CC02

Students' Willingness to Pay for Offsetting Carbon Emissions on IUB Campus: A Contingent Valuation Approach

Sanzida Akhter, *Lecturer, Independent University, Bangladesh*

***Abstract*—Being aware of its responsibilities towards mitigating climate change impact, the Independent University, Bangladesh (IUB) aims to reduce its absolute GHG emission levels, by the end of 2010, to 10% below the base level year 2002. As a part of this strategy, IUB is considering the purchase of 'carbon offsets' with the principle 'reduce what you can, offset what you can't'. A small survey of around 200 respondents was conducted to elicit IUB students' willingness to pay (WTP) for carbon offsets. The study employs contingent valuation (CV) method through personal face to face interviews to collect data. In general, with the essential results of the majority's acceptance to pay, the analysis shows that IUB students have a positive attitude and knowledge about the importance of CO2 emissions reduction, and they generally support the initiative of campus 'carbon offsets'. The study estimates an average WTP of $27 per semester that varies significantly with respondents' perception towards valuing healthy environment and biodiversity preservation.**

INTRODUCTION

Contingent valuation method (CVM) has been applied as an effective valuation technique in many countries to address a wide variety of issues such as water quality improvements and sanitation [1],[2], valuing forestry [3], [4], flood risk exposure [5], wetland conservation [6], offsetting CO2 emissions and groundwater contamination [7]. One of the underlying assumptions of CVM is that people are willing and able to report a monetary valuation of their preferences for a given good or service. One advantage of the method is that a hypothetical scenario can be created for goods and services for which no real market exists. On the other hand, the application of contingent valuation is subject to a number of well-documented biases including information; strategic; starting point; compliance; and hypothetical. Therefore, the estimated economic value obtained through the contingent valuation responses by creating a hypothetical scenario may underestimate or overestimate the true value of the good in question. However, careful application of the technique and design of surveys help to minimize the effect of such biases. This study carried out a small scale survey at the IUB campus, asked 200 students for their preferences for campus carbon offsets using a payment card CV method.

The remainder of this paper is organised as follows. Section two discusses the analytical framework. The third section gives a description of the case study area followed by the methodology, including a description of the general survey and sample characteristics in Section four. Output from the regression analysis and other test results are presented in Section five followed by the conclusions and recommendations from the study in Section six.

ANALYTICAL FRAMEWORKS

Following theoretical model has been developed for students' WTP based on intuition and general theoretical constructs:

$$WTP_i = F(D_i, A_i) \quad \ldots\ldots (1)$$

Equation (1) represents the WTP of an individual student i for carbon offsets, which is expected to depend on demographic characteristics (D_i) and attitudinal characteristics (A_i). Based on the theoretical framework, the statistical model through which the hypotheses will be tested takes the following form:

$$WTP_i = \beta_0 + \beta_1\, Age_i + \beta_2\, Gender_i + \beta_3\, District_i + \beta_4\, Study\_status_i + \beta_5\, Field\_study_i + \beta_6\, Finance_i + \beta_7\, Health_i + \beta_8\, Education_i + \beta_9\, Environment_i + \beta_{10}\, Employment_i + \beta_{11}\, Housing_i + \beta_{12}\, Air_i + \beta_{13}\, Water\_quality_i + \beta_{14}\, Water\_quantity_i + \beta_{15}\, Biodiversity_i + \beta_{16}\, Deforestation_i + \beta_{17}\, Climate\_chng_i + \varepsilon$$

Where, i = individual students

$\beta_0 \sim \beta_{17}$ are the coefficients

ε is the error variable

We expect significant statistical relationships between WTP and all the variables mentioned above. However, we keep an open mind about most of the demographic variables to have significant relationship with the dependent variable; nevertheless, we strongly expect highly significant positive relationship between Environment and similar variables including Biodiversity, Deforestation and Climate change.

DESCRIPTION OF THE SURVEY

The study undertook a CV technique to estimate how much value carbon offsetting provides to IUB students. A payment card method is applied due to widespread acceptance of this question format. In addition, this format is not only statistically more informative compared to any other format, but also easier to analyse. Data for the study was collected from a sample of an extensive individual survey looking generally at the potential for setting up various options to fund offsets programs which would be shared by the whole IUB community. The study site for the study was therefore obviously the IUB campus.

Approximately 200 interviews were conducted in different locations within the campus. The selection of respondents in each of the location followed a random sampling method to avoid sample selection bias. The questionnaire used in this case study was developed based on pre-tests with approximately 30-40 individuals in different parts of the study area.

