HOUSEHOLDS' WILLINGNESS TO PAY FOR RESTORING ENVIRONMENTAL RESOURCE: A CASE STUDY OF FOREST RESOURCE FROM DIRE DAWA AREA, EASTERN, ETHIOPIA

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Abstract

This paper assesses households' perceptions on forest lose and presents empirical results of households' willingness to pay for restoring forest resource in Dire Dawa area, Ethiopia. Probit and Tobit models were applied to determine the mean and factors affecting willingness to pay for forest restoration, respectively. A sample of 393 households was randomly selected, and the survey was used a face to face interviews. However, after checked for sample selection bias 10 protest bidders were excluded from the data set. The descriptive analysis shows that the forest resources have been cleared. That is, 82% of the respondents reported that the reasons attributed to the forest lost were population pressure, overgrazing, soil and water degradation and agricultural expansion. The econometric result shows that the mean willingness to pay from double bound elicitation method was computed at 94.09 ETB with the total willingness to pay 2,026,604.51 ETB (1 US$=18.44 ETB) per annum for five years. Whereas, the mean willingness to pay from open ended elicitation method was computed at 64.82 ETB with aggregation value of 1,396,157.98 ETB per year. The result from double bounded elicitation method is greater than open ended elicitation method. This might be due to anchoring effect from the double bounded method. The result suggested that any forest restoration intervention in the study area needs to consider monthly income, initial bids, perception, educational level, ownership type and access to extension services for successful forest restoration activities. Total farm land holding and sex are also significant variables needs to consider.

Key Words: Willingness to Pay, Contingent Valuation Method, Forest Restoration, Probit Model, Tobit Model

JEL Classification: Q00; Q20; Q50; Q57; Q59.

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1. Introduction

Forest is a minimum area of land with a tree crown cover of more than 10-30% and 0.05-1 hectare with the trees height of 2 to 5 meter at maturity *in situ* (FAO, 2006). Forests, like other natural resources perform a set of functions to meet the needs of people (Cavatassi, 2004; Pak *et al.* 2010). Forests are providing various direct and indirect benefits to human welfare (Dogru, 2001; WWF and IUCN, 2001; Chaudhury, 2006 and Wu *et al.* 2010). Some of these benefits include increase precipitations, recreation, timber production and fuel wood (Bishop 1999; WWF and IUCN 2001 and Turner *et al.* 2004). On the other hand, forest resources are using for protecting watershed, reducing erosion and removing greenhouse gas from the atmosphere (WWF and IUCN, 2001). However, the degree of deforestation and forest degradation is more fast and huge especially in the developing tropical countries (FAO, 2005). It is estimated that 350 million hectares of tropical forest land have been severely damaged (ITTO, 2002). The attenuation and degradation of forest enhance soil erosion, decreasing water quantity and household income, and hence increase poverty (Azene Bekele-Tesemma, 2002 and Maginnis and Jackson, 2003).

In Ethiopia a data on forest resources showed that it is among countries with forest cover of 10-30%. According to this report Ethiopia's forest cover is 12.2 million hectare. It further indicated that the forest cover shows a decline from 15.11million ha in 1990 to 12.2 million ha in 2010, during which 2.65% of the forest cover was deforested (FAO, 2010). This showed that the country is characterized by high rate of deforestation. The major causes of deforestation are expansion of agricultural land, and increasing need for fuel wood, and overgrazing. Consequently, in Ethiopia as well as in the study area because of deforestation households have been faced shortage of fuel wood, land productivity problems, flood, low income and shortage of water. In general, deforestation and over-exploitation of forest resource leads to low economic benefits, unsustainable economic development and hence poverty.

Consequently, restoration of forest resource is very important from both a socioeconomic and environmental angle. Because, forest restoration can be used to reverse some of the more severe impacts of forest loss and degradation by providing a range of forest products (Maginnis and Jackson, 2003). Moreover, forest restoration may mitigate global climate change by reducing carbon stocks. For example, restoring forest resource effectively in the non cultivated land of the study area may continue to provide the economic valuable services of forest resource to the people living around

the resource. However, in the study area no attempt was made to estimate the economic value of forest restoration using acceptable environmental valuation techniques. Fail to estimate the economic value of forest restoration enhance the complexity of forest restoration and management decision.

Yet, in recent decades, concerns have arisen about the proper valuation of environmental resources and progress has been achieved in developing valuation methods (Kramer *et al.* 1997 and Wu *et al.* 2010). An economists use the concept of willingness to pay (WTP) to determine consumers WTP for improved and avoiding deterioration of environmental resource (Agudelo, 2001 and Pearce, 2002). In this study therefore, an attempt was done to estimate the economic values of forest restoration in the non cultivated land of Dire Dawa area. Besides, the study assessed the level of households perception on problems of forest lose, and determined the factors affecting households WTP. It is believed that the study plays a key role in formulation of a successful forest policy and determination of the real contributions of forest resources to sustainable economic development. The study also helps the government and concerned body to identify salient households' features that would increase the targeting and subsequent success of forest restoration activities in the study area as well as in other area with similar characteristics. Contingent valuation (CV) method was used to identify households' WTP for forest restoration.

2. Theory of Welfare Economics

In the case of welfare economics the main purpose of any economic activities is to increase the well being of the responding individuals or economic agents. In this study, the basic assumption is an individual makes a decision to maximize their utility from restoring forest resource given income constraints. Following this, measurement of the economic values of forest restoration is depends on the effect of the hypothesis project on households' welfare.

A Pareto criterion is the best way to explain welfare. It is indicating that policy changes make at least one person better off without making any one worse off. Besides, Pareto improvement noted public intervention is good for efficient resource allocation. If the cost of the public action is less than the sum of the benefits from a public action, it is considered worthwhile by the criterion (Haab and McConnell, 2002). The applied side of modern welfare economics works a variant of the Pareto criterion by trying to find ways to place a dollar value on the improvement and deterioration from environmental

changes. This allows the calculation of net gain or loss from a policy change, and determination of whether the change is potentially Pareto improvement or not. Changes in environmental quantity and quality may affect individual's welfare. Because environmental change may lead to changes in prices an individual pay for marketed goods and inputs. Moreover, it may changes the quantities or qualities of environmental goods such as forest resource, in our case.

