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Subjective perceptions about benefit and cost levels in contingent valuation

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Abstract

This paper hypothesizes that respondents in contingent valuation surveys may form different benefit and cost levels that deviate from the levels specified by the researcher. The conceptual framework investigates potential biases based on the direction of deviations. Survey data on the restoration of wetlands in Tampa Bay show that a significant portion of the respondents deviate from the benefit and cost levels presented in the scenario. Empirical results indicate that willingness-to-pay (WTP) estimates are very sensitive to the perceived benefit and cost levels. Depending on the direction of the deviations, WTP estimates could fluctuate up to +61 percent and −82 percent, compared to the estimate from those who evaluate the scenario at the presented levels.

Keywords: Contingent valuation; subjective perceptions; wetlands

JEL Codes: Q51; Q57

Introduction

Contingent valuation (CV) is widely used in various disciplines for its flexibility and capability of capturing both use and nonuse values. In recent years, Carson and Groves (2007) found that the referendum-style, single-bound CV is the only preference elicitation format that is incentive-compatible if survey respondents believe that their choices will have an impact on the outcome of the future policy, and they care about the outcome of such actions. This is referred to as consequentiality in the literature. Consequentiality is essentially the probability of the utility changing from the status quo level (utility without the proposed program or voting no) to the level with the proposed program if the program is implemented (utility of voting yes), as perceived by respondents. When respondents perceive CV as inconsequential, meaning the utility would stay at the status quo level regardless of the outcome of the survey, their choices in the referendum may be random. Consequently, the effects of consequentiality have been extensively examined in the empirical literature (e.g., Bulte et al. 2005; Vossler and Evans 2009; Landry and List 2007; Nepal et al. 2009; Broadbent, Grandy, and Berrens 2010; Vossler, Doyon, and Rondeau 2012; Hwang, Petrolia, and Interis 2014; Interis and Petrolia 2016; Groothuis et al. 2002; Zawojska, Bartczak, and Czajkowski 2019). However, consequentiality examined in the

literature is mainly concerned with the perceived probability rather than the degree/magnitude of the change in utility. One may perceive that it is certain that their utility will change from status quo if the proposed program is implemented (consequential), but the degree of the change can be different from what the researcher intended to measure if they have subjective perceptions about benefit and cost levels that are different from what is specified in the survey. Champ et al. (2002) tested how the payment mechanism affects subjective perceptions about the cost level. They included a survey question that asked whether the cost presented in the survey was what respondents thought they would actually pay. They included three payment mechanisms: (1) voluntary individual contribution to a trust fund set up for the program; (2) provision point mechanism involving voluntary contributions to a trust fund set up which specified that at least 30 percent of the households in the region would have to agree to pay for the program; and (3) one-time tax for residents based on the results of a referendum. They found that for the individual contribution mechanism, 37 percent of the respondents thought that the actual cost would be what was presented in the survey, 50 percent thought the actual cost would be higher, and 37 percent thought the actual cost would be lower. For the provision point mechanism, 52 percent of the respondents thought that the actual cost would be what was presented in the survey, 40 percent thought the actual cost would be higher, and 8 percent thought the actual cost would be lower. For the referendum, 58 percent of the respondents thought that the actual cost would be what was presented in the survey, 38 percent thought the actual cost would be higher, and 4 percent thought the actual cost would be lower. However, they did not utilize the measured perceptions in their willingness-to-pay (WTP) estimation. Flores and Strong (2007) theoretically showed that subjective perceptions regarding the actual cost of a proposed program result in biased WTP estimates. They found that when a respondent perceives that the actual cost will be higher (lower) than what is stated in the survey, the mean WTP estimate suffers from a downward (upward) bias. To my knowledge, there is no study in the literature that empirically tests effects of subjective perceptions about the actual cost or deviations from the cost level on WTP. Carson, Flores, and Meade (2001) and Carson and Groves (2007) argued that the payment mechanism in CV must be credible to respondents so that they believe that they will actually have to pay the cost presented in the referendum if it is implemented. This is often referred to as payment consequentiality in the literature (e.g., Zawojska, Bartczak, and Czajkowski 2019). Similar to consequentiality discussed earlier, payment consequentiality examined in the literature is mainly concerned with the probability/probability of payment rather than subjective perceptions about the cost amount. Vossler and Holladay (2018) showed that it is critical that the cost amount is described as uncertain in the valuation question in order to have incentive-compatible responses for open-ended or payment-card elicitation formats.

It is also possible that respondents perceive that the actual benefit level will be different than what is specified in the survey. Although there are studies that measured respondents' confidence in agencies providing the benefit proposed in the survey (e.g., Petrolia, Interis, and Hwang 2014), to my knowledge, there is no study in the literature that examines subjective perceptions or deviations from the benefit level. The main contribution of this paper is to measure the subjective perceptions about the benefit and cost levels in terms of and empirically test their effects on WTP estimates.

