

The Economic Valuation Of Gedo Natural Forest Conservation Benefits, Ethiopia

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Research

Keywords: Gedo Natural Forest, Economic Valuation, Seemingly Unrelated Bivariate Probit Regression, Tobit Model, Willingness to Pay

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1 **The economic valuation of Gedo Natural Forest conservation benefits,**

2 **Ethiopia**

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22 **Abstract**

23 Forest ecosystem economic valuation is responsible for ecologically aware and reasonable gains
24 to the country and particularly to the surrounding groups through different means. Thus, the
25 central objective of this study was to analyze the economic valuation Gedo Natural Forest
26 conservation benefits of using the contingent valuation method. Both primary and secondary data
27 were employed in this study. The interview responses of 342 households nominated from three
28 kebeles around Gedo natural forest were collected in purpose and random sampling procedures
29 through a semi-structure questionnaire. The mean willingness to pay calculated by means of
30 Krinsky Robb technique after running of Seemingly Unrelated Bivariate Probit Regression from
31 the dichotomous choice format and open-ended questions was 24.97 and 23.91 birr per year,
32 respectively. The outcomes of Tobit model shown that the total livestock unit, total annual
33 income of the household, and the amount of credit utilization are meaningful variables positively
34 and significantly related to the likelihood of willingness to pay for the conservation benefits of
35 Gedo natural forest. On the other hand, the households' family size, the households' age, and
36 initial bid value were other important variables negatively and significantly influence
37 households' willingness to pay for the conservation benefits of Gedo natural forest. The liable
38 body could, therefore, apply the scenario of willingness to pay in the study area, so that the Gedo
39 natural forest could be conserved, measurable benefit to the households could be practical, and
40 future awareness of respective household could be raised.

41 **Keywords** Gedo Natural Forest, Economic Valuation, Seemingly Unrelated Bivariate Probit
42 Regression, Tobit Model, Willingness to Pay

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45 **Introduction**

46 Forest environments that comprise approximately 31% of the world's total land-living region
47 (FAO 2013) are known for its meaningful implications like recreation, water management,
48 nutriment processing, soil conservation, air contamination assimilation and water cleansing
49 which need the public, policy-makers and other stakeholders' considerations as a result of that
50 their values cannot be traded in the collective market. Given these results, administrations and
51 communities challenged by the growth-preservation problem can generate further thoughtful
52 results and strategies that could support their efforts to preserve forests and the environment
53 amenities they offer, and in that way, proclaim social welfare and justifiable improvement
54 (Komeil et al. 2017). Overemployment, mismanagement, and the contamination of water
55 resources are also results of the direct impact of mishandle of forest resources. Hence, it is
56 important to protect forests zones with a financial reward in surplus of other practices in order to
57 make their conservation economically feasible (Ayenew and Tesfay 2015).

58 Ethiopia is remarkable for its different natural resources in general and forest source in
59 particular. Nonetheless, because of the unwise exploitation of the forest gifts of the country
60 which has been established over time, the remaining forest coverage is extremely insignificant
61 for many reasons: cultivation advance, the demand for increasing amounts of construction
62 material, fires, fuel wood, and charcoal. As a result, a collective action of resource management
63 and eco-development standards for continuing and justifiable forest management ought to be
64 encouraging (Amogne 2014). The latest renewal of wooded areas in the country is so far a surge
65 in forest resources when estimated in economic terms. These forest resources provide several
66 amenities in Ethiopia, and there is an increasing attention to accounting for the varied economic

67 welfare resulting from these forests on a general scale to complement normal economic
68 designators like growth in domestic product (Narita et al. 2018).

69 Gedo Natural Forestry is a type of rare evergreen forest in the country with 10,000 hectares
70 of land (MEFCC 2017), where one can see a high figure of plant type diversity and remarkable
71 vegetation stands. This forest is greatly appreciated for its high economic and other
72 environmental services. Despite all these services, forest vegetation removal will seemingly
73 continue for some time to come for the simple reason that forest trees are still the major source of
74 inputs and timber materials for the rural and urban population. Moreover, misused parts by local
75 societies and traditional awareness of the uses of forest plants are other effects of the part.
76 Therefore, the future management approach of Gedo Natural Forest should also focus on
77 multiple-use conservation strategies (Kebede et al. 2014).