Such welfare changes can be measured using ordinary consumer's surplus, compensating variation, compensating surplus, equivalent variation and equivalent surplus. However, ordinary consumer's surplus does holds income constant but not the level of utility. On the other hand, compensating variation and compensating surplus measures of the gains or loss and hold utility constant at the initial level, while equivalent variation and equivalent surplus measures welfare change and hold utility constant at some specified alternative level. Generally, depending on the consumers' property position vis-à-vis the good in question (in this study forest restoration) all these Hicks welfare measures involve either payment or compensation to maintain utility at the specified level (Randall and Stall (1980), cited from Mitchell and Carson, 1989). If the proposed change is welfare increasing (restoring forest resource), which is the focus of this study the appropriate welfare measure, is the compensating surplus. This measure can be interpreted as the consumer's WTP for the environmental resource which maintains their initial utility level constant (Mitchell and Carson, 1989).

In Hicksian welfare measure estimation of the economic benefits of the environmental goods requires identification of the actual demand function for the improvement of the environmental goods. However, it is very tricky to estimate the actual demand curve since it requires accurate market data. Therefore, to fill this problem we should use an alternative method which requires the creation of hypothetical market scenario. The alternative method is that a CVM and this method can generate the WTP data, which will be used to value the forest restoration without having to estimate the actual demand curve.

This concept can be further emphasized from the relationship between the expenditure function and Hicksian compensated surplus measure (CS). According to Haab and McConnell (2002), the expenditure function that provides the theoretical structure for welfare estimation is specified as:

$$M = e(p, q, u) = \min_x \{p.x / u(x, u) \geq u\} \quad (1)$$

Where: M is the minimum amount of income needed to maintain utility level given the price and public good vectors; q= is the vector of environmental goods; p= is a vector of prices; u=is level of utility when $u = V(p, q, y)$, x= is the vector of private goods and y= income.

Let p_0, q_0, u_0, m_0 represent some initial level of those respective arguments and p_1, q_1, u_1, m_1 represent some succeeding levels. The compensation surplus can be specified by:

$$WTP = CS = [e(p_0, q_0, u_0) = m_0] - [e(p_0, q_1, u_0) = m_1] \quad (2)$$

q_1 is preferred to q_0 for proposed new project brings welfare gain (just like in the case of this study). In this case, the compensated surplus (CS) measure tells us the consumers" WTP for welfare gain. Contingent valuation is capable of obtaining the appropriate Hicksian measure for a proposed change in the public good (Mitchell and Carson 1989). It can be viewed as a way of estimating the change in the expenditure function (Haab and McConnell 2002). Coming to the case of forest restoration of this study the value of forest resource could be determined through household WTP.

3. Empirical Reviews

Contingent valuation surveys have been widely applicable methods in valuing use and non use values of environmental goods and services (like forest resource) (Whittington *et al.,* 1990; Whittington 1998). There have been a large number of studies for valuing non-market benefits of forests in monetary terms using contingent valuation technique. A few selected case studies pertaining to certain forests in the world as well as in Ethiopia are discussed below.

Bin Ramlan *et al.* (2011) were estimated the economic value of forest research institute Malaysia's canopy walkway from visitors using CVM in the form of dichotomous choice elicitation methods. The authors used a Logit and Probit models to estimate the visitor's WTP responses for the access to the walkway. Based on the estimation results, the calculated mean of WTP ranged from MYR5.33 to MYR[2]13.32 for the logit model, whereas the value ranged from MYR5.39 to MYR13.02 for the probit model based on 95 % confidence interval. The study had shown that visitors to forest research institute

[2] MYR refers Malaysian Ringgit which is the Malaysian currency.

Malaysia's canopy walkway are willing to pay about MYR7.61 for the entrance permit. The study concluded that the entrance fee collections are used as additional funds for the costs of maintenance and conservation of forest research institute Malaysia's canopy walkway.

A study by Carlsson *et al.* (2004) applied a contingent valuation method to estimate the economic values of community plantations trees in the highlands of Ethiopia. A discrete-continuous elicitation format was applied. The survey covered a total of 1520 households from both East Gojam and South Wollo of Amhara region. The mean WTP from sample respondents is estimated to 10 ETB[3] for the closed-ended responses. The study found that there is a problem in applying a closed ended elicitation format because it would exaggerate the respondent willingness to pay for community plantations trees. Besides, the analysis of the bid function shows that women in villages without any existing community plantation are significantly more interested in the establishment of a plantation than men. The authors recommended that separate interviews are made with heads and spouses when it comes to valuation of local natural resources. The result of the study also showed that the aggregate willingness to pay vary dramatically between villages. Therefore, the concerned body needs to develop good tools for the selection of locations for community plantations if they seek to maximize their contribution to welfare.

Chukwuone and Okorji (2008) were conducted a study to determines households willingness to pay for systematic management of community forests in the rainforest region of Nigeria. The study used the contingent-valuation method in the form of discrete choice with open-ended follow-up question. The study was used a Tobit model, and found that a variables wealth category, occupation, formal education and number of females in a household positively and significantly influence WTP. Male headed households, initial bid, number of males in a household and distance from home to forests area negatively and significantly influence WTP. The authors concluded that organizing the local community in systematic management of community forests for forest conservation will enhance participation and hence poverty alleviation.

A study by Garrod and Willis (1997) estimated the mean WTP of the public for the non-use biodiversity value of remote coniferous forests in Britain using contingent

[3] ETB refers Ethiopian birr which is the Ethiopian currency

ranking method and contingent valuation in the form of double bounded elicitation method. It estimated the public's WTP for a number of forest management standards that could be adopted to improve levels of biodiversity in remote upland coniferous forests, which the respondent would never visit. The authors estimated the value of marginal changes in biodiversity of remote upland coniferous forests, rather than the total value of biodiversity in remote upland coniferous forests as a whole. The value for increasing biodiversity of these forests using contingent valuation at the margin was £10 to £11 per household per year for biodiversity for a 30% increase of the area of this forest type. Whereas, the value for increasing biodiversity of these forests using a contingent ranking method was £0.30 to £0.35 per household per year for a 1% increase in these forests.

