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The effect of respondent uncertainty on economic value estimates

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Abstract: Respondent uncertainty is often considered as one of the main limitations of the stated preference methods, which are nowadays being widely used for valuing environmental goods and services. These methods usually assume that respondents know their preferences with certainty. However, empirical evidence demonstrates that respondents are often uncertain when answering contingent valuation questions. It has been argued that this affects the validity of the results derived from the contingent valuation method. This is a relevant issue since outcomes of valuation are often being used for decision making in environmental management and in setting environmental policies. This article examines the effect of respondent uncertainty on welfare estimates by comparing the results from stated preferences (contingent valuation method) with those from revealed preferences (travel cost method). The latter are based on observed rather than stated (hypothetical) behavior and can therefore serve as a baseline for testing the validity of results obtained from the former methods. In this study this is done in the context of beach protection against erosion. Respondent (un)certainty levels about their stated willingness to pay are elicited using a five-category polychotomous choice question. Two different approaches for uncertainty calibration are tested. One approach shows no advantages of incorporating information on respondent uncertainty, while the other one shows gains only at one out of two beaches. Finally, the most important factors that cause respondent uncertainty are identified and analyzed.

***Keywords**:* Respondent uncertainty; contingent valuation method; travel cost method; valuation; ecosystem services

1 INTRODUCTION

Contingent valuation method (CVM) is a widely used method for estimating economic values for all kinds of ecosystem services and environmental goods which are not traded in the market and hence have no market price. It is also referred to as a stated preference method because it asks people in a survey to state how much they would be willing to pay for a (change in) specific environmental service. An advantage of CVM (and other stated preference techniques) over revealed preference techniques (like hedonic pricing or travel cost method) is that it can address hypothetical changes in policy and can estimate both use and non-use values of an environmental good or service. Revealed preference methods are able to estimate only use values. The main disadvantage is that data generated by CVM are hypothetical. For this reason, most economists tend to

assign more credibility to revealed preference techniques which use data about actual, past choices by individuals in markets. Because of its reliance upon stated or hypothetical WTP values, the reliability of CVM results have received much attention in the literature. Some studies suggest that values obtained by the CVM tend to overestimate the real values. Such divergence between real and hypothetical payments is known as a hypothetical bias.

Most existing valuation studies assume that respondents know their preferences with certainty. However, empirical evidence demonstrates that respondents are often uncertain when answering contingent valuation questions (Ready *et al*., 1995; Champ *et al*., 1997; Alberini *et al*., 2003). It has been argued that respondent uncertainty affects the validity of CVM results. Several studies have shown that the higher is the degree of uncertainty of a respondent about the stated hypothetical payment, the lower is the probability that s/he would actually pay the stated amount in a real situation (Polasky *et al*., 1996; Champ *et al*., 1997; Johannesson *et al*., 1998). Incorporating information about respondent uncertainty might reduce the hypothetical bias and result in more efficient parameter and WTP estimates (Welsh and Bishop, 1993; Li and Mattsson, 1995; Blumenschein *et al*., 1998; Champ and Bishop, 2001). However, there are also studies that report deteriorated welfare estimations (Ekstrand and Loomis, 1998; Samnaliev et al., 2006; Brouwer, 2009).

The current study estimates the WTP of beach visitors for beach protection against erosion. The study assesses use values only, which means that WTP estimates obtained with the CVM are comparable to those derived from the travel cost method (TCM). A follow-up polychotomous choice (PC) question captures information on respondents' uncertainty regarding the responses provided to the WTP questions. The yes/no responses are then adjusted for uncertainty in two different ways: by recoding uncertain 'yes' responses into 'no' responses and by treating uncertain responses as missing. We can then assess whether and how incorporating information on uncertainty affects WTP estimates with respect to both the standard CVM model and the TCM model. In addition, we identify factors which explain uncertainty reported by respondents.

