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Willingness to Pay for Wood Work Enterprises to Recover Deforested Softwood Trees in Eastern Ethiopia

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Abstract: This study was carried out to find out the economic value of forests by woodwork enterprises for the reforestation of Softwood Pine trees in Eastern Ethiopia, namely Dire Dawa administrative council, Harari regional state, and Deder district of East Hararghe Zone. Forests in Eastern Ethiopia were the major sources of softwood pine logs. Nowadays, some commercially important pine species are over-exploited and in short supply. The study was undertaken to estimate Woodwork enterprises heads willingness to pay in Dire Dawa, Harari, and Deder districts for the recovery of deforested softwood pine trees in cubic meters (m^3) using a contingent valuation method in Double Bounded Dichotomous Choice (DBDC) format. A seemingly Unrelated Bivariate Probit (SUBVP) model was used to examine aspects that affect woodwork enterprise heads willingness to pay (WTP) and to calculate the mean and aggregate WTP. To elicit their WTP for reforestation, 136 sample woodwork enterprise heads were randomly selected from 1076 enterprise heads and interviewed. Among these sample enterprise heads 87.5% of them were willing to pay for the reforestation while 12.5% were not. The mean WTP of the enterprise heads ranged from Birr 97.92 to Birr 174 per month per person or Birr 1,175.05 to Birr 2,088 per m^3 per year per person and the aggregate WTP was Birr 1,264,343.04 per m^3 per year and that could enable to reforest 88 hectares. The result also indicated that second bid value, family size, capital, perception, source connection, profit, substitution, liability, and distance were significantly related to WTP for reforestation. All these suggest softwood pine trees forest is of high value and therefore, there is an opportunity to mobilize woodwork enterprises to combat the softwood trees deforestation problem in the selected study areas.

Keywords: WTP, Deforestation, DBDC, CV, SUBVP, Softwood Pine Trees, Woodwork

Introduction

Ethiopia is found in the horn-like land mass of Africa betwixt 3°-15° North Latitude and 33°-48° East longitude, bordering Sudan, Eritrea, Kenya, Somalia, and Djibouti. The nation stretches above 1,140,000 km^2 and altitudes range from 125 m lower down sea level at Afar depression, to 4620 m over sea level at Ras Dashen Mountain, which results in a broad diversity of climatic areas and soil conditions (FDRE, 2011; 2012). In Eastern African countries next to Nigeria Ethiopia is the most populous nation. The Worldometers (2023) data elaboration shows that Ethiopia's current population is 122,723,366 (1.47% of the total world population) with a density of 115 people per km^2 with an annual population growth of more than 2.6%.

Ethiopia is naturally given plentiful natural resources of water, fertile soil, a favored climate, and different flora and fauna. More than 80% population of Ethiopia resides lives in rural areas depending on agriculture and other natural and forest resources. Ethiopia owns different vegetation that ranges from lowlands stunted forest scrubs to tropical climatic rain forests. The Global Forest Resource Assessment (FRA, 2020) report shows that estimated Ethiopia's forest coverage was around 15.7%. Forest resources included planted and naturally gifted forests. A natural forest includes moist Afromontane forests, dry tropical Afromontane forests, stunted scrubs, shrubs, and other woodlands (FAO, 2020).

Ethiopia's forests are the source land for industrial and commodity crops, they provide fuel wood for household consumption and market softwood logs and timber as raw materials for construction and furniture. Forest plays a significant role in environmental protection including water and carbon cycles, and it also encourages economic development. Among ecosystem services by forests is the regulation of climate processes and others. If forests improve carbon sequestration that helps to reduce the worse of climate change (UNFF, 2023). However, the expanse of forest areas is declining across the globe, recent five years' data from 2015-2020 shows that the deforestation rate was estimated at 10,000,000 ha annually, partly as a result of logging activities which accounts for up to 43% of the world tropical forest (FRA, 2020). According to the forum for environment policy report, in Ethiopia land degradation and deforestation problems arises from unsustainable use of land, consumption of wood, and lack of appropriate governmental, legal, institutional, and regulatory frameworks including other factors such as Demographic and economic factors (Heckett and Aklilu, 2009). Loss of forest increases beyond the 2000s. At the earlier time around 50 years before 40% of Ethiopia's land was covered with planted and natural forests. The UN 0mework for conventions on climate change forest reference level for 2017 shows that, Ethiopia's forests are in trouble with 72,000 ha loss or at a 0.54% rate of deforestation. The Ethiopia ministry of environment and forest projections indicates that, if there is no action taken to change the previous trend around 9,000,000 ha of forest might be deforested betwixt 2010 and 2030 (EMEF, 2015). The forest loss extent estimated by Mongabay from 2002 to 2020 was around 75,719 ha (Mongabay, 2022). Oromia and the Southern Nations, Nationalities, and Peoples (SNNP) are the two Ethiopian states that were engaged for 82% of all the country's forest losses. Nowadays, the country's remaining forest is found in the South Western part of the country (Assfaw, 2020). Deforestation in Ethiopia has led to severe shortages of forest resources and products like fuel wood, construction and industrial wood, and other non-wood and wood products (NFSDP, 2018). On the other hand, the economic and population growth led to the demand for wood and wood products increasing fast. Urbanization, rapid change in the economy, and the growth of population led to the demand for wood and wood products increasing at an increasing rate. The growth of the middle-class economy, the boom in construction sectors, and the expansion of the urban population are the drivers for this rapidly growing in the need for wood and other forest products (EEFRI, 2021).