78 The value given to forest amenities by particular societies in the area is usually unidentified
79 in unindustrialized nations (Okumu and Muchapondwa 2017). Appropriate valuing and
80 estimation is a predictable application if indigenous suppliers explicitly continue to offer their
81 goods and services in on-going return sources (Agrawal et al. 2012). Accordingly, the valuation
82 of environmental resources by setting economic prices for ecological destruction or development
83 permits economists to estimate the optimum, particularly where the market fails to distribute
84 resources optimally. It is also essential to assimilate ecological principles into economic
85 decision-making procedures since failure to do so can have confrontational consequences for not
86 only present generations but also forthcoming generations (Kolstad 2000). Therefore, the basic
87 concept of investigating the economic valuation of natural forests is a well-timed study, if the
88 conservational benefit is enhanced.

89 All the preceding works by other scholars have concentrated only on estimating the
90 likelihood of respondents' willingness to pay for forest environments, but have failed to examine
91 the actual amount of cash they could sacrifice that is associated with their characteristics, which
92 are the significant variables. Consequently, this study work is distinct in that it presented both the
93 likelihood of the households' willingness to pay and the real cash they would sacrifice for Gedo
94 Natural Forest, which is in a straight line with important variables. Therefore, this paper makes
95 an effort to examine the economic valuation of Gedo Natural Forest conservation benefits and
96 identify the elements that determine willingness to pay for Gedo Natural Forestry.

97

98 **Methodologies**

99 **Description of the study area**

100 This work has been undertaken in the Cheliya District, West Shoa Zone of Ethiopia, around the
101 Gedo Evergreen Natural Forest. This forest is a part of the National Forest Priority Areas in the
102 country (MEFCC 2017), located roughly in the interval of 90 01' -90 02' N latitudes and 370 25' -
103 370 16' E longitudes, and about 188 km west of Addis Ababa (Kebede et al. 2014).

104

105 **Type of data, sources and approaches of data collection**

106 Primary and secondary data together were employed for this work. The primary data was taken
107 from households' representatives using a semi-structured survey by means of direct interview in
108 the study area. The FGD (focus group discussion) was added as well to improve the quality of
109 the survey. Secondary data was also taken from the Zonal Forest and Air Resource Authority
110 Bureau and other pertinent sources.

111 A pre-test approach was completed in order to fix groups of bids and order new fitting
112 questions for 30 representative households living in the three kebeles around Gedo Natural
113 Forest. As we have used the double-bound dichotomous choice format, the most repeatedly
114 stated values were taken as an initial bid. Then, the five different initial bid amounts (10, 15, 20,
115 25, and 30 birr) were provided to household heads to state their willingness to pay. Pairs of
116 prices were decided for the double-bound dichotomous format by taking the first price twice if
117 the initial answer was "Yes" and a partial of it if the answer was "No" (Cameron and Quiggin,
118 1994). For that reason, the groups of offered prices for our purpose are, (10, 5, 20), (15, 7.5, 30),
119 (20, 10, 40), (25, 12.5, 50), and (30, 15, 60).

120

121 **Methods of sampling and sample size**

122 This study has taken the two-stage sampling method into account. Primarily, three kebeles,
123 Sokondo, Refiso-Alenga, and Jarso-Dire, around the forest area were positively preferred for
124 their closeness and potential to preserve the natural forest, Gedo Forest. Next, sample households
125 from each kebele were selected randomly.

126 A simple formula delivered by Yamane (1967) was employed for our purpose to validate the
127 desired sample size at 0.5 degree of variability, 5% precision level and 95% level of confidence.

$$128 \quad n = \frac{N}{1+N(e)^2}$$

129 N is the total number of households that could conserve the forest, n is the sample size, and e
130 is the accuracy level. There are 2,350 family units in the vicinity to conserve (WSZFARAO,
131 2020). Hence, the required sample size is equal to 342 people.

132

133 **Methods of data analysis**

134 The percentage and frequency were the descriptive statistics calculated to identify the segment of
135 willing and non-willing households in the area.

136 The respondents' mean willingness to pay after the double bounded draw out technique was
137 computed by Seemingly Unrelated Bivariate Probit Regression (SUBPR) model.

