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The Effect of Protest Votes on the Estimates of Willingness to Pay for Use Values of Recreational Sites

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SUMMARY

Selectivity bias caused by protest responses in Contingent Valuation studies can be detected and corrected by means of sample selection models. This paper compares two methods: the Heckman 2-steps method and the full ML, applied to data on forest recreation – where WTP is elicited as a continuous variable. Either method has its own drawback: computational complexity for the ML method, susceptibility to collinearity problems for the 2-steps method. The latter problem is observed in our best fitting specification, with the ML estimator outperforming the 2-steps. In this application, overlooking the effect of protest responses would cause an upwards bias of the final estimates of WTP.

Keywords: Contingent valuation, protest responses, sample selection, MLE, two-steps method

JEL: C35, C51, C81, D60, H41, Q26

NON TECHNICAL SUMMARY

Contingent Valuation studies are often characterized by a considerable amount of protest responses, which may have an important effect on the final estimates if the protest responses are not randomly distributed across the sample. If the standard procedure of censoring protest responses is adopted, the estimates may be biased. Sample selection models can detect and – if necessary– correct selectivity bias. We apply a sample selection model to data on valuation of forest resources for recreational use, where WTP responses are obtained through a mixed dichotomous choice-open ended elicitation method. Dealing with continuous data for WTP allows us to apply the Heckman 2-steps method, and compare it to the full ML estimator. Either method has its own drawback: computational complexity for the ML method, susceptibility to collinearity problems for the 2-steps method. The latter is observed in our model. The results show that censoring protest responses in this study would lead to overestimates of the willingness to pay.

CONTENTS

1. Introduction

Every analyst of survey data knows that a certain percentage of missing responses is inevitable, and that even the best designed questionnaire cannot do away with this problem. It may happen that people consider some questions as invasive of their privacy, and this may lead respondents to give inaccurate answers or no answers at all. The problem in contingent valuation analyses is that such reactions are frequently observed when the very crucial question is posed, i.e. the question aimed at eliciting the value that the individual attaches to the good under analysis.

Many CV studies suffer from a high percentage of respondents in the sample who refuse to contribute to the payment of the public good. Of course, respondents may be truly averse or indifferent to the good: in such a case, the refusal to pay is to be interpreted as a genuine valuation statement. However, the same response may be obtained from individuals that in other sections of the interview express interest in the provision of the good. This behavior may be due to a variety of reasons: free riding, reaction to the interview, or to the method of elicitation adopted. In these circumstances, the individual value is in fact missing, since the individual is not revealing her true reservation price.

Debriefing questions to clarify the reasons behind the refusal to participate in the payment have been recently introduced in the protocols to discriminate true zero or negative values from protest responses (see Haab, 1999). Once zero bids are properly discriminated between true zero values and protest responses, it is still unclear exactly what to do with the data. The standard is to include in the analysis only true valuation responses, while protest responses are removed (Whitehead et al. (1993); Mitchell and Carson (1989); see Jorgensen et al. (1999) for a thorough discussion). However, as hinted by Halstead et al. (1992), Shyamsundar and Kramer (1996), and Jorgensen and Syme (2000), and shown by Calia and Strazzera (1999), and Strazzera et al. (2000), this procedure may affect the validity of the estimates. Removal of protest responses would be legitimate only if the group of protesters is not significantly different, in terms of characteristics influencing the valuation of the good, from the group of people that participate in the evaluation exercise. If this is not the case, i.e. if a sample selection issue arises, the estimates obtained from the sub-sample of non protesters are biased, and a sample selection model is required to produce correct estimates for the parameters of the model and the welfare estimates. Sample selection models take into account the fact that the value obtained from the individual after the elicitation question is the result of two possibly correlated choices: the individual chooses whether to participate or not in the assessment; and, if she does, she chooses the value reflecting her valuation.

Unfortunately, sample selection models are not friendly tools. Full information maximum likelihood models are recognized as the most efficient, as long as they are correctly specified. However, notwithstanding the progress in microcomputers capabilities, the amount of calculations involved is still burdensome. The maximization procedures often break down, maximum likelihood computations may not converge, or standard errors of the coefficients cannot be computed. A fashionable alternative to full ML models is given by semiparametric methods. In fact these models are especially designed to overcome the problem of stringent distributional assumptions required by parametric sample selection models –but not the problem of the burden of calculations, though. They are even more highly computer intensive than full MLE, and require larger data sets than what most contingent valuation surveys collect. In practice, even though semiparametric models can be used in some large sample studies, the parametric method is probably best suited to average contingent valuation applications.

