Correcting for the endogeneity of pro-environment behavioral choices in contingent valuation

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A B S T R A C T

In contingent valuation studies, observed behavioral choices often enter as independent variables in the willingness to pay function. However, these variables may be endogenously determined when the error term in the behavioral model is correlated with the error term in the willingness to pay model. We investigate the effects of correcting for the endogeneity of a variable, namely membership status in environmental organizations that proxies unobservable characteristics of the respondents. Jointly modeling the membership variable and the willingness to pay response yields an estimate for the effect of the former that contradicts previous findings but is intuitive and agrees with theoretical expectations.

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1. Introduction

The total economic value of a resource consists of several components, including passive (or *non-use*) values. Since passive values cannot be estimated through market prices, researchers must resort to non-market valuation techniques that do not rely on observing market behavior, but on stated preferences instead. The most common stated-preference technique is the Contingent Valuation (*CV*) Method, which is based on directly eliciting the value individuals place on a proposed policy (e. g. Cummings et al., 1986; Mitchell and Carson, 1989; Freeman, 1993).

In *CV* studies willingness to pay functions are routinely estimated to identify the variables that affect willingness to pay, which can help to test the theoretical validity of willingness to pay (*WTP*) measures. For example, it is usually assumed that *WTP* should be positively correlated with income (e.g. Torgler and García-Valiñas, 2007) or that those who are more knowledgeable about nature (Whitehead et al., 1993; Loomis and White, 1996) or belong to an environmental organization are willing to pay more for nature conservation (Arrow

et al., 1993; Torgler and García-Valiñas, 2007). In general, observed behavioral choices (membership in a conservation group, recycling, and subscription to nature journals) are often encountered as independent variables of the *WTP* functions in many CV studies, since they can act as a proxy for underlying unobservable attitudes towards the environment. Moreover, Torgler and García-Valiñas (2007) cite membership in a voluntary environmental organization as one of the main factors, together with age, income, and education, to explain preferences for environmental protection. These variables, however, may be endogenously determined, in which case including them without correction in the explanatory model would lead to biased and inconsistent parameter estimates.

In the present contribution, we focus on the effect of correcting for the endogeneity of a variable often used to proxy underlying unobservable attitudes towards the environment, namely a binary indicator of status as a member of an environmental organization (*enviro* in our notation). The question of whether variables on pro-environmental behaviors should be treated as endogenous has, to our knowledge, never been asked in the literature. We aim to fill this gap.

If there are common unobservable characteristics of the respondents that affect their likelihood of belonging to an environmental organization and also their *WTP*, standard regression techniques (e.g. a naïve probit model) will result in biased and inconsistent estimates of the coefficient on *enviro*. This is because they would reflect the combined effect of *enviro* itself and of unobserved attitudes towards

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and/or norms about the resource. The bias would be positive (negative) if the sign of the effect of the unobservables is the same (opposite) on both likelihoods. Intuitively, it could well be that, all else remaining, those who see themselves already contributing enough to environmental causes through their membership fees feel less inclined to agree to support an additional conservation policy.

Many *CV* practitioners include a question or series of questions about membership in environmental organizations, environmental attitudes, choices, and behavior. This practice follows one of the guidelines in Arrow et al. (1993): the use of respondent 'attitudes towards the environment' to help provide internal tests of response plausibility (Kotchen and Reiling, 2000; Christie, 2007).

Most *CV* studies found that being a member of an environmental organization significantly increases the probability of answering "yes" to a *WTP* question with a dichotomous choice format or indicating a higher *WTP* in response to an open-ended format question as compared to non-members (e.g. Pate and Loomis, 1997; Berrens et al., 2002; Shrestha and Alavalapati, 2004; Whitehead et al., 2009). It is often stressed that this positive estimate constitutes supporting evidence of the validity of valuation exercise (e. g. Christie, 2007). However, others, such as Wang (1997) and Riera and Mogas (2004), report a positive but non-significant effect of a variable like *enviro*, while Bateman et al. (2008) highlight the importance of specifying carefully the type of environmental group to which the survey refers.[1]

The problem of endogeneity of variables about membership in environmental organizations remains currently under-explored in *CV* studies. Some researchers (e.g. Berrens et al., 2002; Aldrich et al., 2007) do mention the potential endogeneity of variables indicating membership or attitudes, but choose not to explore this issue.

The paper is organized as follows. The dataset is described in Section 1. The empirical model is presented in Section 2. Section 3 discusses the results of the regression analysis, followed by conclusions and suggestions for future research in Section 4.

