

Valuing Community Based Forest Landscapes Restoration: Bivariate Probit Analysis for Degraded Forest Lands in North Western Ethiopia

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Abstract
Restoring forest landscapes is recognized as one of the strategies for tackling some of the major environmental problems of our time, notably climate change, loss of biodiversity and desertification. The latest strategy of the UN Convention on Biological Diversity (2011 - 2020) sets the bold goal of restoring at least 15% of the world's degraded ecosystems by 2020. The value of using community based payments in ecosystem restoration is receiving growing recognition among practitioners and policymakers. This study examined households' willingness to pay for restoration of degraded forest lands in a hypothetical market. The study was conducted in Sekella woreda of the Amhara region, northwestern Ethiopia. A total of 320 households had been surveyed in the study area in November and December 2013. During the survey, Contingent Valuation Method with double bounded dichotomous choice with follow up question format was applied to elicit willingness to pay of restoration of degraded forest lands capes. A bivariat probit model were used for the estimation of mean WTP from the double bounded responses. The study indicates that 75% of the surveyed households showed their willingness to pay if the restoration of the degraded forest land capes will be carried out. The bivariat probit model result shows that mean willingness to pay for rehabilitation of degraded forest resources ranged from ETB 19.18 to 21.02 ETB.
Keywords: Forest landscapes, WTP, Bivariat probit, double bounded dichotomous choice

1. INTRODUCTION

For many developing countries, forests represent an important resource base for economic development. If managed wisely, the forest has the capacity to provide a perpetual stream of income and subsistence products, while supporting other economic activities (such as fisheries and agriculture) through its ecological services and functions. Forestland may be utilized in many different ways. It can be used for commercial timber extraction, it may be converted for commercial agriculture purposes such as oil palm or rubber plantations, it may be used for traditional subsistence activities (for example, traditional agricultural practices such as agroforestry and shifting cultivation, and/or for the extraction of non-timber forest products or it may be afforded various levels of protection through the establishment of a Protected Area, a National Park or Wildlife Sanctuary (TIED 1994).

How best to manage forests lands has become a growing concern for policy makers, interest groups and the public due to: the increasing scarcity of virgin forest land, greater awareness and understanding of the social and economic implications of destructive forest practices; and, a growing realization that the significant opportunities for economic Development based on forestry activities should not be wasted. Greater attempts are now being made to rationalize the decision making process with respect to the restoration of degraded forest lands. A problem has been that traditional project evaluation procedures do not incorporate the full range of environmental and social costs associated with different forestland use options. Due to this omission, decisions on forestland use have been biased in favour of development options, some of which have been shown to be economically unjustifiable once the relevant environmental costs are accounted for. One reason for this shortcoming has been a lack of understanding of, and expertise in, monetary evaluation of environmental impacts such that they can be included in the appraisal process. In response to the need to value environmental goods and services, economists have developed a range of new valuation techniques. Meaningful assignment of monetary values to environmental goods and services is therefore possible. This facilitates their use in the economic appraisal framework and thereby improves traditional measurement. A key objective of economic valuation of the environment is therefore the integration of environmental concerns into the conventional economic decision making process in order to furnish policy analysts and decision makers with better information upon which to base decisions. A wide range of tools are available to evaluate forestland use options. Methods of appraisal include physical approaches such as environmental impact assessment, as well as financial and economic methods such as willingness to pay and cost effective analysis. This study focuses on the contingent valuation method based on the hypothetical market that analysis of community based payment is an important tool for achieving degraded forest land restoration..

2. METHODOLGY

Prior studies have largely utilized multiple regression, probit, or logit models to analyze statistical relations between willingness to pay and other explanatory variables. Because of the discrete nature of the dependent variable in this study, ordinary least squares regression estimation will result in biased and inconsistent parameter estimates. Dependent variables, the value of which is censored at zero, pose self selection problem in econometric estimation and econometric models such as probit and logit models has been suggested to overcome self selection problem (Gujurati, 2004). A binary logit or probit specification as utilized in Spector and Mazzeo (1980) gives discrete outcomes, thereby arbitrarily aggregating willingness outcomes into two groups.