When the individual reservation price is elicited as a discrete variable (as in the dichotomous choice method), full ML is the only available technique to model a parametric sample selection model. If the valuation data is elicited instead as a continuous variable, a convenient alternative to the simultaneous ML model is the Heckman's two-step model. Heckman's model is much easier to implement than the ML model, which explains why it is the most frequently used method to deal with selectivity in microeconomic applications (see Vella, 1998, p.133).

The dichotomous choice method is currently considered the most appropriate for eliciting values for public goods. The problem is that a single bidding question has a poor informative content. Double and multiple bounds methods have been developed in order to secure some gain in efficiency, which is substantial for the double bound, as shown by Hanemann et al. (1991); while the addition of further bounds seems less beneficial, especially if weighted against the risk of introducing response bias (see Scarpa and Bateman, 2000, and Bateman et al., 2001). Indeed, results on possible bias effects produced by iterating the elicitation mechanism have driven many practitioners back to using the single bound method[1]. However, when budget or time constraints impose a tight limit on the sample size, it may be advisable to increase the information obtained after the single bound procedure. The risk of a relevant number of protest responses makes the need for acquiring more information after the single bound question more stringent. Whether they are removed from the sample or treated by means of a sample selection model, the presence of protest responses reduces the informative content of the data –so, in a sense, a small data set is even "smaller" when it contains protest responses.

A fully efficient method is to directly ask as a follow-up to the dichotomous choice question, the maximum price the respondent would be willing to pay for access to the good, as suggested in Green et al. (1998). While, as in the double or multiple bound format, there may be some response bias due to the possible anchoring to the first bid proposed (see Bateman et al., 1999, for a thorough analysis of elicitation effects across methods), the gain in efficiency could be substantial when the sample size is small. Moreover, some methods have been suggested (see Herridges and Shogren, 1996, Cameron and Quiggin, 1994, Alberini et al., 1997) to deal and correct for specific forms of bias such as the anchoring effect, which can be used at the estimation stage[2].

The contingent valuation data used in this paper was obtained using the combined method, i.e. dichotomous choice with an open ended follow up. It will be shown how to detect and correct selectivity bias due to the presence of protest responses with this type of data, or, more generally, when the valuation data is continuous. The data refers to the assessment of the recreational values of 15 heavily used forest sites in Scotland.

We present the results from two alternative estimation techniques: full information maximum likelihood, which is known to be more efficient, but computationally intensive, and Heckman's two-steps model. The presence of selectivity bias is tested within each model, and results are compared.

[1] As shown in Calia and Strazzera (2000), the efficiency differentials between the single and double methods decrease by increasing the number of observations: if the sample size is large enough, the choice of the single bound is warranted also in terms of efficiency of the estimates.

The outline of the paper is as follows: the next section describes the methods employed (i.e. ML and 2-steps), and the models adopted for the respondents' choices; section 3 contains a description of the survey and the data, while section 4 shows the results, and section 5 concludes the paper.

2. Models

Zero values can be included in CV analysis in a very easy way, simply constructing a mixture or spike model (as in Kristrom, 1997, Reiser and Schechter, 1999, An and Ayala, 1996: see Scarpa et al., 2001, for an application), where the probability of obtaining a zero value is estimated independently of the valuation function referring to individuals with positive WTP. If this is the correct model, the estimates of the coefficients of the valuation function are unaffected by censoring of zero values; however, if the assumption of independence is incorrect, then, as shown by Werner (1999) and Haab (1999) we would obtain biased estimates.

As will be seen in the next section, in our data set the percentage of zero values is negligible, and for simplicity we do not include them in the present analysis. We assume that all other respondents have a positive WTP. Some of them reveal the value attached to recreation in the forest, by stating their (supposedly true) WTP; others instead do not reveal their valuation, because of alleged disagreement with the elicitation method employed. For both categories, we have information on their socio-economic characteristics and on their visit to the forest.