Solomon (2004) used a contingent valuation method in the form of open ended, single and double bounded elicitation format to elicit households WTP for multi-purpose tree resources in three selected Districts of Arsi Zone, Ethiopia. The study considered two groups of Trees including the common eucalyptus tree type and three indigenous trees (Guniprus Excise, Acacia Abisinica and Acacia Seyal). The study found that the mean WTP for eucalyptus tree from open ended, single and double bounded elicitation format are computed at 22.79 ETB, 45.81 ETB and 38.06 ETB, respectively. Using similar procedure the mean willingness to pay for indigenous trees using open, single and double bounded probit model were also computed at 22.14 ETB, 44.31 ETB and 26.96 ETB, respectively. The author found that the mean WTP from all elicitation methods were greater for eucalyptus than for indigenous trees. This could be indigenous trees are not, in most cases, fast growing like eucalyptus tree. The results of study also show that age, types of ownership, access to credit, the value of livestock owned by the family and bid are significant influences households' WTP for eucalyptus and indigenous trees. The study concludes that labor was the most preferred payment vehicle than cash and kind.

The study by Tefera (2006) applied contingent valuation method in the form of double bounded elicitation method to estimate the economic values of improved natural forest in Wondo-Wosha Sub-catchment, Ethiopia. A questionnaire survey was conducted on 148 respondents from six peasant associations surrounding the natural forest. The mean WTP for a single household was about 30 ETB (US$ 1 = 8.7 ETB) per year. The mean willingness to accept for a single household was 44.6 birr per year. Moreover, about 72% of the respondents gave the value of the forest at a price of 30 birr or more per year while 18% of the respondents agreed to pay nothing assuming

that they have traditional rights to the land and/or have low level of income. The bid function analysis suggested that household income has minimum influence on WTP. Therefore, it can be concluded that even the poor households were willing to pay the average values in terms of time or labor contribution to save the natural forest. On the other hand, community valuations for forest resources in the catchment do not vary much in magnitude when the payment vehicle was changed from cash to labor contribution. Therefore, people are concerned about conservation issues, what so ever their status and the situations. The concept of valuing forests is well supported by the community.

Tegegne (1999) also applied this method to elicit people's valuation for environmental protection in terms of both cash requirement and labor contribution. He concluded that households in the study area are willing contribute in terms of labor than cash. Moreover, education, age, sex and family size turned out to be factors affecting the willingness to pay in terms of labor.

It may be observed from these empirical studies that there are large numbers of direct and indirect benefits of forests. Using CV method for valuation across regions, different estimates of economic values of tangible and intangible benefits are obtained. The variations in the estimates could be partly on account of different socio-economic variables and the scope of the studies. Furthermore, the literatures above suggested that contingent valuation method is viable techniques to quantify households' WTP for non-marketed goods in the developing countries. Thus the given literature above provided some sound footings to this study to value households WTP for forest restoration in Dire Dawa area.

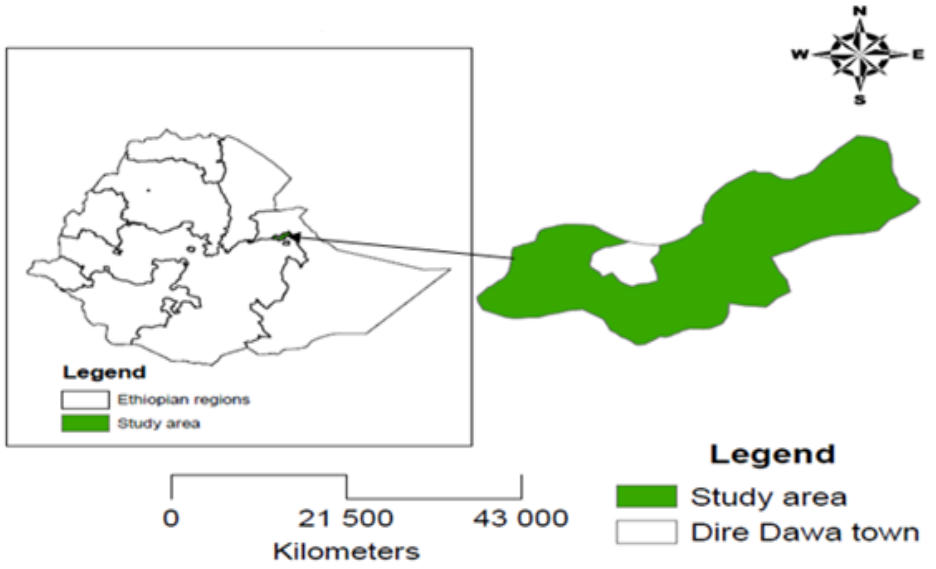
4. Research Methodology

4.1 Description of the Study Area

The study was conducted in Dire Dawa Administrative Council located 515 kms far from Addis Ababa between 9°27' and 9°49' latitudes north and 41°38' and 42°19' longitude east. The landscape of the study area is varies with an altitude ranging between 950 and 2260 m.a.s.l. The total land coverage of the study area is 128,802 hectares. About 13.47% of the total area of the administration is cultivable land; where as 2.22% and 84.31% of the total area is urban land and non cultivated land, respectively. Specifically, within the four sample kebeles 9,730 hectares is non cultivated land, which is the target area. The total population of the study area is

342,827 with 171,930 male and 170,897 females (FDREPCC, 2008). The livelihood of the population typically depends on the production of perennials and annual crops, and rearing animals. The average farmland holding per household of the rural households is less than 0.5 hectare (FDRE, 2001).

Figure 1: The Study Area (Source: Own sketch)



The annual temperature and rainfall is ranges between 24.8°c and 31.4°c, and 500-850 mm, respectively. The natural forest has been cleared to satisfy the demands of the ever increasing population. The remaining high forests cover less than 1% while the majority of the landmass is covered with shrub lands.