The remainder of the article is organized as follows. Section 2 describes the case study. Section 3 compares WTP estimates of CVM models corrected for uncertainty with both CVM models uncorrected for uncertainty and the TCM model. Section 4 presents results of the econometric analysis of factors of influence on respondent uncertainty. Section 5 concludes.

2 CASE STUDY AND SURVEY DESIGN

Beaches have high recreational values and most of coastal tourist destinations heavily depend on the existence of these natural resources. Since visiting beaches generates benefits (consumer surplus) to its users, it is not unreasonable to ask them to pay part of the costs associated with the resource management or conservation, applying the user-pays principle. This article examines the WTP of beach visitors for the costs associated with the prevention of beach loss due to erosion in the form of beach entrance fees. For this purpose, a field experiment was undertaken at two beaches in the town of Crikvenica in Croatia; one where an entrance fee is already levied and at the nearest free beach. The reason for levying a beach entrance fee is dual. Firstly, it is the only sand beach in the town and the erosion effect is causing a need to nourish the beach each year, which makes its maintenance costly. Secondly, part of the funds raised by the fee is invested into additional facilities, which do not exist at other beaches. The beach entrance fee is €1.66/person/day for adults and half of the price for children. The texture of the free beach is pebble. Its advantage over the paid beach is that it is located closer to the town centre.

The questionnaire consisted of the two main parts. The first part gathered information concerning travel costs while the second part included the CVM questions. Hypothetical scenarios for the two beaches slightly differed. Visitors at

the free (paid) beach were told that due to a (magnified) problem with beach erosion, and without any protection measures, the beach will withdraw over time and will completely disappear in ten years. They were further explained that the costs of beach protection cannot be covered from the town budget and were asked whether they would be willing to pay a (higher) beach entrance fee. A double-bounded dichotomous choice format was used for eliciting WTP values. At each beach, four different versions of the questionnaire were used, varying in bid amounts. Respondents were then asked to express their level of uncertainty about their stated responses by choosing from five response categories: 'very confident', 'confident', 'neutral', 'not so confident', and 'not confident at all'. The survey also gathered information about the characteristics of respondents' town and beach visit, their preferences and attitudes towards beaches and beach entrance fees and their socio-economic characteristics. Administration of the surveys took place in July 2008. Systematic sampling was used. The number of visitors who agreed to participate in the survey amounts to 366 at the paid beach and 379 at the free beach. The response rates were 79% and 69%, respectively.

Summary of descriptive statistics for the free and the paid beach is provided in Table 1. It shows that at the free beach there are more domestic visitors, while at the paid beach there are more foreigners and Croats, Bosnians and Serbs who live abroad. The last category was created given the large number of such visitors. Socio-economic characteristics vary between the two visitor groups. A *t*-test shows that respondents at the paid beach are on average significantly younger than those at the free beach and have a significantly higher net monthly household income.

Table 1. Descriptive statistics

		Beach	
		Free	**Paid**
Composition of visitors	Domestic visitors (%)	55.5	34.1
	Foreign visitors (%)	18.9	29.9
	Croatian, Bosnian and Serbian visitors who live abroad (%)	25.6	35.9
Number of previous visits to the town		13.4	14.0
Days spent in the town		10.0	8.8
Reasons for choosing the particular beach	Proximity (%)	43.6	12.9
	Texture (%)	6.1	44.3
	Facilities (%)	5.5	23.7
	Free access (%)	5.5	0.0
	Other (%)	59.1	59.3
Level of satisfaction with the beach	Unsatisfied or very unsatisfied (%)	2.4	0.9
	Neutral (%)	14.3	10.5
	Satisfied or very satisfied (%)	83.3	88.6
Number of persons in the travel group		2.9	3.2
Beach evaluation score (scale 1 to 5)		4.0	4.2
Visited the other beach under study	(%)	57.0	51.8
Knowing reasons for paying the fee	(%)	31.7	51.2
In favor of introducing a beach entrance fee to other beaches (%)		63.4	76.3
Who should pay for beach maintenance	Local government (%)	48.3	33.9
	National government (%)	19.0	20.4
	Residents (%)	0.9	0.3
	Tourists (%)	3.4	4.8
	Beach users (%)	9.8	16.2
	All previous categories (%)	15.6	18.6
	Other (%)	3.1	5.7
Gender	Male (%)	43.6	48.5
	Female (%)	56.4	51.5
Age		42.1	37.7
Income		€ 1843	€ 2324