Conceptual framework

For a referendum-style CV, utilities of voting yes and no for an individual i can be represented as $U_{iyes}(y_i - t_i,\ x_1)$ and $U_{ino}(y_i,\ x_0)$, respectively, where y_i is income, t_i is the

bid amount (cost) of the proposed program presented in the referendum, x_1 is the new level of quantity/quality of environmental goods/services of interest after the proposed program is implemented (benefit level), and x_0 is the current level of quantity/quality of the environmental goods/service, say wetlands. It is assumed that respondents evaluate their options based on the benefit and cost levels presented in the referendum. However, if a respondent has subjective expectations/perceptions about benefit and cost levels that deviate from the levels specified by the researcher, the utility of voting yes becomes $\tilde{U}_{iyes}(y_i - \tilde{t}_i,\ \tilde{x}_{i1})$. For such respondents, they evaluate their tradeoffs at $\tilde{t}_i$ and $\tilde{x}_{i1}$ rather than at t_i and x_1 which implies that the preferences measured are different from what the researcher intended to measure. Therefore, there is a potential measurement error, and WTP estimates may be biased. If we assume $t_i > \tilde{t}_i$ and $x_1 < \tilde{x}_{i1}$ are preferred (by respondents) to $t_i = \tilde{t}_i$ and $x_1 = \tilde{x}_{i1}$, respectively, and $t_i = \tilde{t}_i$ and $x_1 = \tilde{x}_{i1}$ are preferred to $t_i < \tilde{t}_i$ and $x_1 > \tilde{x}_{i1}$, respectively, we can predict the directions of the bias as follows:

1) If $t_i > \tilde{t}_i$, $U_{iyes} < \tilde{U}_{iyes}$, and $\widehat{WTP}_i > \widetilde{WTP}_i$.
2) If $t_i = \tilde{t}_i$, $U_{iyes} = \tilde{U}_{iyes}$, and $\widehat{WTP}_i = \widetilde{WTP}_i$.
3) If $t_i < \tilde{t}_i$, $U_{iyes} > \tilde{U}_{iyes}$, and $\widehat{WTP}_i < \widetilde{WTP}_i$.
4) If $x_1 > \tilde{x}_{i1}$, $U_{iyes} > \tilde{U}_{iyes}$, and $\widehat{WTP}_i < \widetilde{WTP}_i$.
5) If $x_1 = \tilde{x}_{i1}$, $U_{iyes} = \tilde{U}_{iyes}$, and $\widehat{WTP}_i = \widetilde{WTP}_i$.
6) If $x_1 < \tilde{x}_{i1}$, $U_{iyes} < \tilde{U}_{iyes}$, and $\widehat{WTP}_i > \widetilde{WTP}_i$.

For example, if one perceived that the actual cost would be less than what was presented ($t_i > \tilde{t}_i$), the proposed scenario would be more appealing to them than what the researcher intended ($U_{iyes} < \tilde{U}_{iyes}$,). If they voted yes, then the correct inference of their WTP would be $\widetilde{WTP}_i \geq \tilde{t}_i$ rather than $\widehat{WTP}_i \geq t_i$. Therefore, $\widehat{WTP}_i > \widetilde{WTP}_i$. Based on the assumptions above, there are two cases where the WTP estimate is unbiased (*2* and *5*), two cases where the WTP estimate suffers from an upward bias (*1* and *6*), and two cases where the WTP estimate suffers from a downward bias (*3* and *4*). It is worth noting that it is less likely that respondents would perceive that more wetlands would be restored than what was proposed. Therefore, it is reasonable to suspect that Case 6 is less likely to occur or the proportion of respondents in the sample who fall under Case 6 is very small. Consequently, of the three remaining biased cases, two of them are biased downwards, and only one of them is biased upwards.

Since respondents are evaluating both benefit and cost of the proposed program simultaneously to determine which vote they cast, we need to consider $\tilde{t}_i$ and $\tilde{x}_i$ together. Considering both $\tilde{t}_i$ and $\tilde{x}_i$ together, we can predict directions of the bias as follows:

a) If $t_i > \tilde{t}_i$ and $x_1 = \tilde{x}_{i1}$, $U_{iyes} < \tilde{U}_{iyes}$, and $\widehat{WTP}_i > \widetilde{WTP}_i$.
b) If $t_i > \tilde{t}_i$ and $x_1 < \tilde{x}_{i1}$, $U_{iyes} < \tilde{U}_{iyes}$, and $\widehat{WTP}_i > \widetilde{WTP}_i$.
c) If $t_i = \tilde{t}_i$ and $x_1 > \tilde{x}_{i1}$, $U_{iyes} > \tilde{U}_{iyes}$, and $\widehat{WTP}_i < \widetilde{WTP}_i$.
d) If $t_i = \tilde{t}_i$ and $x_1 = \tilde{x}_{i1}$, $U_{iyes} = \tilde{U}_{iyes}$, and $\widehat{WTP}_i = \widetilde{WTP}_i$.
e) If $t_i = \tilde{t}_i$ and $x_1 < \tilde{x}_{i1}$, $U_{iyes} < \tilde{U}_{iyes}$, and $\widehat{WTP}_i > \widetilde{WTP}_i$.
f) If $t_i < \tilde{t}_i$ and $x_1 > \tilde{x}_{i1}$, $U_{iyes} > \tilde{U}_{iyes}$, and $\widehat{WTP}_i < \widetilde{WTP}_i$.
g) If $t_i < \tilde{t}_i$ and $x_1 = \tilde{x}_{i1}$, $U_{iyes} > \tilde{U}_{iyes}$, and $\widehat{WTP}_i < \widetilde{WTP}_i$.