176 students were interviewed during the final survey over the first and second week of October by 30 students. The interviewers used for the general survey also participated in the pre-tests and were trained accordingly. The questionnaire that was used for the final survey consisted of around 15 questions and was divided into three main sections:

1) Socio-demographic respondent characteristics such as age, gender, District, studentship status, field of study, sources of financial support, standard of living and so forth.

2) Attitudes to broad social and environmental issues.

3) CV questions to elicit respondent's WTP. Each interview lasted on average about 5-10 minutes. A payment card contingent valuation format was used WTP question.

The 'offset product' was offered to the respondents in the following form:

We are investigating student attitudes about the carbon offsets program discussed above, which would reduce emissions 10% from the 2002 level. Some students may feel this is a valuable policy, worth paying for. Others may be willing to pay little, because of tight budgets or other priorities for social spending. Please consider how much you personally value a carbon offsets program when answering the following questions.

After a detailed description of the hypothetical carbon offset scheme, respondents were asked five WTP questions. First, respondents were asked whether or not they were willing to pay for the proposed offset scheme to reduce campus emissions. Respondents who said 'no' to the first WTP question were subsequently asked for a reason for not paying for carbon offsets. Some of the respondents, who said 'yes' to the first WTP question were followed up with the valuation question asking respondents for circling the highest cost per semester at which they would vote for a carbon offset program. A total of ten different start bids were used. The bid levels were assigned randomly across respondents to avoid starting point bias.

GENERAL SAMPLE CHARACTERISTICS

A summary of socio-economic and demographic variables of sample respondents is presented in Table I. 167 surveys were considered valid for data analysis after screening the data based on the sufficiency criteria. Of the 200 respondents interviewed, the average age of the respondents was around 20 years. More than half of the respondents interviewed during the survey are Dhaka based and female. Less than quarter of the interviewees was sponsored by IUB funding. Very few respondents were studying courses related to environment, while almost all the respondents were fulltime.

Table I Sociodemographic characteristics of the respondents

Variable		Sample average
Respondent number		167
Respondent's age	17 or younger	0.0
	18-20	52.0
	21-23	31.0
	24 or older	16.0
Respondent's sex	Male	43.0
	Female	57.0
District	Dhaka	61.0
	Other	39.0
Study-status	Full-time	97.0
	Part-time	3.0
Field of study		8.0
Sources of support	Self-financed	84.0
	Scholarship	15.0

RESULTS

Basic Willingness to Pay Results

A summary of the WTP results is presented in Fig. 1. A majority of respondents (77%) replied positively to the first WTP question. Respondents who refused to pay the bid value were asked in a follow up question why they were not willing to pay. The most frequently reported reason for rejecting the monetary bid was 'income constraint (82.2%)' followed by reasons like 'There are other social issues that I think are a better use of my money (10.3%)', 'The fees of the university is too high already (5%)', and 'I would participate in a voluntary fee program, but the fee should not be mandatory (2%)'.

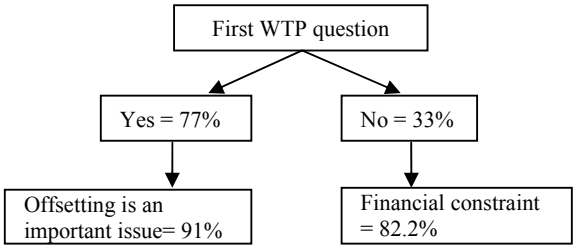

Figure 1 Summary of WTP results

Non-parametric estimate of WTP

The number of observation includes both respondents who agreed to pay something and who refused to pay. Table II demonstrates the descriptive statistics of non-parametric estimates of WTP.

Table II Descriptive statistics

Var	No of obs	Mean	Median	Std. Dev.	Min	Max
L bound	154	27.40	20	28.17	0	100
U bound	154	33.77	30	29.68	0	100
Top Point	154	100.0	100	0	100	100

It is assumed that the circled amount in the payment card is the exact WTP of the respondent. However, since the respondents were asked to circle their WTP, it may be the case that the real WTP is higher than the circled amount. Therefore, theoretically it can be expected that while the circled amount would give an estimate of the lower bound on WTP, the next higher value would give an estimate of the upper bound on WTP. Table II shows the lower and upper bound on WTP have a mean of \$27.40 and \$33.77 respectively. The variable upper bound is more dispersed around the mean than that of the lower bound. The mean and standard deviation of the variable top point (\$100 or more) is 100 and zero respectively, since we do not have any information on the actual WTP in this case.

Multiple regression results

A number of multiple regressions were run with different combination of demographic and attitudinal variables. Demographic variables include gender, district, financial condition, field of study, type of enrolment; where as attitudinal variables include some of those variables that elicit students' attitudes towards social and environmental issues. These independent variables are categorised into two groups for regression analysis using the circles amount as the dependent variable for WTP.