4.2 Sampling Techniques and Method of Data Collection

A three-stage sampling technique was used when selected sample respondents. In the first stage 38 rural kebeles were purposively selected out of the 47 kebeles based on identified as their livelihood is more attached to the environmental resources than the urban kebeles. Secondly, 4 kebeles (Adada, Adigaflema, Eja Aneni and Harela) were randomly selected out of the 38 kebeles. In the third stage, proportionally with population percentage, a total of 393 households were selected randomly. The data was collected using face to face interview with the heads or working members of the households. The author and five local enumerators was administered the survey.

The CVM method was also employed to elicit households WTP for restoring forest resource. In CV surveys, there are about four major elicitation methods, namely payment cards, discrete choice (single bounded dichotomous choice), discrete choice CV with follow-up questions (double-bounded dichotomous choice) and open ended. However, due to limited experience the payment card approach is not used especially in rural areas of developing countries (Venkatachalam, 2004) including our country Ethiopia. The other elicitation method is single bounded dichotomous choice format. It is easier for respondents to make willingness to pay decisions than open-ended questions (Bennett and Carter, 1993). However, the double-bounded dichotomous choice format is better than single-bounded in three ways. It makes clear bounds on unobservable true WTP and sharpens the true WTP, and hence efficiency gains (Haab and McConnell, 2002). Finally, the double-bounded dichotomous choice format is very vital to collect more information about WTP of each respondent's (Hanemann et al. 1991 and Arrow et al. 1993). Therefore, this study employed the double-bounded dichotomous choice format to elicit households' WTP in Dire Dawa area.

4.3 Preliminary Survey and Bids

Before the final survey a pre-test was done using 40 randomly selected households. Then based on the pilot results the starting point prices identified for WTP were 25, 50, 70 and 100 birr per year for five years. Given this, the actual survey was undertaken by dividing the total sampled households randomly into four groups. The field survey was successfully completed with 10 protest zeros. The criteria for selecting protest zero was based on the report of the NOAA Panel on contingent valuation by Arrow *et al.* (1993). The mean difference of households' socio-economic variables of protest and valid responses was compared using t-test and chi square test. Our sample t-test and chi-square test indicated that the mean difference of the households' socio-economic variables of protest and valid responses was insignificant. Therefore, these protest respondents were excluded from the data set.

4.4 Data Analysis Methods

4.4.1 Probit Model

The linear regression analysis is widely accepted to analyze the relationship between the dependent and explanatory variables (Aldrich and Nelson, 1984). In the linear regression analysis the dependent variable is a continuous variable, while the explanatory variables can be either dummy or continuous variables. However, when the

dependent variable in a regression model is binary (0, 1) the analysis can be carried out using either linear probability model, logit and/or probit models (Pindyck and Rubinfeld 1981). But, the results of linear probability model may face the following problems. Firstly, the linear probability model may generate predicted values out of the interval zero and one, which violate the basic principles of probability. Secondly, the coefficient of determination (R^2) is likely to be much lower than one, and it is questionable to use R^2 as measure of goodness of fit (Gujarati, 2004). The third problem with linear probability model is that the partial effect of any explanatory variable is constant (Maddala, 1992).

The limitations of the linear probability model can be solved by applying either logit or probit models or both (Amemiya, 1981). The two models generate predicted values between 0 and 1, which follow the basic principles of probability. The main difference between logit and probit is that the conditional probability approaches zero or one at a slower rate in logit than in probit model (Pindyck and Rubinfeld, 1981 and Gujarati, 2004). Secondly, the error term in the logit model are assumed to follow the standard logistic distribution, whereas in probit model error term is assumed to follow the standard normal distribution. Thirdly, the probit model works well for bivariate models than logit model. However, in most cases the two models are statistically similar (Park, 2008). This statistical similarity between the two models makes a choice of the models depends on the availability and flexibility of computer program, personal preference and experience (Ibid). Therefore, in this study probit model was used to determine the factors that are affecting the WTP of households. Following Cameron and Quiggin (1994), the probit model can be specified as:

$$y_i^* = \beta' x_i + \varepsilon_i \qquad (3)$$
$$y_i = 1 \; if \; y_i^* \geq I_i^*$$
$$y_i = 0 \; if \; y_i^* < I_i^*$$

Where: β'= vector of unknown parameters of the model
x_i= vector of explanatory variables
y_i^*= unobservable households' actual WTP for forest restoration
y_i= discrete response of the respondents for the WTP
I_i^*= the offered initial bids assigned arbitrarily to the i^{th} respondents
ε_i= unobservable random component distributed $N(0, \sigma)$

The bivariate probit model was used to estimate the mean WTP from the double bounded dichotomous elicitation method. But, when the estimated correlation co-efficient of the error terms in bivairate probit model are assumed to follow normal distributions with zero mean and distinguishable from zero (see Equation 4 below), the system of equations could be estimated as seemingly unrelated bivariate probit (SUBVP) model (Haab and McConnell 2002). Therefore, in this study SUBVP was employed to estimate the mean WTP. According to Greene (2003), a bivariate probit model can be specified as:

$$y_1^* = \beta_1 x_1 + \varepsilon_1$$
$$y_2^* = \beta_2 x_2 + \varepsilon_2$$
$$E(\varepsilon_1/x_1, x_2) = E(\varepsilon_2/x_1, x_2) = 0 \quad (4)$$

$$Var(\varepsilon_1/x_1, x_2) = Var(\varepsilon_2/x_1, x_2) = 1$$
$$Cov(\varepsilon_1, \varepsilon_2/x_1, x_2) = \rho$$

Where: y_1^*= ith respondent unobservable true WTP at the time of the first bid offered.
WTP $= 1$ if $y_1^* \geq \beta_i^0$ (initial bids), 0 otherwise;
y_2^*= ith respondent implicit underlying point estimate at the time of the second bid offered.

x_1 *and* x_2 = The first and second bids offered to the respondents respectively.
ε_1 *and* ε_2= Error terms for the first and second equations of Equation 4 above
β_1 *and* β_2= Coefficients of the first and second bids offered

The respondents know their own maximum WTP,y_i^* but to the researcher it is a random variable with a given cumulative distribution function (cdf) denoted by $G(y_i^*, \theta)$ where θ represents the parameters of this distribution, which are to be estimated on the basis of the responses to the CV survey. The log-likelihood function for the responses to a CV survey was specified as:

$$lnL^{DB} = \sum\{d_i^{YY} ln\, G(\beta_i^u; \theta) + d_i^{YN} ln[G(\beta_i^u; \theta) - G(\beta_i^0; \theta)] + d_i^{NY} ln[G(\beta_i^0; \theta) - G(\beta_i^l; \theta)] + d_i^{NN} ln[1 - G(\beta_i^l; \theta)]\} \quad (5)$$

Where $d_i^{YY} = 1$ if the ith response is (Yes, Yes) and 0 otherwise; $d_i^{YN} = 1$ if the ith response is (Yes, No) and 0 otherwise; $d_i^{NY} = 1$ if the ith response is (No, Yes) and 0 otherwise; $d_i^{NN} = 1$ if the ith response is (No, No) and 0 otherwise.