There is one case where the WTP estimate is unbiased (*d*), three cases where the WTP estimate is biased downwards (*c*, *f*, and *g*), and three cases where the WTP estimate is biased upwards (*a*, *b*, and *e*). In Case *d*, respondents evaluate the CV scenario at the benefit and cost levels specified by the researcher. In Case *c*, respondents evaluate the CV scenario at the cost level specified by the researcher but at a lower benefit level than what the researcher specified. In Case *f*, respondents not only perceive that the actual cost level would be higher but also the benefit level would be lower than what the researcher specified. Therefore, Case *f* is predicted to yield the lowest WTP estimate. In Case *g*, even though respondents evaluate the scenario at the given benefit level, they perceive that the actual amount would be higher than what is specified. Respondents in Case *a* perceive that the actual cost would be lower than the specified level even though they perceive that the benefit level does not deviate. Respondents in Case *b* are expected to yield the highest WTP estimate as not only do they perceive that the cost would be lower but also the benefit would be higher than what the scenario describes. Lastly, in Case *e*, respondents perceive that the actual benefit level would be higher than what the scenario describes even though the perceived cost does not deviate from the scenario. Note that if ($t_i > \tilde{t}_i$ and $x_1 > \tilde{x}_{i1}$) or ($t_i < \tilde{t}_i$ and $x_1 < \tilde{x}_{i1}$), the presence or the direction of bias is unclear. As discussed earlier, $x_1 < \tilde{x}_{i1}$ is less likely to occur. Therefore, it is reasonable to suspect that Cases *b* and *e* are less likely to occur, or the proportion of respondents who fall under the two cases in the sample is very small. Of the remaining four cases with a bias, three of them are biased downwards, and only one of them is biased upwards. When $\tilde{t}_i$ and $\tilde{x}_i$ are considered together, a downward bias becomes even more dominant compared to when $\tilde{t}_i$ and $\tilde{x}_i$ are considered separately. Therefore, it can be concluded that without detecting subjective perceptions about the actual benefit and cost levels and without accounting for them, WTP may be generally underestimated. This finding contrasts with the upward bias that the literature generally finds and focuses on due to the hypothetical nature of CV – hypothetical bias (e.g., Champ and Bishop 2001; List 2001; List and Gallet 2001; Aadland and Caplan 2003; Brown, Ajzen, and Hrubes 2003; Murphy et al. 2005; Hensher 2010; Loomis 2011; Penn and Hu 2019; Schmidt and Bijmolt 2020).

Data

Data used in this paper are from an online survey which was administered in 2020 by Qualtrics to its online panels with a goal to understand Floridians' preferences for restoring coastal wetlands in Tampa Bay which is a large natural harbor and shallow estuary connected to the Gulf of Mexico on the west-central coast of Florida. A total of 7,483 Qualtrics panels were invited to take the survey, and 4,146 of them responded to the survey, yielding a response rate of 55.4 percent. After controlling for age, gender, race, education, and income to ensure the representativeness of the sample, 1,243 completed responses were provided by Qualtrics, yielding the incidence rate of 30 percent.

The survey instrument was largely adopted from Petrolia, Interis, and Hwang (2014) and Interis and Petrolia (2016). The survey first provided detailed information about wetlands and ecosystem services provided by them such as wildlife habitats, fisheries support, storm surge protection, and improved water quality. The survey then provided information about how much wetlands have been lost in the area since 1900. The survey stated that policy makers are considering a project that will restore roughly 15,000 acres of wetlands back to the 1900 level. In the referendum-style valuation question, the cost of the proposed project was presented as a one-time payment that would be added to the 2021 federal income tax return. The cost was randomized from the following range: {$50, $300, $650, $950, $1,200}. The referendum question also included a budget constraint reminder

Suppose federal, state, and local governments are considering a wetlands restoration project in Tampa Bay and want to understand Floridians' preferences to decide if the project should be implemented.

If implemented: The proposed project would fully restore wetlands in Tampa Bay from 20,604 acres back to approximately 35,000 acres. The project would take about **3** years to complete. Restored wetlands would improve ecosystem services such as water quality, fisheries support, storm surge protection, and wildlife habitat.

A one-time payment of **$50** would be added to your 2021 Federal income tax return as a special tax. No additional payment would be required.

Would you vote for the proposed project?

Please think about your budget and keep in mind other things you might spend your money on instead of the project. Honestly assess the tradeoffs between supporting and not supporting this project and indicate whether you would support or would not support this project.

- ○ Yes, I support the project.
- ○ No, I don't support the project.
- ○ I prefer not to vote.