We model the decision process as a joint process involving the choice of a monetary value and the choice of whether to reveal it or not. Let Y_1 denote this amount, let Y_2 be a dichotomous variable that takes the value 1 if the individual reveals it and 0 otherwise and let x and z be vectors of explanatory variables for the valuation and participation equations respectively. Then we can write

$$\ln Y_{1i} = x_i^{'}\beta + \sigma u_i \tag{1}$$

[2] In this paper we focus on the selectivity bias problem, and do not analyze the effect of the first bid on the stated WTP. However, we consider its influence on the response at the participation stage: i.e. it may have an effect on the decision to protest or not.

for the WTP equation, where σ is a scale factor, Y_{1i} is observed only when Y_{2i} =1, and

$$Y_{2i} = \begin{cases} 1 \text{ if } z_i'\gamma + \varepsilon_i \geq 0 \\ 0 \text{ if } z_i'\gamma + \varepsilon_i < 0 \end{cases} \qquad (2)$$

for the participation equation.

The joint distribution of (u_i, ε_i) is assumed to be bivariate normal with zero means, variances equal to 1 and correlation ρ. When ρ=0 the two decisions are independent and the parameters of the two equations can be estimated separately.
The log-likelihood of the full ML model is given by

$$l = \sum_{Y_{2i}=0} (1 - I_i) \ln \Phi(-z_i'\gamma) + \sum_{Y_{2i}=1} I_i \ln \phi\left(\frac{\ln Y_{1i} - x_i'\beta}{\sigma} \right) + I_i \ln \Phi\left(\frac{z_i'\gamma + \rho\left((\ln Y_{1i} - x_i'\beta)/\sigma \right)}{\sqrt{1-\rho^2}} \right) - I_i \ln \sigma$$

Maximization of this function produces simultaneous estimation of the parameters of both the participation and the WTP equation.

The Heckman procedure follows two-steps. First, notice that the conditional expected value of ln(WTP) is:

$$E(\ln Y_{1i} \mid Y_{2i} = 1) = x_i'\beta + \rho\sigma\lambda(z_i'\gamma) \qquad (3)$$

where $\lambda(z_i'\gamma) = \frac{\phi(z_i'\gamma)}{\Phi(z_i'\gamma)}$ is the inverse of the Mill's ratio.

The first step of Heckman's procedure entails the estimation of the participation equation by probit, which gives us an estimate of λ. The second step consists of a least squares regression (for non protesters) of Y_{1i} on x and $\hat{\lambda}$.

The two steps procedure is the most widely used in applied microeconomics, while ML models are seldom used because of computational difficulty. However, it has been noted that Heckman's estimator sometimes performs poorly. This finding has spurred researchers to analyze the statistical properties of the two estimators. There seem to exist a general agreement among researchers that if there is no collinearity between the regressors of the two equations (i.e. the x and z), then the Heckman's estimator performs quite well, while the converse holds in the opposite case: see Nawata and Nagase (1996), Leung and Yu (1996, 2000), Puhani (2000). The advantage of MLE in terms of efficiency is not always confirmed in finite samples: Heckman's procedure may turn to be more efficient than MLE (see Leung and Yu, 2000). The same authors point out that the Heckman's model is more robust to measurement errors of the dependent variable in the outcome equation –which, in CV analysis, may also apply to errors in individuals' WTP statements.

A simple method to detect collinearity between the regressors of the two equations is to regress $\hat{\lambda}$ against x: the R^2 gives a measure of collinearity. Following Leung and Yu (1996), we also employ another measure, suggested by Belsey, Kuh and Welsh (1980): we calculate the condition number, which is the (square root of the) ratio of the highest to the lowest eigenvalue of the moment matrix of the regressors ($\hat{\lambda}$ and x). Since the eigenvalues depend on the scale of the data, data is generally scaled to have length one. A condition number around 5 or 10 indicates weak dependency, while numbers from 30 up to 100 indicate moderate to strong correlation (see Judge et al., 1985, p. 902).

3. Description of the survey and data

In 1992 Queen's University Belfast conducted a study on recreational benefits provided by forests in Scotland. Face-to face contingent valuation interviews were administered on-site in 15 heavily used forest sites. Respondents were intercepted on their way back from the visit to the forest, at the car park. All the CV surveys shared an identical design across forest site; the percentage of people completing the interview was extremely high, rating at over 90%.

