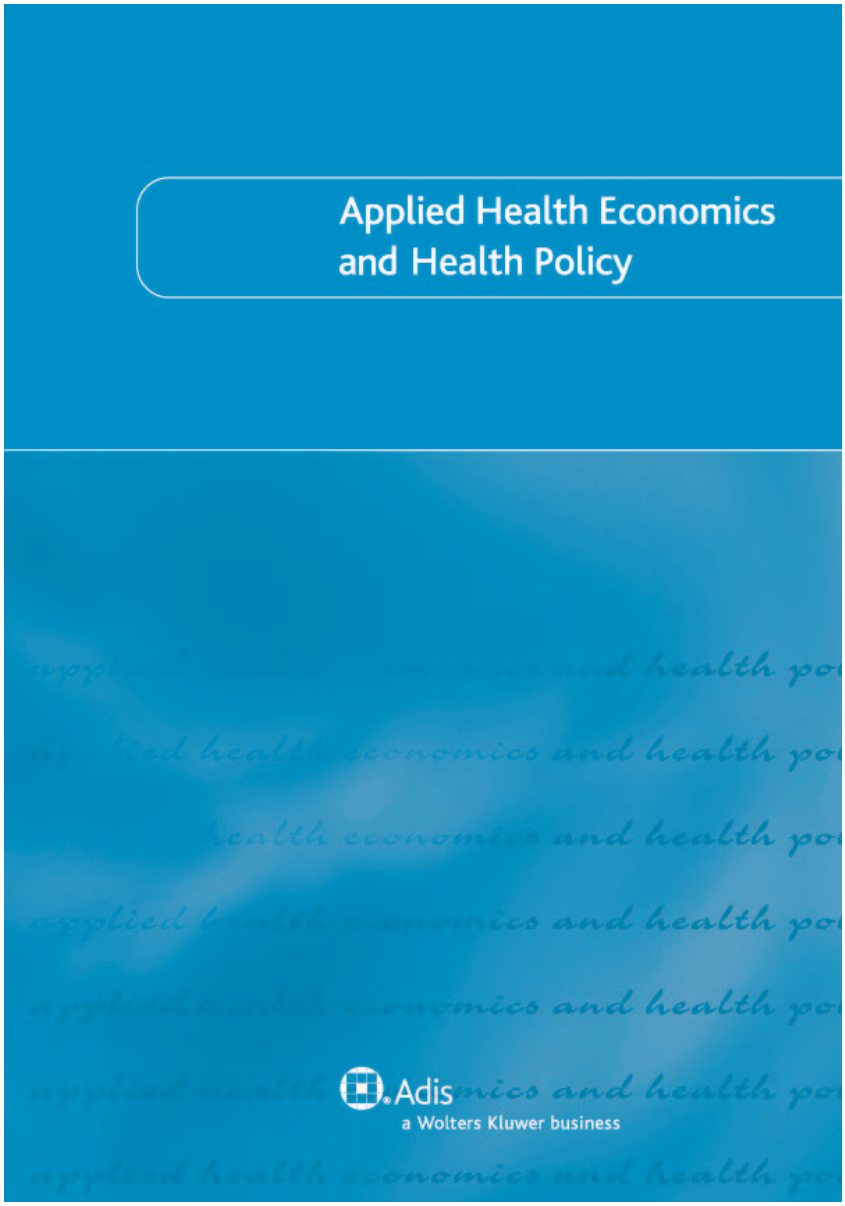

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The Effect of Protest Zeros on Estimates of Willingness to Pay in Healthcare Contingent Valuation Analysis

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Abstract

'Protest zeros' occur when respondents reject some aspect of the contingent valuation (CV) market scenario by reporting a zero value even though they place a positive value on the amenity being valued. This is inevitable even in the best-designed CV study, and, when excluded on an *ad hoc* basis, may cause a selection bias problem. This could affect the reliability of the willingness to pay (WTP) estimates obtained for preference assessment. Treatment of 'protest zeros' in general, and particularly in the context of developing countries, has been rather unsatisfactory. Most case studies employ the Heckman 2-step approach, which is much less robust to co-linearity problems than the Full Information Maximum Likelihood (FIML) estimator.

The main objective of this article is to illustrate a sequential procedure to simultaneously deal with co-linearity and selectivity bias resulting from excluding 'protest zeros' in CV analysis. The sequential procedure involves

different levels of estimation and diagnostics with the 2-step and FIML estimators; the duration of the procedure depends on the diagnostic test results at each stage of the estimations.

The data used for the analysis were elicited using the conventional dichotomous choice buttressed with an open-ended follow-up question. The survey was designed to elicit households' WTP for a proposed community-based malaria control scheme in rural Cameroon. In the application context, we found that the different levels of estimation and diagnostics resulted in reliable WTP estimates from the FIML approach, which would obviously have been overlooked in the absence of such diagnostics.