Figure 1. Valuation question example.

and an option to opt-out ("I prefer not to vote") as suggested by Arrow et al. (1993). Figure 1 presents an example of the valuation question. Table 1 presents responses to the referendum at different bid levels. Overall, out of 1,243 responses, 798 voted yes (64.2 percent), 259 voted no (20.8 percent), and 186 (15.0 percent) opted out. After removing opt-out responses, 1,057 responses were used for the analysis.

In order to elicit respondents' subjective perceptions about the benefit level of the project, the following question was included in the survey:

> *We wish to know if you had a different opinion about the acreage after the proposed restoration project. Which of the following statements best describes your opinion when you were voting?*

1. *If implemented, the project would restore wetlands to the proposed level.*
2. *If implemented, the project would restore wetlands but less than the proposed level.*
3. *If implemented, the project would restore more wetlands than the proposed level.*
4. *I don't know.*

Responses to the question are presented at the top of Table 2. About a half of the respondents (49.9 percent) perceived that the project would restore wetlands to the proposed level ($x_1 = \tilde{x}_{i1}$), 30.8 percent perceived that the project would restore less wetlands than what was presented ($x_1 > \tilde{x}_{i1}$), 7.3 percent perceived that the project would

Table 1. Cross-tabulation between vote and bid in the referendum

	Bid (%)					
Vote	$50	$300	$650	$950	$1,200	Total (%)
Yes	193 (0.75)	159 (0.62)	142 (0.58)	153 (0.63)	151 (0.61)	798 (0.64)
No	27 (0.11)	60 (0.24)	62 (0.25)	52 (0.22)	58 (0.23)	259 (0.21)
Opt-out	36 (0.14)	36 (0.14)	40 (0.16)	36 (0.15)	38 (0.15)	186 (0.15)
Total	256 (1.00)	255 (1.00)	244 (1.00)	241 (1.00)	247 (1.00)	1,057 (1.00)

Table 2. Perceived benefit and cost levels

Perceived benefit level	Freq. (%)
If implemented, the project would restore wetlands to the proposed level $(x_1 = \tilde{x}_{i1})$	527 (49.9)
If implemented, the project would restore wetlands but less than the proposed level $(x_1 > \tilde{x}_{i1})$	325 (30.8)
If implemented, the project would restore more wetlands than the proposed level $(x_1 < \tilde{x}_{i1})$	77 (7.3)
I don't know $(x_1 \; ? \; \tilde{x}_{i1})$	128 (12.1)
Total	1,057 (100.0)
Perceived cost level	
If implemented, I would pay the amount presented in the survey $(t_i = \tilde{t}_i)$	387 (36.6)
If implemented, the actual cost would be lower than the amount presented in the survey $(t_i > \tilde{t}_i)$	272 (25.7)
If implemented, the actual cost would be higher than the amount presented in the survey $(t_i < \tilde{t}_i)$	163 (15.2)
I don't know $(t_i \; ? \; \tilde{t}_i)$	235 (22.2)
Total	1,057(100.00)

restore more wetlands than what was presented ($x_1 < \tilde{x}_{i1}$), and 12.1 percent reported that they were uncertain about what the actual restoration level would be. As suspected, only a small proportion of the respondents perceived that more wetlands would be restored than what was proposed. Based on responses to the question, the following dummy variables were constructed to control for the subjective perceptions about the benefit level: "less benefit" (=1 if chose 2; =0 otherwise), "more benefit" (=1 if chose 3; =0 otherwise), and "DK benefit" (=1 if chose 4; =0 otherwise). Those who chose 1 served as the reference. It is hypothesized that $\beta_{less\ benefit} < 0$ and $\beta_{more\ benefit} > 0$.

In order to elicit respondents' subjective perceptions about the cost of the project, the following question was included in the survey:

> *We wish to know if you had a different opinion about the cost. Which of the following statements best describes your opinion when you were voting?*

Table 3. Cross-tabulation between bid and perceived cost levels

	Bid level (%)				
Perceived cost level	$50	$300	$650	$950	$1,200
$t_i = \tilde{t}_i$	108 (10.2)	77 (7.3)	68 (6.4)	70 (6.6)	64 (6.1)
$t_i > \tilde{t}_i$	43 (4.1)	58 (5.5)	56 (5.3)	57 (5.4)	58 (5.5)
$t_i < \tilde{t}_i$	35 (3.3)	34 (3.2)	33 (3.1)	26 (2.5)	35 (3.3)
t_i ? $\tilde{t}_i$	34 (3.2)	50 (4.7)	47 (4.4)	52 (4.9)	52 (4.9)

1. *If implemented, I would pay the amount presented in the survey.*
2. *If implemented, the actual cost would be lower than the amount presented in the survey.*
3. *If implemented, the actual cost would be higher than the amount presented in the survey.*
4. *I don't know.*