138 Subsequent to the procedure of Haab and McConnell (2002), the econometric modeling for
139 the designing of double bounded data is specified as:

140
$$WTP_{ij} = \mu_i + U_{ij}$$

141 Here:

142 WTP_{ij} = Is the j^{th} household's WTP and $x=1, 2$ denotes initial and next answers;

143 μ_1, μ_2 = Is the mean price for initial and next answer, and

144 U_{ij} = Implicit random factor.

145 $\mu_{ij} = X_{ij}\beta$ = the mean to be influenced by the households' characteristics.

146 The mean willingness to pay and 95% confidence intervals are computed by parametric
147 bootstrapping method settled by Krinsky and Robb (1986) after running regression of the full
148 model. Consequently, the mean willingness to pay value of Gedo natural forest ecosystem could
149 be computed as follows:

150
$$\text{Mean } WTP = \frac{\bar{x}\beta'}{\beta_o}$$

151 Here,

152 \bar{X} = Vector of row for the sample means which consist of 1 for the constant term,

153 $\beta'_{(k-1 \times 1)}$ = Vector of column for predicted coefficients,

154 β_o = Coefficient on the bid variable,

155 β' = Coefficient on the constant term.

156 The Tobit model was also employed in this study to analyze the determinants of willingness
 157 to pay and the maximum cash value that respondents would pay for Gedo natural forest
 158 ecosystem conservation and management.

159 The Tobit model could be derived subsequent to Johnston and Dindaro (1997),

160 $MWTP_i^* = X_i\beta + \varepsilon_i \quad i = 1,2,3 \dots N \dots\dots\dots$

161 $MWTP_i = MWTP_i^*, \text{ if } MWTP_i^* > 0$

162 $MWTP_i = 0, \text{ if } MWTP_i^* \leq 0$

163 Where, $MWTP_i$ = the greatest value i^{th} household would pay

164 $MWTP_i^*$ = Variable that is an implicit when it is fewer than or equal to 0

165 X_i = Determinants of willingness to pay vector

166 β = Unidentified factors vector

167 ε_i = Disturbance terms with mean zero and common variance σ^2 and that are distributed
 168 normally and independently.

169 Moving on same way of Maddala (1997), the variation in the likelihood of willingness to pay
 170 when explanatory variable varies is:

171 $\frac{\partial F(t)}{\partial X_i} = f(t) \frac{\beta'}{\sigma}$

172 The variation in the extent of willingness to pay between individuals who are willing to pay
 173 in terms of variation in independent variable is:

174 $\partial E \left(\frac{MWTP_i}{MWTP_i^* \neq 0} \right) = \beta' \left[1 - t \frac{f(t)}{F(t)} - \left(\frac{f(t)}{F(t)} \right)^2 \right]$

175 β' is the tobit maximum likelihood estimate vector, $F(t)$ is the cumulative normal distribution
 176 of T, $f(t)$ is the the normal curve derivative value at a certain point, t is the T score for the area
 177 under normal curve, and σ is the standard deviation of the disturbance term.

178 **Description of variables and working hypothesis**

179 The endogenous variables in this study were:

180 **WTP:** It is respondents' willingness to pay for the conservational benefits of Gedo Natural
 181 Forest ecosystems. It is an artificial variable that assumes 1 if the respondent is willing to accept
 182 the offered bids and 0 otherwise.

183 **MWTP:** The amount of cash that households were requested to answer their top amount of cash
 184 for the conservational benefits of Gedo Natural Forest ecosystems. It is a numeric variable
 185 measured in cash (birr).

186 **Table 1** Descriptions and expected signs of the explanatory variables

Variables	Description of variables	Type of variable	of Measurement	Sign
DSRCE	Distance from the forest ecosystem	Continuous	Hour	-
EDUC	Level of Education the household head attend	Continuous	Class year	+
FARMSIZ	Total farm size	Continuous	Timad (0.25ha)	+
FAMSIZ	Family size	Continuous	Adult equivalent	-
TLU	Total livestock in Tropical Livestock Unit	Continuous	Count	+
INCOM	Total annual income of the household head	Continuous	birr	+
IBID	Initial offered bid	Continuous	birr	-
AGE	Age of the household head	Continuous	Year	+/-
ENVAW	Environmental awareness created	Dummy	1 if the household was participated in awareness created, 0 otherwise	+
SEX	Household head's sex	Dummy	It takes 1 if male, 0 otherwise	+
CREDITUT	Credit utilization	Continuous	birr	+
BENSAT	Forest benefit satisfaction	Dummy	1if satisfied with the forest benefit, 0 otherwise	+

