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Valuing conservation of the Sundarbans mangrove forest ecosystem

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ABSTRACT

Estimating the value of conservation attributes of the Sundarbans mangrove forest provides important information in maintenance of a sustainable ecosystem. This study fills a gap in the literature regarding the non-market valuation connected with conservation attributes of the Sundarbans. It estimates tourists' willingness-to-pay (WTP) for the conservation of the Sundarbans under proposed attributes. The contingent valuation (CV) is used to estimate the factors and attributes influencing WTP for conservation. The CV is applied in a few tourist spots in the Sundarbans to elicit stated preference data and estimate WTP. Tourists would be willing to pay a maximum Bangladeshi Taka of 30 and a Taka of 10 for the conservation of the Sundarbans. Provision of ecotourism, forest landscape restoration, nurturing mangrove and other native tree species biodiversity, and WTP may increase the recreational value because of their contribution to conservation of the Sundarbans and protect it from deforestation. Other salient explanatory variables behind WTP for proper conservation of the Sundarbans include age, monthly income, occupation, travel cost, distance, years of schooling, and family size. This study offers evidence of positive prospects for proposed attributes of conservation of the Sundarbans and development of its ecosystem service, driven by bequest motivation that is essential for policymakers and future researchers.

1. Introduction

Non-market conservation attributes have no homogeneous identity (Marre et al., 2015). These can be influenced by perception, preference, ability, interest, awareness, social mobilization, familiarity, provision, tradition, and motivation (Gava et al., 2017; Faccioli, 2011; Iqbal, 2020a). In some cases, passive and non-use values may be the most important values associated with forest conservation (Brown et al., 2014). Motivation underlying values for proposed conservation attributes can be heterogeneous across socioeconomic-demographic (SED) characteristics reported in the literature (Rahimi et al., 2020). The study of spatial and temporal effects adds another dimension to how economic values placed on conservation attributes are affected by physical proximity (Ferraro et al., 2015).

Reduced non-market economic value may be explained by lower levels of conservation management strategy awareness, social mobilization, and knowledge (Garcia et al., 2018). Beyond social constructs, bio-physical thresholds, unwise use of forest resources, and illegal commercialization can restrict conservation initiatives within the boundary area of the forest (Rotundo, 2019). Effects of tourists' motivation, ability, and perception on conservation have been reported by Rasoolimanesh et al. (2017). Some have derived functions between economic values and conservation, as in the case of Verma et al. (2017). The Sundarbans mangrove forest requires proper conservation due to its high ecological value and well-being functions (Iqbal, 2020a).

Non-market economic value for conservation in forests has been studied in a few studies. For instance, Subroy et al. (2019) suggest that non-market values for conservation can decline across regions or countries. However, very little is known in detail about non-market economic value connected to non-use attributes beyond biophysical threshold and temporal aspects. This study strives to make a contribution to a better understanding of non-market economic valuation for the conservation of forests and fills a void in the assessment of values derived from some hypothetical conservation attributes.

The study estimates the non-market valuation of related conservation attributes of the Sundarbans. These attributes are essential for ensuring sustainable conservation. Tourists' perception and their willingness-to-pay abbreviated as WTP (the maximum payment for the conservation of the Sundarbans given by each tourist) play an important role in developing, designing, and initiating such hypothetical

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attributes. This study elicits stated preference data and measures WTP to conserve the Sundarbans mangrove forest. Forest conservation is selected for a few reasons. *First*, forest conservation increases recreational value for tourists. *Second*, it provides and sustains numerous ecosystem services, covering habitat for diverse aquatic and terrestrial species, offers flood control, improves livelihood conditions, and works as a carbon sink (Iqbal, 2020a). *Third*, the benefits of conservation are derived from direct and indirect uses, and these require valuation (Rani et al., 2020).

