NOTA DI LAVORO

15.2017

A Novel Approach to Estimating the Demand Value of Road Safety

Christoph M. Rheinberger, European Chemicals Agency (ECHA), Helsinki
Felix Schläpfer, Kalaidos University of Applied Sciences, Zurich
Michael Lobsiger, B,S,S. Economic Consultants Ltd., Basel

Economic Theory
Series Editor: Carlo Carraro

A Novel Approach to Estimating the Demand Value of Road Safety

By Christoph M. Rheinberger, European Chemicals Agency (ECHA), Helsinki
Felix Schläpfer, Kalaidos University of Applied Sciences, Zurich
Michael Lobsiger, B,S,S. Economic Consultants Ltd., Basel

Summary

We estimate the demand value of road safety improvements in Switzerland from survey data using a novel elicitation approach. Individuals' responses to questions about how much public spending on road safety should be increased are combined with observations of income, tax rate, and road usage to estimate the economic value of a statistical accident avoided. Information obtained from a risk-risk tradeoff elicitation allows us to distinguish willingness-to-pay values for various degrees of accident severity. Our most comprehensive estimate of the value of a statistical accident avoided amounts to CHF 11.0 million ($11.6 million); the corresponding value per statistical life is close to CHF 4.2 million ($4.5 million). We explore the sensitivity of these estimates to anchoring and other framing effects and find that the popularity of specific road safety programs is influenced by both the availability of different choice options and the provision of partisan cues expressing political endorsement or opposition.

Keywords: Road Safety, Value of Life, Public Goods

JEL Classification: H41, I38, J17

The research presented in this paper was funded by the Swiss Federal Road Office through project no. VSS 2011/104. We thank Henrik Andersson, Sue Chilton, James Hammitt and Rebecca McDonald for helpful comments on an earlier version of the paper. Opinions expressed in the paper are ours and should not be construed to represent endorsement by the Swiss Federal Road Office or any other agency.

Address for correspondence:
Christoph M. Rheinberger
European Chemicals Agency (ECHA)
Annankatu 18
P.O. Box 400
FI-00121 Helsinki
Finland
E-mail: rheinberger.cm@gmail.com

A Novel Approach to Estimating the Demand Value of Road Safety

Christoph M. Rheinberger, Felix Schläpfer, Michael Lobsiger*

This version: March 8, 2016

Abstract

We estimate the demand value of road safety improvements in Switzerland from survey data using a novel elicitation approach. Individuals' responses to questions about how much public spending on road safety should be increased are combined with observations of income, tax rate, and road usage to estimate the economic value of a statistical accident avoided. Information obtained from a risk-risk tradeoff elicitation allows us to distinguish willingness-to-pay values for various degrees of accident severity. Our most comprehensive estimate of the value of a statistical accident avoided amounts to CHF 11.0 million ($11.6 million); the corresponding value per statistical life is close to CHF 4.2 million ($4.5 million). We explore the sensitivity of these estimates to anchoring and other framing effects and find that the popularity of specific road safety programs is influenced by both the availability of different choice options and the provision of partisan cues expressing political endorsement or opposition.

JEL classification: H41, I38, J17

*CMR: European Chemicals Agency (ECHA), Helsinki, Finland (e-mail: rheinberger.cm@gmail.com); FS: Kalaidos University of Applied Sciences, Zurich, Switzerland (e-mail: felix.schlaepfer@kalaidos-fh.ch); ML: B,S,S. Economic Consultants Ltd., Basel, Switzerland (e-mail: michael.lobsiger@bss-basel.ch). The research presented in this paper was funded by the Swiss Federal Road Office through project no. VSS 2011/104. We thank Henrik Andersson, Sue Chilton, James Hammitt and Rebecca McDonald for helpful comments on an earlier version of the paper. Opinions expressed in the paper are ours and should not be construed to represent endorsement by the Swiss Federal Road Office or any other agency.

1 Introduction

The marginal rate of substitution between wealth and mortality risk—commonly referred to as the value per statistical life (VSL)—is a major determinant of environmental, health, and transport policies. For example, reductions in mortality risk account for more than 90% of quantified benefits of the 1990 Clean Air Act Amendments, and the total value of these benefits hinges on the VSL value assumed (Cropper et al. 2011). Similar observations apply to drinking water regulations, road safety programs, and other areas of public safety (Ashenfelter 2006). The policy relevance of the VSL is unambiguous: The larger the VSL, the more likely is it that a new regulation passes the benefit-cost test (Shogren and Stamland 2002). That makes estimating the VSL a policy-relevant research enterprise.

VSL estimates have been obtained almost exclusively from hedonic-wage regressions (Viscusi and Aldy 2003) and from conventional stated preference (SP) studies (Cropper et al. 2011).[1] In this paper, we propose a novel elicitation mechanism based on the demand function approach pioneered by Bergstrom et al. (1982) and apply it to estimating the VSL in the context of road safety. The key idea of our approach is that people indicate a preferred quantity-price bundle from a realistic safety production function. This enables us to elicit people's willingness to contribute to the provision of a public good without asking them to consider counterfactual costs. Instead, a respondent is confronted with the individual cost that they would incur if their preferred policy option was actually implemented. As we will show, this largely reduces incentives for strategic answers—a well-known problem of contingent valuation and other SP methods (Kling et al. 2012).

Although the demand function approach is theoretically appealing, it is no panacea. The most important issues that remain relate to the stability of preferences. We address these issues in our empirical application by incorporating a 2×2-treatment design that enables us

[1] A small number of studies have applied the hedonic approach to estimate the VSL outside the labor market. For instance, Gayer et al. (2000) looked at housing market evidence near superfund sites to infer the VSL. Ashenfelter and Greenstone (2004) exploited differences in mandated speed limits on rural and urban roads to measure the VSL.

to explore the sensitivity of WTP estimates for various health endpoints to anchoring and other framing effects. The first treatment is an anchoring experiment in the spirit of Green et al. (1998), which allows us to gauge preference variance across the split samples. We find respondents to be inadequately sensitive to the actual cost of providing the public good, suggesting that their preferences for road safety are inherently constructive and susceptible to arbitrary pieces of information (Ariely et al. 2003). The second treatment provides half of the respondents with partisan cues, offering them a substitute for the range of political views and opinions they would have encountered in an actual voting process. This allows us to test how genuine preferences for public safety are. The experimental provision of partisan cues affected preference statements of those subjects sympathizing with right-wing parties which had earlier voted in Parliament against the expansion of road safety programs, whereas it had no detectable effect on supporters of left-wing and center parties.

In a nutshell, our findings suggest that the avoidance of one statistical accident—a road accident that causes an average number of fatalities, disabilities, and injuries as recorded in the Swiss accident statistics—is valued at CHF 11.0 million.[2] Using a risk-risk tradeoff elicitation task similar to that of Magat et al. (1996), we provide a breakdown into WTP values for various degrees of accident severity. Our most comprehensive estimates imply a VSL of CHF 4.2 million, a value per statistical disability case of CHF 1.7 million, and values per statistical injury of CHF 0.2 million, CHF 23,000 and CHF 1,350 per severe, moderate and mild case, respectively. We use a number of controls in our reduced-form regressions to explore the impact of risk perception on the stated WTP for the provision of road safety. Other drivers of the demand for road safety are altruistic preferences, political orientation, educational attainment, income, and road usage. While these findings resonate well with economic theory, we find that respondents who evaluated a less extensive subset of road safety programs were willing to pay 38% less than those who evaluated a more extensive subset. Similarly, the provision of partisan cues reduced the WTP by about 20% on average.

[2] At the time of survey conduct, one Swiss franc (CHF) corresponded to $1.06.

These treatment effects highlight the importance of context and frames in decisions about public good provisions. On first thought, they might be interpreted to corroborate doubts as to whether hypothetical valuation methods can provide robust information to policy makers (Kahneman et al. 1999; Hausman 2012). On second thought they are not so surprising, however. It is well known that decisions, whether hypothetical or not, are often influenced by arbitrary anchors (Tversky and Kahneman 1974, Ariely et al. 2003), available choice options (Stewart et al. 2003), choice bracketing (Menon et al. 1997, Read et al. 1999), and the relative position of options within a choice set (Tversky and Simonson 1993; Drolet et al. 2000). As Kamenica (2008) demonstrates, context and frames may provide payoff-relevant information to decision makers. For example, the information implicit in a firm's offer of a particular set of goods allows the uninformed consumer to infer from the product line which good is optimal for them. Likewise, the undecided voter draws inferences from contextual information which may let them intentionally violate naïve formulations of standard choice theory.

However one wants to interpret context and framing effects in SP studies, there is no reason to believe that VSL estimates from labor market studies would necessarily offer better policy guidance. Indeed, the analysis of compensating wage differentials has several drawbacks mostly related to the fact that workers vary across typically unobserved dimensions such as productivity type (Hwang et al. 1992), skills (Shogren and Stamland (2002), and risk preferences (DeLeire et al. 2013). A number of econometric remedies have been developed to address the resulting biases in the estimation of the VSL.[3] However, these approaches require fine-grained occupational risk data. Even if such data is available and the above problems can be overcome, several conceptual problems remain.

These include the fact that hedonic techniques ignore effects on the quality of life as well as other-regarding safety preferences, both of which are important aspects of public safety

[3]These include panel data estimations that control for fixed effects of job switchers (Black and Kniesner 2003; Kniesner et al. 2012), quantile regression models that address heterogeneity in risk across workers in the same industry (Evans and Schaur 2010; Kniesner et al. 2010), and Roy models to correct for sorting biases (DeLeire et al. 2013).

interventions. Even more important is the question how well wage-risk tradeoffs observed in the labor market proxy for the preferences of the general population. Observed wage-risk decisions are predominantly made by male, blue-collar workers aged 20 to 65. Transferring VSL estimates obtained from this specific subgroup to the general population requires strong assumptions about the underlying homogeneity of societal preferences for safety.

For this reason, health, environmental and transport economists have increasingly turned to SP approaches to infer the economic value of risk reductions from survey questions about the allocation of private or public good provisions. Private good scenarios allow researchers to examine WTP for reduction in *own* risk by offering goods that are strictly private and reasonably familiar (Beattie et al. 1998). In most cases, such choices involve small probabilities that respondents may find difficult to evaluate in a meaningful manner (Baron 1997; Kunreuther et al. 2001). Unsurprisingly, SP studies that estimate the VSL based on small risk reductions are often insensitive to the absolute size of the risk reduction (Hammitt and Graham 1999). In other words, respondents are willing to pay nearly the same amount for reductions in risk that differ by an order of magnitude or more (Andersson et al. 2016).

A popular way to overcome the problem of ill-understood probabilities is to provide respondents with visual aids to make them better understand the baseline risk and the risk reduction under consideration. Corso et al. (2001) found that respondents made WTP statements nearly proportional to the size of risk reduction when presented with an array of dots representing different reductions in risk. They contemplated that the dots visualized risk in a frequency format, which psychologists have found to be more accessible than small probabilities. While visual aids may certainly help in communicating risks to respondents, this does not help to address the problem of unfamiliarity—even if nicely displayed, a $1:10,000$ reduction in mortality risk remains an abstract benefit likely to be interpreted differently by different people.