Responses to the question are presented at the bottom of Table 2. Just over a third of the respondents (36.6 percent) perceived that the actual cost would be what was presented in the survey ($t_i = \tilde{t}_i$), 25.7 percent of the respondents perceived that the actual cost would be lower than what was presented ($t_i > \tilde{t}_i$), 15.4 percent of the respondents perceived that the actual cost would be higher than what was presented ($t_i < \tilde{t}_i$), and 22.2 percent of the respondents stated that they were uncertain about what the actual cost would be. Based on responses to the question, the following dummy variables were constructed to control for the subjective perceptions about cost: "less pay" (=1 if chose 2; =0 otherwise), "more pay" (=1 if chose 3; =0 otherwise), and "DK pay" (=1 if chose 4; =0 otherwise). Those who chose 1 served as the reference. It is hypothesized that $\beta_{less\ pay} > 0$ and $\beta_{more\ pay} < 0$. As for those who are uncertain about the actual benefit and cost levels, the sign of the coefficients is unclear.

Table 3 presents a cross-tabulation between the bid and perceived cost levels. The proportion of respondents who perceived that the actual cost would be what was presented in the survey ($t_i = \tilde{t}_i$) tended to decrease as the bid amount increased, and the proportion of "DK pay" tended to increase as the bid amount increased, but there were no clear patterns. Table 4 presents a cross-tabulation between the perceived benefit and cost levels. A large proportion of the sample believed that the actual benefit and cost levels would be what was presented in the survey (Case *d*) which is good, but the proportion was smaller than one third (27.4 percent) which is concerning because it implies that 72.6 percent the sample is potentially biased. Also, 10.5 percent, 7.4 percent, 6.7 percent, 3.6 percent, 2.6 percent, and 1.3 percent of the sample fell under Cases *a*, *f*, *c*, *g*, *b*, and *e*, respectively. In the conceptual framework, it was suspected that the Cases *b* and *e* would be less likely to occur. Data indicate that the Cases *b* and *e* indeed had the smallest proportions amongst all cases in the sample. Data also indicate that 17.7 percent of the sample is potentially biased downwards (*c*, *f*, and *g*), whereas 10.5 percent of the sample is potentially biased upwards (*a*). Therefore, data signals that the WTP estimate is likely to be biased downwards if the subjective perceptions are not accounted for, and the assumptions that $t_i > \tilde{t}_i$ and $x_1 < \tilde{x}_{i1}$ are preferred (by respondents) to $t = \tilde{t}_i$ and $x_1 = \tilde{x}_{i1}$, respectively, and $t_i = \tilde{t}_i$ and $x_1 = \tilde{x}_{i1}$ are preferred to $t_i < \tilde{t}_i$ and $x_1 > \tilde{x}_{i1}$, respectively, hold. Finally, it is worth noting that for 40.3 percent of the sample, the presence or the direction of a potential bias cannot

Table 4. Cross-tabulation between perceived benefit and cost levels

Perceived benefit level	Perceived cost level			
	$t_i = \tilde{t}_i$	$t_i > \tilde{t}_i$	$t_i < \tilde{t}_i$	$t_i \ ? \ \tilde{t}_i$
$x_1 = \tilde{x}_{i1}$	290 (27.4)	111 (10.5)	38 (3.6)	88 (8.3)
$x_1 > \tilde{x}_{i1}$	71 (6.7)	124 (11.7)	78 (7.4)	52 (4.9)
$x_1 < \tilde{x}_{i1}$	14 (1.3)	27 (2.6)	19 (1.8)	17 (1.6)
$x_1 \ ? \ \tilde{x}_{i1}$	12 (1.1)	10 (0.9)	28 (2.6)	78 (7.4)

Note: Percentages out of 1,057 are in the parentheses.

Table 5. Summary statistics

Variable	Mean	Std. Dev.	Min	Max
Bid	619.54	420.50	50	1200
Less benefit	0.31	0.46	0	1
More benefit	0.07	0.26	0	1
DK benefit	0.12	0.33	0	1
Less pay	0.26	0.44	0	1
More pay	0.15	0.36	0	1
DK pay	0.22	0.42	0	1
Income	7.08	5.24	1	21
White	0.66	0.47	0	1
Employed	0.54	0.50	0	1
College	0.31	0.46	0	1

be predicted (for those who are uncertain about the actual cost and benefit levels and those who fall under cases where $[t_i > \tilde{t}_i$ and $x_1 > \tilde{x}_{i1}]$ or $[t_i < \tilde{t}_i$ and $x_1 < \tilde{x}_{i1}]$).

In addition to the dummy variables designed to control for subjective perceptions about the benefit and cost levels, other demographic variables such as "income" which is the annual household income with a range from 1 (less than $9,999) to 21 ($200,000 or more) with $10,000 increments, "white" (=1 if race is white; =0 otherwise), "employed" (=1 currently employed; =0 otherwise), and "college" (=1 if holds a bachelor's degree or higher; =0 otherwise) were included in the regression model. Table 5 presents summary statistics of the variables used in the regression analysis.