After a series of questions regarding the visit to the forest, individuals were asked if they were willing to pay a given entry fee to the forest rather than forging the experience they just enjoyed. A special feature of the question was that the fee was supposed to be paid by the respondent for each person in the party. This particular format was chosen after conducting a series of pilot studies where other access charges payment vehicles were considered, such as annual permits and parking fees. Choosing the party, rather than the individual, as a sampling unit can be justified by the fact that when people travel in groups, many trip expenses are collective: for example, if moving by car, gasoline or parking fees. In this line, we restrict our attention to car pools, and use as a WTP the stated amount multiplied by the number of the components of the pool.

The initial (first bound) bid amounts t used were: {50, 100, 150, 250, 400} (in pence). They were uniformly distributed across visitors. Respondents who answered "yes" were presented with a follow-up question that reiterated the *WTP* question with a higher bid amount t^h: respectively {100, 150, 250, 400, 700}. Instead, respondents who answered "no" were asked the same question again, with a lower bid amount t^l: respectively {30, 60, 80, 150, 250}. Bid amounts were chosen on the basis of initial parameter estimates of the *WTP* distribution obtained from extensive pilot studies.

Finally, another follow up question was posed, asking the maximum amount the respondent were willing to pay as an entry charge for each component of the party. If the value stated by the respondent at this stage was zero, another question was posed to disentangle true zero values from protest responses. This debriefing question prompted the individual with four possible alternatives:

a) recreational benefits stemming from the forest were not enough to warrant any payment;

b) budget constraints impose a restriction on additional expenses;

c) the method of payment (entry charge) is considered inappropriate;

d) it is unfair to charge for recreation in that forest.

In our analysis, responses in the first two categories were classified as true zero values; while the other two categories were considered protest responses.

During the interview, other information was also obtained concerning the characteristics of the visit, such as main reason for the visit, time spent in the forest, main activities engaged in during the visit, etc. To complete the socio-economic profile of visitors, data such as age, sex, household income, personal income, education, was also collected.

Table I gives summary statistics of the data relevant to this analysis: the variables used in the estimation, plus some information on the responses obtained in the elicitation process. Full descriptions of these variables are given in Appendix A. It can be seen that the number of true zero values is almost negligible: only 49 individuals, which amounts to 1.46% of the whole sample: while there are 535 protest zeros making up 17.75% of the sample.

Table I: Means and standard deviations (in parenthesis) by groups of respondents

	TYPE OF RESPONDENT			
	ALL	TRUE ZERO	PROTESTER	POSITIVE RESPONSE
WTP (£) mean	3.41(3.64)	0 (0)	…	4.23(3.6)
WTP (£) median	2.5	0	…	3
Young	0.87 (1.08)	0.79 (1.15)	0.85 (1.09)	0.88 (1.07)
Adults	2.08 (0.76)	2.12 (0.78)	2.02 (0.82)	2.09 (0.75)
Time	142.7 (103.3)	104.8 (67.7)	115.3 (93.6)	149.5 (104.8)
Parking	0.488 (1.35)	0.05 (0.15)	0.15 (0.87)	0.57 (1.44)
Eating	2.83 (5.87)	1.68 (3.47)	2.32 (6)	2.96 (5.89)
Past	17.18 (54.55)	36.16 (90.74)	37.60 (88.95)	12.3 (40.8)
Other	11.3 (38.8)	9.28 (23.65)	18 (57.65)	9.86 (33.35)
Improved	0.91 (0.27)	0.69 (0.46)	0.9 (0.29)	0.92 (0.26)
Income				
1: <16000	0.32 (0.46)	0.53 (0.5)	0.36 (0.48)	0.31 (0.46)
2: 16000-30000	0.47 (0.5)	0.42 (0.5)	0.41 (0.49)	0.48 (0.49)
Sex	0.65 (0.47)	0.73 (0.44)	0.65 (0.47)	0.65 (0.47)
Sample size	3013	49	535	2429

For many of the considered variables such as sex, income, attitude towards recreational benefits of the forest and age composition of the pool, the differences between protesters and positive responses are not substantial. However for variables related to expenditures (parking and eating), the means are considerably lower for the first group. Moreover, a striking feature of the data is that protesters visited this and other forests in the previous year at least twice as many times as respondents who reveal their willingness to pay. If these variables influence the WTP for the visit to the forest, we can expect that censoring protest responses will bias the final estimates.