In the past few years, the contingent valuation (CV) method has attracted significant policy attention in the health sector, especially in the context of developing countries.[1,2] For many health policy planners, CV is very flexible and adaptable to many valuation tasks that alternative healthcare evaluation techniques cannot handle. Its results are relatively easy to interpret and to use for health policy purposes. For example, willingness to pay (WTP) values can be presented in terms of mean or median per household or aggregate values for the relevant population.[3]

However, common to CV surveys, like many other survey methodologies, is the recording of a large number of responses with WTP values of zero (i.e. 'true' zeros and 'protest' zeros). 'True' zeros correspond to where respondents find the amenity or commodity valueless, whereas 'protest' zeros (or 'protest votes') occur when respondents reject some aspect of the constructed market scenario by reporting a zero value even though they place a positive value on the amenity being valued.[4] 'Protest zeros', depending on the amenity being valued and the payment vehicle adopted, constitute a substantial portion of zero WTP bids in CV surveys.[5,6]

In several health valuation studies, the standard procedure for treating 'protest zeros' is to exclude such bids from the analyses.[7] The exclusion of 'protest' bids or zeros may be deemed satisfactory if not different from the remainder of the sample at least in terms of the co-variates employed in the econometric estimation. If this is not the case, the analyst faces a sample selection bias problem, which could have two consequences on the CV findings.[8] First, the empirical analysis of the valuation function used to test for theoretical validity may generate inconsistent parameter estimates for reasons similar to those described by Heckman[9] and others.[10-17] Second, the estimated benefit measures, and hence the aggregate values, may also be biased.

Of the few developing country health valuation studies that have attempted to model 'protest zeros', the modelling approach has been quite unsatisfactory.[7,18] Most applied Heckman's 2-step estimator, which, as a matter of fact, produces WTP estimates that are much less robust to co-linearity problems than Full Information Maximum Likelihood (FIML) estimates.[15] Thus, most often these studies trade-off reliable WTP estimates crucial for health policy design, at the expense of less reliable estimates as a result of ease in estimation.

Therefore, the main purpose of this article is to illustrate a sequential procedure to deal with the presence of both sample selection bias and co-linearity problems in general. The sequential procedure involves different levels of estimation and diagnostics with the ordinary least squares (OLS), Heckman 2-step and FIML estimators; the duration of the procedure depends on the diagnostic test results at each stage of the modelling process.[15] The data used for the analysis were elicited using the dichotomous choice format, buttressed with an open-ended follow-up elicitation question. The essence of the survey was to elicit WTP values for a proposed community-based malaria control scheme in rural Cameroon.

1. The Rationale for Controlling Malaria in Bambalang, Ndop, Cameroon

The socioeconomic considerations that informed the location of the Bamendjim water dam[1] in the Ndop area of Cameroon appear consistent with the problems of the Ndop locality. It was anticipated that the dam would play a catalytic role in transforming the Ndop economy while simultaneously enhancing sustainable rural development in the whole of the Ndop locality.[19] However, surprisingly, the location of the project has had widespread backwash effects on Ndop and its precincts, most notably, Bambalang.[20] [2]

Of the plethora of problems arising from the location of the dam, the health effects are considered the most disastrous. The dam has created permanent ponds of stagnated water, marshlands and fields that act as a habitat for several species of mosquitoes. The situation is made worse by the dearth of medical facilities and personnel. On average, 1455 individuals in Bambalang have access to one health worker, with four health centres to cater for more than 16 000 inhabitants.[7] The inadequacy of health facilities has forced the people to rely heavily on mosquito coils, animal droppings and local remedies as preventive measures against malaria. This has resulted in poor educational enrolment of children, high infant mortality rates, rural-urban drift, poor saving and investment, loss of productivity and extra medical costs, etc. This scenario has made the prospect of economic growth and development of the Bambalang area rather bleak, and poverty and health crises are accepted with equanimity.[20]

Several attempts by the Government of Cameroon and non-governmental organizations (NGOs) to eradicate malaria in Bambalang have failed.[21] This is simply because no major attempt has been made so far to attach a monetary value to the disease eradication in the area, which is essential for several reasons.

First, the decline in budgetary allocations from the government to the health sector as a result of the devaluation of the Central African CFA franc (CFA) in 1994 has necessitated direct household contribution to the sector through a variety of policy reforms such as user fees at government healthcare facilities, encouragement of community-based financing schemes and encouragement of non-profit-making but fee-charging NGOs.[20]

Second, it is difficult to design and implement an effective malaria control programme in the area without the active participation of the community.

Third, knowledge of the maximum amount the people are willing to pay will also help the government, NGOs and donor agencies to consider the introduction of subsidies in order to achieve the ultimate objective of malaria eradication in the area.