Environment, forest, and climate change commission projection for Ethiopia's demand for wood products to increase by 27.0% for the coming 20 years that reaches an annual consumption of 158,000,000 m^3 by 2033 (EFSR, 2017). To meet the country's needs derived from a growing economy the supply gap is around 4,400,000 m^3 of industrial round wood; industrial wood will be needed for the coming 20 years (EFCCC, 2020). To develop continual plantations in Ethiopia, it is important to give more consideration to the demand and supply of wood resources; which leads to narrowing the gap between demand and supply for wood and wood products. The forest sector review reported that demands for construction wood, utility poles, pulps, papers, and furniture products are estimated at around 8,400,000 m^3 (EFSR, 2017). The gap between demand and supply is high in discrepancies and it will expand from time to time. The Ethiopian environment and forest research institute's prediction for the status of wood products supply and demand in Ethiopia show that in 2013 the softwood logs projected demand-supply gap was around 1,800,000 m^3 and this gap will increase to 4,400,000 m^3 by the year 2033 (EEFRI, 2021).

East Hararghe Zone is the zone included in the 12 Eastern Ethiopia Oromia zones. Deder district is one of the Oromia districts. Forests in the Deder district have immense natural and planted forest resources; from these areas forests there is a huge demand for wood and wood products. So, the district experienced illegal loggers' pressure for its forest resources; indeed commercially important softwood Pines are over-exploited which resulted in a short supply from these forest areas and this creates an insufficient supply of wood and wood products. This has brought two economically un-favored outcomes; on the first hand, the shortage of supply of wood and wood products forces specifically the region and the country as a whole makes heavily depend on importing the resource from abroad for the local industries. The trend in the district is trying to protect the remaining untouched forests by hiring guards. On the other hand, the need for forest resources increases the demand resulting in cutting which brings deforestation and over-exploitation rates to remain high around and particularly the district's remnant and planted forest and woodlands resources.

Unless immediate actions are taken, the current exacerbating practice will drive further deforestation and further degradation of these area forests; which create a shortage of the supply of these resources which highly affects the foreign exchange reserves. This confirms that state and regional governments must designate the establishment of professionally and sustainably managed forests plantation to supply quality wood products and to satisfy the increasing domestic and abroad market demand.

Since forests provide many benefits; they do not have direct market values where their values are directly observed. Increasing the knowledge of all forest resources will aid to make decisions for this sector. In managing forest resources in addition to the economic implication there are other ways as alternatives such as reforestation of the deforested forests and woodlands; this can be taken into account. Since, large-scale, medium-scale, small, and micro-level woodwork

enterprises and their Willingness to Pay (WtP) to reforest is not yet studied and documented. This inspires the study to examine these enterprises' heads WTP for restoring deforested softwood trees, in the hypothetical or notional market created in the three study areas.

Dire dawa administrative council, Harari regional state, and Deder district are the three study areas located in Eastern Ethiopia. Forest in the Deder district covers most of the three small rural towns these are Kobo, Chelenko, and Karra Makkala area forests. Nevertheless, local and neighboring loggers over-cutting and deforestation worsen it, especially in the Karra makkala area forests. Softwood forests in this area have to experience so many over-exploitation practices pressure due to the increasing demand for forest resources, especially for softwood pines logs. Logging by both legal and illegal loggers and weak conservation practices brings overexploitation of these valuable resources. According to Li *et al*. (2008), illicit and unlawful logging and ally trading is the main problem for environmental, social, and economical reasons that bring serious concerns about resource depletion, exploitation, and poor forest management practices.

To make the most of their wood products and for construction purposes, woodwork enterprises and consumers in Eastern Ethiopia using softwood resources reach a high level of consumption. To avert all these catastrophic effects being brought by the depletion of the resource; it is essential to take action quickly and on an immense scale. The Karra makkala area mountainous forests in the deder district including *Gondela, gara tullu, Jebel tita, and Gara obii*, are characterized by different landscapes with altitudes ranging from 2500-3381 meters above sea level. The coldest climate and highest elevation of these forests are very suitable agro-ecological conditions to reforest Pines species. According to El Zein and El Mamoun's (2014) study result, elevation or altitude remarkably affects the moisture, microbial activities, and organic matter of the soil; all these have a positive effect on the growth of important pines species such as *Cupressus lusitanica, Pinus radiata, and Pinus putula* favorably.

To this end, an attempt was made to analyze Woodwork enterprises heads WTP for the reforestation of deforested softwood pines trees in Karra makkala area forests. In addition, the study attempted to identify determinants of WTP of Woodwork enterprises and to estimate the mean and the aggregate WTP of these enterprises. Given the relative advantages and objective of this study, the economic valuation measure through a hypothetical market valuation associated with forest and tree cover changes, the Contingent Valuation Method (CVM) with a Double Bounded Dichotomous Choice (DBDC) format was used to draw out Woodwork enterprises' WTP (Carson *et al*., 1986; Gregersen *et al*., 1997). Accordingly, it will provide baseline information for the researchers, and regional and federal authorities. Hence, this study gave emphasis to assess woodwork enterprises WTP in Eastern Ethiopia to recover deforested softwood trees for the benefit of future supply and other environmental co-benefits.

Materials and Methods

Description of the Study Areas

East Hararghe Zone is found in Eastern Ethiopia Oromia Region. This Zone is bordered on the West-by-West Hararghe Zone, on the Southwest by Bale, on the East by the Harari and Somali Region, and on the North by Dire Dawa administrative council (Fig. 1). The administrative center of this zone is Harar. Deder district is located in the East Hararghe zone with an altitude of 6,946 feet or 2,117 m over sea level and *Gondela* is the highest point. The total area of this district is about 674.24 km^2 (Central Statistical Agency (CSA) and ORC Macro, 2006). Dire Dawa administrative council is one of two chartered urban settlements in Ethiopia (the other being the capital city, Addis Ababa). Dire Dawa lies in the Eastern part of the country and it is the second-largest urban settlement. Dire Dawa has an estimated total land area of 1559 km^2. It is located 515 km East of Addis Ababa between Addis Ababa and Djibouti. The Harari people's regional state is one of the eleven regional divisions of Ethiopia and is located in the Eastern part of the country. Harari region is an enclave in Eastern Hararghe (Fig. 1). The existing administrative division of the region is composed of 19 urban Kebeles and 17-peasant associations making a total of 36 administrative divisions at the Kebele level. The total area of the urban administrative units is 19.5 km^2 and the rural administrative units constitute about 323.7 km^2 (Central Statistical Agency (CSA) and ORC Macro, 2006).