3 THE EFFECT OF RESPONDENT UNCERTAINTY ON WELFARE ESTIMATES

This article adds a new piece of evidence to the discussion about the effects of respondent uncertainty on welfare estimates. It estimates the mean WTP values for the two beaches derived from the TCM, the standard CVM model assuming

certainty and from CVM models corrected for different levels of uncertainty. We also examine how incorporating information on uncertainty affects the precision of welfare estimates and the statistical significance of models.

There are two possible calibration approaches when using a follow-up PC format question for reporting a degree of respondent certainty. Studies have shown that recoding certain responses as 'yes' and the rest as 'no' responses yields estimates that best match the actual purchase behavior (Johannesson et al., 1998; Blumenschein et al., 2008). An alternative calibration approach is to treat uncertain responses as missing (Vossler et al., 2003; Akter et al., 2008). An overview of results is presented in Table 2.

The TCM estimates were obtained by applying the negative binomial model developed by Englin and Shonkwiler (1995). The generalized travel costs consist of transportation costs, travel time, parking costs and the beach entrance fee. They include the cost of a round trip and are based on the distance traveled and the mode of transport. The opportunity cost of travel time is included the trip price by applying the Cesario approach, in which the travel time is valued at 1/3 of the wage rate. Apart from the travel costs, other explanatory variables in our models include accommodation costs per adult night and spending at the beach per adult day. Furthermore, dummy variable which distinguishes between single and multiple-destination trips, beach characteristics and socio-economic characteristics of visitors were included in the model. We used travel costs for all persons traveling together and for the entire trip. Following Loomis (2006), once the WTP per trip estimates were derived, they were further divided by the median number of adults in the travel group and the median number of days on the trip.

The double-bounded contingent valuation elicitation format is analyzed by maximizing the likelihood function using a probit model. Precision of the mean WTP estimates are compared across the models based on the 95% confidence intervals and efficiency of the estimated mean value (EFWTP). Confidence intervals are calculated by employing bootstrapping. EFWTP is a precision indicator calculated as the confidence interval difference divided by the mean WTP (Loomis and Ekstrand, 1998).

The results indicate that the mean WTP estimates derived from standard CVM models and TCM models have the same order of magnitude, although CVM estimates are somewhat higher. The first calibration approach, in which models are adjusted for uncertainty by treating uncertain responses as missing, generates rather similar welfare estimates to those obtained from the standard CVM model in the case of both beaches. Nevertheless, in the case of the paid beach, the estimates gradually decrease as more extreme recoding is applied (i.e. when only 'confident' and/or 'very confident' responses are taken into account), while the estimates for the free beach are either equal to or higher than those in the standard CVM model. A two-tailed independent sample *t*-test, however, showed that there is no statistically significant difference between the mean WTP values derived from the models adjusted for uncertainty using this calibration technique and the standard CVM models in the case of both beaches.