The main purpose of this study was to design an improved planning methodology that could help elicit information on the value placed by the Bambalang people on communal re-stocking of the lake with larva-eating fish species, and inform appropriate household levies or fees. A key concept in such an improved planning methodology is that of the WTP for the scheme. Eliciting households' WTP, with the aid of CV, to inform health reforms and policy making is not a novelty in health economics literature. It has been used extensively in valuing specific benefits of healthcare intervention and programmes in developing countries. These benefits include the initiation of community-based health insurance schemes,[18,22-25] community-based financing of filariasis control,[26,27] malaria control and pre-

1 The main function of the dam is to increase the volume of water into the River Sanaga that supplies Cameroon with hydroelectricity. The dam is located in the Bamendjim community of the Western Province of Cameroon; however, the artificial lake is found in the Ndop area of the Ngoketunjia Division, Northwest Province, Cameroon.

2 The study area, which is one of the 13 communities that make up the entire Ndop clan, is located in the Ngoketunjia Division of the Northwest Province, Cameroon. By 2004, Bambalang comprised 15 quarters, with a population estimate of approximately 16 000 inhabitants living some few kilometers away from the lake.

vention programmes,[7,28,29] etc. However, as indicated earlier, several of these applications failed to account for the effect of 'protest zeros' on the estimates of mean WTP for the programmes valued.

The objectives of this study were therefore 2-fold. The first was to attach a monetary value to malaria eradication in the area to help establish empirical grounds for pricing the scheme within a community-based financing framework. The second was to illustrate a sequential procedure to simultaneously deal with co-linearity and selectivity bias resulting from excluding 'protest zeros' in healthcare CV analysis. We expect, aside from the direct policy implications the findings have for malaria control in the area, to significantly contribute to the ongoing methodological debate on the effect of modelling 'protest zeros' in healthcare CV analysis.

2. What Role Do Elicitation Formats Play in Minimizing Protest Zeros?

It is extremely difficult to state with certainty which response format is best suited for minimizing the occurrence of 'protest zeros' in CV surveys; people protest for several different reasons. Some may protest because they are basically free riders, others possibly because they are reacting to the interview in general, while for some it may be because of the payment vehicle adopted in the survey design. Hence, in practice, the presence of protest bids is to be considered almost physiological in a CV survey, rather than a result of the elicitation procedure used.[30]

Notwithstanding, of the four principal CV elicitation methods (open-ended, bidding game, payment card, dichotomous choice [although other elicitation methods exist, they can be considered as extensions or hybrids of these four methods]),[31] it has been argued that the dichotomous choice, when buttressed with a follow-up elicitation question, apart from being incentive-compatible, may likely minimize the occurrence of sample non-response risk.[4] Based on this, and coupled with the fact that the format is closer to what most respondents are familiar with (as it mimics a bargaining process in which the respondents, as buyers of a commodity, would expect the price to first be stated by the seller and then after some bargaining would decide on a final amount they would pay), this method was selected as the preferred format for the application.

However, it is important here to emphasize that, for most health valuation studies, the health analyst is often concerned with issues related to inverse demand (i.e. the value of a good) rather than quantity, as is the case with resource valuation. This accounts for some of the confusion facing the health sector expert when deciding what elicitation methods are preferred in different settings and for different research questions,[31] and explains why most health valuation studies employ at least two or three of the four principal methods discussed here.

2.1 Open-Ended Approach

The open-ended format simply asks individuals to state the maximum amount they are willing to pay in the form of an open-ended question (i.e. 'for this good, what is the most that you would be willing to pay?'). Although it has a reputation for producing conservative results,[31] it tends to produce an unacceptably large number of non-responses or protest zero responses to the WTP questions.[5]

2.2 Bidding Game Technique

The oldest and most widely used of the CV elicitation techniques is the bidding game technique. It is modelled after a typical auction sale principle, and begins by querying consumers at some initial amount about their WTP for the level of the good proposed. The amount is then varied up or down in repetitive questions and the highest positive response is recorded as the consumers' maximum WTP amount.[4] Although partially void of a large number of non-responses when compared with the open-ended approach, it is more prone to starting point bias and induces boredom to the respondents as a result of the lengthy iterative bidding process.

2.3 Payment Card Approach

The payment card approach was designed as an alternative to the bidding game technique. The procedure circumvents the need to provide a single starting point, but offers the respondent more of a context for his/her bid than the open-ended question method. In a typical survey setting, individuals are presented with a card (visual aid) that contains a large array of potential WTP amounts, ranging from, say, 0 to some large amount, and are then asked 'what amount on the card or any amount in between is the most that you would be willing to pay' for the level of good being proposed.[5] However, given that a maximum and minimum price has to be presented, the method is highly susceptible to range bias,[31] as well as implied value cues caused by the design configuration of the payment card approach.