187 Source: Self-computation, 2020.

188

189 **Results and discussion**

190 **Willingness to pay for Gedo Forest conservation benefits**

191 Five type of set bid values (10, 5, 20), (15, 7.50, 30), (20, 10, 40), (25, 12.5, 50), (30, 15, 60) for
192 the consistent valuation query were given during the pilot survey. Subsequent to the answers
193 obtained after households' heads was requested for their willingness to pay for conservational
194 benefits of Gedo Natural Forest, the data elucidated that 90.35% were willing to pay for
195 conservational benefits of Gedo Natural Forest and 9.65% were not willing to pay for the
196 conservational benefits of Gedo Natural Forest.

197 **Table 2** Willing and non-willing to pay response distribution for conservation of Gedo Natural
198 Forest

Responses to WTP	Frequency	Percent
Yes	309	90.35
No	33	6.65
Total	342	100

199 Source: Author's computation, 2021.

200 All the answers of zero willingness to pay were simply for a financial reason. The preceding
201 studies (Tolera et al. 2017; Etensa 2014) were measured such a response as non-protest reaction.
202 Accordingly, we could not consider as protest votes and we could not skip from the calculation
203 of mean willingness to pay.

204 As Table 3 indications, the joint frequencies of distinct responses, 23.39% answered "Yes-
205 No", 41.23% answered "Yes-Yes" for the initial and following bids equally, 12.57% responded
206 "No-No", and 22.81% reacted "No-Yes".

207

208 **Table 3** Sample households’ joint answer frequency

Mutual answer	Frequency	Percent
Yes-No	80	23.39
Yes-Yes	141	41.23
No-No	43	12.57
No-Yes	78	22.81
Total	342	100.00

209 Source: Author’s computation, 2021.

210

211 **Mean and total willingness to pay for benefits of Gedo Forest conservation**

212 The outcomes from Table 4 show the valued correlation coefficients of the two equations in the
 213 bivariate probit model. The projected result, 0.79, indicates that the dual variables are principally
 214 and confidently associated, which implies the likelihood of variables being dependent on each
 215 other. The null hypothesis, which predicts all parameters to be equal to zero, is precluded at a 1%
 216 level of significance by the Wald test ($Wald\ Chi^2(2) = 224.60$), which also ratifies the soundness
 217 of the value of the estimate and the goodness-of-fit. The regression outcome also discovered that
 218 the coefficients of both offered bids are negative and significant at a 1% level of significance.
 219 This shows that, as the initial and next bid increase, the respondents’ willingness to pay for the
 220 conservational benefits of natural forestry declines.

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225 **Table 4** Seemingly Unrelated Bivariate Probit model estimated results

Variables	Coefficients	Std. dev.	Z-Value
First bid answer			
First bid	0.0771492***	0.0095743	-8.06
Constant	1.926507***	0.2134967	9.02
Final bid answer			
Final bid	-0.0624618***	0.0048056	-13.00
Constant	1.881201***	0.1312948	14.33
Rho	0.79	0.0860537	

226 No. of sample = 342; Wald χ^2 (2) = 224.60; Log-likelihood = -355.24642;

227 Prob > χ^2 = 0.000; Likelihood-ratio test of rho = 0: χ^2 (1) = 25.2393; Prob > χ^2 = 0.0000

228 *** 1% significance level.

229 Source: Author's estimation, 2021.

230 The mean WTP was valued using the Krinsky-Robb technique based on first and final
 231 willingness to pay for offered price answers from the double-bounded choice format after
 232 running the results of the Seemingly Unrelated Bivariate Probit model. This method was
 233 developed by Krinsky and Robb (1986), and we favored it because it is found to be robust and
 234 copy confidence intervals with the Krinsky-Robb procedure.

