sample used – users, convenient samples, general population – and the sample must be selected to best match the policy and research questions (Diener *et al.* 1998).

2.2. Survey design

2.2.1. Descriptor

The optimal CV survey design is what matches best with the intended real implementation context. A context specific design allows the measurement of preference of specific individuals or groups who are affected by certain proposals. CV studies can suffer from hypothetical bias, yeah-saying responses, non-responses, and unreliable WTP estimates if the terms of the product provision is poorly described (Carson *et al.* 2001). While the product description should be comprehensive enough to maximise the strength of the WTP approach, the product attributes to be included in the descriptor must also be guided by what are relevant and important to answer the research/policy questions. The CV survey must

contain a descriptor to inform the respondents the relevant decision-making context, nature of the product to be valued, its use (private versus public risk reduction; current versus future use) and/or non-use values (option value in the form of insurance or externalities in the form of welfare of others), its expected outcomes (road safety improvement, duration, probability) and/or non-outcome attributes (process utility: information, anxiety reduction), the payment vehicle used (e.g. taxation, contributions to a fund, insurance premium, out-of-pocket, existing road safety budget), and the institutional setting in which the product will be provided (public or private) before asking about WTP (Arrow *et al.* 1993, Carson *et al.* 2001, List and Gallet 2001). This is because they are all shown to influence the value provided by the respondents (Klose 1999). The descriptor must be sufficiently informative to the extent that is feasible but not too complex to understand (Carson *et al.* 2001, Powe and Bateman 2004). Avoid using scientific or technical words and possibly utilise visual aids for uncommon/unfamiliar products.

If the product being valued is likely to trigger strategic behaviour in the real world, then this ought to be directly dealt with within the survey (Carson *et al.* 2001). For example, if the product to be valued is likely to be publicly provided then this should be made transparent rather than hide it in order to suppress strategic behavior.

From a purely economic point of view respondents must also be aware of the budget constraints and thus the opportunity cost in terms of the benefits forgone from placing a value on one program over another to avoid overestimates (Kahneman and Tversky 1979, Arrow *et al.* 1993, Johansson 1995). This is especially relevant when the rationale for the cost-benefit analysis is allocative efficiency in which decisions to choose between two or more intervention alternatives must be made.

2.2.2. Description of risk or uncertainty

The main purpose of CV surveys is to estimate the value of risk reduction produced by the policy product being evaluated and the CV method assumes that people correctly perceive the risks (Zerbe 1998). A general problem with road safety valuation is the low probability of a crash event. The risk reduction must be communicated in the CV survey in a way that is most likely to make sense to people. Use of percentage reduction in risk has been suggested assuming the current risk is understood by the respondents before being asked about the WTP value (Guria *et al.* 2003). Authors have also demonstrated that individuals are significantly more accurate at making judgment when presented with information as absolute frequencies than probabilities, hence minimizing scope and scale biases (Gigerenzer and Hoffrage 1995). For example, an absolute reduction in number of deaths and injuries (intervention reduces 50 deaths) rather than proportion (intervention reduces crashes from 8 to 7 in 10000 licence holders) may be more meaningful to respondents. Visual aids for the communications of risks have also been found to be helpful (Corso *et al.* 2001, Alberini 2004).

2.2.3. Elicitation format

Psychological and health economics literature suggest that different elicitation techniques result in different WTP estimates (Klose 1999). Generally higher response rates are achieved with closed-ended questions than open-ended questions because respondents find it easier to give a monetary valuation when they are guided with a price (Arrow *et al.* 1993, Whyne *et al.* 2003). Various formats of open and

closed-ended questions exist with differing advantages and limitations (Table 2). Being aware of the limitations and advantages of each type of elicitation methods is critical to choose the most appropriate elicitation format within each research context and to address the potential biases in the CV design and analyses.

In general it is recommended to avoid using open-ended questions. The potential starting point bias in the bidding format or double-bounded dichotomous choice format can be controlled for by randomising the ordering of the bids presentation within the sample (Smith 2006). Range bias is not found unless the payment card does not present the upper and lower ends that respondents may desire to select, thus a pilot study is recommended to cover the range of possible values in practice (Rowe *et al.* 1996). A 'no answer' option should be explicitly allowed in addition to the 'yes' and 'no' vote options to close-ended questions (Arrow *et al.* 1993).