2.4 Dichotomous Choice Format

The dichotomous choice format is currently the most widely used of the elicitation formats because of its incentive compatibility property. It is sometimes referred to as the referendum or 'take-it or leave-it' format, because it mimics a typical political referendum. In a typical referendum CV setting, respondents are asked 'Would you vote in favour of a specified new policy change that, if approved, would cost you *X* amount?' Given that referendum prices are set exogenously, this method has been argued to be more representative of the market (demand) situation.[31] Also, since it estimates WTP in terms of an upper and lower bound, it has the advantage of producing an interval estimate. Furthermore, the method has an extra advantage over others in that it allows provision for follow-up questions, which reduces the occurrence of sample non-response.[4] The limitations are that it is subject to 'yea-saying' (the tendency of the respondent to respond positively to a hypothetical scenario, regardless of the content or scenario), it requires more observation than the other methods for the same level of statistical precision in sample WTP estimates[31] and it tends to obscure the importance of the normality assumption of the error term.[5]

3. Data

The aim of the study was primarily to meet the policy challenge of improving malaria illness through biological control of the disease vector. The data used for the study were collected between December 2004 and April 2005. Pre-tested interviewer-administered questionnaires were used to collect the CV survey data from 1000 randomly selected households in the Bambalang community of the Ndop area, Northwest Province, Cameroon. The value elicitation format used was the dichotomous choice format, buttressed with an open-ended follow-up question.

Five starting prices were used in the dichotomous choice question as follows: CFA200 ($US0.41); CFA400 ($US0.82); CFA600 ($US1.2); CFA800 ($US1.6) and CFA1000 ($US2.0), expressed in the local currency (CFA).[3] If the respondent said yes to the initial bid proposed, a follow-up question was then asked, to elicit the respondent's maximum WTP amount for the scheme. However, if the answer was no, another follow-up question was asked, to find out the respondent's actual WTP amount if different from that of the proposed bid. If no WTP amount was reported at this stage, a follow-up question was posed to find the reason(s) for not being willing to pay. This was simply to distinguish 'true' zero bidders from 'protest' zero bidders. If the respondent's answer was either 'we don't have faith in the community trust fund', 'wait for the government' or 'don't know', then it was classified as a 'protest' vote. However, if the respondent's answer was 'we can't pay due to lack of income' or 'the scheme is not important to us', it was classified as a 'true' zero vote.

Overall, of the 1000 households randomly selected for interview, 941 were successfully interviewed either during the first visit or during re-visit. The others (n = 59) were mainly those who refused to be interviewed. It is important to

3 At the time of the survey, $US1 = CFA490, based on the official exchange rate for April 2005 from the Bank of Central African States (BEAC).[32]

note here that the interviewers were instructed to interview only heads of the households, except on rare occasions when, after repeated visits, the next eldest individual in the household was to be interviewed.

4. Econometric Models

First, the determinants of households' WTP for the scheme are briefly explored, before introducing the econometric methods used for the empirical estimation. On this note, we expected household heads who were quite certain about the implementation of the scheme to express higher participation rates and higher WTP amounts. Likewise, the same can be said about household heads who were very certain of their future income. The greater the certainty, the higher the probability of stating positive WTP values and the higher the reported WTP amounts. Other variables that were expected to influence WTP for the scheme included the starting price, education, age, a hypothetical trust fund, sex, occupation, etc. Also, from CV health literature, it is hypothesized that the determinants of malaria prevention include household income, household size, distance to health facility, cost of treatment, means of treatment, knowledge of malaria illness, household control mechanism, etc.[7,26-29]

The determinants of WTP for the scheme were therefore modelled as a joint decision process, first involving whether or not a household decides to pay for the scheme (i.e. participation equation), and second, having decided to pay, the maximum WTP amount (i.e. valuation equation). Let Y denote this maximum amount, and Z denote a binary variable, assuming the value of 1 if a household decides to pay or 0 if it does not (i.e. no WTP or 'protest zero'); x and w are the matrices of explanatory variables for the participation and valuation equations, respectively. The participation function is shown in equation 1.

$$\begin{aligned} Z^* &= x_i'\alpha + \varepsilon_i \\ Z_i &= 0 \ if \ Z_i' \leq 0; \\ Z_i &= 1 \ if \ Z_i' > 0 \end{aligned} \qquad \text{(Eq. 1)}$$

The valuation function is shown in equation 2.

$$\begin{aligned} Y^* &= w_i'\beta + \mu_i \\ Y_i &= Y^* \ if \ Z_i' = 1; \\ Y_i &\ not \ observed \ if \ Z_i' = 0 \end{aligned} \qquad \text{(Eq. 2)}$$

In the model, the error terms ε_i and μ_i are assumed to have a bivariate Normal distribution with a mean of zero, variance equal to 1 and correlation coefficient ρ. When $\rho = 0$, the two decisions are independent and the parameters of the two equations can be estimated separately.[15] Note that equations 1 and 2 have been frequently estimated in most empirical health valuation studies involving selectivity bias using Heckman's 2-step approach because of its simplicity as an alternative to the FIML, which is computationally complex.