Econometric model

Following Greene (2012), responses to the referendum question can be modeled using the latent regression approach. A latent regression for the data can be specified as

$$y^* = \beta_0 + \beta_1 Bid + \boldsymbol{\beta}_X' \boldsymbol{X} + \boldsymbol{\beta}_T' \boldsymbol{T} + \boldsymbol{\beta}_Z' \boldsymbol{Z} + \varepsilon \quad (1)$$

where the observed counterpart to y^* is $y = 1$ if and only if $y^* > 0$; $\boldsymbol{\beta}_X'$ and $\boldsymbol{X}$ are vectors of coefficients and the perceived benefit level variables; $\boldsymbol{\beta}_T'$ and $\boldsymbol{T}$ are vectors of coefficients and the perceived cost level variables; $\boldsymbol{\beta}_Z'$ and $\boldsymbol{Z}$ are vectors of coefficients and the other individual-specific variables, and ε is the error term. Further, $\boldsymbol{\beta}_X'\boldsymbol{X}$, $\boldsymbol{\beta}_T'\boldsymbol{T}$, and $\boldsymbol{\beta}_Z'\boldsymbol{Z}$ are specified as

$$\boldsymbol{\beta}_X'\boldsymbol{X} = \beta_2 LessBenefit + \beta_3 MoreBenefit + \beta_4 DKBenefit \quad (2)$$

$$\boldsymbol{\beta}_T'\boldsymbol{T} = \beta_5 LessPay + \beta_6 MorePay + \beta_7 DKPay \quad (3)$$

$$\boldsymbol{\beta}_Z'\boldsymbol{Z} = \beta_8 Income + \beta_9 White + \beta_{10} Employed + \beta_{11} College \quad (4)$$

Note that those who perceived that the actual benefit and cost levels would be what was specified in the survey serve as the base category. Assuming that ε is normally distributed, it can be estimated using the probit model.

Following Haab and McConnell (2002), the overall WTP is calculated as

$$WTP_{Overall} = -\frac{\beta_0 + \boldsymbol{\beta}_X'\bar{\boldsymbol{X}} + \boldsymbol{\beta}_T'\bar{\boldsymbol{T}} + \boldsymbol{\beta}_Z'\bar{\boldsymbol{Z}}}{\beta_1} \quad (5)$$

where $\overline{\boldsymbol{X}}$, $\overline{\boldsymbol{T}}$, and $\overline{\boldsymbol{Z}}$ are vectors of the variables evaluated at their means. Separate WTPs based on the benefit and cost perceptions can be calculated as

$$WTP_{x_j, t_k} = -\frac{\beta_0 + \beta_j + \beta_k + \boldsymbol{\beta}_Z'\bar{\boldsymbol{Z}}}{\beta_1} \quad (6)$$

where β_j is the coefficient of the corresponding perceived benefit level ($j = 2, 3, 4$), and β_k is the coefficient of the corresponding perceived cost level ($k = 5, 6, 7$). For example, WTP for those who perceived that the actual benefit and cost levels would be higher than what was presented in the survey is

$$WTP_{x_{more\ benefit}, t_{more\ pay}} = -\frac{\beta_0 + \beta_3 + \beta_6 + \boldsymbol{\beta}_Z'\bar{\boldsymbol{Z}}}{\beta_1} \quad (7)$$

Results

Table 6 presents probit regression results. First and foremost, the coefficient for bid is statistically significant and negative as it should be. The coefficient for less benefit is statistically significant and negative, implying that respondents who perceived that the actual benefit level would be less than what was proposed are less likely to vote yes, as expected. The coefficient for more benefit is positive as expected but is not statistically significant. This is potentially due to the fact that only a small proportion of the sample (7 percent) indicated that they perceived that more wetlands than what was proposed would be restored. An alternative explanation could be the diminishing marginal utility. It is possible that the proposed level of improvement (roughly 15,000 acres) is sufficient such that believing that restoring more than the proposed level does not increase their utility. The coefficient for DK benefit is statistically significant and negative, implying those who were uncertain about the benefit level are less likely to vote yes. Although subjective perceptions about the benefit level and perceptions about consequentiality are different measures, this finding is similar to what Interis and Petrolia (2014) found; those who are uncertain about the consequentiality of the survey are less likely to vote yes.

Table 6. Probit regression results (N=1,057)

	Coef.		Std. Err.
Bid	−0.0003	**	0.0001
Less benefit	−0.275	**	0.108
More benefit	0.203		0.189
DK benefit	−0.288	**	0.145
Less pay	−0.647	***	0.132
More pay	−1.062	***	0.146
DK pay	−1.036	***	0.136
Income	0.011		0.010
White	−0.331	***	0.102
Employed	0.134		0.095
College	−0.096		0.114
Constant	1.739	***	0.164
Log likelihood	−510.582		

Note: *** and ** indicate statistical significance at the $p = 0.01$ and 0.05 levels, respectively.