Questions involving expected numbers of deaths or injuries avoided may be easier for

respondents to process, but imply the elicitation of preferences for safety as a public good. The valuation of public good provisions with SP methods bears a number of additional problems. First, choice tasks involving public good scenarios and changes in tax rates are often cognitively more demanding than choices over private goods (List and Gallet 2001). Second, randomly assigned bids may be incredible (Flores and Strong 2007) and especially so, if the proposed policy is to be financed through typical sources of tax revenues. Third, respondents might answer strategically if the survey choices are believed to be consequential (Green et al. 1998).[4] And fourth, stated contributions to a public good may be driven by the private value a person receives from contributing to a worthy cause beyond use value. While such warm glow motives are one of many pro-social behaviors that may lead people to contribute to a public good (Kling et al. 2012), they need to be carefully considered in order for SP studies not to confound private and social values (Bergstrom 2006).

Our elicitation mechanism addresses most of the above issues. The approach derives VSL estimates from people's preferred quantities of road safety interventions rather than from CV referendum questions. Incentives for strategic misrepresentations are minimized since the bid amounts are knotted to personal taxes and mileages driven and respondents receive accurate information about the marginal cost of an additional unit of risk reduction and their personal contribution to its provision. We frame the choices over quantity-price bundles as a multiple proposal ballot—one form of referendum in Switzerland's direct-democratic system—allowing respondents to reveal their WTP for public safety in a meaningful and realistic way and provides a link between the hypothetical vote and the subjective probability that a specific program will be adopted. It also mitigates problems related to the perception of small changes in risk, because respondents evaluate programs that are characterized by

[4]In the public good context, incentive problems with single binary choice CV questions arise from the random assignment of bids, which are often different from the respondent's contribution were the policy to be implemented (Schläpfer 2017). The experimental design implies there be some respondents who pay no income tax at all, but face the highest bid. If these respondents are in favor of the project, they have an incentive for approval at 'any price' (Flores and Strong 2007). Vice versa, people who contribute a lot to the tax revenue of a community have an incentive to downplay their true WTP (Rheinberger and Schläpfer 2015).

the expected number of fatalities and injuries avoided per year. In other words, quantities of the public good under consideration are clearly defined, which eliminates the potential bias that arises when some respondents focus on the risk of dying, while others also consider the risk of getting injured.

In Section 2, we embed the proposed mechanism for eliciting the demand for public safety in microeconomic theory. Section 3 contains a description of the survey instrument and the data used in the empirical part. In Section 4, we outline our empirical strategy. Section 5 reports the main findings of our study and the results of validity and robustness checks and section 6 concludes with a brief discussion of the implications of our results for future research and policy applications.

2 Theoretical Model

Demand for safety is typically measured by the compensating variation c that makes an individual indifferent between facing risk p_0 at wealth level w_0 and facing the reduced risk $p_1 = p_0 - \Delta$ at the lower wealth level $w_1 = w_0 - c$ (Pratt and Zeckhauser 1996). The standard model readily applies to private valuations of risk reductions. Road safety, however, is better characterized as a public good because the risk faced by the individual driver or passenger is determined through regulations and other governmental interventions financed from tax revenue. Moreover, no road user, whether contributing or not, can be excluded from improvements in safety. Below, we extend the standard VSL model to account for the public good context.

2.1 Demand for Public Safety

Consider an individual i who earns income Y_i and receives Q units of risk reduction (that is Q fewer road accidents) at a per unit tax price P. The individual's utility is a non-decreasing, quasi-concave function of the collective good Q, and the quantities $(Q_1, \ldots, Q_m)$ and prices

$(P_1, \ldots, P_m)$ of m private goods, which implies the following set of demand equations:

$$Q_j^* = g_j(P_1, ..., P_m, Y_i - PQ, Q) \qquad j = 1, ..., m. \tag{1}$$

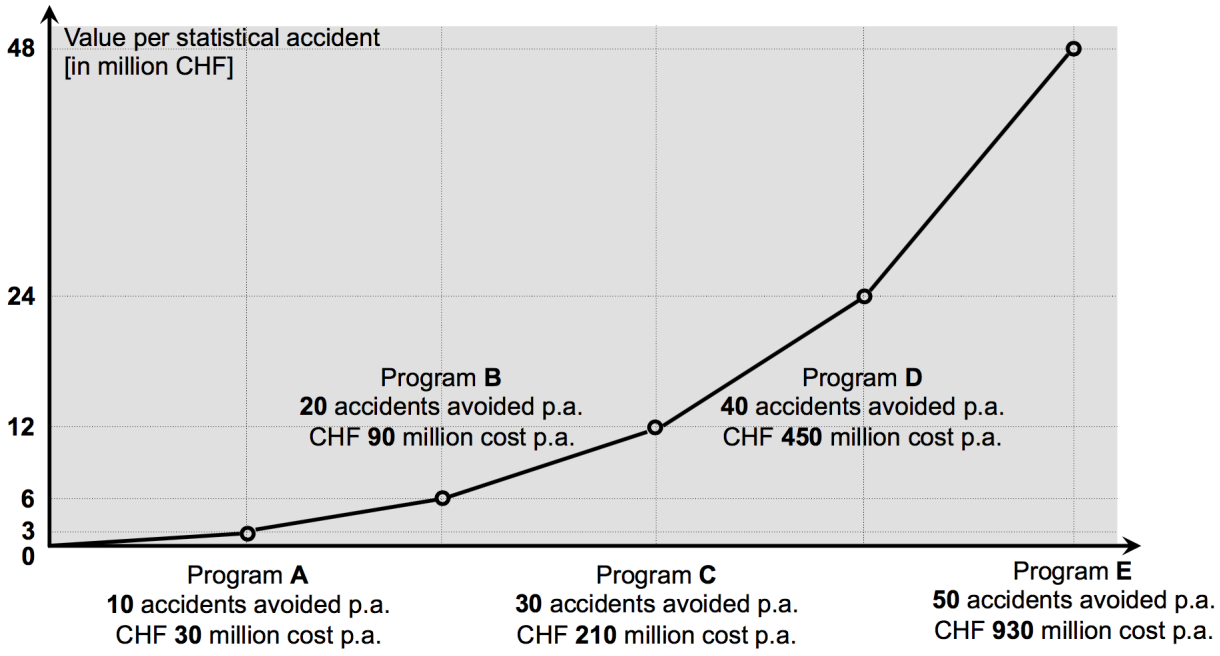
Each of the conditional demand functions g_j in Eq. (1) is subject to the budget constraint $Y_i - PQ > 0$, and individual i's optimal but unobserved amount of the collective good is given by $Q^* = h(P_1, \ldots, P_m, P^*, Y_i)$.

Because the amount of safety that each individual receives is fixed, the conditional demand functions meet all requirements of ordinary demand functions (Pollack 1969). We may hence substitute them into the individual's utility function to evaluate alternative levels of safety provision. Individual i prefers a road safety program A over another program B if $v_i(Y_i - P^{\mathsf{A}}Q^{\mathsf{A}}, Q^{\mathsf{A}}) > v_i(Y_i - P^{\mathsf{B}}Q^{\mathsf{B}}, Q^{\mathsf{B}})$. When faced with a choice between several alternatives, the individual chooses the road safety program that is utility maximizing. Under the assumptions spelled out below such choices provide sufficient information to estimate the individual's WTP per unit of risk reduction.

As we seek to estimate the demand value for road safety in Switzerland, we frame the task as a multiple proposal ballot. The ballot proposes five alternative road safety programs, A–E, that avoid successively more accidents at an increasing marginal cost. This assumption is legitimate since efficient safety provision requires that accidents be avoided where avoidance is least costly. Second, we assume that WTP per unit of risk reduction is constant over the range of risk examined in the survey. The latter assumption is consistent with the theoretical result that, for small risk reductions, WTP should be nearly proportional to the change in risk (Hammitt and Graham 1999). Figure 1 illustrates the resulting safety production function.

Based on these assumptions, we designed a survey that required a discrete choice from among five different road safety programs including the status quo. Each of these programs represents a distinct quantity-price pair $\left\{Q^k, P^k\right\}$, and the differences between two consecutive pairs determine the implied value of a statistical accident avoided. The benefits of avoiding statistical accidents are described to the respondent in terms of the number of pre-

Figure 1: Safety production function.



Note: The safety production function was used to construct the respondent-specific cost of each of the offered road safety programs. The actual cost to the respondent was determined based on the calculus presented in the Appendix.

vented fatalities (F), disability cases (D), and serious (S), moderate (M), and minor (O) injuries, respectively. The vector $Q^k = \left\{F^k, D^k, S^k, M^k, O^k\right\}$ summarizes the benefits expected from the program k. Table 1 lists the properties of each of the road safety programs proposed to the respondents.

One major concern with SP studies is that respondents might over- or understate their WTP—either to help induce or hinder the provision of the public good (Green et al. 1998), or because the respondent believes their actual cost would differ from the cost stated in the survey (Flores and Strong 2007). In order to minimize strategic incentives and to enhance survey credibility, we carefully described the designated funding mechanism and amended the information in Table 1 with estimates of the respondent's actual cost expected from the implementation of any of the proposed road safety programs. These actual cost estimates, denoted C_i^k, were derived based on the respondent's income tax and mileage driven in the

Table 1: Summary of the proposed road safety programs.

	Road Safety Programs				
	A	B	C	D	E
Fatalities avoided	10	20	30	40	50
Disabilities avoided	12	24	36	48	60
Severe injuries avoided	200	400	600	800	1,000
Moderate injuries avoided	300	600	900	1,200	1,500
Mild injuries avoided	2,000	4,000	6,000	8,000	10,000

previous year.[5]

If a respondent assigns a positive probability λ to the consequentiality of the response, they should maximize the expected payoff function:

$$\mathbb{E}_{\Theta}\left[\pi_i\right] = \sum_{k} \left(\tilde{\omega}_i - C_i^k\right) \lambda \frac{n\left(1 - \Theta_i(k)\right) + \mathbf{1}\left(y \geq C_i^k\right)}{n+1}, \tag{2}$$

where $\tilde{\omega}_i$ is the true, but unobserved WTP linked to the optimal amount of safety provision Q^*, Θ_i denotes the CDF of i's belief about the approval rate of program k by the other n respondents, and $\mathbf{1}(.)$ is an indicator of whether the respondent approves program k by accepting to make a contribution y at least as large as C_i^k (Green et al. 1998).

It is straightforward to see that the expected payoff is maximized at $\tilde{\omega}_i = y$, leading rational respondents to reveal their true preferences. Different to the common multiple ballot (Gibbard 1973; Satterthwaite 1975), there is no incentive for "favorite betrayal" here. Consider a respondent who envisions a close race between the competing programs k and $k+1$. She prefers the most expensive program K, implying the preferential order $K \succ \ldots \succ k+1 \succ k \succ \ldots 0$ (with $\succ$ denoting a strict preference). It would not make sense for her to vote for the "lesser evil", i.e. program $k+1$, since truthful voting reveals her latent WTP: $\tilde{\omega}_i > C_i^{k+1} > C_i^k$.[6]

[5]Details on the derivation of C_i^k are provided in Table 6 of the Appendix.

[6]Respondents may still misreport their WTP if they believe that the *aggregated* WTP rather than plurality determines how much of the public good is provided. Even in that case, the individualized cost vector reduces strategic misrepresentations as any respondent's answers have very limited leverage power.