4.4.2 The Censored Regression (Tobit) Model

The study employed Tobit model to investigate results of the open-ended question, which is used as a second elicitation technique in the CV questionnaire of this study to model the actual household's WTP for restoring forest resource. In probit and logit model the dependent variable ($\boldsymbol{y_i^*}$) is not observed, what we observe is the dummy variable. However, in Tobit model the dependent variable, or the WTP, is partially observed and the dependent variable ($\boldsymbol{y_i^*}$) assumes zero values for a substantial part of the sample. That is, $\boldsymbol{y_i^*}$ is observed if $\boldsymbol{y_i^* > 0}$ and is not observed if $\boldsymbol{y_i^* \leq 0}$. If y^* and $\mathbf{x}_i$ were observed for everyone in the population, there would be nothing new, and we could use standard regression methods (ordinary least squares (OLS)) (Maddala, 1992). However, in this study since we deal with maximum WTP for forest restoration which is partly observed, therefore, using OLS leads bias and hence, this study employed Tobit model. In general, the censored regression (Tobit) models generally apply when the variable to be explained is partly continuous. According to Maddala (1992) the equation for Tobit model is specified as:

$$y_i^* = \beta x_i + \varepsilon_i \tag{6}$$

$$y_i = \begin{cases} y_i^* = \beta x_i + \varepsilon_i \text{ if } y_i^* > 0 \\ 0 \qquad\qquad\quad \text{if } y_i^* \leq 0 \end{cases}$$

where: y_i^* is latent or unobserved willingness to pay for forest restoration; y_i is a household's actual maximum willingness to pay for forest restoration; x_i is vector of explanatory variables; β is a parameter vector common to all households; α is the intercept; and assuming the random error ε_i is independent and normally distributed across respondents, $\varepsilon_i \sim \text{NID}(0, \sigma^2)$. Some of the households interviewed did not have any WTP, whereas, some of them had WTP for restoring forest resource. For those not undertaking WTP is zero in Tobit model the WTP is a random variable and has probability distribution and it is possible to determine each observations probability.

$$p(y_i = 0) = p(\varepsilon_i < \beta x_i) = 1 - F(\beta x_i) \tag{7}$$
$$p(y_i > 0) = 1 - p(y_i = 0) = F(\beta x_i)$$

Where p is probability distribution and $F(\beta x_i)$ is cumulative density function.

The model parameters can be estimated by maximizing the Tobit likelihood function of the following form.

$$L = \prod_{y^*>0} \frac{1}{\sigma} f\, In\left(\frac{y_i-\beta x}{\sigma}\right) \prod_{y^*\leq 0} \frac{1}{\sigma} F\left(\frac{-\beta x}{\sigma}\right) \quad (8)$$

f and F are the density probability function and cumulative distribution function of y_i^*, respectively. $\prod_{y^*>0}$ means that the product over those i for which $y^* > 0$, and $\prod_{y^*\leq 0}$ means the product over those i for $y^* \leq 0$.

The Tobit coefficients do not directly give the marginal effects of the explanatory variables on the dependent variable. But their signs show the direction of change in probability of WTP as the respective explanatory variables changes. Therefore, it is not reasonable to interpret in the same way as the one interprets coefficients in an uncensored linear model (Johnston and Dinardo, 1997). Hence, we should estimate the marginal effect of the Tobit model. Following Long (1997) and McDonald and Maffitt (1980) the following techniques could be used to identify the effects of explanatory variables on the probability of WTP and the amount of households' WTP (the whole and willing respondents only).

The change in the probability of willingness to pay for forest restoration as explanatory variables X_i changes was estimated by:

$$\frac{\partial F(z)}{\partial X_i} = f(z)\frac{\beta}{\delta} \quad (9)$$

The marginal effect of an explanatory variable on the expected value of willingness to pay was estimated by:

$$\frac{\partial E(y_i)}{\partial X_i} = F(z)\beta \quad (10)$$

Similarly, the change in the probability of willingness to pay with respect to a change in explanatory variable among willing respondents was estimated by:

$$\frac{\partial E(y_i/y_i^*>0)}{\partial X_i} = \beta\left[1 - Z\frac{f(z)}{F(z)} - \left(\frac{f(z)}{F(z)}\right)^2\right] \quad (11)$$

Where, $z = \frac{X\beta}{\delta}$, F(z) is the cumulative normal distribution of Z, f(z) is the value of the derivative of the normal curve at a given point(that is, unit normal density), Z is the Z-score for the area under the normal curve, β is the vector of Tobit maximum likelihood estimates and δ is the standard error of the error term.

5 Results and Discussion

5.1 Characteristics of Sample Households

A total of 393 sampled households were interviewed. However, ten respondents were protested zero bidders. We compare the means of households' socio-economic variables of protest and valid responses using independent samples T test and crosstabs- chi square test. The mean of the households' socio-economic variables of protest and valid responses was insignificant. Thus, only the valid response that is, 383 households were included in the analysis. Of the total 383 respondents, 54% were males while 46% were female respondents. The age of these sampled respondents' ranges from 16 to 78 years with an average of 37.59 years old. The survey results also showed that 71% of the respondents were married and the rest 29% were un-married. A total number of 2731 family sizes were recorded with a minimum of 2 persons and a maximum of 15 persons per households. On average, about 7 persons per household were recorded which was above the national average of 4.7 persons (FDREPCC, 2008). The result on the status of the respondents showed that 68% of the respondents were head of the households, and the rest 32% were working member of the households.