Sources of Data and Methods of Data Collection

Data is brought about from both primary and secondary sources. The initial data were collected from the sample Woodwork enterprise heads by using structured questionnaires for face-to-face interviews. The distribution of woodwork enterprise in the three study areas was 55.86% in Dire Dawa, 33.09% in the Harari region, and 11.06% in the Deder district of the total population. The questionnaire gathered technical, institutional, and financial information about woodwork enterprises. The secondary data were gathered from different sources, mainly from regional Bureaus, District and zonal agriculture offices, and personal observations regarding softwood tree forests, logs, and timber. The outcomes of these discussions were employed to generate qualitative information.

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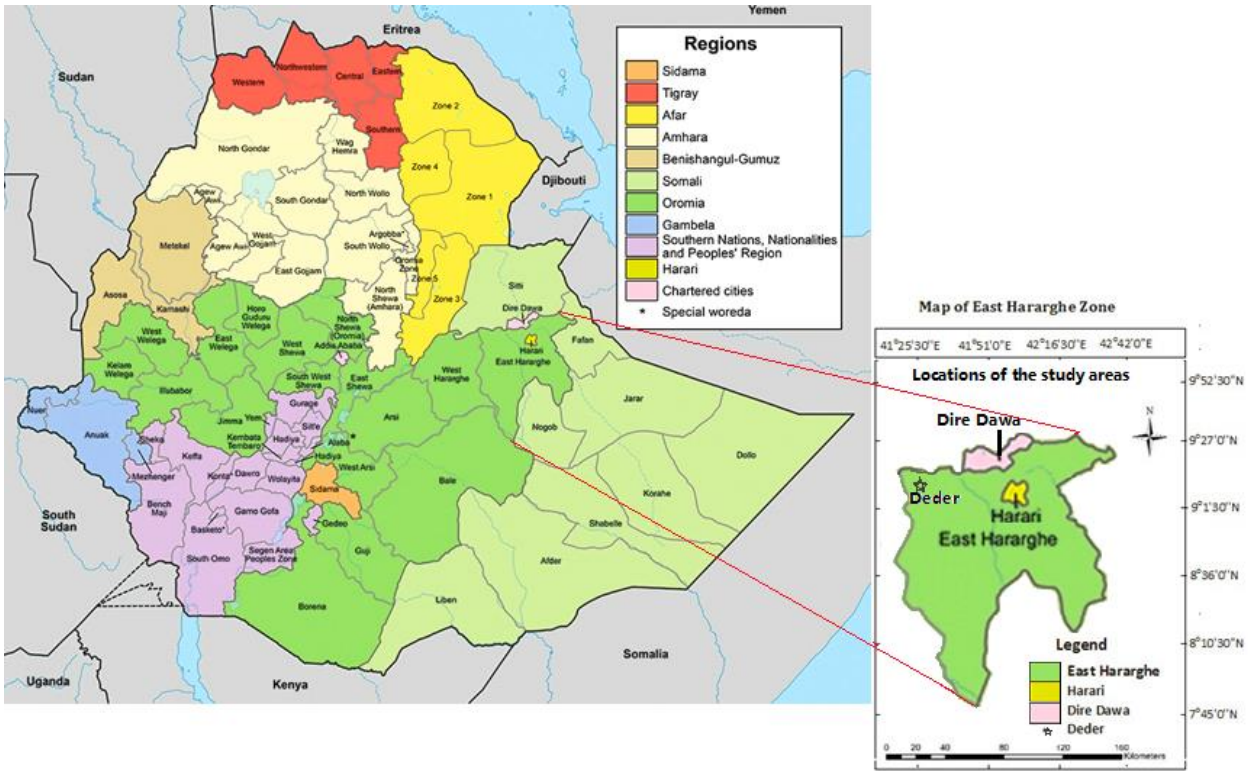

Fig. 1: Maps: Showing locations of the study areas (Deder, Dire Dawa, and Harari region in Eastern Ethiopia)

Sampling Techniques and Sample Size

To select 136 sample woodwork enterprises from a population of 1076 enterprises a two-stage sampling technique was used. In the first stage, 38 Kebele Administrative (KAs) with active enterprises using Pines resources in Dire Dawa, Harari, and Deder districts were intentionally selected. In the second stage, on the proportion of their size 76 woodwork enterprises from the Dire Dawa administrative council, 45 enterprises from Harari Region, and 15 enterprises from and Deder district were selected by using the random sampling technique. Finally, 136 representative sample enterprises were randomly selected from the three study areas. To find out the required sample size (n) the following simplified formula specified by Taro Yamane (1967) was used. Since there was a finite population (N) of woodwork enterprises, the above-stated formula for establishing the sample size becomes:

$$n=\frac{N}{1+N(e)^2} \quad (1)$$

where, N is the population size, n is the sample size and e is the margin of error or level of precision. To compute the sample size (n) given N is 1076 which is the population size and e is the degree of uncertainty or margin of error (the precision level) and 8% is an acceptable sample error:

$$n=\frac{1076}{1+1076(0.08)^2}=136$$

So, 136 enterprises were randomly selected from the target population.

Methods of Data Analysis

Descriptive Statistics

Descriptive statistics were employed to clarify various socio-economic, demographical, and institutional characteristics of sampled woodwork enterprise heads. It was also important to compare the willing and unwilling enterprise heads to pay for reforestation in terms of different explanatory variables using *a* t-test for continuous and chi-square (χ^2) tests for dummy variables.