One conceivable aspect of this type of preference inquiry is that respondents might not only consider their own reduction in risk, but also care about the reduction in risk to others. Moreover, they might not only consider their own contribution to the provision of public safety, but also those of others. This brings up a series of questions related to altruism in the valuation of public goods (Bergstrom 2006). In the empirical analysis, we include a number of regressors to control for altruistic preferences with regard to risk and wealth.

2.2 Risk-Risk Tradeoffs

The framework outlined above does not permit to directly estimate the VSL or the WTP for avoiding a statistical case of disability or injury. Rather, we obtain estimates of the economic value per statistical accident avoided (VSA). The VSA is a composite WTP metric reflecting that, for every road fatality avoided, program k avoids 1.2 cases of permanent disability, and 20, 30, and 200 cases of severe, moderate, and minor injuries, respectively.[7] We use the reference lottery metric introduced by Magat et al. (1996) to tease out the VSL and the WTP values for the other health endpoints. With this preference elicitation technique different health risks are traded off against each other, so that ultimately all impacts can be converted into death risk equivalents.

For illustration, take the tradeoff between road fatalities and accident-caused cases of disability. We asked respondents to choose between two regions, a and b, which differ only in the number of road fatalities (F^a vs. F^b) and disability cases (D^a vs. D^b) per 100,000 people. Let $F^b > F^a$ and $D^a > D^b$ and suppose the respondent is an expected utility maximizer. She will be indifferent between regions a and b, if and only if

$$p^a u(F^a) + q^a u(D^a) + (1 - p^a - q^a)u(1) = p^b u(F^b) + q^b u(D^b) + (1 - p^b - q^b)u(1), \qquad (3)$$

where $p^\bullet = F^\bullet/100,000$ and $q^\bullet = D^\bullet/100,000$ are the probabilities to meet with a fatal and

[7] These figures are based on confidential accident statistics of the Swiss Federal Roads Office.

a disabiliating accident, respectively. The utility from not having an accident is denoted by $u(1)$. If we normalize the utility of death to zero, Eq. (3) can be re-stated as:

$$\mu_D^F \equiv (1 - \frac{u(D)}{u(1)}) = \frac{p^b - p^a}{q^a - q^b} = \frac{\Delta p}{\Delta q}. \tag{4}$$

Eq. (4) states that the percentage degradation in the utility of full health caused by a disabiliating accident equals the ratio between the death risk difference Δp and the disability risk difference Δq. Given the equality in Eq. (3), this ratio equals the marginal rate of substitution μ_D^F between fatality and disability risk. By varying the values of p^a and q^b across respondents, location choices between regions a and b provide sufficient information to identify μ_D^F, and similarly μ_S^D, μ_M^S, and μ_O^M (Van Houtven et al. 2008). Based on the marginal rates of substitution between the different health endpoints, we may then convert the VSA into the VSL and the corresponding WTP values.

3 Data

Our study implements the demand function approach using a computer-based survey in which respondents choose among different road safety programs that reduce a specified number of car accidents at a marginally increasing cost. We used a pivot design (Rose et al. 2008) to make the cost of each program contingent upon the respondent's income tax and road usage. Choices among these programs are the basis for estimating the VSA. Respondents then moved on to the location-choice task, based on which we elicit the marginal rates of substitution between various health endpoints.

Next, we briefly describe the survey instrument, the allocation of treatments, and the sample from which data were obtained.

3.1 Survey Instrument

The survey instrument was developed in close collaboration with the Swiss Association of Traffic and Road Experts. The development phase spanned nine months and included the development of realistic road safety programs based on official and confidential road accident data and expert information about the cost of various safety interventions, the development of the choice tasks outlined below, a confirmatory workshop with traffic experts, and pretests with a convenience sample. In an iterative process, the survey instrument was refined after each step. The final survey consisted of five parts.

The introductory part screened out non-target persons so as to attain target quotas for age, gender, occupational status, and primary language. We informed respondents that the survey was commissioned by research of the Federal Roads Office and explained its general objectives. We asked them to carefully consider the questions, emphasized that there were no wrong answers, guaranteed anonymity, and pointed out that their responses will eventually inform policymakers.

Part two presented a summary of the prevailing accident risk on Swiss roads, possible programs to reduce the number of accidents and corresponding costs. Respondents had access to this information at any time via a hyperlink. We detailed out that any such program would be financed through a mix of automobile, income and fuel taxes and inquired about the respondent's last tax invoice and the mileage driven in the previous year. Respondents were then asked to compare four different road safety programs to the status quo situation. The programs differed in terms of numbers of fatalities and injuries avoided, the social cost, and the individual cost contribution. A cheap-talk script reminded respondents of their budget constraint (Cummings and Taylor 1999) and, depending on the experimental condition, they had access to partisan cues as a decision aid. The actual choice task proceeded in two steps. Respondents first evaluated each of the four programs against the status quo. They were instructed to consider each comparison as independent ballot on the adoption of the corresponding program. If a respondent approved more than one program, they were asked

to choose the preferred one.

In part three, we asked respondents how certain they were about their decisions, how much time they had spent studying the information and whether they had considered the partisan cues (if applicable). Moreover, respondents expressed on a scale from 0 = 'own safety only' to 10 = 'public safety only' their safety attitudes. They then indicated those factors on a multiple-item list that they had considered when making their choices. In another rating question, respondents expressed their opinions about the current provision of road safety using a scale from 0 ('far too much') to 10 ('way too little'). A series of further questions inquired about their risk perception, risky behavior, and other traffic-related attitudes.

Part four included the location choice task outlined in Section 2, which we largely adapted from van Houtven et al. (2008). At the outset of the task respondents received detailed road accident statistics including the annual number of accidents leading to death, disability, and injuries of three severity grades specified according to the definition of the Swiss Federal Road Office. In order to enable the evaluation of the risk-risk tradeoffs in a meaningful way, we listed 2012 accidents in each category and presented visual risk representations. Each respondent then faced four location choices between regions a and b that corresponded to tradeoffs between F and D, D and S, S and M, and M and O. These tradeoffs varied across respondents to enable the elicitation of marginal rates of substitution between the health endpoints. We allocated the risk-risk tradeoffs according to the following three premises:

1. The expected number of respondents is close to one thousand;

2. Four marginal rates of substitution have to be elicited; and

3. Risk-risk tradeoffs ought to be consistent with empirically observed WTP values.

Respondents evaluated 16 scenarios (four per risk-risk tradeoff) spanning a wide range of WTP values broadly consistent with the health economics literature. To keep the cognitive burden at a reasonable level, we constructed a fractional factorial design of 40 risk-risk tradeoff combinations, which we split into four questions per respondent using an orthogonal

blocking factor. The survey instrument randomly allocated the ten choice sets to the respondents. Following Van Houtven et al. (2008), we framed the task as location choice between two regions and emphasized that it was unrelated to the previous program choices and did not involve any cost.

In the last part of the survey, we collected information on the usual socio-economic characteristics along with indications of political orientation, general interest in politics, and participation in national and regional ballots.

3.2 Sample

The survey was fielded in September 2014 to a stratified sample of the LINK Internet panel, a 130,000 member nationally representative web-based sample of the Swiss population aged 15 to 74. Stratification was based on age, gender, and primary language. 1,007 of 2,022 panel members, who initially accepted to participate, completed the survey for a response rate of just under 50%. Among the dropouts, 337 members were excluded either because they did not enjoy voting rights or because the respective quota was already filled. Table 2 suggests that the socio-economic characteristics of our sample reasonably follow the distribution of the Swiss adult population except for the deliberately oversampled proportions of French and Italian speakers, participants aged 70 (who are under-sampled by construction of the panel), and the educational attainment which is larger in our sample than in the Swiss population.

Table 2: Sample statistics and representativeness.

Variable	Value or level	Sample (%)	Population (%)
Age	18-34	28.5	25
	35-54	38.6	34
	55-69	27.3	28
	70 or older	5.6	13
Gender	Male	47.9	48
	Female	52.1	52
Region	German speaking	64.7	74
	French speaking	25.1	21
	Italian speaking	10.2	5
Work status	Working (part-time)	60.8	63
	Not working	39.2	37
Education	Basic secondary	4.9	19
	Higher secondary	52.4	54
	Tertiary	42.8	27
Income (CHF/months)	Less than 4,000	36.7	22
	4,001-6,000	25.2	33
	6,001-8,000	18.0	23
	8,001-10,000	11.4	12
	10,001-12,000	5.0	5
	$>$ 12,000	3.7	5
Political party support	BDP (center-right)	7	5
	CVP (center)	10	15
	EVP (center-left)	4	1
	FDP (center-right)	17	15
	GPS (left)	8	8
	GLP (center)	9	6
	SVP (right)	23	29
	SP (left)	23	23

Note: $n = 1,007$; population statistics are retrieved from the following official sources: STATPOP register data; survey of household structure; survey of income and living conditions; results of 2011 elections for national council; year 2010 traffic census.

3.3 Treatment Allocation

We built two experimental factors into the study design, which enable us exploring the sensitivity of WTP responses to anchoring and endorsement effects. In what is essentially a variant of the Green et al. (1998) anchoring experiment, we randomly allocated respondents to two survey versions. Half of respondents evaluated road safety programs A–D, while the other

half evaluated programs B–E. Approval of one of the programs implied aggregated marginal WTP values corresponding to CHF 3 to 24 million and CHF 6 to 48 million per statistical accident avoided, respectively. Respondents could also choose the status quo rejecting any contribution. If preferences are stable, then roughly the same number of respondents should prefer program C under both treatment conditions. Moreover, WTP estimates should differ because of boundary effects only. Else the valuation is affected by anchoring effects and the stated preferences, albeit internally coherent, are unstable (Ariely et al. 2003).

To investigate the effect of partisan cues on the stability of WTP responses, we randomly allocated half of the respondents to a treatment group that received the tally of the parliamentary vote on the road safety program *Via sicura*, which was similar in scope and cost to the proposed program A.[8] This type of framing experiment has been frequently used in political sciences to explore the genuineness of voter preferences (e.g., Druckman 2001; Taber and Lodge 2006; Slothuus and de Vreese 2010). The provision of partisan cues seizes on the idea that preferences for public goods emerge from interactions between individuals and their social environment (Druckman and Lupia 2000). Accordingly, one way of helping people make choices that are consistent with their preferences is the provision of information about peer preferences (Akerlof and Cranton 2010). Partisan cues are perhaps the best possible example. If safety preferences are inherent and stable, then the provision of such contextual information should not affect the respondent's valuation; on the contrary, if safety preferences are socially constructed, then a respondent should be more likely to follow the advice of their endorsed political party.

In order to control for potential interaction between the two treatments, we used a survey design that orthogonally crossed the two experimental factors and allocated respondents in rotation. This resulted in four balanced treatment samples, which showed no differences with regard to socio-economic characteristics and response time.

[8]The *Via sicura* initiative was approved by the Swiss Parliament in 2012. Treated respondents received the vote tally and were referred to the similar scope of this initiative and the proposed program A (low anchor condition) or they were told that the *Via sicura* initiative is comparable in scope to a program half the size of program B (high anchor condition).