In the second calibration approach (recoding uncertain 'yes' responses as 'no' responses) welfare estimates for the paid beach descend gradually when using a more extreme recoding. This trend is much more prominent than when using the first calibration technique. Consequently, the WTP estimates come closer to those obtained from the observed market behavior (TCM). A *t*-test indicates that when either 'very confident' and 'confident' or only 'very confident' responses are calibrated as 'yes' and the rest as 'no' are the mean WTP values for the paid beach derived from uncertainty-adjusted models significantly lower than that obtained from the standard model (t=4.664, p<0.001 and t=12.601, p<0.001, respectively). This result is in line with the findings of Johannesson *et al*. (1998) and Blomquist *et al*. (2009), indicating that treating only highly certain hypothetical 'yes' responses as the real 'yes' responses yields a welfare estimate that approaches the actual WTP. Nevertheless, such convergence of stated and revealed WTP estimates comes at

the expense of a loss in estimate precision. For the free beach, the mean WTP values are not significantly different from that of the standard certainty model. In general, one can observe a gradual deterioration of estimate efficiency as more extreme coding is applied, regardless of the calibration approach.

Thus, our results indicate no advantage of incorporating information on respondent uncertainty by using the first calibration approach, based on a comparison with the estimates obtained from revealed preferences (TCM) and the results of tests for statistical difference between welfare estimates derived from the standard CVM model and CVM models adjusted for uncertainty. As for the second calibration approach, gains in welfare estimates are found only in the case of the paid beach.

Table 2. Welfare estimates, estimate efficiency and statistical significance of alternative models

	Mean WTP	Median WTP	95% CI of the mean	EFWTP[1]	Statistical significance of the model[2]	Number of observations
PAID BEACH						
Travel cost model	€ 2.16	-	€ 1.36 – 2.96	0.74	168.09 (p<0.001)	324
Standard CVM model	€ 3.40	€ 3.18	€ 3.21 – 3.59	0.11	76.97 (p<0.001)	327
Models adjusted for uncertainty – recoding uncertain responses as missing						
Uncertainty level 5[3] = missing	€ 3.41	€ 3.18	€ 3.21 – 3.60	0.11	74.92 (p<0.001)	321
Uncertainty level 4 & 5 = missing	€ 3.39	€ 3.15	€ 3.18 – 3.59	0.12	68.92 (p<0.001)	300
Uncertainty level 3, 4 & 5 = missing	€ 3.37	€ 3.13	€ 3.15 – 3.59	0.13	52.45 (p<0.001)	250
Uncertainty level 2, 3, 4 & 5 = missing	€ 3.27	€ 3.04	€ 2.96 – 3.58	0.19	40.22 (p<0.001)	142
Models adjusted for uncertainty – recoding uncertain 'yes' responses as 'no' responses						
Uncertainty level 5 = 'no'	€ 3.38	€ 3.14	€ 3.19 – 3.57	0.11	73.35 (p<0.001)	327
Uncertainty level 4 & 5 = 'no'	€ 3.25	€ 2.96	€ 3.04 – 3.45	0.13	63.22 (p<0.001)	327
Uncertainty level 3, 4 & 5 = 'no'	€ 2.92	€ 2.53	€ 2.70 – 3.15	0.15	36.42 (p<0.001)	327
Uncertainty level 2, 3, 4 & 5 = 'no'	€ 2.02	€ 1.58	€ 1.74 – 2.31	0.28	28.12 (p<0.01)	327
FREE BEACH						
Travel cost model	€ 1.62	-	€ 0.81 – 2.42	0.89	143.10 (p<0.001)	320
Standard CVM model	€ 2.25	€ 1.75	€ 1.95 – 2.56	0.27	58.62 (p<0.001)	321
Models adjusted for uncertainty – recoding uncertain responses as missing						
Uncertainty level 5 = missing	€ 2.25	€ 1.75	€ 1.95 – 2.56	0.27	58.62 (p<0.001)	321
Uncertainty level 4 & 5 = missing	€ 2.29	€ 1.78	€ 1.95 – 2.64	0.30	55.95 (p<0.001)	302
Uncertainty level 3, 4 & 5 = missing	€ 2.33	€ 1.77	€ 1.94 – 2.72	0.33	49.40 (p<0.001)	278
Uncertainty level 2, 3, 4 & 5 = missing	€ 2.26	€ 1.75	€ 1.74 – 2.77	0.46	46.16 (p<0.001)	155
Models adjusted for uncertainty – recoding uncertain 'yes' responses as 'no' responses						
Uncertainty level 5 = 'no'	€ 2.25	€ 1.75	€ 1.95 – 2.56	0.27	58.62 (p<0.001)	321
Uncertainty level 4 & 5 = 'no'	€ 2.32	€ 1.64	€ 1.92 – 2.71	0.34	56.44 (p<0.001)	321
Uncertainty level 3, 4 & 5 = 'no'	€ 2.39	€ 1.43	€ 1.83 – 2.95	0.47	47.29 (p<0.001)	321
Uncertainty level 2, 3, 4 & 5 = 'no'	€ 2.24	€ 0.44	€ 0.55 – 3.92	1.50	p>0.01	321