Educational attainment is another parameter considered in our empirical models. The educational status of the sampled respondents ranges from zero (illiterate) to 10+3 years of schooling with an average of about 6 years of schooling. The household survey found that 13.58% of the respondents were illiterate, and most of the respondents (64.23%) never went beyond elementary level. Among the sampled respondents, only 22.19% attained higher level of education beyond elementary school. The total farm land holding of the sampled households was also estimated at 187.75 hectar with average cultivated farm size per household of 0.49 ha. This indicated that the average farm size of the study area is lower than the national average of 0.8 ha (CSA, 1995). Moreover, the result shows that access to extension service of sample respondents. Data with regard to access to extension service showed that 89% of the households' access to extension service whereas the remaining 11% were not.

5.2 Income Sources of Surveyed Households

Households in the study area were engaged in production of cash crop, annual crop and rearing animals. They were also engaged in off farm activities (working in governmental and nongovernmental organizations, trade). The total monthly income of sampled households from the on farm and off farm activities was computed at 629,293.45 ETB with minimum 258 and maximum of 5850 ETB. On average the income of the surveyed households were estimated 1643.06 ETB per month. Taking the average family size of 7, the average per capital incomes was ETB 230.44 per month. This is approximately four times higher than ETB 62.7 monthly average per capital income reported by the IMF at country level (IMF, 2001). Higher average per capita incomes in the study area could be due to production of cash crops like chat and livestock production.

Major sources of income in the study area are from on farm activities, primarily from production of cash crops and livestock production. The total monthly income of these households from on farm activities was computed at 496,452.12 ETB. On the other hand, the monthly income of the households obtained from off farm activities were also computed at ETB 132,841.33. The fact that off-farm incomes contribute smallest to the total family income, it explains that most of the surveyed household can rely mainly on agricultural activities with relatively narrow landholding size for their livelihood. It also indicates that large portion of the households engaged in on farm income generating activities to meet their family livelihood needs. Data related to livestock owned by the respondents was also collected in terms of TLU[4]. The survey result shows that on average 1.95 TLU with a minimum of 1.56 and maximum of 3.87 was recorded per households.

5.3 Causes of forest lose and Its Protection Measures

In the study area vegetation is not found in contiguous form covering large area; rather it is seen as fragmented patches of bush land, shrub land and trees in agricultural sites and hillsides. The natural forest has been cleared to satisfy the demands of the ever increasing population such as construction material, fuel wood, fodder and agricultural expansion. The majority of the landmass is covered with shrub lands with the remaining high forests of less than 1%. Therefore, household perception on the

[4] Conversion factors used in estimation of tropical livestock unit (TLU) were Donkey = 0.7; Cow, Bulls and Ox=1; Calf = 0.25; Sheep and Goats= 0.13; Chicken=0.013 and Camel = 1.25

problems of forest loses has a direct effect on households willingness to value the forest restoration. Most of the respondents are aware about the availability of the resource. About 82% of the respondents were known the goods to be valued properly. They have an experience of using the resource for fire wood, charcoal, construction, shelter, feed, and source of income.

Perceived respondents reported that the availability of forest resource is decreasing from time to time, and the reasons attributed to the problem of forest lost were population pressure, overgrazing, agricultural expansion, and soil and water degradation. More specifically, 22.91% of the respondents frequently mentioned population pressure as the first environmental problem followed by overgrazing and soil and water degradations. On the other hand, about 18.28% of the respondents did not perceive the problems of forest lose (See Table 1 below).

Table 1: Environmental problems of the study area listed by the respondents

Problems	Number of households	%
Population pressure	85	22.91
Agricultural expansion	65	16.97
Soil and water degradations	81	21.15
Overgrazing	82	21.41
None	70	18.28
Total	383	100%

Source: Survey result, 2012

Suggestions were also elicited from the aware respondents to overcome the problem of forest lost. These include massive tree planting, strong government regulation, soil and water conservation, and training forest users (see Table 2 below).

Table 2: Alternative Protection Measures

Protection Measures	Frequency	%
Massive tree planting	81	21.15
Soil and Water Conservation	75	19.58
Strong government regulation	79	20.63
Training forest users	78	20.37
None	70	18.28
Total	383	100%

Source: Survey data, 2012

5.4 Households Willingness to Pay for restoring forest resource

The results revealed that about 89% of the total 383 sample households were willing to pay for forest restoration and their WTP is positive. The double bounded dichotomous choice format was used to estimate the mean WTP from responses of both the first and the second bids offered. The analysis was conducted using seemingly unrelated bivariate probit model. The estimation result of model is reported in Table 3 below.

Table 3: Estimation results of the bivariate probit model

Variable	Coef	Z	P > |z|
Initial bids	-0.0153904	-6.12	0.000
Constant	1.51082	8.37	0.000
Second bids	-0.0215554	-9.8	0.000
Constant	1.978898	11.66	0.000
ρ***	0.926	3.53	0.000
Number of obs	383		
Log likelihood	-398.86335		
Wald chi2(2)	122.05		
Prob > chi2	0.000		
Likelihood-ratio test of rho=0:chi2(1)= 34.351 Prob>chi2=0.000			
Mean WTP[5]= 94.09 birr (At 95% CI, 98.17 to 90 ETB)			

The mean willingness to pay for forest restoration was computed at 94.09 ETB per year per household for five years horizon. At 95% confidence interval the WTP varies between 98.17 to 90 ETB (see Table 3 above). The result shows that the mean WTP from double bound format was greater than the mean value from the open ended response which was computed at 64.82 ETB per year per household for five years. This may indicate the existence of anchoring effect from the double bounded elicitation method. In other word, the open ended elicitation method has an advantage to avoid the anchoring effect. This result is consistent with the various studies (Alemu, 2000; Köhlin, 2001; Carlsson *et al.*, 2004 and Solomon, 2004).