Turning to the perceived cost levels, the coefficient for more pay is statistically significant and negative, implying those who perceived that the actual cost would be higher than what was presented are less likely to vote yes, as expected. Interestingly, the coefficient for less pay is statistically significant but negative which is the opposite of what was hypothesized, and what Flores and Strong theoretically predicted, implying that those who perceived that the actual cost would be less than what was proposed are less likely to vote yes. This finding is also seemingly contradictory to Zawojska et al. (2019) that found that WTP decreases as respondents perceive that they would actually have to pay the bid amount presented. The coefficient for DK pay is also statistically significant and negative implying those who were uncertain about the actual cost are less likely to vote yes. All the cost-related perception variables have negative coefficients, implying those who did not perceive that the cost presented in the referendum would be the actual cost are less likely to vote yes regardless of the direction of their subjective perceptions. Moreover, the magnitude of the coefficients for more pay and DK pay are larger than and statistically different from the coefficient for less pay ($\chi^2(1) = 9.60$ and $\chi^2(1) = 9.16$, respectively). Therefore, these results may be interpreted as those who did not perceive the cost of the proposed program "credible" are less likely to vote yes regardless of the direction of their subjective perceptions, but those who perceived that the actual cost would be less than what was proposed are more likely to vote yes than those who perceived that the actual cost would be higher or those who are uncertain about the actual cost.

Table 7 presents WTP estimates. The overall WTP (when the explanatory variables are evaluated at their mean values) is $3,630.01. Looking at effects of the subjective perceptions on WTP, WTP from those who perceived that the presented cost would be the actual cost (i.e., those who evaluated the CV scenario at the cost level intended by the researcher) is $5,719.08. This finding indicates that the overall WTP suffers from a substantial

Table 7. WTP estimates

		Parametric		Nonparametric Turnbull			
		Probit regression		Lower-bound		Upper-bound	
		WTP	% change	WTP	% change	WTP	% change
Case	Overall	$3,630.01		$477.96		$2,652.39	
1	$t_i > \tilde{t}_i$	$3,307.04	−42.18%	$228.61	−78.57%	$2,714.90	−14.49%
2	$t_i = \tilde{t}_i$	$5,719.08	–	$1,066.74	–	$3,174.80	–
3	$t_i < \tilde{t}_i$	$1,761.96	−69.19%	$664.24	−37.73%	$1,984.48	−37.49%
	$t_i \ ? \ \tilde{t}_i$	$1,859.26	−69.19%	$177.09	−83.40%	$2,098.11	−33.91%
4	$x_1 > \tilde{x}_1$	$2,995.79	−25.48%	$772.70	−19.52%	$2,360.37	−18.40%
5	$x_1 = \tilde{x}_1$	$4,020.03	–	$960.15	–	$2,892.78	–
6	$x_1 < \tilde{x}_1$	$4,020.03	–	$245.37	−74.44%	$2,910.46	+0.61%
	$x_1 \ ? \ \tilde{x}_1$	$2,945.66	−26.73%	$351.83	−63.36%	$2,009.02	−30.55%
a	$t_i > \tilde{t}_i \ \& \ x_1 = \tilde{x}_1$	$3,697.06	+60.52%	$940.37	+88.35%	$2,835.33	+89.79%
b	$t_i > \tilde{t}_i \ \& \ x_1 < \tilde{x}_1$	$3,697.06	+60.52%	$620.77	+107.44%	$2,390.00	+73.04%
c	$t_i = \tilde{t}_i \ \& \ x_1 > \tilde{x}_1$	$5,084.86	−16.77%	$567.02	−46.73%	$3,223.40	+2.08%
d	$t_i = \tilde{t}_i \ \& \ x_1 = \tilde{x}_1$	$6,109.10	–	$1,064.34	–	$3,157.64	–
e	$t_i = \tilde{t}_i \ \& \ x_1 < \tilde{x}_1$	$6,109.10	–	$577.78	−45.71%	$3,272.22	+3.63%
f	$t_i < \tilde{t}_i \ \& \ x_1 > \tilde{x}_1$	$1,127.74	−81.54%	$567.02	−46.73%	$3,223.40	+2.08%
g	$t_i < \tilde{t}_i \ \& \ x_1 = \tilde{x}_1$	$2,151.98	−64.77%	$177.78	−83.30%	$2,255.56	−28.57%
	$t_i < \tilde{t}_i \ \& \ x_1 < \tilde{x}_1$	$2,151.98	−64.77%	$42.11	−96.04%	$3,039.47	−3.74%
	$t_i > \tilde{t}_i \ \& \ x_1 > \tilde{x}_1$	$2,672.81	−56.25%	$529.81	−50.22%	$1,697.29	−46.25%

downward bias. WTP from those who perceived that the actual cost would be less than what was presented is $3,307.04. WTP from those who perceived that the actual cost would be higher than what was presented is $1,761.96. WTP from those who were uncertain about the actual cost is $1,859.26.

WTP from those who perceived that the proposed benefit level would be the actual benefit level (i.e., those who evaluated the CV scenario at the benefit level intended by the researcher) is $4,020.03. Given the coefficient for more benefit is not statistically significant, WTP from those who perceived that the actual benefit level would be higher than what was proposed does not change from $4,020.03. WTPs from those who perceived that the actual benefit level would be lower than what was proposed or those who were uncertain about the actual benefit level are $2,995.79 and $2,945.66, respectively.