4 Empirical Strategy

This section describes our empirical strategy to estimate the VSA and to derive the WTP metrics for the specific health endpoints associated with road accidents. We first consider the choices over road safety programs, before we turn to the estimation of the marginal rates of substitution between the different health endpoints.

4.1 Analysis of Program Choices

The program choice task involves tradeoffs between road safety programs that offer a decreasing number of accidents at an increasing cost. The choice of a program k can be framed in terms of the additional number of accidents avoided $\Delta Q_k^{k+1} = Q^{k+1} - Q^k$ and the corresponding additional cost $\Delta_i C_k^{k+1} = C_i^{k+1} - C_i^k$ to be incurred by respondent i. If the respondent were indifferent between the two programs $k+1$ and k, their WTP for avoiding one statistical accident would just equal the risk-money tradeoff: $\omega_i = \Delta Q_k^{k+1} / \Delta_i C_k^{k+1}$. The expression of indifference was not possible in our task, however. Respondents had to choose their preferred program, providing us with bounds on their latent WTP similar to the double-bounded dichotomous choice format (Carson and Hanemann 2005). Assume respondent i chooses program k. This choice implies $\omega_i^{k+1} > \tilde{\omega}_i \geq \omega_i^k$, meaning that i's unobserved WTP, $\tilde{\omega}_i$, is contained in the closed interval $[\omega_i^k, \omega_i^{k+1})$. The choice of the largest program K and the status quo imply the intervals $[\omega_i^K, \infty)$ and $[0, \omega_i^1)$, respectively.

The appropriate technique to address double-censored data is interval regression. The resulting coefficient estimates are interpretable in the same way as OLS coefficients, enabling us to estimate $\hat{\omega}_i$ for each respondent i. If we assumed the WTP for public safety is normally distributed, we could do so based on the untransformed intervals provided by the respondent's choice. However, negative WTP values as implied by the normal distribution are at odds with economic theory. We therefore transform the intervals to $[\log \omega_i^k, \log \omega_i^{k+1})$, $[\log \omega_i^K, \infty)$ and $[-\infty, \log \omega_i^1)$, respectively.

4.2 Analysis of Location Choices

The analysis of the location choices is based on the binary choice framework proposed by Cameron and James (1987). It exploits that, by varying the risk-risk tradeoff $\Delta \equiv (p^b - p^a)/(q^a - q^b)$ over subjects, one obtains information about the dispersion parameter σ of the conditional distribution of the marginal rate of substitution μ_i between two health endpoints. Assume that $\mu_i = \beta' X_i + \varepsilon_i$, where X_i is a vector of covariates. Each respondent faces a randomly allocated Δ_i, so that the choice for or against region b reveals whether μ_i is greater or less than Δ_i. For a normally distributed error term ε_i, we can thus derive the probit model:

$$\Pr(y_i = 1|X_i) = \Pr(\mu_i > \Delta_i) = 1 - \Phi((\Delta_i - \beta' X_i)/\sigma). \tag{5}$$

As Cameron and James (1987) demonstrated, one can treat the risk-risk tradeoff as an observable by appending the coefficient α on Δ_i. Then, $\hat{\alpha}$ will be a point estimate of $-1/\sigma$, while the coefficient vector $\hat{\theta}$ will collect estimates of β/σ. Based on the vector estimates $\hat{\alpha}$ and $\hat{\theta}$, it is trivial to obtain the corresponding estimate of the marginal rate of substitution:

$$\hat{\mu}_i = \hat{\alpha}^{-1} N^{-1} \sum_{i=1}^{N} \hat{\theta}' X_i, \tag{6}$$

where N is the number of respondents. One thing to keep in mind is, however, that each respondent faced a series of four location choices pertaining to the tradeoffs between the five health endpoints. Given the structure of the task, it is unlikely that choices by one respondent are independent of each other. We therefore estimate a multivariate extension of the Cameron-James model, assuming that the errors share a multivariate normal distribution.

4.3 Conversion of WTP Metrics

Once the individual marginal rates of substitution are estimated, we can convert into the specific WTP metric for each of the different health endpoints by exploiting that:

$$\hat{\omega}_i = \tilde{\omega}_i^F \left(1 + \hat{\mu}_F^D \left(D + \hat{\mu}_D^S \left(S + \hat{\mu}_S^M \left(M + \hat{\mu}_M^O O\right)\right)\right)\right), \tag{7}$$

with $\hat{\mu}_y^x = 1/\hat{\mu}_x^y$. That is, we convert the non-fatal health outcomes of a statistical accident into fatality equivalents and since all but the VSL parameter $\tilde{\omega}_i^F$ in Eq. (7) are known, we may simply solve for it. Estimates of $\tilde{\omega}_i^D$, $\tilde{\omega}_i^S$, $\tilde{\omega}_i^M$, and $\tilde{\omega}_i^O$ are obtained in a similar way. One practical issue is that the derivation involves the multiplication of several estimated variables. In the empirical application, we use a pairs cluster bootstrap (Cameron and Miller 2015) to estimate consistent confidence intervals around the derived WTP metrics.

5 Results

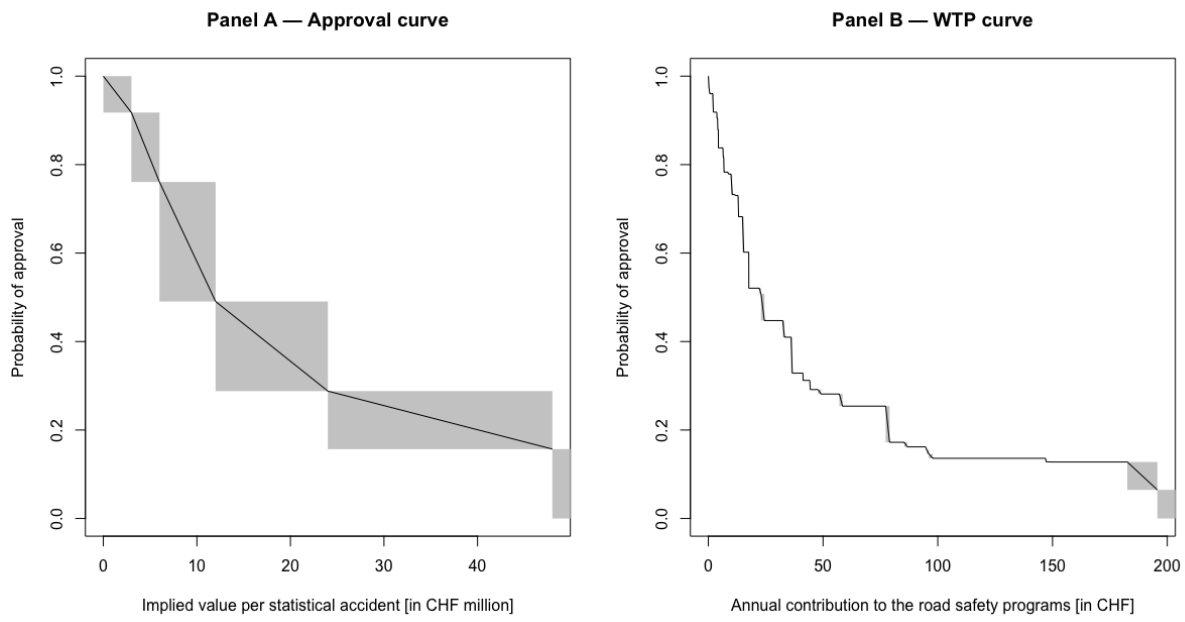
Perhaps the most intuitive way to present our results is by plotting the approval rate for each of the five road safety programs against the implied VSA. Panel A of Figure 2 shows this approval curve, suggesting that the endorsed median VSA is close to CHF 11 million, respectively. Based on the response probability distribution to the individual bids, it is possible to construct a WTP curve, which illustrates the fraction of respondents who are willing to make a specific contribution per accident avoided (see Panel B of Figure 2). This WTP curve is well-behaved in the sense that the fraction of respondents who are willing to contribute more than a specific amount is rapidly declining so that the median contribution for avoiding one additional statistical road accident is close to CHF 2.30.[9]

5.1 WTP for Avoiding a Statistical Accident

Next, we present regression-based estimates of the WTP for avoiding one statistical road accident. As McFadden (1994) notes, there is no need to include covariates such as income, age, or gender for estimating the mean or median WTP in a target population. However, we

[9]Note that there is a close link to an aggregate demand curve, as the WTP curve depicts how demand declines when the per unit price of the public good increases (Carson and Hanemann 2005).

Figure 2: Approval of road safety programs.



Note: Lines indicate linear interpolations within the gray intervals.

seek to understand how risk perceptions, other-regarding preferences and other concomitant factors affect the willingness to contribute to road safety. Table 3 provides a summary of the variables included in the interval regression analysis.

Table 4 presents three models with different sets of explanatory variables. Model I comprises the full set of covariates but omits the treatment effects. Yet, as the treatments were randomly allocated, the omission does not affect the mean WTP estimate. The model therefore mimics the analysis of a naïve researcher, who ignores that cognitive factors may undermine the interpretation of stated preferences as "true" preferences. Indeed, the coefficient estimates of Model I resonate well with theoretical expectations. We observe neither gender nor regional differences, suggesting that the ballot questions were posed in a neutral way. Educational attainment, income, mileage driven and having children had the expected positive impact on WTP. The first two factors make it cheaper in utility terms to spend money on a public good, while the latter two factors make the provision of safety more valuable to the respondent.

Table 3: Summary of explanatory variables.

Variable	Definition	n	Mean	SD	Min	Max
High anchor	Respondent evaluated programs B-E	1,007	0.49	0.50	0	1
Partisan cues	Respondent received partisan cues	1,007	0.50	0.50	0	1
Age	Age	1,007	46.5	14.9	18	74
Female	Female	1,007	0.52	0.50	0	1
French	French-speaking region	1,007	0.25	0.43	0	1
Italian	Italian-speaking region	1,007	0.10	0.30	0	1
Basic	Basic education	1,007	0.03	0.18	0	1
University	University education	1,007	0.44	0.50	0	1
Income group 2	Monthly income: CHF 4,001-6,000	996	0.26	0.44	0	1
Income group 3	Monthly income: CHF 6,001-8,000	996	0.18	0.39	0	1
Income group 4	Monthly income: CHF 8,001-10,000	996	0.12	0.32	0	1
Income group 5	Monthly income: > CHF 10,000	996	0.09	0.29	0	1
Children	Household with children	1,007	0.39	0.49	0	1
Rural	Rural community	1,007	0.25	0.43	0	1
Left	Political orientation: left	992	0.31	0.46	0	1
Right	Political orientation: right	992	0.39	0.49	0	1
Rail card	Owner of a rail card	1,007	0.62	0.49	0	1
Perceived risk	Perceived risk of road travel§	994	0.00	1.98	-4.1	5.9
Uncertainty	Stated uncertainty about response	1,007	0.24	0.43	0	1
Completion time	Time spent studying information (in minutes)§	1,007	0.00	4.00	-1.5	99.6
Own safety	Own vs. others' safety (on a scale from 0 to 10): <3	1,007	0.01	0.12	0	1
Others' safety	Own vs. others' safety (on a scale from 0 to 10): >7	1,007	0.13	0.33	0	1
Cost	Considered additional costs	1,007	0.69	0.46	0	1
Death	Considered own risk of death	1,007	0.43	0.49	0	1
Injury	Considered own risk of injury	1,007	0.45	0.50	0	1
Public safety	Considered public safety	1,007	0.56	0.50	0	1
Own driving	Considered own driving ability	1,007	0.36	0.48	0	1
Other driving	Considered driving ability of others	1,007	0.43	0.50	0	1
Donate	Respondent donated survey compensation	1,007	0.30	0.46	0	1
Never vote	Votes never or rarely	1,007	0.06	0.24	0	1
Mileage	Annual mileage driven (in 1,000 km)§	1,006	0.00	6.80	-8.1	19.4

Note: § denotes mean-centered variables.