Creation of a resource base, provision of alternative livelihood options, provision of ecotourism, and WTP may improve the conservation of the Sundarbans (De, 2013). Conservation of mangrove forests, and their associated ecosystems has been studied worldwide to assess the role of collective action and common property institutional arrangement in the conservation of forests. Thomson (2003) reported that the role of tourists and informal institutional arrangements may contribute to the conservation of forest. Based on Schlager and Ostrom's theoretical framework, Alam (2009) argued that WTP practice may change tourists' attitudes towards WTP for the conservation of the Sundarbans mangrove forest. Ray (2016) further argued that socioeconomic-demographic (SED) characteristics such as age, education, income, security, religion, and social mobilization may also change tourists' attitudes towards WTP and the conservation of the Sundarbans. Reforestation is another approach to the conservation of the Sundarbans (Chua, 2002). Planting mixed-species forests and establishing biodiversity conservation corridors are highly effective methods of maximizing and ensuring comfortable habitat for wild animals and birds, biodiversity, food web connectivity, net ecosystem production (NEP), scenic view, and decent mangrove forest (Alongi, 2011).

The mangrove forest is essential for tangible and intangible benefits in the form of socioeconomic development opportunities like tourism, fishing, trading, and biodiversity (Ramli et al., 2017). The monetization of conservation attributes of the Sundarbans mangrove forest is essential to policymakers in decision making about the implementation of eco-tourism and land use. The contingent valuation (CV) creates a bridge between the valuation of conservation attributes and the WTP. This is a method of recovering essential information about preferences or WTP for changes in the quantity or quality of goods or services and the effect of covariates on WTP (Needham and Hanley, 2019). Ramli et al. (2017) showed an estimated WTP for the conservation fee where every visitor pays 17.60 Ringgit (Malaysian currency), which is essential for the conservation of Matang mangrove forest in Perak, Malaysia. Direct interview questions and questionnaire surveys are the main building blocks of CV (Zambrano-Monserrate and Ruano, 2020). Under this method, open-ended CV, bidding games, payment cards, and dichotomous or discrete choice can be used to obtain WTP-related information, where the National Oceanic and Atmospheric Administration (NOAA) guidelines are essential for valuing elicitation surveys (Jin et al., 2020 Based on the CV, survey through the open-ended questionnaire, and logit model, Amirnejad et al. (2006) measured WTP and showed that 65.8% of tourists have a positive response to WTP for better management of the northern forest of Iran. Stone et al. (2008) applied CV to value the conservation attributes of mangrove forests in India. They argue that tourists have a greater contribution to making mangrove forests safe through the provision of WTP.

Since its structural formation and theoretical explanation by Cragg in 1971 (Orlowski and Wicker, 2016), the double-hurdle model has enjoyed widespread use in determining the implicit value of different aspects of conservation attributes. After that, many studies have applied the Double-hurdle model to estimate the value of recreational amenities such as 'improvement of environmental welfare', 'effective conservation in the forest', 'improving conservation practice', 'maintaining the usual cultural heritage and practice', 'promoting the provision of ecotourism', 'forest landscape restoration', 'improving carbon sequestration practice', and 'nurturing mangrove and other native tree species' (Chen et al., 2020; Chi, 2017; Armel, 2020; Okoffo et al., 2016; Kontogeorgopoulos, 2003; Cenamo and Carrero, 2012; Sharma et al., 2020; Bryan et al., 2014; Bayissa, 2014). This model has two stages: the first stage is a concern about a certain action, and the two-tier stage offers an improvement over the traditional dichotomous choice. The basic model for analyzing dichotomous CV responses is the random utility model, which is driven by the Probit model and the truncated Ordinary Least Square (OLS) method (Ndebele and Forgie, 2017).

This study may be the first attempt to describe the proper structural form of the CV which has been successfully applied to measure WTP for conservation attributes of the Sundarbans. Besides, the study allows Probit coefficients, Probit marginal effects, truncated OLS coefficients, and WTP for proper empirical investigation and economic valuation of conservation attributes of the Sundarbans mangrove forest.

2. Materials and methods

2.1. Structure of CV

The CV is well-rooted in welfare economics, followed by the concept of neoclassical economic value and the maximization of individual utility. Economists, researchers, and policymakers prefer to apply this survey technique for designing effective and reliable policies because of its versatile and complete methodological ground for benefit estimation in the case of environmental improvements and other public goods (Bance and Chassy, 2020). This survey technique became very popular for valuing non-market environmental goods through WTP, followed by stated preference (SP) data during the 1980s and 1990s (Kolstad, 2016). The SP data and CV are complementary to each other. The SP data appears to date back to the early 1960s when Davis conducted a study in 1963 and highlighted the value of recreation in the Marine woods of the United States (Kolstad, 2016). The goal of estimating parameters from dichotomous choices derived from CV responses is to measure WTP (Sever et al., 2020). Respondents are directly asked about their WTP for a hypothetical policy. Payment cards and bidding games (conducted by single-bounded dichotomous or discrete choice and double-bounded dichotomous or discrete choice) are the major elicitation formats of WTP under this survey technique. A random sample of people is directly asked in this survey technique to express their maximum WTP for a change in the level of goods and services (Tonin, 2019).

