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Research Article

A seemingly unrelated bivariate probit model to estimate the non-use value of wildlife

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Abstract

The benefits of wildlife and natural resources, both in their use and non-use, are significant for humans. A market must exist to ensure that these resources are utilized efficiently and optimally. In a study involving 900 respondents, a Seemingly Unrelated Bivariate Probit Model (SUBPM) was used to analyze the non-use value of wildlife. The regression results from the SUBPM revealed that the willingness to pay (WTP) for the non-use value of wildlife is affected by the initial bid price, monthly income, the respondent's connection with wildlife, and age. Furthermore, the Krinsky Robb estimation for double dichotomous WTP indicated that the average annual willingness to pay for wildlife conservation is estimated at 8 Ethiopian Birr (ETB) per person and 1,627,290 Ethiopian Birr for the total population. The study suggested that dichotomous choice or double-bounded elicitation procedures are preferable to open-ended ones. These results are encouraging concerning the potential to measure the non-use value of wildlife, which could assist park management and decision-makers in implementing welfare measures for the non-use value component of the park, ensuring the sustainable use of wildlife through conservation activities.

Keywords: Willingness to pay, Seemingly Unrelated Bivariate Probit Model, dichotomous choice elicitation procedures, Non-Use Value

Introduction

Certain environmental resources hold an intrinsic value that is significant to humans. The awe-inspiring panoramic views of towering mountain ranges and serene beaches, the captivating encounters with diverse wildlife at zoological parks, and the role that healthy ecosystems play in providing essential life-supporting services are all deeply cherished aspects of our lives. Wildlife

provides us with a wide range of benefits, from food supply and natural pest control to the medicinal use of various plants (Biruk, 2019; Diriba, 2023; Frew *et al*., 2018; Gascoigne *et al*., 2021; Guimaraes *et al.,* 2015). Conserving wildlife plays a significant role in combating poverty and advancing sustainable development goals. Healthy ecosystems provide essential services, such as clean water, fertile soil, and natural resources, which are vital for the livelihoods of many communities. By promoting biodiversity and protecting natural habitats, we safeguard the rich variety of life on Earth and create opportunities for sustainable economic growth (Andualem, 2024). Additionally, wildlife and natural landscapes play a crucial role in attracting tourists and are key components of the tourism industry (Tolera, 2022; Wubalem *et al*., 2023). Preserving wildlife and environmental amenities is crucial for the well-being of future generations, and there is widespread willingness among people to protect and conserve these valuable natural resources. However, most natural and environmental resources do not have a market value (Jianjun *et al*., 2018; Othman and Jafari, 2019; Rosli *et al*., 2021). Even if some beaches and zoological parks have admission or user fees, these charges often do not fully reflect the true value of the resource. It is important to recognize the value of environmental amenities and wildlife, even compared to the direct benefits we derive from them. People have a strong appreciation for environmental resources, even when they are not actively using them, and they hope to have access to them in the future. Additionally, there is a shared desire to protect certain species, such as Ethiopia's endemic animals like the Abyssinian lion and the Gelada baboon. Relying solely on price-based models may not be suitable in such cases (Abdul, 2016; Basu and Nagendra, 2021; Jamean *et al*., 2023).

The market pricing mechanism for traded commodities relies on the balance between supply and demand, efficiently directing resources. This system is effective for goods with private property rights and divisible production factors. However, accurately assessing the level of demand for most environmental products, even if property rights were extended to them, poses significant challenges. The value of many environmental amenities and natural resources remains largely unknown. This lack of information could harm the quality of environmental amenities and natural resources, particularly wildlife. The absence of known prices and underestimating values might lead to exploitation and inadequate protection of environmental resources. In cases where a resource is enjoyed at no cost, people are more likely to exploit it, ultimately affecting human well-being. Therefore, it is crucial to determine the value of natural resources, including wildlife, to ensure their proper protection and assign them the correct value (Cameron, 1996; Jianjun *et al.,* 2018; Nordin, 2020; Othman and Jafari, 2019; Rosli *et al*., 2021). There is an extensive list of

studies on the economic valuation of environmental resources (Abdul, 2016; Basu and Nagendra, 2021; Jamean *et al*., 2023), on the value of natural resources, particularly forests and amusement parks (Martino and Kenter, 2023; Jianjun *et al.,* 2018; Nordin, 2020; Othman & Jafari, 2019), and on the non-use value of the ecosystems and endangered species (Whitehead and Aiken, 2015; Zhou et al., 2021; Chapagain and Poudyal, 2020; Casola et al.2022).