Table 4: Results of interval regression models.

	Model I			Model II			Model III		
	Coef.	z-stat		Coef.	z-stat		Coef.	z-stat	
High anchor shown				0.487	4.18	***	0.440	4.46	***
Partisan cues provided				-0.202	-1.66	*	-0.240	-2.34	**
Treatment interaction				0.041	0.25		0.065	0.64	
Age	0.006	2.09	**				0.005	1.88	*
Female	-0.014	-0.17					-0.020	-0.25	
French	0.071	0.75					0.085	0.96	
Italian	-0.091	-0.64					-0.108	-0.80	
Basic	-0.261	-0.83					-0.300	-0.99	
Tertiary	0.232	2.77	***				0.208	2.64	***
Income group 2	0.173	1.79	*				0.160	1.77	*
Income group 3	0.250	2.38	**				0.248	2.49	**
Income group 4	0.268	1.90	*				0.280	2.05	**
Income group 5	0.269	1.53					0.295	1.77	*
Children	0.150	1.97	**				0.161	2.24	**
Rural	-0.142	-1.67	*				-0.148	-1.82	*
Left	0.161	1.68	*				0.102	1.09	
Right	-0.176	-2.04	**				-0.201	-2.64	**
Traffic card	0.126	1.50					0.096	1.19	
Travel risk	0.025	1.27					0.017	0.89	
Uncertain	-0.309	-3.48	***				-0.304	-3.65	***
Completion time	0.012	0.83					0.010	0.74	
Own safety	-0.520	-1.36					-0.506	-1.55	
Other safety	-0.092	-0.69					-0.116	-0.91	
Additional cost	-0.277	-2.94	***				-0.295	-3.29	***
Risk of death	0.388	4.47	***				0.358	4.35	***
Risk of injury	0.327	3.86	***				0.298	3.74	***
Public safety	0.580	7.71	***				0.600	8.30	***
Own driving	-0.262	-3.16	***				-0.253	-3.18	***
Other driving	0.169	2.17	**				0.133	1.79	*
Donate	0.266	3.23	***				0.250	3.18	***
Never vote	-0.276	-1.67	*				-0.311	-1.93	*
Mileage	0.025	4.17	***				0.024	4.12	***
Intercept	-0.634	-2.96	***	0.195	2.18	**	-0.612	-2.86	**
Number of respondents	971			1,007			971		
Log pseudo-likelihood	-1,473.6			-1,671.3			-1,447.7		
McFadden's R^2	0.098			0.012			0.114		

Note: Dependent variable is log(WTP) interval. Significance levels: '***' 0.01, '**' 0.05, '*' 0.1.

A number of perceptional factors are associated with a higher WTP for road safety. These include the perceived risk of road travel in Switzerland measured on a scale from 0 ('no risk at all') to ('very high risk') and further dummies indicating whether the respondent had considered their own risk of dying or getting injured as well as their and other road users' driving skills. We find also factors that are negatively associated with the stated WTP. Political orientation had a significant effect with right-wing party supporters being willing to pay roughly 20% less than supporters of centrist parties and 30% less than supporters of left-wing parties. Respondents who were relatively uncertain about their choices expressed a 30 percent points lower WTP than those who felt relatively certain about their answers. Similarly, respondents who had considered their own driving skills stated a 25% lower WTP, while those who had considered the driving skills of other road users stated a roughly 15% higher WTP.

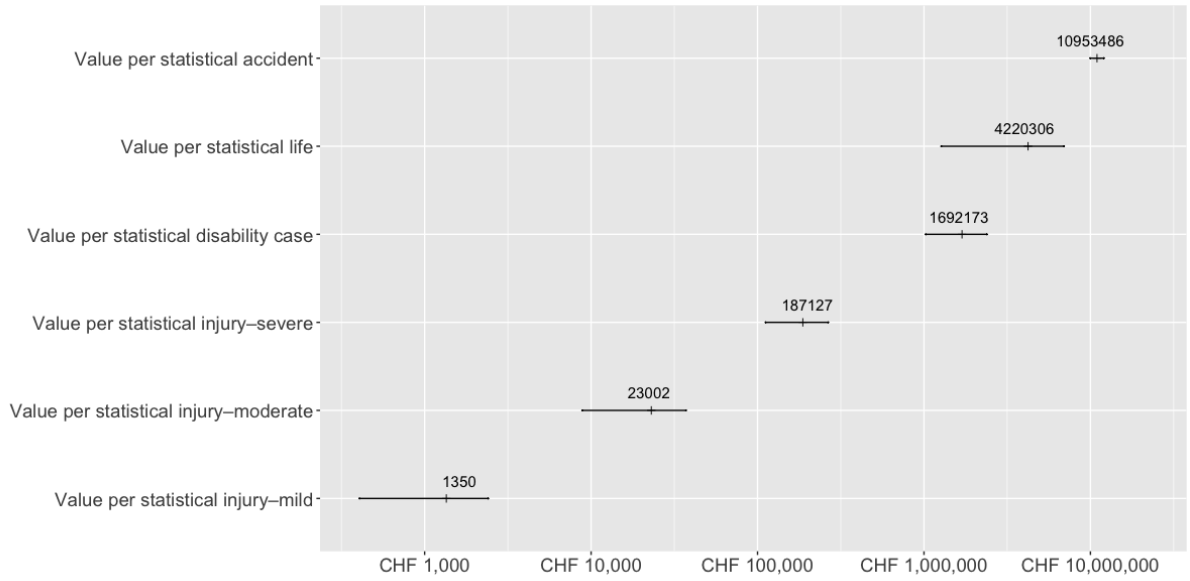
We included several covariates related to the altruistic preferences. Many of them have statistically significant and large effects on the stated WTP. A respondent who considered only their own safety and worried about additional costs that would accrue when adopting one of the proposed road safety programs was willing to pay almost three times less than the average respondent. On the other hand, a respondent who had considered safety as a public good, and had donated the compensation for participating in the survey (about CHF 10) to a charity organization was willing to pay more than twice as much as the average respondent. These results underline that preferences for road safety are very heterogeneous and altruism has a distinct impact on people's preferences for road safety.

5.2 Aggregation of Individual-level WTP

We applied population weights as reported in Table 2 to aggregate the individual-level WTP estimates. We then converted the obtained VSA estimates into WTP metrics for different accident severity using the marginal rates of substitution between health endpoints that

we derived from the risk-risk tradeoffs.[10] Figure 3 reports the obtained mean value for each of the WTP metrics as well as the corresponding 10-percentile and 90-percentile values obtained from the pairs cluster bootstrap with 1,000 draws. By construction, the largest variability pertains to the VSL estimates. The range and the central VSL estimate are, however, consistent with the VSL literature (see Viscusi and Aldy 2003, Cropper et al. 2011). We also notice that the value per statistical disability is roughly 40% of the VSL. Assuming that an irreversible disability reduces life quality by about 60%, this estimate does not seem far off from those implied by QALY losses associated with severe diseases such as heart attack or stroke (Salomon et al. 2013). The mean values per statistical injury range from roughly CHF 1,000 for mild injuries up to CHF 167,000 for severe injuries. This is consistent with evidence obtained from Swiss labor market data (Ruf and Kuhn 2013).

Figure 3: WTP metrics for different accident severities (in CHF).



Note: Left and right endpoints of the bars indicate the 10th and 90th percentiles of the distribution of the corresponding WTP metric obtained by pairs cluster bootstrapping.

[10]Results of the underlying multivariate probit model are reported in the Appendix.

5.3 Treatment effects

Overall, the naïve analyst would be quite comfortable with the obtained WTP estimates. In a next step, we look at the treatment effects which give reasons for concern about the validity of our results. Models II and III in Table 4 include the treatment factors instead or in addition to the covariates included in Model I. The comparison of the effect sizes indicates that both treatment effects are conditionally independent of the covariates. Since the coefficients of the covariates are hardly altered by the inclusion of the treatment effects, we focus our discussion on the more parsimonious Model II. Table 5 presents a summary of individual-level mean WTP values for the four treatment conditions. From this summary table, a large anchoring effect and a modest effect of partisan cues are apparent. Below, we discuss both treatment effects in more detail.

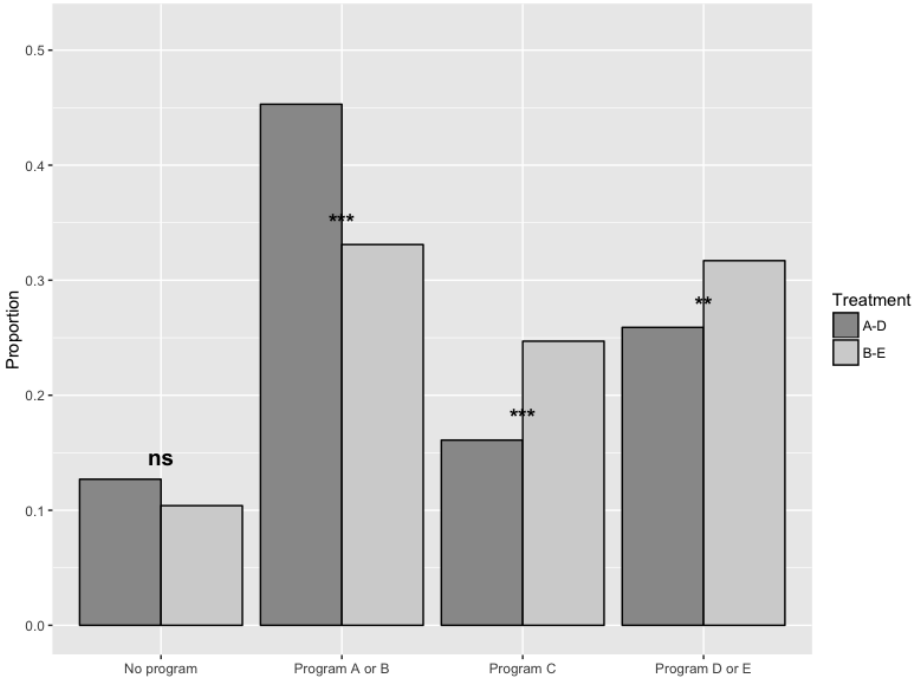
Table 5: Mean individual WTP estimates across the treatment conditions (in CHF).

		Anchoring treatment		
		Low anchor	High anchor	All
Information	Control	1.25 ($n = 254$)	1.96 ($n = 249$)	1.55 ($n = 503$)
treatment	Partisan Cues	0.99 ($n = 256$)	1.68 ($n = 248$)	1.29 ($n = 504$)
	All	1.11 ($n = 510$)	1.82 ($n = 497$)	1.41 ($n = 1,007$)

Note: Predicted values of Model II (see Table 4) evaluated at sample means.