When we have two choices or alternatives in the CV case, we can write the indirect utility for respondent j as follows:

$$u_{ij} = u_i\left(y_j, Z_j, \varepsilon_{ij}\right) \tag{1}$$

where $i$can take the values 1 and 0. The value 1 indicates the condition of the final state under the CV, and 0 indicates the status quo. The contributors of this utility are y_j(the j^{th} respondent's discretionary income), Z_j(the k-dimensional vector of respondents' characteristics), and ε_{ij} (a set of preferences known to every respondent but unknown to the investigator). Under this condition, it is possible to measure proposed hypothetical attribute e.g., a quality of indicator x could change from $x^0$to x^1 where $u_{0j} = u(y_j, Z_j, x^0, \varepsilon_{0j})$is associated to status quo situation and $u_{ij} = u(y_j, Z_j, x^1, \varepsilon_{1j})$is associated to improved condition. Under consideration of both conditions (status quo and improved), it is possible to write the following equation when respondent j answers "*yes*" to improved conditions and wants to pay t_j amount of money for this improvement.

$$u_1\left(y_j - t_j, Z_j, \varepsilon_{1j}\right) \rangle u_0\left(y_j, Z_j, \varepsilon_{0j}\right); u_1 > u_0 \tag{2}$$

Probability statement about "*yes*" or "*no*" becomes more effective when there is less scope of prediction about the random part of preference. For respondent j, the probability can be written as:

$$\Pr\left(y_j\right) = \Pr\left[\left(y_j - t_j, Z_j, \varepsilon_{1j}\right) > u_0\left(y_j, Z_j, \varepsilon_{0j}\right)\right] \tag{3}$$

Under the conditions presented in Eq. (3), the functional form of $u(y_j,$

Z_j, ε_{1j})must be chosen first. After this step, the distribution of ε_{1j}must be specified. The first step is known as deterministic or non-stochastic, and the last step is known as stochastic performance. The deterministic and stochastic performances of utility functions are additively separable. Thus, it can be said that indirect utility is the sum of a deterministic component and a stochastic component which holds the following mathematical form:

$$u_i(y_j, Z_j, \varepsilon_{ij}) = u_i(y_j, Z_j) + \varepsilon_{ij} \tag{4}$$

Combination of the additive specification and the probability statement for respondent *j* becomes:

$$\Pr(y_j) = \Pr\left[\tau_1(y_j - t_j, Z_j) + \varepsilon_{1j} > \tau_0(y_j, Z_j) + \varepsilon_{0j}\right] \tag{5}$$

Eq. (5) does not guarantee estimation. To overcome this situation, we consider the linear utility function arises from the linearity in income and covariates of the deterministic preference function. The linear utility function can be written as:

$$\tau_{ij}(y_j) = \alpha_1 Z_j + \beta_i(y_j) \tag{6}$$

where $y_j$denotes discretionary income, Z_j is an m-dimensional vector of variables related to respondent *j*, and α_i is an *m*-dimensional vector of parameter. Both the αi and Z_j satisfied the condition of α_i and $Z_j = \sum_{k=1}^{m} \alpha_{ik} Z_{jk}$. The NOAA guided CV questions induce the respondent to select between the proposed attributes at a certain amount of payment (t), and the current state (Haab and McConnell, 2002). The deterministic preference based utility for the proposed CV attributes and the status quo utility scenario are written as:

$$\tau_{1j}(y_j - t_j) = \alpha_1 Z_j + \beta_1(y_j - t_j) \tag{7}$$

$$\tau_{0j}(y_j) = \alpha_0 Z_j + \beta_0 y_j \tag{8}$$

The change in deterministic preference based utility can be written as:

$$\tau_{1j} - \tau_{0j} = (\alpha_1 - \alpha_0) Z_j + \beta_1(y_j - t_j) - \beta_0 y_j \tag{9}$$

According to Haab and McConnell (2002), the marginal utility of income is assumed to be constant between the two CV states, unless the proposed CV provides a substantial change. Under this condition, it is possible to write $\beta_0 = \beta_1 = \beta$.