Value Elicitation Format

Three universal estimates of economic values related to natural resources trees and forests cover to convert are frequently used are; market cost or price, proxy (substitute) or surrogate market prices, and theoretical valuations. In the truancy of an ordered market, an instinctively attractive approach to divulging the preferences of an individual is the use of the Contingent Valuation Method (CVM) presented by Mitchell and Carson (1989). Regarding in contingent valuation survey; there are four crucial elicitation or

drawing techniques as yet used. These are: Bidding games, payment cards, and 'take it or leave it' approaches with Single Bounded Dichotomous Choice (SBDC) and 'take it or leave it' with follow-up Double Bounded Dichotomous Choice (DBDC) on finding out about reply.

The double bounded model increases efficiencies over SBDC choices in three procedures. First, 'Yes-No' or 'No-Yes' replies succession reveals clear bounds on willingness to pay. For the 'No-No' and 'Yes-Yes' pair of replies, there are efficiency gains too. These appear for the reason that, of an extra question, even when they could not bounds willingness to pay totally, more prevail on the limited extent of the part of the distribution where the respondent's willingness to pay can be situated. Ultimately, replies are increased, in such a manner that a given function is appropriate with further observation (Haab and McConnell, 2002). This approach reduces non-replied or unresponsive questions, and starting point bias and also keeps away from the eccentricity of outliers. Thus in this approach, participants have required a question demanding a 'Yes' or 'No' answer about he or they would pay a designated amount. If the participants say 'Yes' he or they will be asked another willingness to pay question using a high amount arbitrarily chosen from a pre-stated list. if the answer is 'No', the following question is propounded and arbitrarily chosen as the lowest amount. Accordingly, the closed-ended Dichotomous Choice question has evolved into the regular approach to bring out willingness to pay (WBI, 2002). So, the DBDC approach which is proposed by Carson was applied in this study.

Initial Bid Values

A Focus Group Discussion (FGD) implies the way to know important information for the initial bid value set up. Each respondent faced a random price randomly estimated for one volume of Pine log in m^3 per year for 10 years (Snyder *et al*., 2008). The prices which resulted from the FGDs were determined for the initial question to set initial bid values in a monthly payment manner (Table 1).

After making proper adjustments on amounts which are obtained from the FGDs, Birr 150 was taken as a base bid; then classified into four (75, 150, 225, and 300) for initial bid amounts. As a sequel to Cameron and Quiggin (1994), collection of bids was established for double bounded dichotomous choice format via producing doubling the starting bid if the first participants' response is 'Yes' and half of this bid amount if the participants' response is 'No' Boyle *et al.* (1988). Thus, four possible outcomes were observed: (i) The two answers are 'Yes': (ii) the two answers are 'No': (iii) A 'Yes' answer followed by a 'No' answer: And (iv) A 'No' answer followed by a 'Yes' answer. The double-bounded dichotomous choice bid scheme that was used in the ultimate contingent valuation survey is presented here in Table 1.

Econometric Method

As a sequel to Haab and McConnell, the econometric model for the systematic expression of the Double Bounded data is specified as:

$$WTP_{ij} = \mu_i + \varepsilon_{ij} \quad (2)$$

where, WTP_{ij} is the willingness to pay of individual *'j'*, it epitomizes a vector of values for the dummy replied variables; and '*i* = 1, 2' that represents dichotomous choice 1 and dichotomous choice 2; correspondingly; *'μ_i'* is the mean value for initial and the following answers; inclusive bids *'β'* is a respecting vector of the multiplier. The error term *'ε_{ij}'* includes both individuals and questions particular or the exact error. Setting; $\mu_{ij} = X'_{ij}\beta_i$ permits the mean to be dependent on the characteristics of representative enterprise participants and X'_{ij} *(i = 1, 2)* is a vector of explanatory variables. Variables; to develop the probability function the likelihood of examining each of the feasible both bid replies courses, these (Yes-Yes, Yes-No, No-Yes, No-No) are presented as follows. The likelihood that participant *'j'* answers to the first bid and to the second bid is given by Haab and McConnell (2002):

$$Probability\ (Yes,\ Yes) = Prob.(WTP_{1j}\ t_1,\ WTP_{2j}\ t_2) = Prob.(m_1 + e_{1j}t_1, m_2 + e_{2j}t_2) \quad (3)$$

$$Probability\ (Yes,\ No) = Prob.(WTP_{1j}\ t_1,\ WTP_{2j}\ t_2) = Prob.(m_1 + e_{1j}t_1, m_2 + e_{2j}t_2) \quad (4)$$

$$Probability\ (No,\ Yes) = Prob.(WTP_{1j}\ t_1,\ WTP_{2j}\ t_2) = Prob.(m_1 + e_{1j}t_1, m_2 + e_{2j}t_2) \quad (5)$$

$$Probability\ (No,\ No) = Prob.(WTP_{1j} < t_1,\ WTP_{2j} < t_2) = Prob.(\mu_1 + \varepsilon_{1j} < t_1, \mu_2 + \varepsilon_{2j} <_2) \quad (6)$$

The *'j*th*'* contribution to the probability or likeliness function is stated as:

$$L_j(m/t) = Prob.(m_1 + e_{1j}t_1, m_2 + e_{2j}t_2)^{YY}\ Prob.(m_1 + e_{1j}t_1, m_2 + e_{2j}t_2)^{YN}\ Prob.(m_1 + e_{1j}t_1, m_2 + e_{2j}t_2)^{NY}\ Prob.(m_1 + e_{1j}t_1, m_2 + e_{2j}t_2)^{NN} \quad (7)$$

Table1: Random bid plan employed for the contingent valuation survey

The first bid value (in Birr/month)	Follow-up bid (decreased) (if, 'No' answer for the first bid value)	Follow-up bid (increased) (if, 'Yes' answer for the first bid value)
75	38	150
150	75	300
225	113	450
300	150	600