We find—and this would have slipped the attention of the naïve analyst who estimated Model I—that the estimated individual WTP values are strongly correlated with the quantitative scales of the response options. Respondents who evaluated road safety programs A through D, and thus a choice set whose least and most expensive programs were half as costly as those implied by the choice set including programs B through E, were on average willing to pay roughly 40% less per accident avoided than the latter group (CHF 1.11 vs CHF 1.82). Although there might be some boundary effects related to the fact that approving the most expensive program does only establish a lower bound on the approving respondent's latent WTP, one would have expected a much smaller effect, if any. Moreover, one would have expected that program C, which was offered to both treatment groups, were chosen equally

Figure 4: Proportion of chosen road safety programs by anchoring treatment.



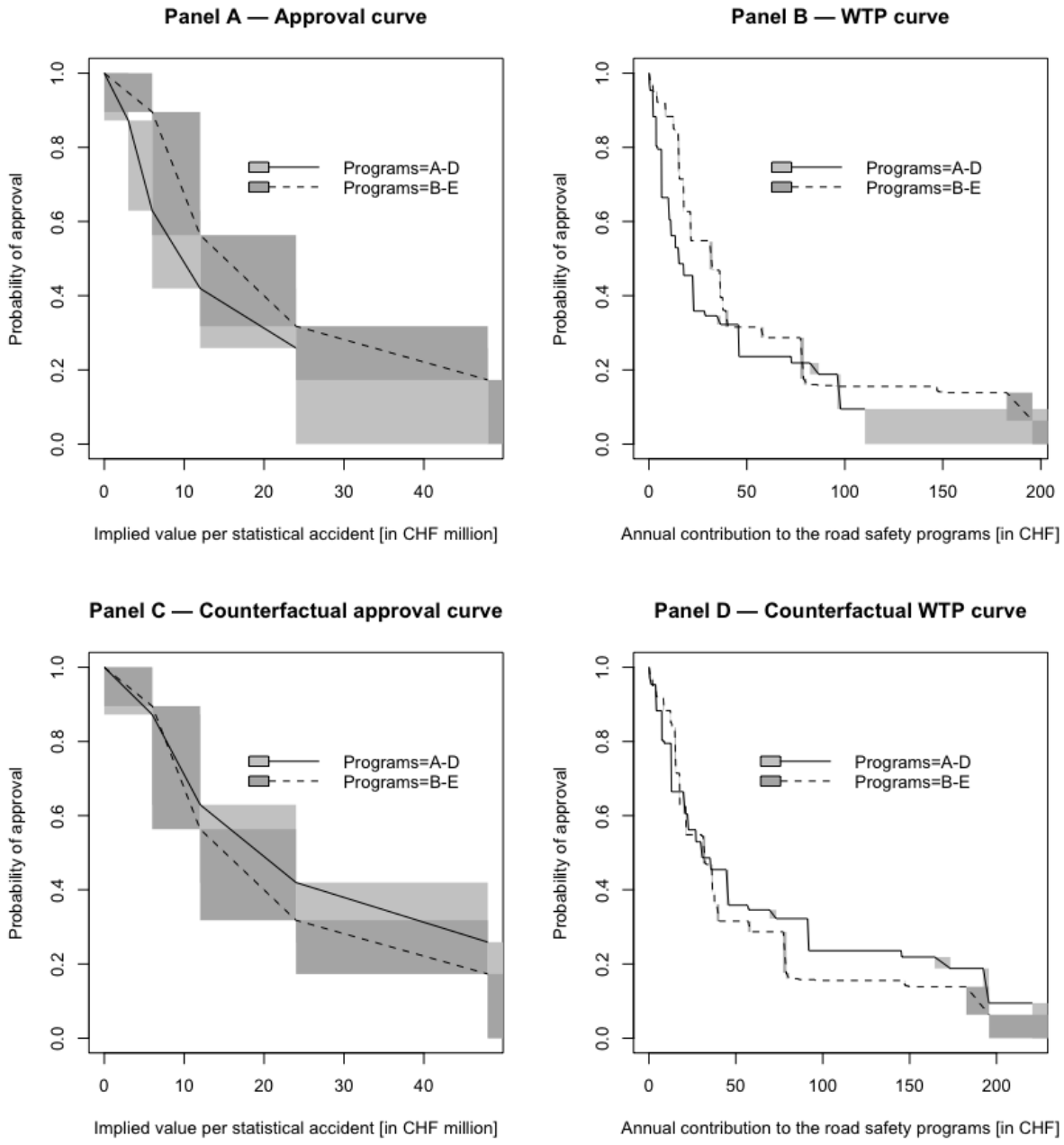
Note: Differences in proportions tested using the Exact Fisher test. Significance levels: '***' 0.01, '**' 0.05, '*' 0.1, 'NS' non significant.

frequently (Kahneman et al. 1999). As Figure 4 shows, this was clearly not the case. Significantly more respondents (25% vs. 16%) chose program C if it was presented as an option within the choice set $\{\mathsf{B}, \mathsf{C}, \mathsf{D}, \mathsf{E}\}$ rather than the choice set $\{\mathsf{A}, \mathsf{B}, \mathsf{C}, \mathsf{D}\}$.

A look at the approval and the WTP curves of the two treatment groups in Panels A and B of Figure 5 suggests that the respective WTP values are indeed drawn from two horizontally shifted distributions. Panels C and D plot out counterfactual distributions presuming that every respondent had faced programs B through E.[11] The counterfactual analysis indicates that the two treatment conditions invoked a relatively stable number of approvals of the least and second least expensive program, whereas in the high-bid range sensitivity to scope was more pronounced.

[11]The counterfactual distributions were derived by simply doubling the bids of the treatment group who evaluated programs A through D.

Figure 5: Anchoring effect on the approval of road safety programs.



Note: Lines indicate linear interpolations within the gray intervals.

The provision of partisan cues had a significant, albeit smaller effect on the choices over the road safety programs. Compared to the untreated, respondents who had received information about the political parties' endorsement of road safety expenditure before making their choices reduced their contribution by 20% on average (CHF 1.55 vs CHF 1.29). While

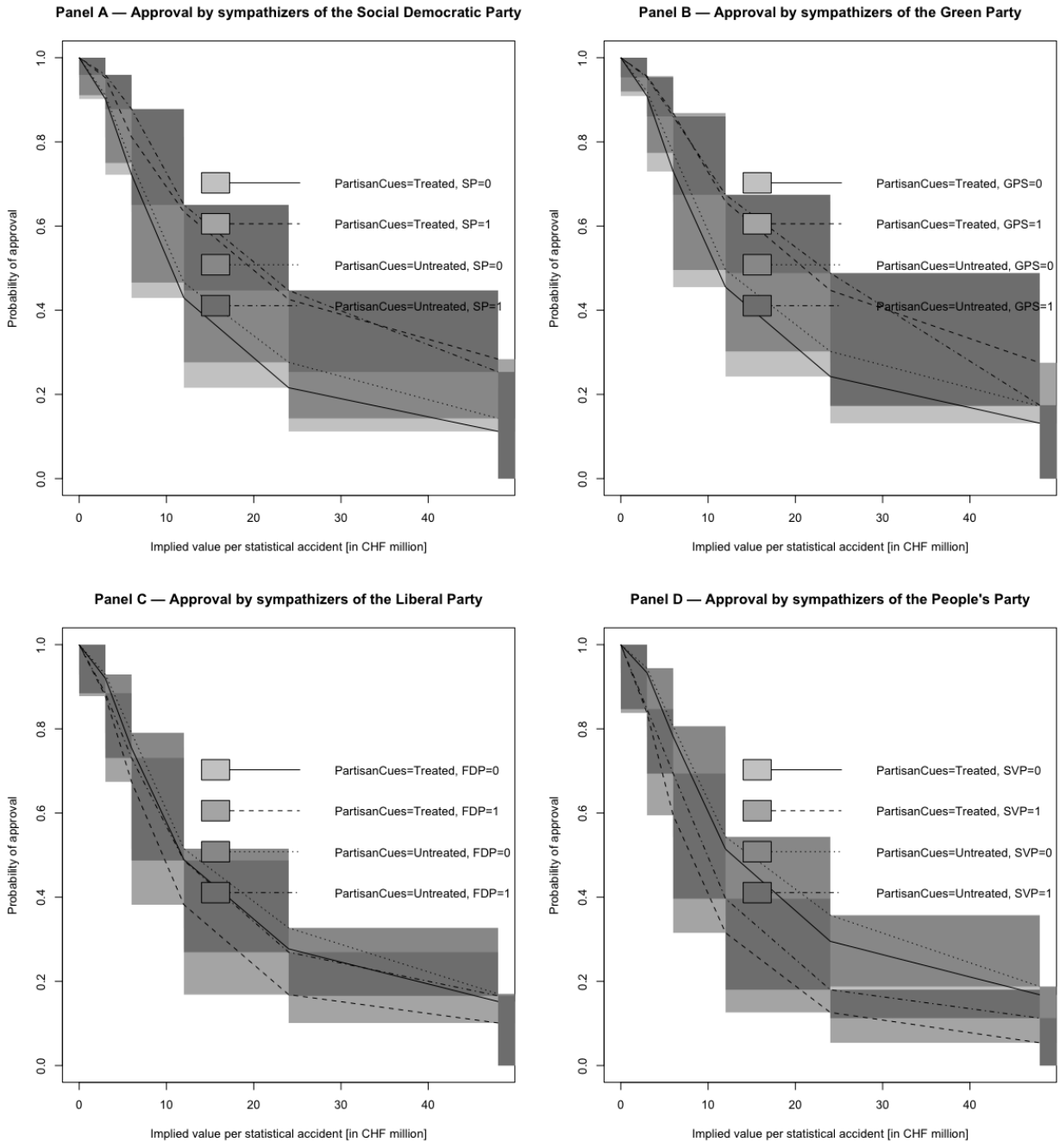
the treatment reduced particularly the willingness to contribute large amounts, it had no detectable effect on the likelihood of contributing per se. In other words, the treatment effect reduced the intensive margin but not the extensive margin of the demand for road safety.

In light of the vast literature on framing effects, it comes hardly as a surprise that partisan cues affected the willingness to contribute to the public good. What is interesting, however, is that the treatment affected respondents with different political preferences differently. As Figure 6 shows, the provision of partisan cues had no detectable effect on respondents sympathizing with the two most left-leaning parties (Panels A and B), whereas it had a pronounced effect on supporters of the two most right-leaning parties (Panels C and D).[12] Treated supporters of the Liberal Party (Panel C) and the People's Party (Panel D) significantly reduced their approval of the proposed road safety programs after learning that their parties had not been in full support of (the Liberal Party) or had blackballed (the People's Party) the *Via sicura* program.

Finally, we controlled for a possible interaction between the two experimental factors. However, the interaction term is insignificant, rejecting the hypothesis that partisan cues moderate WTP responses in such a way that they would crowd out the effects of the arbitrary anchoring on the response scales. One might have thought that if these treatments had any effect on the respondents' WTP, then the effect on respondents who evaluated programs B through E should be more pronounced than on those who evaluated programs A through D because more is at stake in terms of public expenditure to a good endorsed by left wing parties and rejected by right wing parties. Testing for an interaction effect between the partisan cues treatment and the endorsed political party of the respondent did, however, not result in a statistically significant effect.