The Heckman's procedure is carried out in two stages as follows. First, note that the conditional expected value of WTP is as shown in equation 3:

$$E[Y_i | Z_i = 1, w] = w_i'\beta + \rho\sigma\lambda(x_i'\alpha) \qquad \text{(Eq. 3)}$$

where $\lambda(x_i'\alpha) = \phi(x_i'\alpha)|\Phi(x_i'\alpha)$ is the inverse of the mills ratio, σ is the standard deviation, and ϕ and Φ are the standard Normal density and standard Normal functions, respectively. The first step of Heckman's proposal is to use a probit model of equation 1 to obtain a consistent estimator of α and then use the estimated α to construct the variable mills lambda (λ). In the second step, including λ as a regressor in equation 2 allows easy estimation of w and ρ consistently by OLS. Under the null hypothesis of no selection bias ($\rho = 0$), the usual formula provides a consistent estimate of the co-variance matrix of w. Under the alternative hypothesis $\rho \neq 0$, Heckman suggests the use of the t-test of the coefficient on the λ variable as a test of sample selection bias.[33]

However, because the 2-step approach is much less robust than the FIML in dealing with co-linearity problems, Strazzera et al.[15] suggest using the following sequential procedure to simultaneously deal with sample selection and co-linearity: (i) estimate equations 1 and 2 in two parts using the OLS estimation technique; (ii) estimate the models using Heckman's 2-step approach and control for the significance of the coefficient on λ (i.e. the inverse mills ratio);

(iii) check for co-linearity by regressing λ against the co-variates of the valuation equation. If there are no co-linearity problems (i.e. judging from the resultant R^2 from the OLS estimation procedure), and the coefficient on λ is not significantly different from zero, accept the OLS estimates at the first stage. If there are no co-linearity problems, but the coefficient on λ is significantly different from zero, accept instead the 2-step estimates at the second stage. However, if there are some co-linearity problems, then proceed to the fourth step as follows: (iv) estimate the two equations using an FIML sample selection model, and check for the presence of correlation by looking at the significance of the parameter ρ. If it is not significant, revert to the plain OLS estimates; otherwise, accept the estimates obtained from the FIML sample selection model. For the log-likelihood, the FIML estimates can be obtained by maximizing equation 4:

$$L = \sum_{0} \ln(1 - \Phi_i) + \sum_{1} \ln 1 \Big/ \sqrt{2\pi\sigma_{\mu_i}^2} - \sum_{1} 1 \Big/ 2\sigma_{\mu_i}^2 [Y_i - w_i'\beta]^2 + \sum_{1} \ln \Phi_i \left[x_i'\alpha + \rho(Y_i - w_i'\beta/\sigma_{\mu_i}) \Big/ (1 - \rho^2)^{1/2} \right] \quad \text{(Eq. 4)}$$

5. Empirical Results

5.1 Sample Statistics

In terms of age distribution, the average age of the heads of households that participated in the survey was about 40 years. The average monthly income for the sample was about CFA21 654 or approximately $US44 for an average household of seven members. About 46% of the sampled respondents were certain that their income would improve in the 6 months following the survey. More than 70% of the sample was very certain that the scheme would be implemented in the community. The average cost of treating malaria, including prevention, was estimated at about CFA6654 or about $US13.6 per month per household. More than 71% of households reported using mosquito coils as a preventive measure against malaria. The average distance from a household to the nearest healthcare facility was about 2.5 km. On the other hand, only about 9% of the sample had no knowledge of malaria illness, while more than 80% of those who reported having contracted malaria reported visiting a health centre. Furthermore, about 88% reported having previously participated in a community development project, while more than 94% of the sample had confidence in the hypothetical community trust fund. In terms of sex distribution, about 68% of those interviewed were men, while the average length of schooling for the sample was about 4.7 years. Finally, less than 11% of the sample was engaged in a skilled occupation (e.g. clerks, agricultural extension officers, teachers, etc.).

5.2 Comparison of Means and Standard Deviations by Groups of Respondents

Of a total of 941 respondents actually interviewed, 802 respondents (85.2%) reported a positive WTP value, while 139 (14.8%) bid zero or were unwilling to pay for the scheme. Of the 139 zero bidders, 23 (2.4%) were identified as 'true zero' bidders, while 116 (12.3%) were classified as 'protest zero' bidders. Given the negligible percentage of 'true zero' bidders in the dataset, this group was not considered in the analysis. However, this category of responses can be analysed in CV surveys using a double hurdle model or a Tobit model with selectivity.[7,30,34,35]

As indicated earlier, it was also necessary to determine whether excluding 'protest zeros' from the econometric analysis would lead to a sample selection bias. Simple comparisons of means of household co-variates between the two groups (i.e. 'protest' vs 'positive' voters) were performed using sample T-statistics. Any significant difference between these two groups of respondents is an early warning indicator of the presence of sample selection bias and justifies the use of a sample selection model (see table I for results).