According to Haab and McConnell (2002), double-bounded models substantially increase the complexity of the analysis, because now the second question may depend in some way on the first question. It is instructive to look at the double-bounded model in a general form to understand the nature of efficiency gains and estimating an empirical WTP model based on the CV survey responses to derive a mean of the WTP distribution. Cameron and Quiggin (1994) propose the use of a bivariate probit contingent valuation model when respondents are offered a follow-up bid to an initial contingent valuation question. It is normal probability density function, employed commonly by statisticians crucially; they allow for a non-zero correlation, whereas the standard logistic distribution does not. Hence, we used the bivariate probit model in this study to estimate the mean WTP from the double bounded dichotomous choice employing the following equation as specified by Haab and McConnell (2002).

$$L_j(\mu / t) = \Pr(\mu_1 + \varepsilon_{1j} \geq t_1, \mu_2 + \varepsilon_{2j} < t_2)^{YN} * \Pr(\mu_1 + \varepsilon_{1j} > t_1, \mu_2 + \varepsilon_{2j} \geq t_2)^{YY} * \Pr(\mu_1 + \varepsilon_{1j} < t_1, \mu_2 + \varepsilon_{2j} < t_2)^{NN} * \Pr(\mu_1 + \varepsilon_{1j} < t_1, \mu_2 + \varepsilon_{2j} \geq t_2)^{NY} \quad (1)$$

Where; μ = mean value for willingness to pay, YY = 1 for a yes-yes answer, 0 otherwise, NY =1 for a no-yes answer, 0 otherwise, etc. Thus, the coefficient for the constant term and coefficient for the bid is estimated by regressing dependent variable on initial, the follow up bid amount, other explanatory variables held constant and then these estimated coefficients are replaced in the following formula to calculate the mean WTP value (Haab and McConnell, 2002).

$$MWTP = -\alpha / \boldsymbol{\beta} \quad (2)$$

Where α is a constant term, $\boldsymbol{\beta}$ is a coefficient for the amount of the bid.

3. RESULTS AND DISCUSSION

3.1. Total willingness to pay and aggregation

Analyzing data obtained from the CVM needs estimating and aggregating data i.e. the values from the sample has to be scaled up to the relevant population (Perman, 2003). In line with this, we estimated the total WTP from our survey results.

In this sub section total willingness to pay at different prices that households in Sekella woreda are willing to pay are calculated and the demand curve were derived. The total WTP is the total economic benefit of a project for improving the forest cover. Therefore, the estimated aggregate WTP for Sekella woreda is shown in Table 14. From the table we can see that the total WTP for selected households in Sekella woreda is ETB 61151.11 per year. This is obtained by summing up total willingness to pay amounts at each total WTP, and this is the amount all the interviewed households in Sekella woreda are expected to pay if the suggested rehabilitation of degraded forest resource project is to be a reality.

Kebele	No. of HH	Mean WTP (birr)	Std. Deviation	Total HH	No. of	Total WTP (birr)
Abbay-Sangeb	64	20.00	1.54244	770		15400.00
Aemebisi	49	20.47	1.58758	337		6898.39
Sawesa Guder	68	21.61	1.72051	574		12404.14
Kolele na Lecha	41	16.52	1.57690	569		9399.88
Gundele Koreta	49	15.16	7.78362	485		7352.60
Gumbela Mariam	49	20.63	1.57382	470		9696.10
Total	320	19.06		3205		61151.11

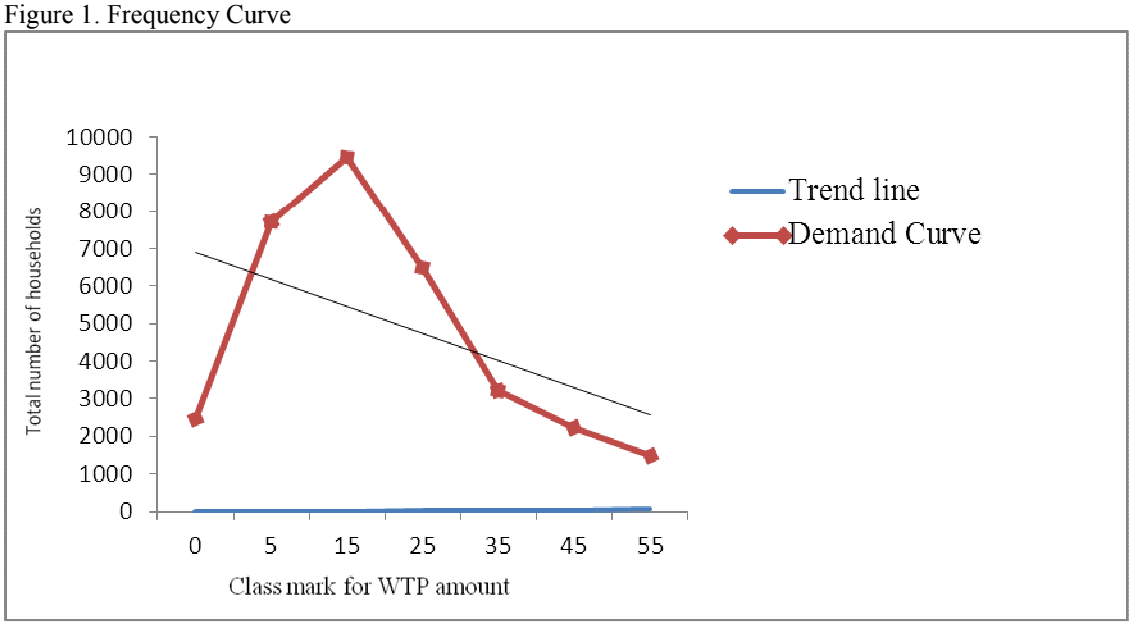
Table 1. Estimated mean and total WTP by kebele
WTP= Willingness to pay
HH=Household
Source: survey result