[12]The treatment had a limited effect on supporters of centrist parties as well, primarily through reducing their willingness to contribute large amounts.

Figure 6: Partisan cue effect on the approval of road safety programs by different party supporters.



Note: Lines indicate linear interpolations within the gray intervals.

6 Conclusion

We have pursued three objectives in this paper. First, we sought to derive preferences for road safety based on people's choices over different levels of safety provision. To achieve this goal, we refrained from using the standard CV referendum approach which relies on randomly assigned prices. Instead, we presented survey respondents with credible road safety programs that could be implemented and would have a similar impact on traffic accidents than what we described to respondents. Second, we used an anchoring experiment to assess how sensitive the survey results are to normatively irrelevant factors. Lastly, we used an experiment offering partisan cues to one treatment group in order to test if any arbitrariness in the responses can be decreased by offering partisan cues as a substitute for the political views and opinions available in an actual public voting process. Below, we discuss the main findings relating to each of these objectives.

By deriving WTP values from people's preferred quantities of road safety programs, we linked the provision of a public good to credible individual costs rather than to randomly assigned bids as in standard CV referendum exercises. Asking about the approval of realistic policy options is perhaps the most natural way to elicit preferences in a public good context. Moreover, it is well known that randomly assigned bids may differ sharply from credible individual costs (Flores and Strong 2007). Our survey instrument had desirable properties regarding the incentive compatibility of our questions. Indeed, incentives for giving strategic answering are decreased because the bid amounts are linked to what one would actually contribute in terms of direct taxes on income and indirect taxes on gasoline consumption. Hence, even if a respondent tried to game the survey, their leverage power was small because the bids corresponded to their actual contributions would one of the programs be implemented.

This said, the anchoring experiment incorporated into the survey revealed a significant effect of the response scale on the stated WTP: when all choice options offered decreased in cost and benefit by 100%, the mean WTP per statistical accident avoided was reduced by roughly 40 percent points. This figure provides a readily interpretable measure of the

anchoring effect (Kahneman et al. 1999) and suggests that the demand for safety "travelled" with the choice set (Drolet et al. 2000). Unfortunately, comparable statistics are scarce in applied work. The most common experimental sensitivity test in standard referendum CV surveys is a scope sensitivity test, which examines whether WTP values are affected by the amount or scope of the commodity provided (Hammitt and Graham 1999). A recent meta-analysis by the OECD (2012) found that only 199 of 405 VSL studies had reported a split-sample scope sensitivity test. Of these 199 studies, only 79 passed a weak form of the test, meaning that the VSL showed at least some sensitivity to the amount of risk reduction. Since our VSL estimates change less than proportionally with the cost indicated in the response scale, they are comparable to weakly scope-sensitive estimates. In other words, while our estimates are affected by contextual factors, they still pass the—admittedly weak—standards currently applied in the VSL literature.

We offer three possible explanations for the significant anchoring effect (although we cannot rigorously test them with our data).

The first explanation relates to boundary effects. By assuming a lognormal WTP distribution, one implies that a fraction of respondents who approve road safety program k would also approve program $k + 1$. However, if the observed choices do not follow the lognormal distribution—perhaps because the empirical distribution is fat-tailed—then one ends up with differences in the stated mean WTP that are independent of the underlying preferences.

The second explanation relates to attraction and compromise effects as found in the experimental studies by Drolet et al. (2000) and Ariely et al. (2003), among others. The counterfactual analysis presented in Figure 5 suggests that for individual contributions below CHF 35, respondents might have simply ignored the absolute benefits and costs of a program and instead applied simplistic choice rules such as 'choose the least expensive' or 'choose the middle option'. Beyond CHF 50, however, the respondents seemed to pay attention to the actual benefits and costs associated with a program.

The last explanation links back to the model of Kamenica (2008), which incorporates contextual influences into the choice process. The main idea here is that the respondent learns something about the scope of the public good that helps them in forming their preferences. E.g., if program E is offered to a respondent, they may conclude that government could do more than implementing program D to reduce car accidents. The mere knowledge that more safety could be provided may well offer clues to respondents that are reconcilable with standard choice theory.

Our third objective was to explore if information about the political support for or opposition to additional public spending on road safety programs would affect respondents' preference formation and whether or not this would help them in forming consistent preferences when confronting seemingly irrelevant differences in the response scale. Our results suggest that some of the treated respondents squared their preference for road safety with their political identity (Akerlof and Cranton 2010). Indeed, supporters of right-wing parties who had received the information about their parties recently rejecting a road safety program in Parliament became significantly less willing to contribute to the public good, whereas supporters of centrist and left-wing parties were almost unaffected by the treatment. The information provision did not balance the anchoring effect, however. Perhaps if the political parties had directly endorsed their preferred program—as in a real ballot—the political advice would have had a stronger impact. Understanding how alternative types of contextual information shapes choices over public goods remains a topic for future research.

We conclude that, while the presented demand function approach is not immune against anchoring and framing effects, it has several desirable properties, particularly with regard to incentive compatibility. Specifically, it enables the analyst to determine the median preferred quantity of the public good, which is strategy-proof. In actual debates about the provision of a public good, the median preferred quantity may therefore serve as an incentive compatible benchmark that gauges the political support for a specific policy recommendation beyond the typical benefit-cost criteria.

References

Akerlof, G., Cranton, R., 2010. Identity Economics. Princeton University Press, New Jersey, NJ.

Andersson, H., Hole, A. R., Svensson, M., 2016. Valuation of small and multiple health risks: A critical analysis of SP data applied to food and water safety. Journal of Environmental Economics and Management 75, 41–53.

Ariely, D., Loewenstein, G., Prelec, D., 2003. "Coherent arbitrariness": Stable demand curves without stable preferences. Quarterly Journal of Economics 118 (1), 73–105.

Ashenfelter, O., 2006. Measuring the value of a statistical life: Problems and prospects. Economic Journal 116 (510), 10–23.

Ashenfelter, O., Greenstone, M., 2004. Using mandated speed limits to measure the value of a statistical life. Journal of Political Economy 112 (1), 226–267.

Baron, J., 1997. Confusion of relative and absolute risk in valuation. Journal of Risk and Uncertainty 14 (3), 301–309.

Beattie, J., Covey, J., Dolan, P., Hopkins, L., Jones-Lee, M., Loomes, G., Pidgeon, N., Robinson, A., Spencer, A., 1998. On the contingent valuation of safety and the safety of contingent valuation: part 1—caveat investigator. Journal of Risk and Uncertainty 17 (1), 5–26.

Bergstrom, T. C., 2006. Benefit-cost in a benevolent society. American Economic Review 96 (1), 339–351.

Bergstrom, T. C., Rubinfeld, D. L., Shapiro, P., 1982. Micro-based estimates of demand functions for local school expenditures. Econometrica 50 (5), 1183–1205.

Black, D. A., Kniesner, T. J., 2003. On the measurement of job risk in hedonic wage models. Journal of Risk and Uncertainty 27 (3), 205–220.

Cameron, A. C., Miller, D. L., 2015. A practitioner's guide to cluster-robust inference. Journal of Human Resources 50 (2), 317–372.

Cameron, T. A., James, M. D., 1987. Efficient estimation methods for "closed-ended" contingent valuation surveys. Review of Economics and Statistics 69 (2), 269–276.

Carson, R. T., Hanemann, M., 2005. Contingent valuation. In: Mähler, K.-G., Vincent, J. (Eds.), Handbook of Environmental Economics. Vol. 2. Elsevier B.V., London.

Corso, P. S., Hammitt, J. K., Graham, J. D., 2001. Valuing mortality-risk reduction: Using visual aids to improve the validity of contingent valuation. Journal of Risk and Uncertainty 23 (2), 165–184.

Cropper, M., Hammitt, J. K., Robinson, L. A., 2011. Valuing mortality risk reductions: Progress and challenges. Annual Review of Resource Economics 3, 313–336.

Cummings, R. G., Taylor, L. O., 1999. Unbiased value estimates for environmental goods: A cheap talk design for the contingent valuation method. American Economic Review 89 (3), 649–665.

DeLeire, T., Khan, S., Timmins, C., 2013. Roy model sorting and nonrandom selection in the valuation of a statistical life. International Economic Review 54 (1), 279–306.

Drolet, A., Simonson, I., Tversky, A., 2000. Indifference curves that travel with the choice set. Marketing Letters 11 (3), 199–209.

Druckman, J. N., 2001. Using credible advice to overcome framing effects. Journal of Law, Economics, and Organization 17 (1), 62–82.

Druckman, J. N., Lupia, A., 2000. Preference formation. Annual Review of Political Science 3 (1), 1–24.

Evans, M. F., Schaur, G., 2010. A quantile estimation approach to identify income and age variation in the value of a statistical life. Journal of Environmental Economics and Management 59 (3), 260–270.

Flores, N. E., Strong, A., 2007. Cost credibility and the stated preference analysis of public goods. Environmental and Resource Economics 29 (3), 195–205.

Gayer, T., Hamilton, J. T., Viscusi, W. K., 2000. Private values of risk tradeoffs at superfund sites: housing market evidence on learning about risk. Review of Economics and Statistics 82 (3), 439–451.

Gibbard, A., 1973. Manipulation of voting schemes: A general result. Econometrica 41 (4), 587–601.

Green, D. P., Jacowitz, K. E., Kahneman, D., McFadden, D., 1998. Referendum contingent valuation, anchoring, and willingness to pay for public goods. Resource and Energy Economics 20 (2), 85–116.

Hammitt, J. K., Graham, J. D., 1999. Willingness to pay for health protection: Inadequate sensitivity to probability? Journal of Risk and Uncertainty 18 (1), 33–62.

Hausman, J. A., 2012. Contingent valuation: From dubious to hopeless. Journal of Economic Perspectives 26 (4), 43–56.

Hwang, H. S., Reed, W. R., Hubbard, C., 1992. Compensating wage differentials and unobserved productivity. Journal of Political Economy 100 (4), 835–858.

Kahneman, D., Ritov, I., Schkade, D., 1999. Economic preferences or attitude expressions? An analysis of dollar responses to public issues. Journal of Risk and Uncertainty 19 (1-3), 203–235.

Kamenica, E., 2008. Contextual inference in markets: On the informational content of product lines. American Economic Review 98 (5), 2127–2149.

Kling, C. L., Phaneuf, D. J., Zhao, J., 2012. From Exxon to BP: Has some number become better than no number? Journal of Economic Perspectives 26 (4), 3–26.

Kniesner, T. J., Viscusi, W. K., Woock, C., Ziliak, J. P., 2012. The value of a statistical life: Evidence from panel data. Review of Economics and Statistics 94 (1), 74–87.

Kniesner, T. J., Viscusi, W. K., Ziliak, J. P., 2010. Policy relevant heterogeneity in the value of statistical life: New evidence from panel data quantile regressions. Journal of Risk and Uncertainty 40 (1), 15–31.

Kunreuther, H., Novemsky, N., Kahneman, D., 2001. Making low probabilities useful. Journal of Risk and Uncertainty 23 (2), 103–120.

List, J. A., Gallet, C. A., 2001. What experimental protocol influence disparities between actual and hypothetical stated values? Environmental and Resource Economics 20 (3), 241–254.