Source: Own computation from FGDs

where, *'t_1'* and *'t_2'* are both initial and the following bid values; *YY* equals: 1 for a 'Yes-Yes' reply; 0 if not; *'YN'* equals: 1 for a *'Yes-No'* reply, 0 or else, *'NY'* equals 1 for a 'No-Yes' reply, 0 if not; and *'NN'* equals: 1 for a 'No-No' reply, 0 or else. This expression is alluded to as the bivariate discrete choice model. Suppose normally distributed error terms with mean zero and particular variances *'σ_1^2'* and *'σ_2^2'*, then *'WTP_{1j}'* and *'WTP_{2j}'* have a Bivariate normal distribution with means *'μ_1'* and *'μ_2'*and; variances *'σ_1^2'* and *'σ_2^2'and* the coefficient of correlation *'σ'* and the *'j^{th}'* contribution to the bivariate probit likeliness function becomes:

$$L_j(\mu/t)=\varphi_{\varepsilon_1\varepsilon_2}\left(\left(d_{1j}\right)^{YY}\left(\left(t_1-\mu_1\right)/\sigma_1\right),d_{2j}\left(t_2-\mu_2\right)/\sigma_2\right),d_{1j}d_{2j}\rho \quad (8)$$

where:

$\varphi\varepsilon_1\varepsilon_2$ = Systematized bivariate normal distribution function with the zero mean

d_{1j} = $2y_{1j}$ -1 and d_{2j} = $2y_{2j}$ -1

y_{1j} = 1 If the reply for the initial question is *'Yes'*, 0, or else

y_{2j} = 1 If the response to the second question is *'Yes'*, 0 if not

ρ = Correlation coefficient

σ = Standard deviation of the errors

Bivariate Probit Model

The Bivariate Probit model inaugurated by Cameroon and Quiggin has become an extensive invariable modeling perspective for double bounded contingent valuation survey. It is contended that the replies to both dichotomous choice questions may possibly not be independent; but, to some extent dependent; that is the reply for dichotomous choice 2, is perhaps associated with the reply for dichotomous choice 1. Consecutive arrangement of willingness to pay questions for double bounded dichotomous choice indicates that replies to these questions may not be independent; if unobserved factors exert influences on both replies. To cope with these matters SUBVP model was employed in this study to estimate preferences and discern the correlation in overlooked factors affecting the replies upon the first and the second willingness to pay equations. Generally, the SUBVP model is designated as:

$$Y_{j1}{}^{*}=\beta_1{}^{'}X^{'}{}_{j1}+\varepsilon_{j1} \quad (9)$$

$$Y_{j2}{}^{*}=\beta_2{}^{'}X^{'}{}_{j2}+\varepsilon_{j2} \quad (10)$$

In the data *'Y_{j1}'* and *'Y_{j2}'* are only perceivable through both discrete choice replies in such a matter that:

$$Y_{j1}=\begin{cases}1\ if\ Y_{j1}{}^{*}>Bid\ 1\\ 0\ if\ Y_{j1}{}^{*}\le Bid\ 1\end{cases}\quad and\quad Y_{j2}=\begin{cases}1\ if\ Y_{j2}{}^{*}>Bid\ 2\\ 0\ if\ Y_{j2}{}^{*}\le Bid\ 2\end{cases} \quad (11)$$

$$\begin{aligned}&E[\varepsilon_1]=E[\varepsilon_2]=0\\&Var[\varepsilon_1]=Var[\varepsilon_2]=1\\&Cov[\varepsilon_1,\varepsilon_2]=\rho\end{aligned} \quad (12)$$

As the second WTP question is determined by the first WTP question reply, the error terms are correlated; for this reason, both equations can be calculated together utilizing the model, which assumes Bivariate Normal distribution (BVN) for both valuations:

$$BVN\left(\beta_1 X_1{}^{'};\beta_2 X_2{}^{'};\sigma_1^2;\sigma_2^2;\rho\right)or\ BVN\left(0,0;1,1;\rho\right) \quad (13)$$

The two questions have four possible pairs of responses: (Y_{j1}, Y_{j2}) = (1, 1), (1, 0), (0, 1), and (0, 0). Associating the combining probabilities of all feasible replies in the likelihood function, Eq. (13) can be calculated by utilizing the SUBVP model. After operating regression of the dependent variable on a constant and on the independent variables the mean willingness to pay (μ) is resolute from the SUBVP model. Depending on the normality assumption, the mean WTP or μ was calculated through the formula specified by Haab and McConnell:

$$\mu=-\alpha/\beta \quad (14)$$

where, *'μ'* is the mean WTP for reforestation of the deforested softwood trees; *'α'* is a constant coefficient or intercept term; *'ß'* is a slope coefficient for bid value for the enterprise heads were requested to pay; it is a point estimate of 1/σ. An estimate for σ or the standard deviation or the dispersion parameter of willingness to pay is given by:

$$\sigma=-1/\beta$$

Results and Discussion

Descriptive Analysis

Descriptive Statistics for Dummy Variables

Table 2 depicts the χ^2-test results of dummy variables to attest there is a significant difference between willing and unwilling enterprises heads. Out of eight variables sex and credit access for enterprise, heads were not statistically significant. Whereas, the rest six factors were implying that enterprises were not similar in terms of their labor availability, source connection, perception of

reforestation, the liability of financial obligations to pay, their profitability, and use of substitution of other inputs in place of Pines.

Labor Availability

The outcome implied that there were significant differences between willing and unwilling enterprise heads in terms of labor availability at a 1% probability level. Thus, those enterprise heads who have available labor were more willing than enterprises with unavailable labor for reforestation.

Source Connection

Out of 54 respondents who consented to the connection 51 of them were willing while the remaining 3 were unwilling enterprise heads. The result shows that there was a significant difference between willing and unwilling enterprise heads in terms of source connection at a 5% probability level. Thus, those who approve of future source connection to the deforested area after rehabilitation were more willing to pay for reforestation.