Aggregate estimates are obtained based on estimated sample mean WTP and the total number of households in the study area. We calculate the sample mean willingness to pay, because for most applications, the purpose of demand estimation is benefit calculation that requires aggregate willingness to pay. The results are displayed in Table 12. As it can be seen, aggregates are estimated at ETB 638852 per year. The results can serve as a starting point for cost-benefit analysis of degraded forest resources rehabilitation related policies. These results, which are shown in Table 12, suggest that if a policy aiming at promoting rehabilitation of degraded forest resources and use requires charging a price within the above range, households would be willing to pay for it.

The information obtained from the household maximum willingness to pay result can also be used to draw a frequency curve and to make aggregation for the willingness to pay for rehabilitation of degraded forest resource activities. The frequency curve for willingness to pay for rehabilitation of degraded forest resource is derived to see the extent of cost recovery. The frequency curve can be derived in terms of the total number of households and their associated maximum WTP**.** Figure 1 below shows the frequency curve of the sampled households for the rehabilitation of degraded forest resources. For this, we measure the total number of the households along the vertical axis and the birr stated by the households per year along the horizontal axis. The frequency on the maximum willingness to pay by table is adding class by class. The frequency in a specific class can then be clearly indicated by the number of households that are below or above the class. In other words, from cumulative frequency tables a curve can be drawn, to reflect data in a graphic manner.

As shown in Figure 1, the demand curve is first positively sloped and then negatively sloped as the bid amounts increases indicating the decline in the demand for rehabilitation of degraded forest resources, like most other economic goods, other things remaining the same. If forest is considered as a free resource to the society, the consumers' surplus would be the total area under the demand curve. The area under the demand curve represents the gross value of consumers' surplus if they are not paying any thing for rehabilitation of forests.

Figure 1. Frequency Curve



Source: survey result

3.2. Mean willingness to pay from open ended question

The mean WTP is measured as a range because the willingness to pay for rehabilitation of degraded forest resources estimated by the sampled households was varied in the survey. For the open-ended contingent valuation survey responses, the maximum willingness to pay figures reported by the households can simply be averaged to produce an estimate of mean willingness to pay:

$$\text{Mean WTP} = \frac{\Sigma yi}{n} \quad 3)$$

Where n is the sample size and each y is a reported willingness to pay amount by surveyed households. Using the above formula, we obtained mean willingness to pay for the rehabilitation of degraded forest resources to be 19.54 ETB per year only for the sampled households in this study. This mean WTP was regarded as an upper bound. First, due to the hypothetical nature of the survey data used in the contingent valuation method, mean WTP elicited from the CVM reflects merely what the households' state, which is often larger than what is revealed (Lusk, 2003). Second, mean WTP would likely be overstated because the feasible upper range for true WTP is 100 percent rather than positive infinity for the 'no' and 'no' group in both the first and second prices.

Assuming that the responses are incentive compatible and unbiased, it takes many fewer responses to achieve a given variance about the mean willingness to pay for the open ended compared with dichotomous choice questions. The open-ended response may not be biased for many respondents, but it often leads to extreme responses. Hence, we have looked for mean WTP from double bounded responses that would retain the incentive properties of discrete choice but would be more efficient. This is because with a given number of responses, more information on the distribution of willingness to pay is obtained, and this information lowers the variance of the estimates of mean WTP.