Magat, W. A., Viscusi, W. K., Huber, J., 1996. A reference lottery metric for valuing health. Management Science 42 (8), 1118–1130.

McFadden, D., 1994. Contingent valuation and social choice. American Journal of Agricultural Economics 76 (4), 689–708.

Menon, G., Raghubir, O., Schwarz, N., 1997. How much will I spend? Factors affecting consumers' estimates of future expense. Journal of Consumer Psychology 6 (2), 141–164.

OECD, 2012. Mortality risk valuation in environment, health and transport policies. Tech. rep., Office of Economic Cooperation and Development Publishing. doi:10.1787/9789264130807-en.

Pollak, R. A., 1969. Conditional demand functions and consumption theory. Quarterly Journal of Economics 83 (1), 60–78.

Pratt, J. W., Zeckhauser, R. J., 1996. Willingness to pay and the distribution of risk and wealth. Journal of Political Economy 104 (4), 747–763.

Read, D., Loewenstein, G., Rabin, M., Keren, G., Laibson, D., 1999. Choice bracketing. Journal of Risk and Uncertainty 19 (1–3), 171–197.

Rheinberger, C. M., Schläpfer, F., 2015. It's the cost credibility, stupid! A comment on "Consequentiality: A theoretical and experimental exploration of a single binary choice". Toulouse School of Economics Working Paper (No. 15-573).

Rose, J. M., Bliemer, M. C., Hensher, D. A., Collins, A. T., 2008. Designing efficient stated choice experiments in the presence of reference alternatives. Transportation Research Part B: Methodological 42 (4), 395–406.

Ruf, O., Kuhn, A., 2013. The value of a statistical injury: New evidence from the Swiss labor market. Swiss Journal of Economics and Statistics 149 (1), 57–86.

Salomon, J. A., Vos, T., Hogan, D. R., et al., 2013. Common values in assessing health outcomes from disease and injury: Disability weights measurement study for the Global Burden of Disease Study 2010. Lancet 380 (9859), 2129–2143.

Satterthwaite, M. A., 1975. Strategy-proofness and Arrow's conditions: Existence and correspondence theorems for voting procedures and social welfare functions. Journal of Economic Theory 10 (2), 187–217.

Schläpfer, F., 2017. Stated preferences for public services: A classification and survey of approaches. Journal of Economic Surveys 31 (1), 258–280.

Shogren, J., Stamland, T., 2002. Skill and the value of life. Journal of Political Economy 110 (5), 1168–1173.

Slothuus, R., De Vreese, C. H., 2010. Political parties, motivated reasoning, and issue framing effects. Journal of Politics 72 (3), 630–645.

Stewart, N., Chater, N., Stott, H. P., Reimers, S., 2003. Prospect relativity: How choice options influence decision under risk. Journal of Experimental Psychology: General 132 (1), 23–46.

Taber, C. S., Lodge, M., 2006. Motivated skepticism in the evaluation of political beliefs. American Journal of Political Science 50 (3), 755–769.

Tversky, A., Kahneman, D., 1974. Judgement under uncertainty: Heuristics and biases. Science 185 (4157), 1124–1131.

Tversky, A., Simonson, I., 1993. Context-dependent preferences. Management Science 39 (10), 1179–1189.

Van Houtven, G., Sullivan, M., Dockins, C., 2008. Cancer premiums and latency effects: A risk tradeoff approach for valuing reductions in fatal cancer risks. Journal of Risk and Uncertainty 36 (2), 179–199.

Viscusi, W. K., Aldy, J. E., 2003. The value of a statistical life: A critical review of market estimates throughout the world. Journal of Risk and Uncertainty 27 (1), 5–76.

Appendix

Table 6: Individual cost calculation for each of the five road safety programs (in CHF).

A: Individual costs through direct revenue taxes

How much did you pay in taxes last year?	A	B	C	D	E
(1) Paid no taxes	0.00	0.00	0.00	0.00	0.00
(2) Between CHF 1 and CHF 2,000	0.30	0.95	2.20	4.70	9.75
(3) Between CHF 2,001 and CHF 6,000	0.65	1.90	4.40	9.45	19.50
(4) Between CHF 6,001 and CHF 10,000	1.25	3.75	8.80	18.85	39.00
(5) Between CHF 10,001 and CHF 14,000	1.90	5.65	13.20	28.30	58.50
(6) Between CHF14,001 and CHF18,000	2.50	7.55	17.60	37.75	78.00
(7) More than CHF 18,000	2.85	8.50	19.80	42.45	87.75
(8) No Response (average amount)	1.55	4.70	11.00	23.60	48.75

B: Individual costs through indirect taxes based on mileage

How many kilometers did you drive last year?	A	B	C	D	E
(1) 0 km	0.00	0.00	0.00	0.00	0.00
(2) 1 to 5,000 km	1.90	5.75	13.45	28.80	59.50
(3) 5,001 km to10,000 km	2.45	7.30	17.10	36.60	75.65
(4) 10,001 km to 15,000 km	2.95	8.90	20.75	44.45	91.80
(5) 15,001 km to 20,000 km	3.50	10.45	24.40	52.25	107.95
(6) 20,001 km to 25,000 km	4.00	12.00	28.00	60.05	124.10
(7) More than 25,000 km	4.50	13.55	31.65	67.85	140.25
(8) No Response (average amount)	2.00	6.05	14.15	30.35	62.75

Table 7: Risk-Risk tradeoff elicitation: results of multivariate probit regression.

	Death vs Disability			Disability vs Severe Injury			Severe vs Moderate Injury			Moderate vs Minor Injury		
	Coef.	z-stat		Coef.	z-stat		Coef.	z-stat		Coef.	z-stat	
Risk-risk tradeoff	-0.066	0.016	***	-0.035	0.006	***	-0.065	0.037	*	-0.018	0.006	***
Age	-0.002	0.003		-0.002	0.003		-0.005	0.003	*	0.003	0.003	
Female	0.062	0.094		-0.098	0.089		-0.082	0.090		-0.090	0.089	
French	0.046	0.101		0.080	0.095		-0.102	0.095		-0.009	0.095	
Italian	0.225	0.141		0.160	0.136		0.410	0.145	***	0.267	0.138	*
Basic education	0.049	0.215		0.608	0.218	***	0.259	0.21		0.003	0.207	
Tertiary education	-0.060	0.223		0.504	0.223	**	0.243	0.217		-0.144	0.214	
Income group 2	-0.041	0.114		-0.041	0.109		-0.055	0.108		-0.053	0.107	
Income group 3	0.064	0.134		-0.062	0.127		0.011	0.128		0.105	0.127	
Income group 4	0.093	0.158		-0.010	0.151		0.082	0.151		0.207	0.150	
Income group 5	0.119	0.214		0.341	0.205	*	0.533	0.218	**	0.424	0.208	**
Intercept	-0.068	0.273		-0.047	0.263		0.548	0.292	*	0.244	0.267	
atanhrho_12	0.305	0.056	***									
atanhrho_13	0.291	0.056	***									
atanhrho_14	0.211	0.055	***									
atanhrho_23	0.371	0.054	***									
atanhrho_24	0.316	0.053	***									
atanhrho_34	0.630	0.057	***									
No. of respondents	996											
Pseudo-log likelihood	-2,449											

Note: Dependent variable is log(WTP) interval. Significance levels: '***' 0.01, '**' 0.05, '*' 0.1.

Table 8: Risk-Risk tradeoff elicitation: substitution between health endpoints.

Marginal rate of substitution	Central estimate	95%-Confidence interval
Death vs Disability (μ_D^F)	3.30	0.12-10.73
Disability vs Severe Injury (μ_S^D)	9.22	5.60-11.76
Severe vs Moderate Injury (μ_M^S)	12.40	5.68-36.26
Moderate vs Minor Injury (μ_O^M)	24.58	13.01-42.06

Note: 95%-Confidence interval based on 1,000 cluster pair bootstrap draws.

NOTE DI LAVORO DELLA FONDAZIONE ENI ENRICO MATTEI

Fondazione Eni Enrico Mattei Working Paper Series

Our Note di Lavoro are available on the Internet at the following addresses:

http://www.feem.it/getpage.aspx?id=73&sez=Publications&padre=20&tab=1
http://papers.ssrn.com/sol3/JELJOUR_Results.cfm?form_name=journalbrowse&journal_id=266659
http://ideas.repec.org/s/fem/femwpa.html
http://www.econis.eu/LNG=EN/FAM?PPN=505954494
http://ageconsearch.umn.edu/handle/35978
http://www.bepress.com/feem/
http://labs.jstor.org/sustainability/

NOTE DI LAVORO PUBLISHED IN 2017

SAS	1.2017	Anna Alberini, Milan Ščasný: The Benefits of Avoiding Cancer (or Dying from Cancer): Evidence from a Four-country Study
ET	2.2017	Cesare Dosi, Michele Moretto: Cost Uncertainty and Time Overruns in Public Procurement: a Scoring Auction for a Contract with Delay Penalties
SAS	3.2017	Gianni Guastella, Stefano Pareglio, Paolo Sckokai: A Spatial Econometric Analysis of Land Use Efficiency in Large and Small Municipalities
ESP	4.2017	Sara Brzuszkiewicz: The Social Contract in the MENA Region and the Energy Sector Reforms
ET	5.2017	Berno Buechel, Lydia Mechtenberg: The Swing Voter's Curse in Social Networks
ET	6.2017	Andrea Bastianin, Marzio Galeotti, Matteo Manera: Statistical and Economic Evaluation of Time Series. Models for Forecasting Arrivals at Call Centers
MITP	7.2017	Robert C. Pietzcker, Falko Ueckerdt, Samuel Carrara, Harmen Sytze de Boer, Jacques Després, Shinichiro Fujimori, Nils Johnson, Alban Kitous, Yvonne Scholz, Patrick Sullivan, Gunnar Luderer: System Integration of Wind and Solar Power in Integrated Assessment Models: a Cross-model Evaluation of New Approaches
MITP	8.2017	Samuel Carrara, Thomas Longden: Freight Futures: The Potential Impact of Road Freight on Climate Policy
ET	9.2017	Claudio Morana, Giacomo Sbrana: Temperature Anomalies, Radiative Forcing and ENSO
ESP	10.2017	Valeria Di Cosmo, Laura Malaguzzi Valeri: Wind, Storage, Interconnection and the Cost of Electricity Generation
EIA	11.2017	Elisa Delpiazzo, Ramiro Parrado, Gabriele Standardi: Extending the Public Sector in the ICES Model with an Explicit Government Institution
MITP	12.2017	Bai-Chen Xie, Jie Gao, Shuang Zhang, ZhongXiang Zhang: What Factors Affect the Competiveness of Power Generation Sector in China? An Analysis Based on Game Cross-efficiency
MITP	13.2017	Stergios Athanasoglou, Valentina Bosetti, Laurent Drouet: A Simple Framework for Climate-Change Policy under Model Uncertainty
MITP	14.2017	Loïc Berger and Johannes Emmerling: Welfare as Simple(x) Equity Equivalents
ET	15.2017	Christoph M. Rheinberger, Felix Schläpfer, Michael Lobsiger: A Novel Approach to Estimating the Demand Value of Road Safety