Perception

Of the total 57 respondents; 53 of them were willing while the rest 4 of them were unwilling respondents. The variable was statistically significant at a 10% probability level; this showed that there is a significant difference between willing and unwilling enterprise heads with regard to their perceptions of reforestation. So, those who have perceptions of reforestation were more willing to pay for reforestation.

Liability

Of the total 119 willing enterprises heads, 46 of them were indebted under the liability of financial obligations to pay while the rest 73 of them were not liable. There were 13 indebted unwilling respondents. The test result proved that there is a significant difference between willing and unwilling enterprise heads with regard to their liability at a 1% probability level. Thus, those respondents who did not liable for financial obligations were willing to pay more for the reforestation.

Profit

There is a significant difference between willing and unwilling enterprise heads with regard to their profitability at a 5% probability level. Thus, those who are profitable enterprises were acquiescent or agreeable to expend more on reforestation than unprofitable enterprises.

Substitution

Participants' responses showed that inputs such as MDF (Medium Density Fiberboard), Eucalyptus, Cordia abyssinica (Wanza), etc., were used as substitutes in place of Pines. The test result proved that there is a significant difference between willing and unwilling enterprise heads with regard to using substitutes at a 5% probability level. Thus, those who were not using substitute inputs were willing to pay more for the reforestation.

Descriptive Statistics for Continuous Variables

Table 3 depicts the *t*-test results of continuous variables to verify whether the means for willing and unwilling enterprise heads are equal or not.

Capital

The SPSS output in Table 3 shows that the average capital of willing enterprise heads is Birr 485,833.01, versus Birr 91,647.06 for unwilling enterprise heads. There is a difference in means of capital amount between enterprise heads to be significant at a 1% probability level. Thus, enterprise owners who have more capital were willing to pay more for reforestation.

Table 2: Descriptive statistics for sampled enterprise heads (dummy variables)

		Willing Ent. Heads = 119		Unwilling Ent. Heads = 17		
Dummy variables	Categories	No	%	No	%	χ^2 value
Sex	Male	106	89.10	16	94.12	0.410
Credit access	Accessed	73	61.34	10	58.82	0.040
Labor availability	Available	102	34.45	7	29.41	18.54***
Source connection	Connected	51	42.86	3	17.65	3.947**
Perception of reforestation	Agree	53	44.53	4	23.53	2.697*
Liability to pay debt	Liable	46	38.66	13	76.47	8.66***
Profitability of enterprises	Profitable	107	89.92	12	70.59	5.08**
Substitutes to pines lumber	Use substitution	24	20.17	7	41.18	3.73**

Source: The survey result
Legend: ***, **, and *means significant at the 1, 5, and 10% prob. levels, correspondingly

Table 3: Descriptive statistics (continuous variables) for sampled enterprise heads

Continuous variables	Total sample ent. heads =136)		Willing ent. heads = 119		Unwilling ent. heads = 17		Difference in means	t-value
	μ	σ	μ	σ	μ	σ		
Education	10.1600	4.259500	10.850000	3.81000	9.470000	4.70900	1.3780000	1.3830
Family size	3.82000	1.377500	3.9300000	1.30700	3.710000	1.44800	0.2270000	0.6610
Experience	10.3450	5.862500	11.220000	7.23700	9.470000	4.48800	1.7480000	0.9680
Capital	288740	343401.3	485833.01	626710	91647.06	60092.6	394185.95	2.583***
Distance	3.28500	2.035000	3.3900000	2.06000	3.180000	2.01000	0.2180000	0.4100

Source: The survey result
Legend: ***and *means significant at the 1 and 10% probability levels; appropriately

Table 4: Enterprise head's choices of the first and the follow-up bid values

Bid amounts	Responses at first and follow-up bids				Total
	No-No	No-Yes	Yes-No	Yes-Yes	
75/(150/38)	7.00	4.00	4.00	5.00	20
150/(300/75)	0.00	3.00	9.00	6.00	18
225/(450/113)	0.00	3.00	6.00	15.00	24
300/(600/150)	0.00	0.00	12.00	62.00	74
Total	7.00	10.00	31.00	88.00	136
Percent (%)	5.15	7.35	22.79	64.71	100

Source: The survey result

Table 5: Estimated coefficients for the SUBVP model

Variables	WTP1 n = 136			WTP2 n = 136			Marginal effects
	Coeffic.	Robust standard error	*Z*	Coeffic.	Robust standard error	*Z*	*dy/dx*
Bid1	0.0155	0.004	3.86***				0.0000
Bid2				-0.0031	0.001	-2.53**	-0.001**
Sex*	1.2659	0.842	1.50	-0.1366	0.838	-0.16	-0.0223
Educate	0.0003	0.063	0.01	0.0552	0.052	1.07	0.0084
Family	-0.2424	0.210	-1.15	0.6069	0.174	3.48***	0.0919***
Exper	-0.0443	0.051	-0.86	0.0604	0.045	1.36	0.0092
Capital	0.0635	0.036	1.77*	0.0141	0.007	2.05**	0.0021**
Credit*	0.5071	0.658	0.77	0.3293	0.444	0.74	0.0527
Percept*	-0.3731	0.569	-0.69	1.3943	0.494	2.82***	0.1959***
Source*	-0.2261	0.537	-0.40	1.1187	0.429	2.61***	0.1523***
Profit*	-1.0624	0.648	-1.64	2.1158	0.632	3.35***	0.6283***
Substit*	0.8178	0.451	1.81*	-1.0042	0.537	-1.87*	-0.1071**
Labor*	-0.5454	0.557	-0.98	1.0993	0.539	2.04**	0.2511
Liability*	0.9123	0.576	1.58	-0.9318	0.466	-2.00**	-0.1342**
Dist	1.5104	0.541	2.79***	-3.4154	0.460	-7.43***	-0.8885***
_cons	-1.2596	1 .446	-0.87	-3.3948	1.251	-2.71***	
/athrho	0.6251	0.306	2.04**				
rho	0.5547	0.212	2.61***				
Wald test of $\rho = 0$:		χ^2 (1) = 4.16258		Prob. > χ^2 = 0.0413			