Looking at effects of the subjective perceived benefit and cost levels on WTP together, the unbiased WTP which is from those who evaluated the CV scenario at the specified benefit and cost levels is $6,109.10. This finding implies that the overall WTP suffers from a substantial downward bias. In all cases, WTPs are lower than the unbiased case (as predicted by the negative coefficients for the related variables) ranging from $1,127.74 to $5,084.86 implying that any deviation from the specified benefit and cost levels results in underestimation of WTP.

Although the coefficient for bid is significant, its magnitude is rather small. This is perhaps because votes in the referendum were not sensitive to the bid level beyond $300. For comparison purposes, nonparametric Turnbull WTP estimates (for more details, see Turnbull 1976; Haab and McConnell 2002) are also reported in Table 7. The lower-bound estimates pooled responses at $300, and the upper-bound estimates pooled responses at $1,200. Overall, the Turnbull estimators produced much smaller WTP estimates compared to that of the parametric method. Even the upper-bound estimates are substantially smaller than that of the parametric method. There are a few cases for the Turnbull upper-bound where WTP estimates remain unchanged when they do for the parametric and the lower-bound methods, but overall, the direction of changes in WTP due to the perceived benefit and cost levels is consistent across the methods.

Discussion

Champ et al. (2002) appear to be the first to examine if survey respondents perceive that the actual cost would be what was presented in the survey, and Flores and Strong (2007) theoretically examined potential errors in estimated WTP for cases where (1) respondents perceive that the actual cost would be higher and (2) respondents perceive that the actual cost would be lower. However, to my knowledge, there is no study in the literature that empirically tests effects of deviations from the cost amount specified in the referendum. Moreover, given respondents are asked to evaluate benefits of a proposed scenario at a given cost in a referendum, deviations from both cost and benefit levels should be examined. This paper presents the first analysis in the literature that tests effects of deviations from both the benefit and cost levels on WTP estimates. Results indicate that WTP estimates are very sensitive to respondent perceptions regarding the actual benefit and cost levels. Depending on the direction of the deviations, WTP estimates fluctuate to up to +61 percent and −82 percent, compared to the estimate from those who evaluate the scenario at the presented levels. Results also indicate that any deviation from the cost amount leads to a lower WTP including those who perceived that the actual cost would be lower than what was presented. In the conceptual framework, it was predicted that WTP would be higher if they perceived the actual cost would be lower than what was presented, assuming $t_i > \tilde{t}_i$ is preferred to $t_i = \tilde{t}_i$. Therefore, the findings imply that the assumption may not hold. Respondents were more likely to vote for yes when they perceived that the actual cost would be the same as what was presented in the referendum. Future research is needed to understand why respondents are less likely to vote yes when they perceive that the actual cost would be lower than what was presented. Also, more empirical studies should measure deviations from the cost amount to understand if the finding can be generalized.

Even though Champ et al. (2002) and Flores and Strong (2007) pioneered the issue of deviations from the cost amount, the focus in the literature has quickly shifted to understanding effects of respondent perceptions about the likelihood of the outcome of the survey having impacts on the future policy (policy consequentiality) and perceptions about the likelihood of them actually having to pay the cost specified in the referendum if the proposed program is implemented (payment consequentiality) since the Carson and Groves (2007) paper was published. However, both policy and payment consequentialities are centered around the perceived probability rather than the perceived benefit and cost levels to which respondents evaluate the presented scenario. Given the alarming findings in this paper, more attention should be given to deviations from the benefit and cost levels. Further, future research should address how the biases from deviating from the benefit and cost levels might interact with hypothetical bias.

It is also worth noting that the incidence of Case 6 ($x_1 < \tilde{x}_{i1}$) may be a function of the benefit level specified in the survey. For example, the restoration project in this study proposed to restore the wetlands back to the 1900 level (full restoration), and therefore the proportion of the sample that falls under this category was small. It is possible that the proportion could have been bigger if the proposed benefit level was lower. Future research may explore how the perceived benefit levels might be affected by the proposed benefit at different levels. Also, results indicated that those who perceived that the actual cost would be lower than what was presented were less likely to vote yes in the referendum. One might suspect that respondents had subjective perceptions about the likelihood of the project successfully restoring wetlands in the area where such perceptions could be a function of funds raised for the project. However, such perceptions were not elicited in the survey instrument used in this paper. I acknowledge any potential errors in the analysis due to the omission of such perceptions. More research is needed to understand the incentive structure of respondents to explain the lower probability of voting yes when $t_i > \tilde{t}_i$. Finally, the referendum described the payment mechanism as a one-time payment which would be added to their tax return. Some respondents might have interpreted this as money that would be added to their tax *refund* and perceived that they would gain money by voting yes. This could potentially explain the large proportions of yes votes, but the survey instrument did not include a question to test how many respondents understood the payment mechanism correctly. I acknowledge any potential errors in the analysis due to the wording in the referendum.

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