235 **Table 5** The mean Willingness to Pay for Gedo Natural Forest conservational benefits

Procedures	WTP	Lower Bound	Upper Bound	Achieved Significance	Mean	Variation
Mean for Equation 1	24.97	22.92	27.52	0.0000	0.18	4.6
Mean for Equation 2	30.12	27.81	32.76	0.0000	0.16	4.95

236 H0: WTP≤0 vs. H1: WTP>0

237 Source: Author’s estimation, 2021.

238 The results of Table 5 indicated that the mean willingness to pay for the conservational
 239 benefits of Gedo Natural Forest for the first and second statements of equality is birr 24.97 and
 240 birr 30.12 per year, respectively. This output is very significant at a 1% level of significance.
 241 Supplementary, the estimated mean willingness to pay for open-ended requests is 23.91 birr per
 242 year. When the means are evaluated, the mean willingness to pay in a double-bounded choice
 243 format is greater than that of an open-ended choice format in which respondents are free riders.
 244 An analogous result was obtained by Getachew (2018). Similarly, Tolera et al. (2017) revealed
 245 the reality that the initial equation ought to be used in calculating mean willingness to pay for the
 246 reason that the following statement of equality parameters is likely to have other disturbances
 247 with respect to fastening partiality as the households are expected to receive the hint after the
 248 initial price while determining their willingness to pay. Consequently, 24.97 birr per household
 249 per year calculated after the initial statement of equality has been used in this study to evaluate
 250 the mean willingness to pay if the situation of conserving Gedo Natural Forest is recognized in
 251 the study zone. In line with this, the cumulative willingness to pay for year-round conservation

252 of Gedo Natural Forest from open-ended and double-bound requests is estimated at 5,076,630.98
253 and 5,301,692.82 birr, respectively. This was completed by considering the multiplication of
254 mean willingness to pay, the sum of households in the area, and the proportion of respondents
255 with "Yes" answers to the question of willingness to pay for the Gedo Natural Forest
256 conservation.

257

258 **Estimated demand for conservational benefits of Gedo Forest**

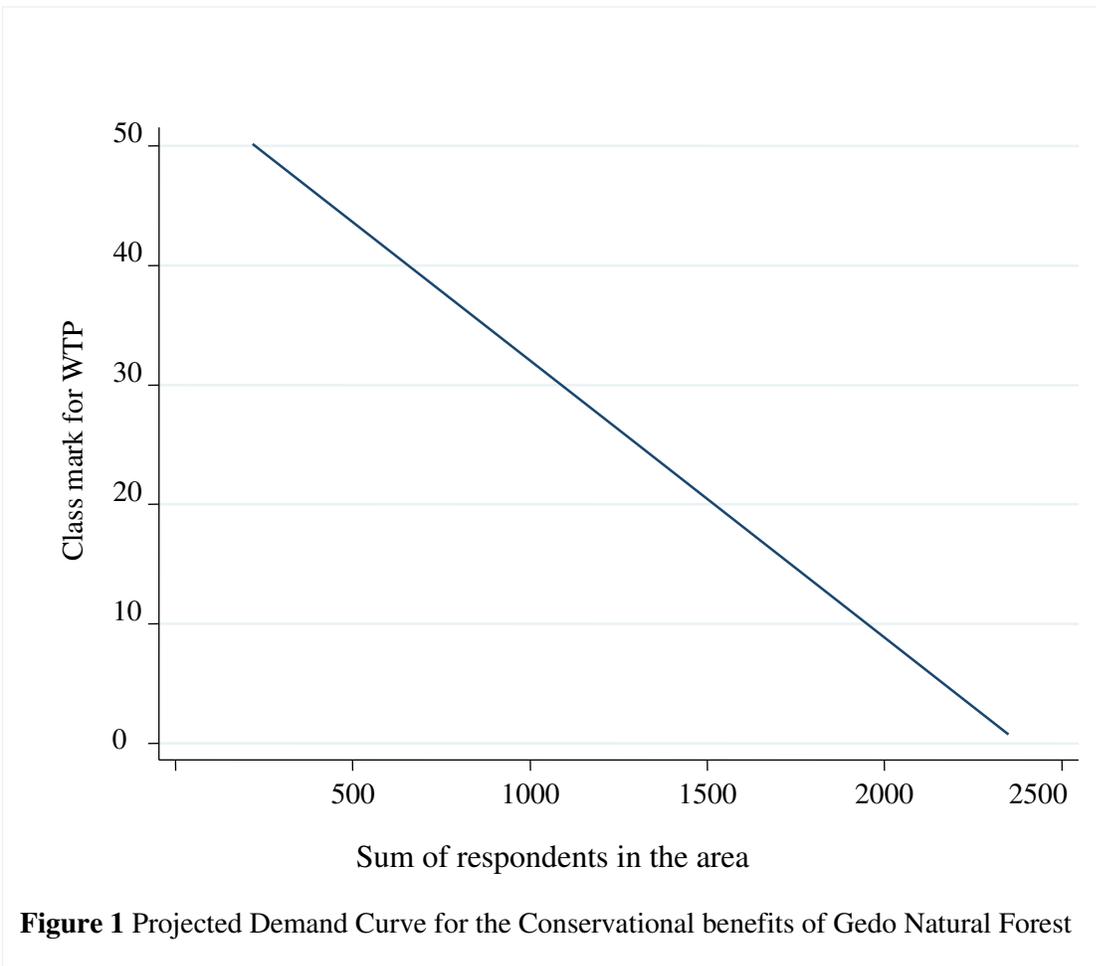
259 Figure1 indicates a demand curve that developed the relationship between the amount of
260 willingness to pay for each annum for Gedo Forest and the number of households. Accordingly,
261 the number of respondents who are willing to pay for the conservational benefits of Gedo
262 Natural Forestry decline as the value of offered bid gets advanced. This describes that, keeping
263 other factors constant, increasing the offered bid has a preventive consequence on the demand
264 for the conservational benefits. This is consistent with the study of Endalew and Assefa (2019).