Source: The survey result
Legend: ***, **and *represent statistically significant at 1, 5, and 10% significant levels, respectively (*p<0.1; **p<0.05; ***p<0.01)
(*) *dy/dx* is for non-continuous variation of dummy variable from zero to one

Willingness to Pay

For the arbitrarily allocate first bid, among all enterprise heads 119 of them replied 'Yes' or they were agreeable to accept the first bid and the rest 17 respondents were not acceding to pay the first bid (Table 4). The follow-up bid was twice for these enterprise heads they were agreeing to pay the given first bid and a half for those that were not agreed to pay the first bid. The randomly assigned follow-up bid and 98 enterprise heads were willing to accept the follow-up bid and 38 enterprise heads were not agreeing to consent to receive the follow-up bid. Out of the total 136 respondents 7 of them both answers were 'No' (No-No) for DBDC CV questions; 10 of them answers no followed by 'Yes'; 31 of them answered 'Yes' followed by 'No'; finally, the rest 88 of them answers both choices 'Yes' (Yes-Yes) (Table 4).

Results for the SUBP Model

As is presented in Table 5, the rho (ρ), is different from 0 at a 1% level of significance; and the Wald test result shows the correlation is statistically different from 0 at a 5% significance level. All-inclusive significances

tests averse to the null hypothesis of all explanatory variables which include the constant term 0 are tested by the Wald chi-square (Wald χ^2 tests). To deal with these issues, a SUBVP model was used, and correlation coefficients and estimated prediction of the discerned factors affecting replies across both willingness questions. The model is jointly significant at a 95% confidence level [Wald chi-square (30) = 158.24; probability > χ^2 = 0.0000] or no less than one variable included in the model is different from 0. The ρ or the coefficient of the correlation between random errors in both regression equations is moderately high (0.5547) and the two disturbances are significantly and positively correlated at 1% this indicates that the estimation of the SUBVP model resulted in estimation efficiency. The LR tests for ρ = 0 [(χ^2(1) = 4.16258 and Prob. > χ^2 = 0.0413)] indicate that both disruptions are significantly correlated at a 5% level of significance (Table 5).

The minimal or insignificant effect shows that the point to the continuous likelihood of an occurrence due to a unit variation of dummy variable from zero to one for separate variables. The initial bid value was insignificant (Table 5). The coefficient for the second bid value was negative and significant at a 5% level of significance. Holding other things constant, increasing in 1 Birr on the follow-up bid value the likelihood of acceptance of accepting the proposed WTP on average decreases by 0.10% points. This shows that the greater the bid value for the reforestation, the lesser the enterprise heads would be agreeing to expend their money, which is clear and supports the demand that the participants are cogent based on economic theory.

The variable family has the anticipated sign positively and is significant at a 1% significance level. This suggests the likelihood of accepting a higher bid increases along with the family size increases. Categorically, ceteris paribus a one-person increase in the family size will increase the likelihood of consent to receive the proposed willingness to pay value by 9.19%. The capital of the enterprise is found to affect the enterprise heads' decision to accept a specified bid, positively and significantly at a 5% significance level. The intimation is that more capital leads to increases in the WTP decision accordingly. The marginal effect of capital amounts shows that, per each ten thousand Birr increase in an enterprise heads' capital, holding other things constant, the likelihood of agreeing to receive the proposed WTP value increased by 0.21%. As expected the study found that perception of reforestation affects the reforestation decision positively and significantly at a 1% significance level. The marginal effect indicates that enterprise heads that have a perception of reforestation were 19.59%; this infers that enterprise heads are more agreeing to pay than the non-perceived ones ceteris paribus. The implication is that enterprises heads with knowledge and experience of using softwood pines resources to constitute their perception were more interested to pay for the reforestation.

As expected, the source connection is found to affect the enterprise heads' decision positively and significantly at a 1% significance level. The positive effect of this variable resulted because; enterprises heads are more interested to pay for the reforestation to get more supply through private ownership. The marginal effect indicates that the enterprise heads who have the consent of future source connection are 15.23% more willing to pay than the non-consented enterprise heads. The implication is that enterprise heads with the consent of future using Pines logs resources after the rehabilitation of softwood forests as a source supply makes them more agreeing to pay for the reforestation than non-consented enterprise heads, ceteris paribus. Profit of the enterprise is found to affect the enterprise heads' decision to accept a specified bid, positively and significantly at a 1% significance level. This positive effect indicated that profitable enterprises willingly said 'yes' for the first and follow-up bids value than unprofitable enterprises. The consequence is, in accordance with the fundamental economic theory, which asserts that individuals' demand for almost all products/goods or services is positively associated with gains or revenue level. Holding other impacts persistent, a 1 Birr increase in profit of the enterprise leads to increases in the likelihood of consent to receive the proposed bid value by about 62.83%. With respect to using substitution is negative as anticipated and relevant at a 5% significance level. For a 1% increase in using of substitutes, the likelihood of agreeing to receive the proposed bid level declined by 10.71%. The rationale behind this result is that as enterprise heads using substitutes, they might have lower demand and expectations of future consumption of pines resources. Thus, they are not willing to pay more than the nonusers of substitute inputs. Liability describes the indebtedness of the enterprise head under the liability of financial obligations to pay claims. The coefficient of this variable is negative as anticipated and significant at a 5% significance level. The minimal effect shows a 1% increase in liability, and the likelihood of accepting the proposed bid level will decrease by 13.42% points, ceteris paribus. This indicates that the more the enterprise heads are liable to financial obligations, the less to be expected they are agreeing to pay. Finally, the last variable distance from the enterprise to the deforested area has a negative impact as expected on their WTP and it is statistically relevant at a 1% significance level. The minimal effect of distance shows that with an hour increase in distance to the deforested area, the likelihood of accepting the proposed bid level will be reduced by 88.85%, holding other things constant. It indicates that the farther the enterprise is from the deforested area, the less likely the enterprise heads would be to agree to accept the payment.