4. Results

The ML sample selection model was estimated using different covariate specifications: the effect of socio-economic characteristics, such as income, education, age, sex; or features of the visit, such as the number and age of components of the car pool, expenses for parking or food, activities undertaken during the visit, previous visit experiences (Appendix A contains a description of the variables used in the study). Table II reports the parameter estimates for the best fitting specification, which was selected by means of likelihood ratio tests for nested specifications. These are compared to the estimates obtained from the Heckman two steps model.

Table IIa: MLE and 2-steps Sample Selection Models

Participation equation

	MLE			2 Steps (Probit)		
Parameters	Estimates	Std. Erro	P-Value	Estimates	Std.Error	P-Value
Constant	1.100	0.075	0.000	1.051	0.075	0.000
Lbid1	-0.272	0.033	0.000	-0.240	0.034	0.000
Time	0.001	0.000	0.000	0.001	0.000	0.000
Parking	0.148	0.030	0.000	0.155	0.031	0.000
Past	-0.003	0.000	0.000	-0.003	0.000	0.000
Other	-0.002	0.000	0.000	-0.002	0.001	0.001
Inc2	0.176	0.056	0.000	0.173	0.056	0.002

Table IIb: MLE and 2-steps Sample Selection Models

Valuation equation

	MLE			2 Steps (OLS)		
Parameters	Estimates	Std. Erro	P-Value	Estimates	Std.Error	P-Value
Constant	-0.132	0.071	0.030	-0.475	0.087	0.000
Lnparty	0.969	0.046	0.000	0.874	0.048	0.000
Young	-0.082	0.018	0.000	-0.079	0.018	0.000
Time	0.001	0.000	0.000	0.002	0.000	0.000
Parking	0.098	0.010	0.000	0.137	0.011	0.000
Eating	0.004	0.002	0.031	0.004	0.002	0.090
Sex	0.076	0.028	0.003	0.082	0.028	0.003
Past	-0.002	0.000	0.000	-0.004	0.000	0.000
Improved	0.158	0.050	0.001	0.172	0.050	0.001
Income1	-0.201	0.038	0.000	-0.194	0.038	0.000
Income2	-0.150	0.035	0.000	-0.073	0.037	0.046
σ	0.660	0.012	0.000			
ρ	0.321	0.079	0.000			
λ	---	---	---	1.285	0.169	0.000
Log. Lik.	-3681.054					

The explanatory variables in the participation equation (table IIa) are: the amount the individual was asked to pay at the first stage of the elicitation process (i.e. the first bid multiplied by the number of people in the party), expressed in logs; the number of visits to the present forest, or to other forest sites during the past year; time spent in the forest; parking expenditure; income (class 2). The effect of the amount the individual is asked to pay is obvious: the higher the amount, the more likely the protest –maybe because the incentive to free ride is higher. Being used to visit forests free of charge has also a negative effect on the participation choice; while the positive effect of the parking expenditure presently borne can be easily understood considering that the elicitation question asked for an entry charge with no parking fees. More time spent in the forest indicates a higher value, which is also reflected in a higher propensity to participate; while the effect of income is not monotonic, with the middle class being more willing to participate than the lower and higher income classes.

Table IIb reports the estimates pertaining to the valuation equation, with ln(WTP) as the dependent variable, including the correlation coefficients: $\hat{\rho}$ for the ML method, and $\hat{\lambda}$ for the 2-steps method. Both coefficients are significantly different from zero, i.e. both methods support the hypothesis that there is sample selection: if protest responses were removed from the sample, the resulting estimates would be biased. In particular, since the correlation is positive, the estimates would be biased upwards, i.e. we would obtain higher estimates for the sample WTP. In this survey, protesters are people that on average hold a lower WTP than people who participate in the valuation. It is not always necessarily like that: it may happen that protesters are people who on average hold a higher WTP: the correlation would be negative, and the estimates obtained after removing protest responses would be biased downwards (see Strazzera et al., cit.). As for the factors that affect willingness to pay, the estimates differ depending on the estimation method –especially for income (class 2) but the signs coincide. More frequent visitors to the forest are willing to pay less (they are also less willing to participate). Time spent at the site, the belief that forests improve recreation as well as expenses in parking and food have a positive effect since some visitors might consider the visit to the park as a composite good (park-transportation-food). Income has the expected effect since the lower income categories are willing to pay less on average (the estimates across methods are different in this case), males are willing to pay more than females. The coefficient estimate for party size is close to one indicating that there is some proportionality between the total amount the respondent is willing to pay and the number of people in the pool. However the negative estimate for the coefficient of Young seems to indicate that respondents placed lower values for the young people in their party: maybe respondents take into account the fact that generally children get reduced entry charges to sites of educational interest. Alternatively, it may be argued that while a party of adults may share the cost, children's expenses are entirely borne by accompanying adults, and this leads to less than proportional increases on the WTP for the party. In McFadden (1994) evidence is found that respondents do not aggregate linearly over household members and that they usually impute a WTP to other household members lower than their own. In our case, respondents impute a lower WTP than their own to the young members of the party only.