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Source: Own design, 2021.

269

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271 **Determinants of willingness to pay for Gedo Forest conservational benefits**

272 The Tobit model was employed to identify the households' willingness to pay determinants for
 273 the conservational benefits of Gedo Natural Forest. The outcomes from the model show that the
 274 households' willingness to pay is influenced by six variables that were found to be statistically
 275 significant out of twelve independent variables involved in the model. The outcomes of the Tobit
 276 model and its marginal effects are presented in Tables 6 and 7, respectively.

277 **Family size:** This variable has a predicted negative sign and is statistically significant at the
 278 10% probability level. This means that an increase in the total family size by a single adult

279 equivalent decreases the likelihood of being willing to pay for the conservational benefits of
280 Gedo Natural Forest by 12.90%, keeping the consequence of unlike influences persistent.
281 Likewise, when the family size of the respondent increases by an adult equivalent, the sum of
282 money a respondent is willing to pay for the conservational benefits of Gedo Natural Forest may
283 decline by 0.31 birr, holding other influences persistent. This is due to the fact that a large family
284 requires a relatively large amount of money to feed the family and become resilient to the idea of
285 paying for forest conservation. Thus, households with large family sizes are hesitant to pay
286 before guaranteeing the source of adequate food.

287 **Total Livestock Unit (TLU):** Total Livestock Unit has positive association with the
288 likelihood of willingness to pay for conservational benefits of forestry and significant at 1%
289 probability level. The results indicate that for an extra rise of Total Livestock Unit, the likelihood
290 of respondents' willingness to pay for the conservational benefits of Gedo Forest will increase by
291 66.89%, keeping the other factors constant. Correspondingly, when the amount of livestock kept
292 by a household rises by one Total Livestock Unit, the extent that a respondent is willing to pay
293 for the conservational benefits of Gedo Natural Forest may increase by 1.61 birr, keeping the
294 effects of other variables constant. This is because of that the livestock has an enormous
295 economic vital and advance the capability of the households to pay.

296 **Total Annual Income:** As predicted, the total annual income is significant at 1% probability
297 level, and has a positive effect. The result specified that an increase in the household's annual
298 income by a thousand birr raises the likelihood of willingness to pay for conservational benefits
299 of Gedo Natural Forest by 1.2%, *ceteris paribus*. In analogous to this, when the total annual
300 income of a respondent rises by a thousand birr, the volume of money a respondent willing to
301 pay for the conservational benefits of Gedo Natural Forest increases by 2.87 birr, holding other

302 factors constant. The respondent has extra income takes better capability to pay for utilizing the
 303 conservational benefits that can be derived from the forest than their counterpart part of lower
 304 income. This result is consistent report of Endalew and Assefa (2019), Seifu and Alemu (2017),
 305 and Tolera et al. (2019).