However, there are scanty studies regarding the valuation of environmental and natural resources in the Ethiopian context (Andualem et al., 2017; Getnet *et al*., 2022; Birara *et al*., 2017; Diriba, 2023. These studies have primarily focused on the use-value of environmental amenities. To the best of the researcher's knowledge, none of the studies have delved into the nonuse value of wildlife in Ethiopia despite the country being the source of endemic wild animals. Given that Ethiopia is the source of endemic wild animals, it would be incredibly valuable to conduct a study on the nonuse value of wildlife. Hence, the main objective of this study is to estimate the non-use value of wildlife by taking the case of wildlife at Addis Zoo Park. This could provide crucial insights into the potential benefits of wild animals in bolstering the tourism sector. This understanding is necessary to answer questions about the importance of caring for endangered animals, their nonuse value to society, and the benefits derived from establishing new zoological gardens.

Material and methods

The study aimed to evaluate the non-use value of wildlife at Addis Zoo Park. This involved gathering primary data through a survey using structured questionnaires. A total of nine hundred non-visitors from Adama City, all aged over eighteen, were directly surveyed about their willingness to pay for the non-use value of wildlife. Adama City is located 100 km from the park, making it less likely for people to visit. This would help to capture the non-use value of wildlife. To ensure accurate results, the sample was divided into different segments of society, including unemployed individuals, students, high-income groups, and low-income groups (Freeman III, 1993). The study used the contingent valuation method to estimate the non-use value of wildlife. Given the substantial contribution of non-use values, particularly for endangered species, other conventional methods like the travel cost method may underestimate the benefits of conserving the environment (Casola *et al*.2022; Cerda and Losada, 2013).

From the different elicitation formats, this study used the double-bounded dichotomous choice questions (DBDC), which are widely employed in practical applications (Bateman *et al*., 2001; Gum and Martin, 1974; Carson, 2000; Chapagain and Poudyal, 2020). Respondents were presented with a scenario where they were asked if they would be willing to pay a certain amount, X, for a particular amenity. If they answered affirmatively, they were then asked if they would also be willing to pay a different amount, Y, instead. The design of the bids is crucial for the efficiency of the estimators because they affect the variance-covariance matrix when they are the only variables used. To get an initial idea about the distribution of Willingness-to-Pay (WTP), I conducted a pilot study using open-ended questions to ask individuals how much they would pay to protect wildlife in Addis Ababa Zoo Park. The results showed that responses ranged from 0 to 100, with many people willing to pay lower amounts. I used nonparametric kernel density estimation to model the observed data points to fit an underlying probability distribution. The bandwidth for the estimated epanechnikov kernel is determined at 6.19 (Fig. 1). Kernel density estimation is a non-parametric way of estimating the probability density function of a random variable. Kernel density estimation is a fundamental data smoothing problem where inferences about the population are made, based on a finite data sample. The bandwidth parameter (smoothing parameter) controls how fast we try to dampen the function and the use of Epanechnikov kernel minimize the variance