Regression with demographic variables

To analyse how the demographic variables influence the dependent variable, WTP, following multiple regression model is estimated:

$$WTP\_Lower_i = \beta_0 + \beta_1\ Gender_i + \beta_2\ District_i + \beta_3\ Study\_status_i + \beta_4\ Finance_i + \beta_5\ Study\_field_i + \beta_6\ Age_i + \varepsilon$$

Table III summarises the regression results.

Table III Summary of the regression results with demographic variables

Variables	Coefficient	t-stat	P > |t|
Gender	-6.864(4.981)	-1.38	0.171
District	2.685(5.696)	0.47	0.638
Study_status	-7.701(15.615	-0.49	0.623
Finance	4.299(7.720)	0.56	0.579
Study_field	-4.771(5.178)	-0.92	0.359
Age	2.893(2.895)	1.00	0.319
Summary statistics of the estimated model			
No of obs	123		
R^2	2%		
Adjusted R^2	-1%		
F-statistic	$F_{(6,116)} = 0.58$		
Root MSE	26.445		
Prob>F	0.7135		

To assess how well the regression model fits the data, the coefficient of determination (R^2) value and F-test value are evaluated. The R^2 tells us the model fit and F-test assesses the overall significance of the model. Since R^2 never decreases with increasing number of regressors even if additional variables have no explanatory power, we consider adjusted- R^2 to correct the variance estimates. Table III reports the value of adjusted-R^2 is -1% implying that almost no variation in the WTP can be explained by the model. The F-statistic value (0.58) represents that the overall significance of the model is not relatively high ($0.58_{\text{F-statistic}} < 1.77_{\text{F-critical}}$). However, since the data set is cross sectional none of these statistics are important to consider for the variation in the dependent variable.

Table III represents none of the demographic variables to be statistically significant at any level. Therefore we can infer that the demographic variables do not have any strong statistical relationship with the dependent variable, in this case students' WTP for carbon offset.

Regression with attitudinal variables

A number of regressions were run with different combination of attitudinal variables. The most significant model is reported here. To analyse how the attitudinal variables influence the dependent variable, WTP, following multiple regression model is estimated:

$WTP\_Lower_i = \beta_0 + \beta_1\ Environment_i + \beta_2\ Climate\_chng_i + \beta_3\ Biodiversity_i + \varepsilon$

Table IV Summary of the regression results with attitudinal variables

Variables	Coefficient	t-stat	P > |t|
Environment	6.720(4.074)*	1.65	0.101
Climate_chng	1.881(3.382)	0.56	0.579
Biodiversity	8.138(3.315)**	2.45	0.015
Summary statistics of the estimated model			
No. of obs	158		
R^2	10%		
Adjusted R^2	8%		
F-statistic	$F_{(3,154)} = 5.82$		
Root MSE	26.304		
Prob>F	0.000		

*, **, *** denotes statistical significance at 10%, 5% and 1% levels respectively

Table IV reports the value of adjusted-R^2 is 0.08 implying that around 8% of the variation in the WTP can be explained by the model. The F-statistic value (5.82) represents that the overall significance of the model is relatively high at 1% significance level ($5.82_{\text{F-statistic}} > 3.78_{\text{F-critical}}$).

The coefficients of regression demonstrate the nature and magnitude of the relationship between variables. The positive coefficients of Environment and Biodiversity imply that the WTP has positive relationship with the variables. However, the coefficient tells us only the magnitude; therefore to test the significance of the coefficients a t-test is employed. The result of the t-test shows two variables, Environment ($1.65_{\text{t-statistic}} > 1.28_{\text{t-critical}}$) is significant at 10% level with $p < 0.1$, and Biodiversity ($2.45_{\text{t-statistic}} > 1.96_{\text{-critical}}$) is significant at 5% level with $p < 0.05$.

From the statistics shown in Table IV and the analysis presented above it can be asserted that respondents who are more concerned about environmental issues are more willing to pay for carbon offsets. This relationship was also expected theoretically and the model shows enough evidence in this regard.

Estimate of the demand curve

Based on each payment point an illustration of the WTP data is provided by Table V, the fraction of respondents who are willing to pay greater than or equal to that amount has been calculated for each payment point.

Table V Illustration of the WTP data

WTP	No. of resps	% of resps with = or > WTP	Change in density
≥ 0	154	100	25.3
≥ 5	115	75	7.7
≥ 10	103	67	9.0
≥ 20	89	58	16.8
≥ 30	63	41	7.1
≥ 40	52	34	4.5
≥ 50	45	29	17.5
≥ 60	18	12	1.9
≥ 70	15	10	1.9
≥ 80	12	8	1.3
≥ 90	10	7	0.6
≥ 100	9	6	5.8

This can be illustrated in Fig. 2, as an estimation of the demand curve which slops downward.