306 **Table 6** Determinants of willingness to pay results from the Tobit model

Variables	Coefficients	Standard Error	t- values
Education (Class Year)	.0471356	.1404949	0.34
Family size (Adult Equivalent)	-.3139676*	.184538	-1.70
TLU	1.627725***	.353129	4.61
Farm size (timad, 0.25ha)	-.1828531	.16715	-1.09
Distance from the forest (Hour)	-1.064053	.8050482	-1.32
Annual income (birr)	2.904969***	.193832	14.99
Age (Year)	-.0952768**	.0433755	- 2.20
Sex (1=Male)	.3244216	1.313321	0.25
Satisfaction level (1= Yes)	-.2988719	1.342397	-0.22
Credit utilization (birr)	4.699895***	1.196844	3.93
Awareness Created (1=Yes)	2.105355	1.711143	1.23
Initial bid (birr)	-.0953039*	.05578	-1.71
Constant	5.191545	3.531435	1.47

307 No. of observation: 342; Log likelihood = -1092.3212; F (12, 330) = 71.29; Pro > F = 0.000;

308 Pseudo R² = 0.1773; Lower threshold = 0.0000 Upper threshold = + infinity

309 ***, **, *:1%, 5% and 10% significance level, respectively. Source: Author's computation, 2021.

310 **Age:** The age of household head has been found to be significant at 5% probability level and
311 undesirably associated to the willingness to pay of Gedo Forest. The outcome of marginal effect
312 states that a year rise in the age of the respondent declines the possibility of willingness to pay
313 for the conservational benefits of Gedo Forest by 3.91%, holding the effect of other variables
314 constant. Correspondingly, when household's age decreased by a year, the volume of money a
315 respondent is would pay for the conservational benefits of Gedo Forest could decrease by 0.094
316 birr, ceteris paribus. The younger can produce more and have more willing to pay to protect their
317 environment generally and the forests particularly. The older households have not as much of
318 mindful about the payment issue for they fear to produce money from their future production.
319 This is interrelated to the matter that older people take to keep the habit they had before, and
320 therefore they are less likely to support idea of paying for some anticipated benefit. This is
321 comparable with the result of Resende et al. (2017), and contradicting with the finding of
322 Getachew (2018).

323 **Credit Utilization:** The amount of credit utilization is found to be significant at 1%
324 significance level and desirably related as anticipated. The model outcome specifies that, keeping
325 other factors unchanged, a thousand birr rise in the households' amount of credit utilization
326 raises the likelihood of the respondents' that they would pay for the conservational benefits of
327 Gedo Natural Forest by 1.93%. Likewise, as the amount of credit utilization of households rises
328 by a thousand birr, the extent of that the respondent could pay for the conservational benefits of
329 Gedo Natural Forest increases by 4.65 birr, keeping the other factors constant. The credit
330 utilization is the foundation of income that boosts the capability of the households to participate
331 in production, and then raises potential of paying for the preservation of natural forest.

332 **Initial Bid:** The first offered bid was negatively interrelated with the likelihood of
 333 willingness to pay of the households for the conservational benefits of Gedo Natural Forest and
 334 found to be important at 10% probability level. This is interpreted as a one birr rise in the amount
 335 of initial bid offered will lessens the likelihood of the households' willingness to pay for the
 336 conservational benefits of Gedo Fores by 3.91%, other factors keep on unchanged.
 337 Correspondingly, a single birr increases in the quantity of initial bid price declines the extent that
 338 the respondents are would pay for the conservational benefits of Gedo Natural Forest by 0.094
 339 birr, ceteris paribus. This is comparable with the statement that economic concept defined that
 340 the demand of particular consumer decline as the charged amount growth. Comparable result
 341 was found by Seifu and Alemu (2017).