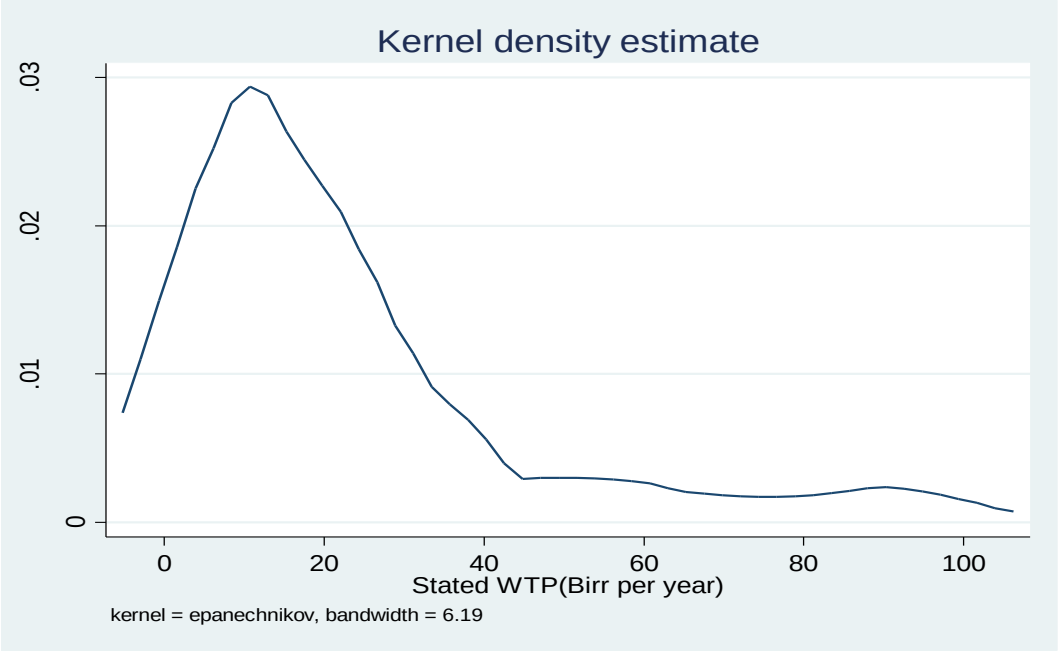

Figure 1. Kernel density estimation for the stated WTP

The graph shown in Figure 1 shows that as the number of observations increases, the likelihood of bid values becomes almost zero. Five bids were randomly selected in the final survey based on the Kernal information starting from 5, 10, 15, 20, and 30 ETB. If a respondent agreed to pay the initial bid, the subsequent bid would double. However, if there were no response, the bid would be reduced by half. For example, if a bid of 5 ETB was offered and the respondent accepted, a follow-up bid of 10 ETB would be given. On the other hand, a bid offer of 2.5 ETB would be made if there were no response. The range of bid vectors in the follow-up, including 2.5 ETB, 5 ETB, 7.5 ETB, 10 ETB, 15 ETB, 20 ETB, 30 ETB, and 60 ETB, covered the relevant left tail of the kernel density where most of the observations were concentrated.

Model Specification

Given two bid prices, the level of the second bid is contingent upon the response to the first bid. If the individual responds "yes" to the first bid (y_1), the second bid (to be denoted y_2) becomes twice higher than the first bid ($y_{2=}2y_1$); if the individual responds "no" to the first bid, the second bid (y_2) is twice smaller than the first bid (($y_{2=}\frac{1}{2}y_1$). Thus, there are four possible outcomes:

a. Both answers are "yes" (1,1);

b. Both answers are "no" (0,0);

c. A "yes" followed by a "no" (1,0); and

d. A "no" followed by a "yes" (0,1)

Where 1 is for “yes” responses and 0 for “no” responses

It is essential to establish whether the first and second actions occur simultaneously or sequentially, mainly if the order of actions affects the outcome. In the case of double dichotomous questions, the second question follows the first question (where y2 depends on y1, but not vice versa). Additionally, when making estimates, the method must consider how the two sets of responses are related, as indicated by the parameter ρ (Haab & McConnell, 2003).

To formulate the model, the study assumes two WTP functions, which can be represented as follows:

Let Y_{i1}^{*} indicate the decision of a given individual i on WTP for a given bid price which depends on a set of economic and social characteristics X_{i1}, and other unobserved variables e_{i1}. The relation can be written as

$$Y_{i1}^{*} = X_{i1}'\beta + e_{i1} \qquad (1)$$

Y_{i1} = 1 if Y_{i1}^{*}>0, 0 otherwise

Similarly, Y_{i2}^{**} indicates the decision of a given individual i on WTP for a given bid price which depends on a set of economic and social characteristics X_{i2}, and unobserved variables e_{i2}. The choice is again an observed binary outcome as shown in Equation (2)

$$Y_{i2}^{*} = X_{i2}'\beta + e_{i2} \quad (2)$$

Y_{i2} = 1 if Y_{i2}^{*}>0, 0 otherwise

The probability of occurrence can be found as:

$$Prob[y1 = 1, y2 = 1] = Prob\{y_2 \leq Max\ WTP\}$$

$$= Prob[y_2 = 1 \,|\, y_1 = 1] \times Prob[y_1 = 1]$$

$$= \frac{\Phi_2(y1=1, y2=1)}{prob[y1=1]} \times Prob[y1 = 1]$$

$$= \frac{\Phi_2\left(X_{y_{1i}}\beta_{y1}, X_{y_{2i}}\beta_{y2}, \rho\right)}{\Phi\left(X_{y_{1i}}\beta_{y1}\right)} \times \Phi\left(X_{y_{1i}}\beta_{y1}\right)$$

$$Prob[y1 = 1, y2 = 1] = \Phi_2\left(X_{y_{1i}}\beta_{y1}, X_{y_{2i}}\beta_{y2}, \rho\right) \qquad (3)$$

The remaining probabilities that enter to the likelihood function are then:

$$Prob[y1 = 0, y2 = 0] = Prob\{0 < Max\ WTP < y_2\}$$

$$= Prob[y_2 = 0 \,|\, y_1 = 0] \times Prob[y_1 = 0]$$

$$= \Phi_2\left(-X_{y_{1i}}\beta_{y1}, -X_{y_{2i}}\beta_{y2}, \rho\right) \qquad (4)$$

$$Prob[y1 = 1, y2 = 0] = Prob\{y_1 \leq Max\ WTP \leq y_2\}$$

$$= Prob[y_2 = 0 \,|\, y_1 = 1] \times Prob[y_1 = 1]$$

$$= \Phi_2\left(X_{y_{1i}}\beta_{y1}, -X_{y_{2i}}\beta_{y2}, -\rho\right) \quad (5)$$

$$Prob[y1 = 0, y2 = 1] = Prob\{y_2 \geq Max\ WTP \geq y_1\}$$

$$= Prob[y_2 = 1 \,|\, y_1 = 0] \times Prob[y_1 = 0]$$

$$= \Phi_2\left(-X_{y_{1i}}\beta_{y1}, X_{y_{2i}}\beta_{y2}, -\rho\right) \quad (6)$$

The form of likelihood depends on the chosen model. The study identified three potential probit model specifications: Independent Probit Model (IPM), Seemingly Unrelated Bivariate Probit Model (SUBPM), and Recursive Probit Model (RPM). The choice of an appropriate model depends on the relationship between the two dependent variables (WTP answers). The Wald Test indicates that ρ (the correlation parameter) was significant for the data collected, and the log-likelihood of the bivariate estimate was significantly less than the joint binomial probit log-likelihood, which suggests that Yi1 and Yi2 are endogenous processes. Therefore, the study selects the SUBP model since it fits better than the other probit models.

A separate estimate of the determinants of an individual's behaviors might therefore be biased because unmeasured variables simultaneously cause both outputs. This potential endogenous bias is purged using simultaneous equations. The random error terms, e_{i1} and e_{i2}, are dependent and normally distributed, such that $E[e_{i1}] = E[e_{i2}] = 0$, $Var[e_{i1}] = Var[e_{i2}] = 1$ and $cov[e_{i1}, e_{i2}] = \rho$.

The log-likelihood for the SUBPM is:

$$L = \prod_{y1=0} \Phi\left(-X_{y_{1i}}\beta_{y1}\right) \prod_{y1=1} \Phi\left(X_{y_{1i}}\beta_{y1}\right) \prod_{y1=1,y2=1} \Phi_2\left(X_{y_{1i}}\beta_{y1}, X_{y_{2i}}\beta_{y2}, \rho\right)$$

$$\prod_{y1=1,y2=0} \Phi_2\left(X_{y_{1i}}\beta_{y1}, -X_{y_{2i}}\beta_{y2}, -\rho\right) \prod_{y1=0,y2=0} \Phi_2\left(-X_{y_{1i}}\beta_{y1}, -X_{y_{2i}}\beta_{y2}, \rho\right)$$

$$\prod_{y1=0,y2=1} \Phi_2\left(-X_{y_{1i}}\beta_{y1}, X_{y_{2i}}\beta_{y2}, -\rho\right) \quad (7)$$

Where Φ is the standard univariate normal cumulative distribution and Φ_2 is the standard bivariate normal cumulative distribution with correlation ρ. Equations (1) and (2) are simultaneously

estimated using maximum likelihood, producing unbiased estimates of parameter coefficients β and ρ.