Table III reports estimates for mean and median WTP from both methods for different scenarios. The first row corresponds to the estimate of the unconditional mean, i.e. for all respondents (protesters and participants); the second row corresponds to the estimate of the median WTP for all respondents again; while the third row shows the confidence intervals for the median WTP.

Table III: Estimates of mean (unconditional, conditional, no correlation), median WTP and confidence intervals for the median from the two methods.

	MLE	**2-Steps**
E(Y)	3.535	3.370
Median(Y)	2.843	2.037
C.I. Median	[2.695, 2.992]	[1.763, 2.310]
$E(Y_{1i} \mid Y_{2i} = 1)$	3.861	4.138
E(Y) $\mid \rho=0$	*3.745*	*3.745*

The mean and median estimates from the two-step method are smaller (especially for the median) than the estimates from maximum likelihood and this, of course, is explained by the differences in the parameter estimates –especially the constant and the effect on $x'\hat{\beta}$. In addition, note that in order to get estimates of $E(Y_1)$ we need to get estimates not only of β but also of σ since Y_1 has a lognormal distribution with parameters $x'\beta$ and σ and $E(Y_1) = \exp(x'\beta + \sigma^2/2)$, while the estimate of the median is given by $\exp(x'\beta)$. Although consistent estimates for ρ and σ can be obtained from the two-stage procedure, problems might arise for any finite sample, since, for instance, nothing prevents the estimate of ρ from being outside [-1,1]. In our setting, the two-step estimate of the coefficient of λ (1.28), which is an estimate of ρσ is much higher than the estimate of ρσ (0.21) that we would obtain from maximum likelihood. Therefore, the two-step estimate of σ turns out to be much higher than the maximum likelihood estimate: this explains the wider difference in the median estimates than in the mean estimates.

When describing the 2-steps method, we reported that collinearity problems may affect the estimates. To check for collinearity, we follow the procedure indicated by Leung and Yu (1996): we first run a regression of the estimated inverse Mills ratio against the regressors of the valuation equation: i.e., using OLS, $\lambda(z_i'\gamma)$ was regressed against x. The resulting R^2= 0.71 indicates a considerable level of correlation. As explained in section 2, we also calculated the condition number: its level, 40.18, is also indicative of some collinearity problems.

The third row in Table III contains the confidence intervals, obtained analytically, as in the Cameron's approach (1991), using the asymptotic parameter variance-covariance matrix and the fact that given the regressors, the median is a transformation of the parameters: the derivation for the lognormal distribution is illustrated in Appendix B.

The confidence interval for the two-step method was computed using the corrected variance covariance matrix of the parameter estimates as in Greene (1997). It can be noticed that the confidence interval is wider for the 2-steps method than for the MLE.

The fourth row shows the estimates of the mean WTP conditional on participating in the assessment, corrected for selectivity bias. The conditional estimate is useful if the final purpose of the valuation exercise is indeed to fix a ticket price for access to the good. In our case, people who would enter in the market would be willing to pay on average 3.861 pounds per person in the party, according to the ML estimate. This analysis of the demand may be particularly useful when dealing with congestion problems. If, instead, the assessment is aimed at understanding the value that people attach to the non-market good under analysis, then the unconditional estimates are those relevant to the scope. Note that for the conditional mean estimate, the two-step method gives a much higher value than the maximum likelihood: once again this is due to the high value of the parameter estimate corresponding to the inverse of the Mill's ratio.