3.3. Mean willingness to pay from double bounded dichotomous choice question

The mean willingness to pay value (MWTP) is calculated in the following manner framework in which households are willing to pay for rehabilitation of degraded forest resources when the expectation of forest cover will increase in future (Haab and McConnell, 2002) as stated in the equation (9) in the methodology part.

$$MWTP = -\alpha / \beta$$

where α is the regression constant value, and β the regression coefficient value for the proposed willingness to pay value in the bivariate probit regression model, the evaluation results of which are presented in Table 15. The explanatory variables are the initial (*BID1*), and the follow-up willingness to pay values (*BID2*) that were proposed to respondents in the survey. Having the bivariate probit coefficient results in Table 15 and using the above equation, the mean willingness to pay ranged from ETB 19.18 to ETB 21.02 for the initial bid and for the follow up bid amount respectively. In the bivariate probit estimates Rho (ρ) is positively and significantly (at 95% confidence level) different from zero; indicating that there is positive correlation between the two responses. As a result, this figure was higher than the mean willingness to pay amount from the open-ended question. Since there is deference in the mean of WTP under the open-ended and double bounded formats this indicates the validity and reliability of the CV outcomes in the empirical analysis. As a result, this mean WTP must be regarded as an upper bound. First, due to the hypothetical nature of the survey data, mean WTP elicited from the CVM reflects merely what is stated by the respondent, which is often larger than what is revealed in the marketplace (Lusk, 2003). Second, mean WTP would likely be overstated because the feasible upper range for true WTP is 100 percent rather than positive infinity for the “no” and “no” group in both the first and second bids.

Table 2. Parameter estimates of bivariate probit regression

Dependent variable	Explanatory variable	Coefficient	Std. Error	Z	P>|z|	95% Conf. Interval	
RespBid1	Intial bidset	-0.0751	0.0295	-2.55	0.011	-0.1329	-0.0174
	Constant	1.4406	0.4665	3.09	0.002	0.5263	2.3548
RespBid2	Intial bidset	-0.0466	0.0289	-1.62	0.106	-0.1031	0.0099
	Constant	0.9795	0.4530	2.16	0.031	0.0916	1.8673
	athrho	0.6971	0.1707	4.08	0.000	0.3626	1.0316
	Rho	0.6025	0.1087			0.3475	0.7746
Number of obs = 320							
Wald chi2(2) = 6.95							
Log likelihood = -145.96298							
Prob > chi2 = 0.0310**							

** Significance level at 5%

Source: survey result

4. SUMMARY

Deforestation and the resulting land degradation combined with heavy dependence on woody biomass for fuel, construction and other activities is a major problem in Ethiopia and a key factor challenging food security, community livelihood and sustainable development. A major strategy to satisfy the increasing demand for woody biomass is therefore to rehabilitate the degraded forest resources through community participation using voluntary contribution. Community based forest conservation and rehabilitation is becoming the main management technique used by governments around the world for enhancing the conservation and management of forest resources. This study, therefore, was conducted to identify and analyze the households’ willingness to pay for rehabilitation of degraded forest resources in the Sekella woreda. More specifically, the study was designed to see the possibility of cost recovery by looking at the demand side of the households’ willingness to pay for rehabilitation of degraded forest resources and identify the variables which determine households’ willingness to pay for rehabilitation of degraded forest resources.

The study used relevant secondary information collected from various publications, reports, and offices but the major sources of data were obtained from a contingent valuation survey of 320 households using simple random sampling technique with structured questionnaire administered with enumerators. The elicitation method used was double bounded dichotomous choice with follow up question. In this study, it was tried to estimate households' mean willingness to pay to rehabilitate the forest using a bivariate probit model. The result implies that the local community is willing to pay to rehabilitate the forest despite the various pressing problems they face and indicate there is a possibility for cost recovery for rehabilitation of degraded forest resources at household level. This further suggests that acceptable programs, which accommodate the interest of the local community and the government, may play a positive role in rehabilitating the forest. The total willingness to pay amount from the total of 29908 households in the district is ETB 638852 per year with mean willingness to pay ranging from ETB 19.18 to ETB 21.02 and ETB 19.54 per households from open ended and double bounded responses, respectively. This proposed willingness to pay amount can help the stakeholders to implement the proposed improvement for rehabilitation of degraded forests. Such evidence revealed that the cost incurred due to voluntary forest rehabilitation activity could be compensated by households' willingness to pay.

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