[1] Efficiency of the estimated mean WTP is calculated as $EFWTP=(WTP_{CIu}-WTP_{CIl})/WTP_{mean}$, where WTP_{CIu} and WTP_{CIl} represent upper and lower bounds of the 95% confidence interval, respectively.
[2] Based on LR chi2 (14df) for TCM models and Wald chi2 (10df) for CVM models.
[3] Uncertainty level 5='not confident at all'; uncertainty level 4='not so confident'; uncertainty level 3='neutral'; uncertainty level 2='confident'; uncertainty level 1='very confident'.

4 FACTORS THAT DETERMINE RESPONDENT UNCERTAINTY

Empirical evidence for the underlying reasons for respondent uncertainty is still rather scarce (Akter *et al*., 2008). Existing studies offer several explanations about the sources of uncertainty, like unfamiliarity of respondents with the good under study, lack of prior non-market valuation experience, lack of respondents' interest, uncertainty about their income or benefits of the program, inability of individuals to make a quick decision, or the questionnaire used.

In this study, ordinal polychotomous categories of uncertainty levels were regressed on a combination of factors. The results of an ordered probit model for two beaches jointly are presented in Table 3. Both *start bid* amount and *squared start bid* amount variables turn out significant, with a positive and a negative sign, respectively. This indicates a U-shaped relationship between the amount respondents are asked to pay and the degree of certainty about their value statement, confirming the findings of Loomis and Ekstrand (1998) and Brouwer (2009). This occurs because when the bid is substantially lower or higher than respondent's maximum WTP, they are more certain about whether they would pay the offered amount or not and vice versa (Loomis and Ekstrand, 1998).

Table 3. Ordered probit model results for respondent certainty levels

Variable	Parameter estimate	Standard error
Start bid	0.3032**	0.1491
Start bid squared	-0.0517**	0.0261
Positive WTP	0.6141***	0.1372
Number of previous visits to Crikvenica	-0.0038	0.0025
Reason for the town visit: have a second home	0.4215***	0.1617
Motivation for choosing the beach: proximity	0.2089*	0.1137
Motivation for choosing the beach: beach texture	0.3075**	0.1239
Motivation for choosing the beach: facilities	-0.0012	0.1576
Motivation for choosing the beach: free access	0.6235**	0.2525
Time spent on the beach: a few hours	-0.3109**	0.1549
Presence of child(ren) in the travel group	0.1651*	0.0889
Know reasons for levying the beach entrance fee	0.1357	0.0912
Agree with introducing the fee to other beaches	0.1407	0.1003
All stakeholders should pay for the costs	-0.3880***	0.1255
Income	<-0.0001	<0.0001
Log likelihood	-768.1545	
Pseudo R^2	0.0389	
Likelihood-ratio stat. (15df)	62.17 (p<0.001)	
Number of observations	688	

Notes: Calculations are performed with STATA
***Significant at the 1% level, ** Significant at the 5% level, * Significant at the 10% level