[5] The mean WTP from bivariate probit model was computed using the formula specified by Haab and Mconnell (2002) that is, $mean\ WTP = -\frac{\alpha}{\beta}$; α is a coefficient for the constant term, and β is a coefficient for offered bids to the respondents

5.5 Determinants of Households' WTP

5.5.1 The probit model estimation result

The estimated result on factors affecting the households' WTP for forest restoration is presented in Table 4 below. The sign of all the explanatory variables were as expected. It could be seen that monthly income of the respondent shows positive and significant relationship with the households' WTP. This positive effect indicated that respondents with higher monthly income were more likely to say yes to the first bid than households with lower income. This indicated that households with higher income have a greater ability to pay than the households with lower income. A study by Alemu (2000) and Tefera (2006) recognizes significant association between households' income and WTP. The result also shows that keeping the influences of other factors constant at their mean value, a one birr increase in income of the respondent, increase the probability of accepting the first bid by about 0.02%.

The result of the probit model showed that education level of the respondents is positively and significantly related to WTP. One possible reason could be that literate individuals are more concerned about forest resource than illiterate one. Educated (or literate) individuals relatively know more about the significance of resources, and they are concerned more about the environmental resource. This is consistent with the findings of Tegegne, (1999) and Carlsson *et al.* (2004). Furthermore, the result revealed that keeping the influences of other factors constant, a one year increase in the educational level of the households, the probability of accepting the first bid increase by 1.39%.

Total farm land holding was one of the hypothesized variables in the probit model, and the effect of which on the WTP was estimated by the model. The sign of total farm land holding turned out to be consistent with the prior expectation, and it was positively and significantly related with the WTP. The significant result indicated that households who have higher cultivated land were more likely to say yes response for the initial bid than the respondents with small cultivated land. This is probably due to the fact that larger farm size earns more income from crop production especially cash crops. The result showed that an increase in family size increases probability of saying yes to the offered prices by about 13.10%. Solomon, 2004 also found the same result.

Perception has an expected positive related to likelihood of saying yes to the first bid. That is, households having higher awareness about the forest lose and environmental

problems are willing to pay positively. The coefficient of this variable was significant (at 5%), keeping other things constant changing the dummy from 0 to 1 will increase probability of accepting the initial bid by about 18.16%. The coefficient of ownership also has positive relation to the likelihood of saying yes to the initial bid. That is, keeping the effect of other variables constant changing ownership from 0 to 1 will increase probability of accepting the initial bid by about 14.61%. This is because the respondents feel secure of their right to use the resource after plantation. This finding is consistent with Solomon, 2004, and Lindhjem and Navrud, 2008. Besides, changing access to extension from 0 to 1 would increase probability of accepting the initial bid by about 80.26%. This is because access to extension is an important source of information, knowledge and advice to smallholder farmers. Similar result was found by Azami *et al.* 2012.

The coefficient of starting bid price has negative sign and significant at 5% level of significance. The negative sign and the significance of this coefficient indicated that as the starting bid price increases by one unit, the probability of household's willingness to pay in birr reduces by 0.3%. This may indicate there is income scarcity or cash poverty. Besides, the result shows that demand for forest restoration is decrease as price increases. This is consistent with the findings of Solomon (2004); Carlsson *et al.* (2004); Bin Ramlan *et al.* (2011); and Mousavi and Akbari, (2011).

Table 4: The probit model estimation results of households' WTP

Dependent variable: Choice in the valuation question (no = 0, yes = 1); 383 observations			
Explanatory Variables	**Coef.**	**Marginal effects**	**z**
Households income	0.001	0.0002***	4.13
Age of the respondents	0.007	0.0019	1.05
Educational level of the respondents	0.052	0.0139**	1.98
Sex of the respondents	-0.101	-0.0270	-0.39
Ownership types	0.533	0.1461**	2.54
Respondents marital status	0.153	0.0422	0.53
Respondents status	-0.368	-0.0928	-1.31
Total family size	0.028	0.0076	0.83
Tropical livestock unit	0.226	0.0606	1.56
Perception	0.588	0.1816**	2.33
Access to extension services	2.60	0.8026***	5.07
Total farm land holding	0.488	0.1310**	2.01
Initial bids	-0.011	-0.0030**	-2.39
Constant	-3.978		-4.63
Number of observation	383		
LR chi2(13)	202.48		
Prob>chi2	0.000		
Pseudo R2	0.431		
Log likelihood	-133.648		

*significant at 10%; ** significant at 5%; *** significant at 1% significance levels Source: own survey

5.5.2 The Tobit model estimation result

The result from Tobit model was different from probit model in the significance level and some variables. That is, 5 of the 13 explanatory variables were statistically significant. The other 8 explanatory variables are insignificant effect on the amount of WTP for restoring forest resource. Except for sex the significant variables have a positive effect on the amount of WTP. However, the interpretation of the censored regression model is not straightforward. That is, the marginal effects cannot be adequately explained from the estimated coefficients of the Tobit model (see Table 5 below). Therefore, for interpretation of the Tobit model this paper report three sets of marginal effects: the effect on the probability of a positive WTP, the effect on conditional WTP, and the effect on unconditional WTP.

To be more specific, households' monthly incomes have positive and significant association with the households WTP for restoring forest resource. That is, when the income of the household increase by one birr, it would increase the probability of willingness of a household to pay for forest restoration by about 0.001%. Besides, when income of the household increase by one birr their willingness to pay would increase, on average, by about 0.005 ETB for all observation and 0.0047 ETB for willing respondents', *ceteris paribus*. This shows that forest restoration is a normal economic good whose demand changes in the direction of income change. Respondents with higher education levels were more likely to state positive WTP, and on average, they actually stated higher conditional and unconditional WTP than respondents with lower educational levels. This result suggests that investing in education of people might help to restore forest resource in degraded environment. The marginal effect of the result shows that the respondent being educated, the probability of willingness to pay for forest restoration increases by 0.22%. Also, as the years of education increases by one year, the amount of cash the household is willing to pay for forest restoration increase by 1.024 birr for the whole sample of study, and 0.91 birr for the willing respondents, *ceteris paribus*. The variables ownership type and access to extension services also have positive and significant effect on the amount of WTP. In terms of ownership type a unit changes from 0(government ownership) to 1 (community ownership) the probability being willing to pay increases by 28.53%. That is, the marginal effect result shows that a unit changes from 0(government ownership) to 1 (community ownership), the willingness to pay increased by 12.5 birr and 11.04 birr for the whole and willing respondents respectively, *ceteris paribus*. This is because the households may feel secure of their right to use the resource after restoration. Access to extension service was another variable found to be significant. Since the parameter estimate is positive, it implies that households having access to extension service increases the probability of WTP by 36.07%. This enhanced the awareness of the respondents on the forest lost and restoration. The male respondents would have a 2.4% probability less than a female to pay for forest restoration. That is, female respondents were willing to pay approximately 10 birr more than the males, *ceteris paribus*.