For some of the variables (e.g. respondents' certainty about the implementation of the scheme in the community, household certainty about future income, cost of treating an episode of malaria illness, household size, household wealth, knowledge of malaria, years spent in school, etc.),

Table I. Comparison of means by groups of respondents

Variable	Measurement/definition	Positive WTP [μ_1][a]	Protest zero [μ_2][a]	Difference [$\mu_1 - \mu_2$]
Observations (n)		802	116	
Age	Years	40.6 (13.91)	39.08 (19.23)	1.52
Certainty[b]	1 = certain about future income, 0 = otherwise	0.68 (0.33)	0.52 (0.54)	0.16***
Cert_scheme[b]	1 = certain about implementation of scheme, 0 = otherwise	0.56 (0.47)	0.44 (0.54)	0.12**
Control[b]	1 = malaria control with mosquito coils, insecticides, local remedy, 0 = other	0.64 (0.46)	0.46 (0.44)	0.18
Cost_treatment	Direct + indirect costs of most recent malaria episode (CFA)	7146.60 (13 151.20)	3817.10 (8357.10)	3329.5***
Distance	Km to health facility	2.46 (1.53)	2.61 (1.52)	–0.15***
Sex[b]	1 = male, 0 = female	0.58 (0.47)	0.45 (0.47)	0.13
Household_size	No. of adults and children being fed	7.7 (5.86)	6.1 (3.8)	1.60**
Know_malaria[b]	1 = knowledge about malaria, 0 = otherwise	0.75 (0.22)	0.35 (0.46)	0.40***
Means_treatment[b]	1 = treatment sought from health centre, 0 = other	0.84 (0.38)	0.59 (0.49)	0.25*
Occupation[b]	1 = skilled occupation, 0 = otherwise	0.12 (0.32)	0.04 (0.20)	0.08
Participation[b]	1 = previous participation in community development project, 0 = otherwise	0.65 (0.21)	0.42 (0.50)	0.23*
Trust_fund[b]	1 = confidence in hypothetical payment fund, 0 = otherwise	0.74 (0.23)	0.45 (0.34)	0.29**
Starting_price	CFA	130.94 (278.41)	572.07 (275.09)	–441.13**
Wealth_index	Assets and other household durables (CFA)	22 871.60 (16 172.50)	14 625.90 (8693.90)	8245.7***
Years_schooled[b]	1 = total >7 years in school, 0 = otherwise	0.22 (0.42)	0.11 (0.31)	0.11**

a Figures are presented as mean (SD) unless otherwise noted.

b Estimated using STATA descriptive statistics.

CFA = Central African CFA franc; **WTP** = willingness to pay; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

the difference between the 'protest' and the 'positive' voters was quite significant at 1% and 5% levels of confidence. If these variables influence the respondents' WTP for the proposed community-based malaria control scheme, then we expect the final estimates obtained from only the sub-sample of households with positive WTP responses to be affected by selectivity bias.

5.3 Determinants of Households' Willingness to Pay (WTP) for the Scheme

Tables II and III present the results of the participation and valuation models using different co-variate specifications related to the effects of households' socioeconomic characteristics as listed in table I. However, note that the tables report only the parameter estimates for the best fitting specifications for the two equations (i.e. participation and valuation), using the Heckman's and FIML estimators selected by means of likelihood ratio test statistics.

Starting with the participation model (table II) to explain included versus excluded households, there were some significant coefficients on variables in the model. These identified variables characterize aspects of the sample that influence the likelihood that a household will pay for the scheme, but do not influence the magnitude of the resulting WTP amounts.[3] Amongst the identified variables, the age of the respondent, how certain the respondent is about his/her future income flow, certainty about the implementation of the scheme, cost of treatment, knowledge of malaria illness, wealth index, means of seeking treatment and the assigned starting price were significantly related to providing a positive WTP value for the scheme.

The effect of the amount the individual is asked to pay for the scheme (i.e. the starting price) was negative, implying higher amounts seem to induce a higher probability of not paying or of 'protest voting'. This may be because of the differential existing between the proposed bid amount and the individual's true reservation price for the scheme. Being younger also had a negative effect on the probability of paying; possibly because younger people are usually more resistant to the illness and find less reason to pay for its control. Conversely, certainty about the implementation of the scheme in the community had a positive effect on the individual's decision to state a positive WTP; the more certain the individual, the greater the probability, as explained by the theory of choice under uncertainty. Similarly, higher costs of malaria treatment also increased the probability of paying; possibly because a higher cost of treatment signifies a greater economic burden to the family for only a single 'basket of good', namely malaria, compared with other household goods and services such as food and leisure. Furthermore, income also had a positive effect on the probability of paying; the higher the income the higher the probability. The same can be said about an individual's knowledge of malaria illness; the more informed the individual, the higher the probability of paying, since the individual is sure of what he/she is paying for. Likewise, an individual's certainty about future income also increased the probability, possibly because a larger expected income would be associated with greater certainty for a given amount of current income. Finally, individuals who sought unorthodox means of treatment such as frequent visits to traditional healers tended to protest more about the scheme than those who visited the health centres during sickness. This may be because such individuals presumed that they were less likely to enjoy the benefits of the scheme than their counterparts.