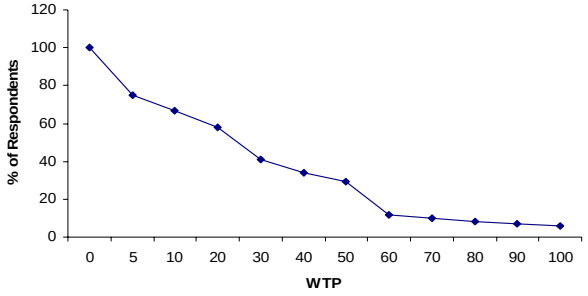

Figure 2 Estimation of the demand curve

Respondents' WTP implies their demand for carbon offset as an environmental good at particular prices. For example, at the price $100, 5.84 percent respondents are willing to pay that demonstrates their demand at that price. Based on the analysis shown in Table V (column 1 and column 5), the area under the demand curve is calculated as follows:

Area under the demand curve = Total value = $100*5.84 +

$90*0.6+$80*1.3+……+$5*7.7+$0*25.3=$27.5……..(2)

In addition, average WTP can also be calculated using the data shown in Table V (column 1 and column 2).

Average WTP = [$100*9 + $90*10 +……+ $5*115 +$0*154]/154 = $27.4…… (3)

Percentage of respondents with equal or higher WTP in (2) is almost the same as number of respondents in (3), therefore, the area under the demand curve can be considered same as the estimated average of WTP. Table V and Fig. 2 show that the change in density of respondents' WTP is the highest at 17.5 which is the interval between $50 and $60. This implies that the number of respondents with $50 WTP drops most when the price increases an interval to $60. Therefore, the highest payment that would pass a majority vote is $50. If it is higher than $50, the number of respondents who are willing to pay will drop dramatically.

DISCUSSIONS AND CONCLUSION

The aim of the study was to estimate the economic value of campus carbon offsets to the students of IUB. A detailed survey of around 200 students was conducted using a CVM. Multiple regression models were presented and tested for the relationship between the explained and explanatory variables. Most of the demographic variables including students' age, gender, district, study status, field of study, and source of financial support were found not to have significant relationship with their WTP. However, model estimated for attitudinal variables showed that both a healthy environment and biodiversity were positively related to WTP at 10% and 1% significant levels respectively. These relationships comply with our hypothesised sign and expectation. Using the survey data on WTP amount, a demand curve was traced out to corroborate the average WTP measure. Both the area under the demand curve and average WTP estimate showed $27 as students maximum WTP to pay an additional fee to support IUB's carbon offset policy payable at enrolment. he analysis shows that students who care about a healthy environment and preserving biodiversity were found to be willing to pay more for offsetting. This relationship suggests that the university can develop awareness programs to educate staff and students so that their awareness regarding environmental issues is improved.

This study relies on a limited number of observations obtained from a CV survey. However, the statistical analysis of data, choice of variables, operationalisation process, and interpretation of regression coefficients ensures the reliability and validity of the research. Despite all the inadequacy, this study provides an important insight into the carbon offset agenda of the date. Moreover, it opens up a stimulating area for further research in the field of offset pricing mechanism and can address the associated limitations of the same.

REFERENCES

[1] D. Whittington, J. Briscoe, X. Mu & W. Barron, "Estimating the willingness to pay for water services in developing countries: A case study of the use of contingent valuation surveys in southern Haiti", *Economic Development and Cultural Change,* vol. 3*8*(2), 1990, pp.293–311.

[2] M. Aguilar & T. Sterner, *WTP for improved communal water services Studies in Environmental Economics and Development.*Environmental Economics Unit, Department of Economics: Göteborg University, 1995, Ch8.

[3] P. Shyamsundar & R. Kramer, "Tropical forest protection: an empirical analysis of the costs borne by local people", *Journal of Environmental Economics and Management,* vol. 31, 1996, pp.129–44.

[4] R. Brouwer, S. Akter, L. Brander & A.K.E. Haque, *Economic valuation of flood risk exposure and flood control in a severely flood prone developing country*, 2006, PREM Working Paper 06-02.

[5] L. Emerton, *Economic Tools for Valuing Wetlands in Eastern Africa,* 1998, IUCN — The World Conservation Union, Eastern Africa Regional Office.

[6] J. Ahmed, B. Goldarb & S. Misrac , "Value of arsenic-free drinking water to rural households in Bangladesh", *Journal of Environmental Management,* vol. 74, 2004, pp.173–185.