Table 5: The Tobit model estimation results of households' WTP

Dependent variable: Maximum Willingness to Pay; 383 observations					
Explanatory Variables	**Coef.**	**t-value**	**Marginal effects**		
			A	**B**	**c**
Households income	0.006***	3.96	0.000011	0.0047	0.005
Age of the respondents	0.146	1.03	0.00031	0.1252	0.141
Educational level of the respondents	1.058**	2.02	0.0022	0.9079	1.024
Sex of the respondents	-11.62**	-2.12	-0.0239	-9.997	-11.25
Ownership types	12.94***	3.27	0.2853	11.04	12.50
Respondents' marital status	4.236	0.76	0.0093	3.613	4.094
Status of the respondents	-1.671	-0.29	-0.0034	-1.437	-1.62
Total family size	-0.261	-0.4	-0.00055	-0.2237	-0.252
Tropical livestock unit	-0.201	-0.07	-0.00042	-0.1727	-0.195
Perception	3.039	0.56	0.0067	2.590	2.937
Access to extension service	59.08***	8.25	0.3607	39.91	50.32
Total farm land holding	6.422	1.64	0.1344	5.513	6.22
Initial bids	-0.600	-7.06	0.0012	0.515	0.5812
Constant	-53.32	-3.87			

(for all sample respondents)

*significant at 10%; ** significant at 5%; *** significant at 1% level of significance

[a] Marginal effects on the probability of being censored

[b] Marginal effects on the truncated expected value(for the willing respondents only)

[c] Marginal Effects on the censored expected value

Source: survey result

5.6 Aggregate WTP for Restoring Forest Resource

An important issue related to the measurement of welfare using WTP is aggregation of benefit (Alemu, 2000). According to Mitchell and Carson (1989) there are four important issues to be considered regarding sample design and estimating a valid aggregation of benefits: population choice bias, sampling frame bias, none response bias and sample selection bias. Random sampling method was used in this study using a list of households. Face to face interview methods was used and protest zero responses were excluded from the analysis and expected protest zeros was accounted in the estimation of the total aggregate benefit of forest restoration in this paper. Hence, none of the above biases was expected in this paper. Mean WTP was used as a measure of aggregate value of forest restoration in this study. The mean is perhaps better than the median since the good dealt with is not a pure public good (Alemu, 2000), as there are

purely private benefits from forest restoration measures. As it is indicated in Table 6 below, the aggregate WTP was calculated by multiplying the mean WTP by the total number of households in the population. Following this, the aggregate WTP for restoring forest resource was computed at 2,026,604.51 birr per year for five years. Whereas, from open ended questions the total WTP for restoring forest resource was also computed at 1,396,157.98 birr per year.

Table 6: Estimation of Total Aggregate Benefits of forest restoration

Total households (Y)	Expected households to have a protest zeros (X)[6]	Expected households with valid responses (Z)[7]	Mean WTP[8]	Aggregate Benefit (in Birr)[9]
22,091	552	21539	94.09	2,026,604.51
22,091	552	21539	64.82	1,396,157.98

Source: own survey, 2012

6 Conclusion and Recommendations

The purpose of this study was to assess the economic value of forest restoration in Dire Dawa area using CVM. The descriptive analysis shows that 82% of the respondents reported that the reasons attributed to the forest lost were population pressure, overgrazing, soil and water degradation and agricultural expansion. In order to restore the forest resource policy makers should encourage and provide technical advice to households who are planting and maintaining tree resource, and practicing soil and water conservation.

The results of the study on willingness to pay showed that the households were willing to pay for restoring forest resource. The annual mean WTP value of households for restoring forest resource based on the double bounded dichotomies choice was computed at 94.09 birr per year for five years. Whereas, the annual total WTP from open ended format was also computed at 64.82 birr per year. The study found that the

[6] 10(2.5%) of 393 sampled households were protest zeros. We excluded those protest zeros from further analysis after we have tested for sample selection bias. So X is the expected number of households which are expected to protest for the proposed project. It is calculated by the percentage of sampled protest zeros (2.5%) by the total population 22091 (Y).

[7] Y-X is the total households in the study area which are expected to have a valid response

[8] Is the mean willingness to pay calculated from the double bounded dichotomous choice estimation and open ended elicitation methods

[9] Is mean multiplied by the number of total households which are expected to have valid response (Z*Mean WTP) measured in ETB

value of forest restoration from open ended format was lower than double bounded elicitation format significantly. The study conclude that there could be a problem in applying a closed-ended elicitation format to forest restoration in developing countries since a forest restoration typically implies a community based scenario and such a scenario invites to anchoring effect. The well-known problem of anchoring effect and/or compliance bias is also difficult to avoid in such settings. Application of a closed-ended format under such circumstances would exaggerate the WTP for forest restoration.

The empirical findings on the determinants of WTP indicated that monthly income, access to extension service, ownership types and initial bids are key factors influencing the willingness to pay in both probit and Tobit models. Besides, the study estimated that there are statistically significant and quantitatively non-negligible effects of perception and total farm land holding on the households' WTP in probit model. The variable sex is also significant effects from Tobit model. Such differences are worth considering when planning households contribution in projects for restoring forest resource. Generally, the study leads us to conclude that understanding of socio-economic characteristics that significantly influenced households WTP is a necessary and first step to achieve restoring forest resource. Moreover, specific factors that affected the valuation of a household for restoring forest resource in open ended elicitation method should be analyzed separately from the valuation of households for restoring forest resource in dichotomous choice elicitation method in order to restore the forest resource.

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