Table II. 2-step sample selection and full information maximum likelihood (FIML) estimates for the participation equation

Variable	Probit estimates (Z-value)	FIML estimates (Z-value)
Constant	–2.009 (–6.35***)	–2.075 (–6.57***)
Age	0.007 (1.57*)	0.008 (1.77*)
Certainty	0.411 (2.08**)	0.438 (2.25**)
Cert_scheme	0.442 (2.94***)	0.452 (3.03***)
Cost_treatment	0.00002 (1.82*)	0.00002 (1.79*)
Know_malaria	0.864 (3.37***)	0.863 (3.42***)
Wealth_index	0.00001 (1.98**)	0.00001 (2.07**)
Means_treatment	–0.480 (–2.27**)	–0.492 (–2.35***)
Starting_price	–0.0012 (–4.97***)	–0.0012 (–4.91***)
% correctly predicted	91.14	91.16

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

In the valuation equation (table III), where WTP is the dependent variable, again the coefficient on household income was significant and positive. This implies that wealthier household heads are willing to pay more for the scheme than their poorer counterparts (presumably for the same reason that they are also more willing to pay for the scheme). Furthermore, the results suggest that households that are further away from the health centres are willing to pay a lesser amount for the scheme than those closer to the health centres. This may perhaps be because distance is highly correlated with the health-seeking behaviour of individuals. Conversely, households that are larger were willing to pay more for the scheme, perhaps because of the correlation between family size and size of medical bills. The larger the household, the more prone members are to malaria attack and the higher the expenses for treating malaria episodes. This explains why such households are willing to pay more than households that are smaller in terms of household size. Finally, the coefficient on the variable 'Trust fund' was also significant and positive, suggesting that individuals who have confidence in the hypothetical trust fund are willing to pay more for the implementation of the scheme than individuals who lack confidence in the trust fund.

5.4 Evaluating the Efficiency of the Three Estimators

Having analysed the determinants of households' WTP for the scheme, attention is now paid to the empirics of the different estimation procedures (i.e. the OLS, 2-step and FIML estimators). Columns 2 and 3 of table III show estimated results from the plain OLS estimation technique

Table III. Ordinary least squares (OLS) without selection, 2-step sample selection and full information maximum likelihood (FIML) estimates for the valuation equation

Variable (1)	OLS estimates (no selection)		2-Step estimates		FIML estimates	
	estimate (2)	T-value (3)	estimate (4)	Z-value (5)	estimate (6)	Z-value (7)
Constant	4.037	9.20***	4.020	8.67***	4.025	8.68***
Distance	–0.054	–3.13***	–0.055	–2.87***	–0.055	–2.89***
Household_size	0.015	3.20***	0.014	2.96***	0.014	2.99***
Wealth_index	0.327	7.34***	0.321	6.82***	0.322	6.83***
Trust_fund	0.247	2.20**	0.233	2.03**	0.235	2.05**
Mills lambda (λ)			0.269	1.85*		
Rho (ρ)					0.297	1.89*
Sigma (σ)	0.75		0.76		0.75	
Adjusted R^2		0.23		0.22		
Log-likelihood						–1011.81

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

when 'protest zeros' were excluded from the analysis. Since there is no way to judge *a priori* from the estimates any evidence of sample selection bias, wrong conclusions can be inferred that excluding 'protest zeros' from the analysis had no effect on the reliability of the final mean WTP estimate. However, when considering the 2-step estimates, the interpretation differs. The t-test of the coefficient on the mills ratio (λ) indicates the existence of sample selection bias (row 8 of column 5 in table III). Specifically, statistical significance indicates the existence of sample selection bias when 'protest zeros' are excluded from the analysis.

However, besides this information, the results give us no additional clue about the degree of correlation between variables of the participation and valuation equations of the 2-step approach; a well known weakness of the method and a critical assumption of econometric estimation in general. If there is any co-linearity problem, the estimates are less likely to be efficient when compared with FIML estimates.[15,36,37] However, if free from co-linearity problems, the estimates would be equally as efficient as the FIML estimates.

To check for the presence of co-linearity in the 2-step approach, an OLS regression of λ against the co-variates of the valuation equation was run as suggested by Strazzera et al.[15] The resulting $R^2 = 0.53$ from the estimation procedure indicates a moderate level of correlation. The presence of co-linearity coupled with the statistical significance of the coefficient on the variable ρ (see row 9, column 7 of table III) justifies the use of the FIML estimator as an alternative to the 2-step estimates.[15] Further evidence of selectivity bias is implied and, in particular, the positive sign suggests that not accounting for selection bias would bias plain OLS estimates upwards.

5.5 Mean WTP Predictions

Table IV summarizes the descriptive statistics for the predicted quarterly mean WTP estimates

Table IV. Descriptive statistics of quarterly mean/median willingness to pay bids[a]

Modelling method	Obs	Mean	Median	95% CI
All respondents (OLS)	941	1010.2 (2.1)	800.0 (1.6)	934.4, 1086.0 (1.9, 2.2)
OLS no selection	802	1179.2 (2.4)	893.1 (1.8)	1160.3, 1198.1 (2.4, 2.5)
Heckman's model	802	1126.5 (2.2)	826.3 (1.6)	1108.7, 1144.3 (2.2, 2.3)
FIML estimator	802	1133.1 (2.3)	853.1 (1.7)	1115.2, 1151.1 (2.2, 2.3)

a All figures presented as CFA ($US).