Results

This section will present the descriptive and econometrics regression results using the data obtained from 900 respondents. The primary objective of this data collection was to evaluate the willingness of the participants to contribute towards the conservation of wildlife. The percentages of responses to nonuse value and motivational questions are shown in Table 1. Respondents were asked to indicate the importance of different reasons for holding economic values for wildlife protection. The specific motivations included altruistic, bequest, benevolence, and rights-based values. Overall, the respondents strongly recognized various nonuse values related to wildlife conservation at Addis Zoo Park. This question aimed to gauge respondents' attitudes towards conserving wildlife to promote tourism. More than 50% of the respondents appreciated the statement for all nonuse-value questions. This recognition reflects the non-consumptive use value of wildlife and its conservation. Among the five motivations considered, the benevolence and bequest motives for maintaining wildlife for future generations appear to be the least important. The relative importance of motivations associated with intrinsic, option, and Stewardship values appears similar. The most important motivation corresponds to the statement: "All endangered species in Addis Zoo Park have a right to exist,'' indicating a rights-based or ethical belief. Based on this stratification, a positive willingness to pay is significantly related to how respondents rate the importance of nonuse motivations. 16.9 percent of the respondents with benevolence motives rated zero willingness to pay for the two WTP prices. This comprises the smallest share of the total number of respondents unwilling to pay for both bid prices.

Table 1. Cross tabulation of respondents' attitude toward the non-use value of wildlife and WTP answers

Nonuse values	Responses to bid prices or WTP				Total (%)
	Yes-Yes (%)	No-No (%)	No-Yes (%)	Yes-No (%)	
Option value	28.9	21.7	17.1	27.7	95.4
Benevolence value	26.5	16.9	16.9	24.1	84.3
Bequest value	26.5	18.1	16.9	22.9	84.3
Intrinsic value	28.7	21.7	19.3	26.5	96.2
Stewardship value	26.5	18.1	18.1	26.5	89.2

The mode of payment in contingent valuation studies is vital for obtaining information on collecting the bid prices. A lump sum price is used in the study to prevent biases related to income

or tax rates. Table 2 illustrates the respondents' means of payment. Of the 76.7% of respondents with a positive Willingness to Pay (WTP) for one or both bid prices, almost half preferred to contribute a lump sum deducted from their salaries for wildlife protection. A few respondents opted to pay through their bank accounts or have the amount included in their monthly electricity and water bills.

Table 2. Cross-tabulation of payment and WTP answers

Mode of payment	Responses to bid prices or WTP (%)				Total (%)
	Yes-Yes	No-No	No-Yes	Yes-No	
I will pay with bank account	0	1.1	1.1	3.3	5.6
I will pay with my Idir book	3.3	2.2	2.2	1.1	8.9
Include with my monthly electricity bill	1.1	1.1	2.2	1.1	5.6
Include with my monthly water bill	3.3	0	3.3	1.1	7.8
Deduct from my salary	16.7	11.1	6.7	14.4	48.9
Unwilling to pay	2.2	7.8	4.4	8.9	23.3
Total (%)	26.7	23.3	20	30	100

Source: Survey result, 2023

Estimation of the Willingness to Pay for the Non-Use Value of Wildlife

This section presents the determinants of individual's willingness to pay using the seemingly unrelated bivariate probit model and estimates the average willingness of people to pay for the non-use value of wildlife. To estimate the SUPB model, two dependent variables are used. The two dummy dependent variables are the first and second WTP bid price responses. After conducting a preliminary specification test, the study adopts a linear-linear functional form. The functional relationship is given below.

$$Y_1=\beta_0 + \beta_1 FBP + \beta_2\, age + \beta_3\, SUP + \beta_4 RSW + \in_i \quad (8)$$

$$Y_2=\beta_0 + \beta_1 SBP + \beta_2\, age + \beta_3\, SUP + \beta_4 Income + \in_i \quad (9)$$