Table 6: Parameters estimates of SUBVP to compute mean willingness to pay

Variables	Coefficients	Robust standard error
WTP first bid		
Bid1	0.0101	6.3200
_cons	-0.9890	-2.7700
WTP second bid		
Bid2	0.0022	0.0006
_cons	-0.3480	0.2570
ρ***	0.5310	0.1770
Mean WTP $\mu = -\alpha/\beta$ (-0.989/0.0101)*-1 = 97.921		

Log-likelihood = -104.07288
Wald test of $\rho = 0$: χ^2 (1) = 5.73593 probability > χ^2 = 0.0166
Source: The survey result

Table 7: Average and aggregate WTP measures by the study areas

The study areas	Total enterprises in the study area	Mean WTP for the reforestation (Birr/month)	Total WTP for the reforestation (Birr/month)	(Birr/year)
Dire dawa	601	97.92	58849.92	706199.04
Harari	356	97.92	34859.52	418314.24
Deder district	119	97.92	11652.48	139829.76
Total	1076	97.92	105361.92	1264343.04

Source: The survey result

Estimation of Average WTP

Table 6, the limiting factors estimations from the initial equation are normally utilized in computing mean WTP (μ) since the follow-up question criterion distinctly possible to contain, more noises with regard to cast anchor bias as the respondents are presumed to grasp clues from the initial bid. Thus, the mean willingness to pay (μ) is estimated from the first equation. The coefficients 'α' and 'β' were made estimated by using the SUBVP model taking the initial bid and follow-up bids as explanatory variables. As presented in the table, the correlation coefficient parameter that estimates the coefficients of correlations betwixt random errors in both regression equations (ρ) is moderately high (0.531) and the two disturbances are significantly correlated at a 1% significance level; which designates the estimation of the SUBVP model resulted in estimation efficiency. The computed mean WTP amount from the SUBVP model opted for the reforestation by sample enterprise heads. The μ estimated from the first bid and the second bid amount extended from Birr 97.92 to Birr 174 per month per person or Birr 1175.05 to Birr 2088 per m^3 per year per person if the scenario of reforesting the deforested softwood trees resources on the deforested area is implemented.

The Aggregate WTP

In order to have a valid aggregation from the SUBVP on dichotomous choice contingent valuation questions with a follow up; the mean from the first equation was used. Thus the estimated sample mean WTP calculated Birr 97.92 per month per person or Birr 1175.05 per year per m^3 per person was applied to estimate the aggregate WTP of the enterprises (Table 7). The aggregate WTP for reforestation estimates is obtained based on this estimated mean amount and the grand total of beneficiaries in the three study areas. The total number of the beneficiary in the three study areas were 1076. Thus, the aggregate WTP of the enterprise heads from the reforestation was found to be Birr 1,264,343.04 per m^3 per year. After 10 years this money amounts to Birr 12,643,430.4 (Table 7).

Conclusion

This study was carried on in Eastern Ethiopia with the overall objective of estimating the WTP of woodwork enterprises to reforest the deforested softwood trees in the Eastern Hararghe Deder district Karra Makkala area forest and to explore socio-economic and institutional determinants of WTP. The mean and the aggregate WTP were also estimated per m^3 per year. In view of the results, the following conclusion and recommendation can be drawn.

Results from the contingent valuation method survey confirm that 87.5% of sampled respondents were willingly given to pay for the reforestation, while 12.5% of the participants were not willing to pay. The SUBVP model revealed that of the entire explanatory variables utilized in the model regression, nine explanatory variables (second bid value, family size, capital, perception, source connection, profit, substitution, liability, and distance to the deforested area) turned out to be significant and all have the expected sign. The model also divulged that the mean willingness to pay for the enterprise heads was Birr 97.92 per month per person or Birr 1,175.05 per m^3 per year per person. The overall

willingness to pay is estimated to be Birr 105,361.92 per month or Birr 1,264,343.04 per m^3 per year. After 10 years this money amounts to Birr 12,643,430.4 and that could be reforested 88 ha.

The mean willingness to pay enterprise heads conceivably is an indicator of the momentousness of reforestation in the deforested areas in the region. Based on these findings, it can be concluded that the sampled enterprise heads in the three study areas acknowledged the existence of deforestation and they are willing to pay for the reforestation. Finally, the regional governments of the study areas in collaboration with the federal government should use this opportunity to mobilize enterprises and the society as a whole to combat the deforestation problem. For that reason, the restoration actions decisions are mandatory to allow the resources to regenerate again and be saved from totally disappeared and loss. Governmental bodies of forest management and administration for the particular rules and regulations carrying out bureaus and agencies of the regions ought to do more to lessen deforestation and the illegitimate maneuver of forests, woodlands, and other sources for tree products. Tree plantlet, sprout, seedling and sapling production, nursery handling and management, and plantation setting up; and the management must be notably upgraded, going through the acquisition of improved technologies and implementation should be practiced in these regions of the country.

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Author's Contributions

Daniel Habtamu Hailemichael: Contributions to conception and designed; acquisition, analysis and interpretation of data; drafted and written the manuscript and reviewed it critically for significant intellectual content; and final approval of the version to be submitted and any revised version.

Lemma Zemedu and Jemma Haji: Contributions to conception and designed, reviewed it critically for significant intellectual content; and final approval of the version to be submitted and any revised version.

Ethical Consideration

In comply with ethical issues: All respondents provided verbal consent to be to participate in this study. Researchers were seeking informed consent from respondents before the data collection. The respondents therefore willingly participated in the study. Thus, there is no data collected without the consent of the respondents and the average values reported does not refer to any group of community or individual respondent. It is only information generated to help their product gets more attention and interventions.

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