CFA = Central African francs; **FIML** = full information maximum likelihood; **Obs** = observations; **OLS** = ordinary least squares.

for the scheme from the three different estimators calculated using Cameron's[38] analytical approach and corrected variance co-variance matrix of the parameter estimates.[14] The first row reports the mean and median WTP values for all respondents (i.e. protest and positive responses) based on plain OLS estimation. For all the respondents, the mean quarterly WTP for the proposed community-based malaria control scheme was about CFA1010.2 (95% CI 934.4, 1086) or $US2.1 (95% CI 1.9, 2.2). The second row reports the estimates for only positive WTP respondents not corrected for selectivity bias and, as shown, they were biased upwards as ρ indicated. The third and fourth rows report estimates from the 2-step and FIML estimators when sample selection bias correction took place.

It is important to observe from the results presented in table IV that the final quarterly mean WTP estimates for the control scheme using the 2-step procedure were marginally lower than those obtained using the FIML estimator and the least squares on the positive responses. The differences between these estimates were possibly due to the marginal differences in the parameter estimates of the valuation equation as presented in table III. The same can be said about their confidence interval estimates; those of the 2-step and FIML estimators were quite similar to each other, while those of the plain OLS for the sub-sample of positive respondents (see row 3, column 5 of table IV) were somewhat different, perhaps suggesting a higher estimation of the mean for the scheme.

6. Discussion

This article was motivated by the fact that the use of CV in healthcare valuation is rapidly gaining ground, especially in the context of developing nations, the reason for this being largely attributable to the ease with which CV results can be read, interpreted and used for health decision making by health policy planners. However, as demonstrated in the article, the treatment of 'protest zero' bidders caused by free riding, or by adverse reaction to the interview in general or, in particular, to the payment vehicle adopted in the CV design, is usually unsatisfactory. Most healthcare CV applications make use of Heckman's 2-step approach, which, for many microeconomics modellers, is much less robust to co-linearity problems than the FIML estimator.

The aim of this study was therefore to examine the effect of excluding 'protest zero' votes on the estimates of mean WTP in healthcare CV analysis. As an empirical case study, a proposed community-based malaria control scheme in the Bambalang area of Ndop, Cameroon, was used. The study indicated that, when 'protest zero' bidders are not identified and accounted for in the estimation procedure, as is the case with most CV applications in developing countries, the results obtained from OLS estimation may likely be overtly understated. However, when identified but excluded on an *ad hoc* basis, the mean may likewise be overstated. Similarly, when identified and accounted for in the analysis by means of the conventional and widely used 2-step approach without addressing the problem of co-linearity, the mean may be biased downwards when compared with FIML estimates.

Therefore, it is important for healthcare experts who are familiar with and interested in the method to thoroughly examine the effect of excluding this category of respondents in CV analysis before carrying out the usual benefit aggregation across the population of interest. Failure to do this is likely to overstate or understate the consumers' true WTP for the healthcare amenity being considered, which violates the principle of 'fairness' and 'equity' in healthcare financing.

Finally, despite the strength of CV in measuring the economic value of many classes of healthcare goods and services for which there is no market, the process often demanded by the method to produce reliable and valid estimates involves choice of preferred elicitation formats, statistically correct methods, treatment of sample non-response risk and other potential sources of bias, survey costs, etc. This can be rather too tasking, when compared with alternative stated-preference techniques such as conjoint analysis. Conjoint analysis, like CV, is a survey-based device used to estimate trade-offs across various attributes of a particular good or service.[31] If

price is included as an attribute in the choice scenario, WTP can be indirectly estimated for both changes in individual attributes and changes in any combination of attributes.[39]

Compared with CV, the conjoint analysis method is quite appealing in many respects. First, the researcher has total control over the attributes of interest, unlike CV, where the researcher must make difficult trade-offs when selecting the preferred elicitation formats. Second, the method requires a much smaller sample size for the same level of statistical precision in sample WTP estimates. For instance, for a sample size of 500 households, assuming that each individual provides answers to four choice sets, this will result in 2000 observations. Third, the method allows the evaluation of new programmes and the collection of multiple observations from individuals, thus ensuring that an efficient dataset can be achieved at a relatively low cost.[39]

7. Conclusions

This article illustrates a sequential procedure for simultaneously dealing with co-linearity and selectivity bias resulting from excluding 'protest zeros' in healthcare CV analysis. Different levels of estimation and diagnostics with the 2-step and FIML estimators resulted in more reliable WTP estimates than simply excluding 'protest zeros' *ad hoc* or using Heckman's 2-step approach without diagnostics.

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