Where,

Y_1= WTP answer for the first bid price as a dummy variable (1=agreed to pay for the first bid price, 0= denied paying the designed bid price)

Y_2= WTP answer for the second bid price as a dummy variable (1=agreed to pay for the second bid price, 0= denied paying the designed bid price)

FBP= the first designed bid price in ETB

SBP= the second designed bid price

RSW= relationship with wildlife as dummy variable (1= relationship with wildlife, 0= no relationship with wildlife)

Age= respondents' age (measured in count number)

Sup= the number of people that the respondent is supporting (measured in count number)

Income= monthly income of the respondent in ETB (Ethiopian Birr)

β_0= constant term

$\in_i$= residual term which has a normal distribution with mean zero and variance δ^2

A preliminary regression was conducted to determine the relevant explanatory variables, followed by a specification test. Finally, a seemingly unrelated bivariate probit model was selected and presented for discussion. The robust regression is presented in Table 3.

Table 3. The robust Seemingly Unrelated Bivariate Probit Model

Explanatory variable	**1st bid response (Y1)**		**2nd bid response (Y2)**		**Marginal Effect**
	Coefficient (Sd)	P-values	Coefficient (Sd)	P-values	
FBP	-0.039 (0.019)	0.047**			-0.015
SBP			-0.012 (0.013)	0.342	-0.005
Age	0.069 (0.028)	0.015***	0.120 (0.036)	0.001***	0.074
Sup	-0.077 (0.082)	0.353	0.029 (0.084)	0.732	-0.017
Income			1.036 (0.634)	0.100 *	0.378
RSW	2.049 (0.591)	0.001***			0.324
Constant	-2.822 (1.031)	0.006	-4.257 (1.173)	0.000	N/A

*, **, *** means significant at 10, 5, and 1 percent.

Numbers in parenthesis are standard errors N/A= not applicable

To choose the right model, the researcher first examined the significance level of ρ (rho), indicating the correlation between the two responses for WTP. The LR test for ρ ($\chi 2$=27.4) indicates that the two disturbances are significantly correlated. The estimated correlation of -1 is significantly different from zero, leading to the rejection of the null hypothesis of no correlation. This suggests that the first and second bid answers are jointly determined. Therefore, the Seemingly Unrelated

Bivariate Probit or Recursive Bivariate Probit model can be used to analyze the two questions. However, separately regressing the two equations will yield inconsistent results due to the rejected correlation between these dependent variables. The model specification test shows that the Seemingly Unrelated model fits the data better than the Recursive Bivariate Probit or Independent Probit model

The significance of the SUBP model is tested using the log-likelihood ratio test and the pseudo-R2 value. The computed pseudo R2 value is 46.6%, and the calculated LR chi2(6) for the likelihood ratio test is 44.72. The critical value of the test with 7 degrees of freedom ($\chi 2_{6}$) at a one percent significance level is 18.4. Since the calculated value is higher than the tabulated value at the one percent significance level, the likelihood ratio test of goodness-of-fit under the null hypothesis that all parameters are zero can be rejected. Based on these results, the seemingly unrelated bivariate probit model fits the data better than other probit models. All explanatory variables, including the first bid price, age, RSW, and SUP, exhibited the expected sign in the WTP for the first bid. All explanatory variables, except SUP, showed the expected sign for WTP for the second bid price. The estimate of the second bid price on the second WTP response and SUP on the first WTP response coefficient produced the expected sign, but the estimated effect of the variable SUP on the second WTP response did not.

Estimation of the Mean WTP

The econometric model explains how decisions about WTP can help us determine the population's average WTP. The mean WTP was estimated using the two WTP bid prices response in two steps. First, we estimate the model using a seemingly unrelated bivariate probit model. Then, find the mean WTP by simulating confidence intervals with the Krinsky-Robb procedure. This method uses random drawings from an assumed multivariate normal distribution to generate new parameter vectors. WTP is then calculated for each of these parameter estimates, which are used to construct the WTP distribution for complete replications. The estimated mean WTP and the confidence intervals are presented in Table 4.