Respondents with a *positive WTP* are more uncertain about their stated WTP than respondents whose WTP is zero. This result is in line with other studies which found that there is a significantly higher certainty of protest and 'no' responses (Loomis and Ekstrand, 1998; Brouwer, 2009). Respondents who stated that the *main reason for visiting Crikvenica is having a second home* in the town expressed a significantly higher degree of uncertainty. A possible explanation is that most of such respondents do not come only because of the beach, but they visit the town for other reasons (e.g. visiting friends or family). Besides, they stay in the town much longer than other respondents. Visitors who *chose the beach primarily because of its proximity*, *beach texture*, or *free access* are more uncertain about their WTP than those who chose the beach for other reasons. Uncertainty of respondents who stated proximity and free access as the main reasons for choosing the beach might reflect high substitutability of beaches, since in the case of a fee increase they can go to another free nearby beach. Higher uncertainty levels of respondents who mainly chose the beach because of its texture can be explained by a considerably higher stated WTP than that of other respondents.On the other hand, visitors who *stay at the beach shorter* than other respondents are more certain and have on average a slightly lower stated WTP. A *child in the travel*

group tends to increase uncertainty significantly. This is not surprising if we take into account that children pay half the access fee, so that total costs for these respondents are higher than for those without children. Respondents who think that *beach maintenance costs should be paid by all stakeholders* (local and national government, residents, tourists, and beach users) rather than only one of them expressed significantly higher certainty. The *number of previous visits to Crikvenica*, which can be considered as a proxy for respondents' familiarity with the site, does not have a significant effect on respondent uncertainty. Prior knowledge of respondents about the *reasons for levying the entrance fee* at the paid beach, their *attitudes towards the beach entrance fee* and their *socio-economic characteristics* do not seem to affect respondent uncertainty significantly.

5 CONCLUSIONS

The main objectives of this article have been contributing to a better understanding of the effect of respondent uncertainty about stated willingness to pay (WTP) on welfare estimates and the underlying drivers of their uncertainty. This has been done in the context of the willingness of beach visitors to pay a daily beach entrance fee with the purpose of preventing beach loss due to erosion. The study applied both the contingent valuation method (CVM) and the travel cost method (TCM). This enabled using revealed WTP along with the standard CVM as baselines in assessing the performance of CVM models incorporating information about respondent uncertainty and in searching for the most appropriate approach for calibrating the stated WTP estimates based on uncertainty.

The article has compared two calibration approaches of polychotomous choice (PC) responses – one which treats uncertain responses as missing and another which recodes uncertain 'yes' responses into certain 'no' responses. The results indicate that the former technique does not offer gains in terms of welfare estimates or estimate precision in comparison with the conventional CVM model assuming certainty. The latter approach generates welfare estimates that are significantly lower than those obtained from the standard model and are closer to the revealed WTP in the case of the paid beach. This occurs when either only 'very confident' or both 'confident' and 'very confident' categories are considered as real 'yes' responses. Such results, however, come at the expense of lower estimate precision. The results for the free beach do not provide evidence of gains in welfare estimates when calibrating uncertain 'yes' responses as 'no' responses compared with the standard certainty model. Overall, these results confirm the validity of the CVM and the robustness of welfare estimates elicited through surveys.

This study has presented one of the first attempts to explore determinants of respondent uncertainty using PC responses. Results of an ordered probit model show that a *positive stated WTP* amount significantly and positively affects respondent uncertainty. An intuitive explanation for this is that many respondents unwilling to pay anything usually represent protest bidders who tend to be quite convinced about their answer. A significant quadratic relationship between the *start bid* and respondent uncertainty was found, implying that respondents are more certain when asked about their WTP around high and low bid amounts, while they seem to be more uncertain around intermediate bids. Respondents who *spend less time at the beach* and those who *think that beach maintenance costs should be paid by all stakeholders* are significantly more certain about their stated WTP than other respondents. Stating the *ownership of a second home* in the town as the main reason for visiting Crikvenica, *choosing the particular beach because of its proximity*, *texture*, or *free access*, and *travelling with a child* significantly increase respondent uncertainty.

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