342 **Table 7** The amount of willingness to pay from the results of Marginal effects of independent
 343 variables

Explanatory Variable	Probability change	Change among Forest users(birr)	Total change
Education (Class Year)	.0000194	.0466814	.0470928
Family size (Adult Equivalent)	-.1290273	-.3109418	-.3136822
TLU	.6689256	1.612039	1.626246
Farm size (timad, 0.25ha)	-.0000751	-.1810909	-.1826869
Distance from the forest (Hour)	-.0004373	-1.053799	-1.063086
Annual income (birr)	.0119382	2.876973	2.902328
Age (Year)	-.0391547	-.0943586	-.0951902
Sex (1=Male)	.0001401	.3211534	.3241104
Satisfaction level (1= Yes)	-.0001173	-.2961077	-.2986134
Credit utilization (birr)	.0193146	4.654602	4.695623
Awareness Created (1=Yes)	.0012776	2.076689	2.102416
Initial bid (birr)	-.0391658	-.0943854	-.0952173

344 Source: Author's computation, 2021.

345 **Summary and conclusions**

346 Natural forests are an economic source that has plenty of worth in enlightening and preserving
347 the environment. Therefore, the examination of the economic valuation of Gedo Natural Forest
348 conservation benefits by employing the contingent valuation method was the core objective of
349 this study.

350 Both primary and secondary data were employed for this study. The Econometric models and
351 descriptive statistics were employed for the analyzing of the survey responses of 342 households
352 selected from three kebeles around Gedo natural forest that were collected in purposive and
353 random sampling procedures through a semi-structure form. Binary constrained format
354 administered with an open ended enquiry was a technique employed to draw out the willingness
355 to pay of the households for the conservational benefits of Gedo natural forest. In this regard,
356 five sets of bids, (10, 5, 20), (15, 7.5, 30), (20, 10, 40), (25, 12.5, 50), and (30, 15, 60), were
357 delivered to each respondent to decide what they would pay for the conservational benefits of
358 Gedo forest.

359 The mean willingness to pay for the conservational benefits of Gedo forest was examined by
360 taking into account the Seemingly Unrelated Bivariate Probit Regression model. The then
361 figured mean willingness to pay from the dichotomous choice setup by means of Krinsky-Robb
362 system was 24.97 birr per year. On the other hand, the mean willingness to pay from open ended
363 requests was 23.91 birr per year. The cumulative (aggregate) benefit gain expected from the
364 conservation of Gedo natural forest from the open ended and double bounded choice setup was
365 figured to be 5,076,630.98 and 5,301,692.82 per year, respectively. As a result, the aggregate
366 value from dichotomous choice format is superior to the open-ended format. This confirms the
367 undervalued outcome from open ended format that is the consequence of the free riding

368 observation in replying to willingness to pay for naturally given supply and the forest
369 predominantly.

370 Factors that determine willingness to pay and the maximum amount of money that household
371 would pay for the conservational benefits of Gedo natural forest ecosystem has been analyzed by
372 the Tobit model in this study. Accordingly, the total livestock unit, total annual income of the
373 household, and credit utilization were important variables meaningfully and positively related to
374 the likelihood of willingness to pay for the conservational benefits of Gedo forest. The
375 households' family size, the households' age, and initial offered bid price were other key
376 variables negatively and significantly affect the willingness to pay of the households for the
377 conservational benefits of Gedo natural forest.

378 Generally, the present study came up with the result of the households' mean willingness to
379 pay, factors that determine willingness to pay, and the actual amount that the households would
380 pay in terms of significant exogenous variables for the conservational benefits of Gedo forest.
381 Therefore, if the situation of willingness to pay turn into effective in fitting way in the study area,
382 the Gedo natural forest could be conserved and managed with providing measurable welfare to
383 the households, and makes possible the respective households to be aware more in the future.

384

385 **Declarations**

386 **Availability of data and materials**

387 The datasets used and/or analyzed during the current study are available from the corresponding
388 author on reasonable request.

389 **Competing interests**

390 The author declares that there are no competing interests.

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393 **Authors' contributions**

394 The study was done individually. The author read and approved the last manuscript.

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397 **Ethics approval and consent to participate**

398 During data collection, respondents gave verbal consent for the data collectors and showed their
399 willingness to fill the dispatched questionnaires.

400 **Consent for publication**

401 Not applicable

402

403 **References**

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