Table 4. Reporting Krinsky Robb estimation results of mean WTP

Mean WTP	LB	UB	P-value	Mean CI	Difference
8.61	7.07	11.11	0.0000	0.47	4.04

According to Table 4, the average willingness to pay (WTP) is 8.61 ETB per year, ranging from 7.07 to 11.11 ETB. This value is considered significant at a significant level of 1% with a p-value of 0.000. The relatively small variation of 4.04 between the upper and lower bounds indicates that the SUBP model is more efficient than the Independent Probit and the Recursive Bivariate Probit models, as it has narrower confidence intervals around the point estimate. Hence, the average Willingness to Pay (WTP) for one person per year for wildlife conservation is 8.61 Ethiopian Birr (ETB). When multiplied by the total population, it reaches the total non-use value of Addis Zoo Park wildlife. Based on the latest Ethiopian population census report, out of the total population of 300,000 in Adama city, 189,000 people are aged over 18, which can be considered the target population. Multiplying the estimated population (189,000 people) by 8.61 ETB gives 1,627,290 ETB annually, which can be collected from Adama City to protect wildlife. Hence, this value represents the total non-use value contribution of wildlife.

Discussion

The response from the respondents indicates that protecting vulnerable wildlife is crucial not only for maintaining the balance of our ecosystems but also for promoting inclusive development in our communities. Every species plays a significant role in its habitat, contributing to biodiversity, pollination, and the overall health of the environment. By safeguarding these animals and their habitats, we can ensure that ecosystems remain resilient and capable of supporting a wide range of life forms. Additionally, fostering a culture of wildlife protection can lead to sustainable tourism and economic opportunities for local communities, allowing them to thrive alongside nature. This harmonious relationship between human development and wildlife conservation is essential for creating a sustainable future for all (Andualem, 2024).

The Seemingly Unrelated model estimated the effects of the bid prices and different socio-economic factors on respondents' willingness to pay. The study found that the SUBP model is more efficient than the Independent Probit and the Recursive Bivariate Probit models, as it has narrower confidence intervals around the point estimate. This has also been supported by other previous studies (Jianjun *et al*., 2018; Nordin, 2020; Othman and Jafari, 2019; Rosli *et al*., 2021). Among the major determinants of willingness to pay, the initial bid price has been identified as the primary variable. Its significance is underscored by its statistical significance at a 5% level. A one-birr increase in the first bid price leads to a 0.015 decrease in the likelihood of the respondent's willingness to pay for wildlife conservation, with all other variables being constant. While this

marginal effect is small, it points to the influence of bid prices on WTP. Importantly, this small effect reassures us of the stability of WTP in the face of bid price changes. This finding is consistent with demand theory and previous studies (Ali *et al*., 2018; Berman & Kofinas, 2004; Boxall & Macnab, 2000; Brock *et al*., 2017; Casola *et al.,* 2022; Cerda & Losada, 2013; Sajise *et al.,* 2021; Sharip *et al*., 2021; Siew *et al*., 22015; Tavárez and Elbakdze, 2021). As indicated in table 4, the mean WTP for wildlife conservation is 8.61 ETB per annum, a relatively modest amount. Consequently, changes in the bid price will have an inverse effect on the initial WTP response, although the impact is not substantial.

An individual's relationship with wildlife also showed expected significance. This variable significantly affects the first WTP response at a 1% significance level. "Relationship with wildlife" can be explained by factors such as membership in wildlife and environmental associations, frequent visits to wildlife protection areas, and level of education related to wildlife. When individuals connect with wildlife, they are more willing to pay because they understand the importance of wildlife for current and future generations. Although there are no studies regarding wildlife nonuse value, studies in other countries confirmed that people who have a connection with wildlife are willing to contribute (Martino and Kenter, 2023; Mmopelwa *et al.*, 2007; Navrud and Mungatana, 1994; Mohd, 2009; Matthew and Stephen, 2000; Nirupam, 2008; Guimaraes *et al.*, 2015; Hamid and Majid, 2005; Ali *et al.*, 2018; Berman and Kofinas, 2004). Therefore, any advertising related to wildlife is likely to improve people's attitudes toward wildlife protection.