Table 2. WTP elicitation formats, advantages and limitations

Elicitation format and example	Advantages	Limitations
<p>Open-ended question</p> <p>“How much are you willing to pay?”</p>	<ul style="list-style-type: none"> • Allows for smaller sample size than other formats. • Simple point-estimates 	<ul style="list-style-type: none"> • Subject to non-response because it is harder than close-ended questions (e.g. yes/no questions).
<p>Single-bounded dichotomous choice (referendum format)</p> <p>“Are you willing to pay \$__?” ‘yes’ or ‘no’ vote to a single nominated value</p>	<ul style="list-style-type: none"> • Simple point-estimates 	<ul style="list-style-type: none"> • Inflated mean WTP due to yeah-saying responses • Low statistical efficiency (Hanemann <i>et al.</i> 1991, Kanninen 1995)
<p>Double-bounded dichotomous choice</p> <p>“Are you willing to pay \$x?” If yes, “Are you willing to pay \$y (amount more than \$x)?” If no, “Are you willing to pay \$z (amount less than \$x)?”</p>	<ul style="list-style-type: none"> • Increased information on the value. • Allow for smaller sample size than the single-bounded dichotomous choice 	<ul style="list-style-type: none"> • Inflated mean WTP due to yeah-saying responses • Vulnerable to starting-point bias and range bias
<p>Bidding format</p> <p>Like an auction the respondents are asked whether they are willing to pay a nominated amount, and depending on their answer, they are asked about lower/higher bids. This process continues until the maximum WTP amount is found.</p>	<ul style="list-style-type: none"> • Higher response rate than an open-ended question • Closer to market situation 	<ul style="list-style-type: none"> • Inflated mean WTP due to yeah-saying responses • Vulnerable to starting-point bias and range bias • Requires an interactive interview format (computer programming, or telephone/face-to-face interviews)
<p>Payment card</p> <p>Showing respondents a series of values on a card and asking them to choose the value that most closely represents their WTP</p>	<ul style="list-style-type: none"> • Higher response rate than an open-ended question • More valid (higher % of variance explained; stronger association with ability to pay) than estimates derived from open-ended questions (Donaldson <i>et al.</i> 1997) 	<ul style="list-style-type: none"> • Vulnerable to range bias • Limited interview format in order to present the payment card to the respondents
<p>Payment ladders</p> <p>Absolutely certain that I would</p>	<ul style="list-style-type: none"> • Allow for range of uncertainty over the value respondents place 	<ul style="list-style-type: none"> • Only an interval estimation between the maximum rejected bid and the

pay at least \$10 and that I would not pay \$20, but I am unsure if I would pay \$15.		maximum accepted bid can be directly obtained.
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2.2.4. Follow-up questions

The motives for the chosen value such as the warm glow effect and protest responses can be identified by asking the respondents about their reasons for their choice of value (Arrow *et al.* 1993, Carson *et al.* 2001). Follow-up questions can also be used to make distinctions between the types of non-responses—indifference between yes or no, inability to make a decision without more information, preference for other products, disinterest or uncooperativeness in the survey. Protest responses can be indicated by reasons for their zeros as “I think the government should pay, not me”; “I pay taxes” (Dalmau-Matarrodona 2001). These are in contrast to real zeros where the reasons can include “I would prefer to pay for something else” (Dalmau-Matarrodona 2001). From attitudinal measurement and policy perspectives, the existence of different motives that influence the value placement are relevant (Carson *et al.* 2001, Hackl and Pruckner 2005). If strategic behavior and warm-glow effects are realistic phenomena in practice, then they need to be identified in the research process. This enables policy makers to be aware of the barriers to implementation and plan ahead ways to manage these barriers.

Follow-up questions on how certain the respondent are on their choice of value are also helpful to identify and manage hypothetical bias, yeah-saying responses to close-ended questions, and scale/scope bias (Johannesson *et al.* 1998, Johannesson 1999). When respondents are confident with their WTP responses the estimates do tend to be sensitive to changing magnitude of risk reduction (Alberini 2004). The data can be analysed excluding low certainty responses to obtain conservative estimates that are not influenced by potential biases and thus more reliable WTP estimates (Poe 2002, Blomquist *et al.* 2009). This CV analysis method is referred to as the certainty calibration.

2.2.5. Randomization of the order in which the products are presented if two or more products are being evaluated

This applies if two or more road safety products are being valued to determine the choice and allocation of resources between the intervention options. Similarly to the management of the starting-point bias in the bidding format elicitation method, the order bias of scenario presentations can be managed by randomizing the order of presentations across respondents. Randomization can cancel out the order bias to produce a more reliable mean WTP estimate.

2.3. Interview format

The NOAA Panel strongly recommends face-to-face interviews on the basis that it allows the presentation of large amount of information in a controlled sequence whilst maintaining respondent interest and attention as well as encouraging the respondent to carefully consider their response, thus minimizing hypothetical bias and yeah-saying responses (Arrow *et al.* 1993). However face-to-face interviews may be more prone to demand characteristics where the respondents desire to please the

interviewer (Blamey *et al.* 1999) and there is no solid evidence for its superiority to telephone interviews (Smith 2006). While the choice between telephone and face-to-face interviews might depend on the cost-efficiency and practicality of conducting the research (Smith 2006), postal surveys are not recommended due to the implications of the order of the question presentation and other complexities to the survey.

2.4. Analyses

Given WTP estimates can vary with potential biases, the robustness of the WTP estimate must be examined by conducting sensitivity analyses. For example, compare the WTP estimates between the entire sample and a sub-sample of only high certainty responses and (Johannesson 1999, Blomquist *et al.* 2009). Similarly, compare the WTP estimates between the entire sample and a sub-sample in which protest responses are excluded. Additionally, if other types of strategic or non-responses are evident, conduct similar sensitivity analyses to understand their influences on the final WTP estimates.

2.5. Reporting of the CV methods

Although methodological research in CV surveys is ample there is still room to refine CV methods such as the risk communication. Reporting of the CV methods used in each CV study in road safety will contribute to the advancement of CV methods and potentially identify strategies unique to road safety research.

3. Conclusion

Lessons learnt from the applications of CV surveys in environmental and health economics are relevant in the applications of CV surveys in road safety research. The literature suggests that potential methodological issues can be addressed and managed in the design and analyses of CV surveys to maximize the validity and reliability of WTP estimates. Employing evidence-based survey designs and question forms are critical to obtain the best possible willingness to pay data in road safety research.

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