2. Material and Methods

2.1. Data

The 29-question phone survey[2] was administered by a professional survey research company and targeted adults (over 19 years old) in the ten Canadian provinces. The final response rate was about 23% and the final sample includes 614 usable observations, although some of these contained some missing values. The response rate is somewhat lower for this sort of phone survey.[3] Respondents might have a higher level of knowledge about wildlife and higher *WTP* for wildlife preservation than an average Canadian. We thus acknowledge that some sample selection bias may have occurred and, therefore, we recommend caution when extrapolating values of welfare measures from our sample to the general population. This extrapolation is, in any event, not necessary for showcasing the effect of accounting for endogeneity, which is the main focus of this paper.

The first section of the survey contained general questions about the respondent's whale watching experiences and travel to, or affinity for, Newfoundland and Labrador (NL). Then respondents heard a brief description of the whale entrapment problem in NL and were asked whether they were aware of it. Afterwards they heard a description of a simple hypothetical but plausible whale conservation policy based

Table 1
Variable definitions.

Variable	Description
age	Age of respondent
agesq	Squared age
agree [a]	Whether the respondent is willing to pay proposed *bid*
beentoNL [a]	Whether respondent from outside NL has ever visited NL
bid	Amount in dollars proposed as contribution to the conservation program: extra taxes or donation per year for five years. Values: $15, $30, $45, $60, $75, or $100
children [a]	Whether respondent household includes members under 18
coastal [a]	Coastal province
enviro [a]	Member of environmental organization
fish	Takes the value of 1 if the respondent fishes for sport
heard [a]	Awareness about the whale entanglement problem
howsure	Degree of stated certainty on response to payment question (from 1 to 10)
hunt	Takes the value of 1 if the respondent hunts
income [b]	Income bracket
planatall [a]	Respondent plans to go whalewatching or maybe go whalewatching within the next five years
tax [a]	Respondent received the tax version of the questionnaire
under18	Number of members of the household under 18
WWW	Sampling weight based on provincial age and gender quotas

[a] Equals 1 if true and 0 otherwise.
[b] Value of 1 corresponds to "less than $30,000", value of 2 — "between $30,000 and $50,000", 3 — "between $50,000 and $70,000", 4 — "between $70,000 and $90,000", 5 — "between $90,000 and $110,000", 6 — "between $110,000 and $130,000", 7 — "over $130,000".

on imposing and subsidizing the use of acoustic alarms to prevent whales from becoming entangled in fishing gear. Respondents were then asked about their willingness to support the policy through a dichotomous-choice question. One version of the survey used voluntary donations to an environmental organization as the payment vehicle and the other suggested a public policy funded by a tax increase instead. The survey also included several socio-economic questions (age, income, education, etc.). Table 1 includes a description of the variables.

Whether the answer to the *WTP* question was "yes" or "no", respondents were asked to rank their confidence on that answer on a scale from 1 (*not sure at all*) to 10 (*very sure*). This variable was labeled *howsure* and used as an independent variable as in Ekstrand and Loomis (1998).[4]

Our dataset contained five variables with missing values: *income*, *age*, *age group*,[5] *education*, and *under18*. We used multivariate imputation techniques based on an interchained equations algorithm to handle these missing values, following Royston (2005).[6]

2.2. Econometric Model

Estimating the relationship between status as member of an environmental organization and the answer to the payment question may be complicated by the potential endogeneity. Thus, we estimated a two-equation latent dependent-variable model. The model is based on the assumption that there are two underlying latent propensity variables. *WTP** represents the propensity to agree to the payment question (thus the *WTP* for whale conservation) and *E** represents the propensity to belong to an environmental organization. Both latent variables are unobservable, but we do know about the realized

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[1] Our survey asked a generic question and suggested only Greenpeace and WWF as an example of environmental or conservation group. Future research could be directed at testing the differential effects of considering different types of environmental organizations.

[2] For a fuller description of the survey effort and the dataset, please refer to the online Appendix or to Lyssenko and Martínez-Espiñeira (2011).

[3] We used sampling weights to reweight the observations by *WWW*, a weight based on the age–gender distribution of respondents in each province to be used in the regression analysis.

[4] Although it would have been possible to take advantage of this variable in order to apply a fuller treatment of response uncertainty, we focused on the issue of endogeneity in this paper.

[5] This variable is not described in Table 1, because it merely captured information on the age interval of those few respondents who did not volunteer a point value for *age*. Its values were used, however, during the recursive imputation process of missing values of *age*.

[6] Further details about this imputation are shown in the online Appendix.