The respondent's income, represented by a dummy variable for high-income and low-income groups, is expected to positively impact the respondent's second willingness to pay (WTP) response. As anticipated, this variable also displayed the expected sign and is statistically significant at the 10% level. As an individual's monthly income increases, their willingness to pay for the non-use value component of wildlife will also increase, as evidenced by other studies (Tassie *et al*., 2024; Tolera, 2022; Wubalem *et al.*, 2023; Yirssaw, 2021; Boxall and Macnab, 2000; Brock *et al.,* 2017;; Cerda and Losada, 2013;; Dalerum *et al.*, 2018; Fischer *et al*., 2015; Frew *et al*., 2018; Gascoigne *et al*., 2021).

The last variable that showed the expected significance level and sign is the age of the respondents. The age of the respondents significantly affected both the first and second bid price Willingness to Pay (WTP) at a 1% significance level. In general, as the age of an individual increases, their attitude toward wildlife is likely to change. When individuals' age increase, they realize that wildlife conservation is critical to ensure high non-use value for future generations through climate

modeling and environmental scenery and which is consistent with previous studies (Kaffashi *et al*, 2015; Lundhede *et al.*, 2015; Martino and Kenter, 2023; Mmopelwa *et al.*, 2007; Navrud and Mungatana, 1994; Nielsen *et al.*, 2014; Spenceley *et al.*, 2017; Travers *et al*., 2019). Therefore, they are more likely to be willing to pay for wildlife conservation. For example, a study by Berman and Kofinas (2004) found that older people are willing to contribute to wild animals in the Arctic village.

Moreover, the Krinsky Robb estimation method validates the claim of improved efficiency of DBDC over SBDC models, which aligns with findings by Bateman *et al.* (2001), Girmaye *et al.* (2023), Hussen and Hailu (2022), and Khan (2003). Furthermore, the double-bounded dichotomous choice model is more efficient than the single-bounded model, leading to significantly reduced confidence intervals for WTP which is consistent with previous studies (Fitsum *et al*., 2021; Getnet *et al*., 2022; Girmaye *et al*., 2023; Hussen and Hailu, 2022; Marlen *et al*., 2017; Maria *et al.*, 2023; Tadesse and Aseffa, 2024; Tassie *et al*., 2024; Tolera, 2022; Wubalem *et al*., 2023; and Yirssaw, 2021).

Conclusion

This research aimed to determine the non-use value of wildlife using the contingent valuation method. The researcher employed the double dichotomous contingent valuation method and data from the CVM scenario to evaluate potential future recreational opportunities. The study used the SUBP model to estimate the non-use value of wildlife and concluded that it was the most appropriate model after comparing it with others. The regression analysis showed that the initial bid price, monthly income, RSW, and age influenced the willingness to pay for the non-use value of wildlife. The study found that using follow-up responses helps generate more accurate estimates of the mean WTP because it provides better information. The estimated mean WTP of SUBPM was more efficient and robust than those obtained from Recursive Bivariate Probit Models and Independent Probit Models. The study evaluated the mean WTP for existing resources using the estimated results. On average, WTP for wildlife conservation is positive, approximately 8 ETB and the annual WTP is around 1,627,290 ETB. In general, these results show promise in measuring the non-use value of wildlife. The study also discussed simulation experiments comparing single- and double-bound estimators. It found that the estimated willingness to pay for the single-bound model was twice the size of the double-bound models. As a result, the study suggested that dichotomous choice elicitation procedures are better than open-ended elicitation methods. The

claim of increased efficiency of double-bound dichotomous choice over single-bound dichotomous choice contingent valuation surveys relied on achieving tighter bounds on mean willingness to pay estimates from the first response equation. The findings of this study are important because they guide park management and decision-makers in implementing measures to ensure the sustainable use of wildlife through conservation efforts. The study demonstrates that knowledge about wildlife significantly influences an individual's willingness to pay (WTP) to conserve wildlife. Therefore, raising awareness is essential to increase the non-use value of wildlife. It is recommended that the park authority enhances these values through advertising. The results of this study can also be used in economic analyses to determine the long-term feasibility of wildlife conservation in the park. However, further research is needed to thoroughly evaluate the robustness of the welfare values derived from the park for long-term management decisions. This study suggests that future research could focus on the non-use value of Addis Zoo Park to validate these findings.

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