The last row in Table III corresponds to the case in which the two equations (participation and valuation) are uncorrelated, and can be estimated separately. In this case, estimation of the WTP equation can be done either by ML or, equivalently, by OLS. As discussed before, this specification was not supported by the data. The difference between the ML estimates in the first and in the last row is the sample selection bias that would be produced by removing protest responses.

5. Conclusions

Many CV studies are characterized by a considerable amount of protest responses. Especially when analyzing goods which have been traditionally provided free of charge, such as parks or forests, protest responses are very likely to be a problem.

The way these responses are treated in the estimation process is going to affect both the parameter estimates and the estimates of mean and median WTP. If the decision to protest is not random, and the two sub-samples of protesters and non protesters have different characteristics, sample selection bias may arise and affect the final estimates. Sample selection models are necessary tools to uncover and –if necessary- correct selectivity bias.

In this paper we explore the behavior of two standard parametric methods on continuous WTP data: full ML estimation, and the Heckman's 2-steps method. Either method has its own drawback: computational complexity for the ML method, susceptibility to collinearity problems for the 2-steps method.

We find evidence that frequent visitors of a forest site are more likely to give a protest response, and willing to pay less on average. This suggests that another payment vehicle – for example an annual fee- for frequent users might have helped to reduce the number of protest responses. As a matter of fact, for private recreational goods that could be comparable in nature, such as an outdoor sports club, fees are usually paid as member fees and not as per time fees. Of course, introducing different payment formats for different categories of individuals would also produce further complications in the analysis.

Finally, our results rely heavily on the joint normality assumption. We set up the model using ln(WTP) as the dependent variable in the valuation equation: the resulting distribution for WTP is lognormal, which is in line with the sample information we have (median WTP is smaller than mean). However, other types of joint distributions could apply to the joint decision process: the analysis of different distributional assumptions will be the object of further research.

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Appendix A

List of variables

Wtp: total amount the respondent is willing to pay for the party, i.e amount per party.

Bid1: first bid presented to respondent in dichotomous choice question (Lbid1=ln(bid1)).

Nparty: size of the party (Lnparty=ln(Nparty)).

Young: number in party younger than 18.

Adults: number of adults in party.

Time: time passed in the forest (minutes).

Parking: cost of parking (pounds).

Eating: cost of food (pounds).

Past: number of visits to the forest in the past year.

Others: numbers of visits-other forests.

Improved: forests improve recreation

1-yes

0-no

Income: Household income

1 <15999

2 16000<30000

3 30000 and above.

Sex: sex of respondent

1-male

0-female

Appendix B

From equation (1) and the fact that u ~ N(0,1) it follows that WTP follows a lognormal distribution and that median WTP is given by $e^{(x'\beta)}$. For a given value of $x=x_0$ the median is given by the following expression,

$m_0 = e^{x_0'\beta}$ and therefore an estimate of median WTP is given by $\hat{m}_0 = e^{x_0'\hat{\beta}}$. A Taylor series expansion of $\hat{m}_0$ around β leads to the following expression,

$\sqrt{n}\hat{m}_0 = \sqrt{n}\left(e^{x_0'\beta} + x_0' e^{x_0'\beta}\ (\beta - \hat{\beta}\ )\right) + o_p(1)$, where the last term corresponds to the quadratic terms in $(\beta - \hat{\beta}\ )$ which vanish to zero faster that $\sqrt{n}$. Rearranging terms we have,

$\sqrt{n}(\widehat{m}_0 - m_0) = \sqrt{n}\left(x_0' e^{x_0'\beta}(\beta - \widehat{\beta})\right) + o_p(1)$ and since $\sqrt{n}(\widehat{\beta} - \beta) \overset{A}{\sim} N(0, \Sigma_\beta)$, we have that $\sqrt{n}(\widehat{m}_0 - m_0) \overset{A}{\sim} N(0, x_0' e^{x_0'\beta} \Sigma_\beta x_0 e^{x_0'\beta})$ thus the 95% confidence interval for the median is given by,

$CI_{.95}(g_0) = e^{x_0'\widehat{\beta}} \pm t_{0.025}\sqrt{x_0' e^{x_0'\beta} \widehat{\Sigma}_\beta x_0 e^{x_0'\beta}}$ and all we need to compute a confidence interval for the median is to obtain the estimate of the asymptotic variance-covariance matrix and apply the above formula.

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