When the deterministic preference is specified, the probability of responding "*yes*" will take the following form:

$$yes_j = \Pr(\alpha Z_j - \beta t_j + \varepsilon_j > 0);\ \varepsilon_j \equiv \varepsilon_{1j} - \varepsilon_{0j} \tag{10}$$

Parameter estimation of the different utilities requires specifying the nature of the random terms in stochastic performance (ε_j). The fundamental assumption of stochastic performance is independently and identically distributed (IID) with a mean zero. Under this condition, two widely used distributions are normal and logistic (Haab and McConnell, 2002). Therefore, the probability of "*yes*" for respondent *j* can be estimated as:

$$\begin{aligned}\alpha Z_j - \beta t_j + \varepsilon_j > 0 &= \Pr\left[-(\alpha Z_j - \beta t_j) < \varepsilon_j\right] = 1 - \Pr\left[-(\alpha Z_j - \beta t_j) > \varepsilon_j\right] \\ &= \Pr(\varepsilon_j < \alpha Z_j - \beta t_j)\end{aligned} \tag{11}$$

Assume that ε_j or converted ε follows the normal distribution with mean 0 and variance σ^2 and $\theta = \varepsilon / \sigma$ that also follows the normal distribution with mean and variance 0 and 1 respectively. Following to this assumption, it is possible to write the following form of equation:

$$\Pr(\varepsilon_j < \alpha Z_j - \beta_{tj}) = \Pr(\theta < \alpha Z_j / \sigma - \beta / \sigma t_j) = \theta(\alpha / Z_j \alpha - \beta / \sigma t_j) \tag{12}$$

where θ denotes the cumulative standard normal distribution that is supported by the Probit model. The parameters of this model can be estimated because the outcome variable takes a value of zero or one. The principal goal of a dichotomous choice CV is to measure WTP and the effects of covariates on WTP (the amount of money that makes the respondents indifferent between the status quo and the proposed attributes of CV). Depending on Eq. (9), WTP can be defined as:

$$\alpha_1 Z_j + \beta(y_j - WTP_j) + \varepsilon_{j1} = \alpha_0 Z_j + \beta y_j + \varepsilon_{jo} \tag{13}$$

It is possible to derive WTP from Eq. (13) and can be written as the following form:

$$WTP_j = \alpha Z_j / \beta + \varepsilon_j / \beta \tag{14}$$

WTP can be measured by the mean or expectation and the median or *50th* percentile or *5th* decile or *2nd* quartile of WTP in terms of preference uncertainty (ε). The following equation presents the structure of WTP derived from the mean or expectation.

$$Ee(WTP_j / \alpha, \beta, Z_j) = \alpha Z_j / \beta \tag{15}$$

For proper empirical assessment, the CV requires focus group discussion (FGD) for selection of attributes and sampling through the semi-structured and open-ended questionnaire. Thus, the following section will discuss the present study, the nature of FGD, sampling technique, data collection procedure, and econometric models of this study.

2.2. Present study

The study is based on the Sundarbans mangrove forest located in the southwest coastal region of Bangladesh. The area of this forest is bounded by the Ganges River in the North, tributaries of the Meghna River in the East, an international boundary in the West, and the Bay of Bengal in the South. The Sundarbans are one of the most attractive heritage sites in the world. It is an area of impenetrable mangrove forest in terms of size, ecological diversity, and biodiversity. This forest consists of three wildlife sanctuaries, such as the West Sundarbans, East Sundarbans, and South Sundarbans. Illegal commercialization, mass tourism, improper forest management, and climate change make the Sundarbans vulnerable to loss of habitat and destruction of the resource base (Islam, 2015). Every FGD participant argued that providing ecotourism, forest landscape restoration, nurturing mangrove and other native tree species, and WTP from tourists for conservation can improve Sundarbans conservation practice. Their arguments also consisted of the findings of Sharma et al. (2020), Cobbinah et al. (2017), Liu et al. (2021), and Pringle (2017).

2.3. Survey instrument and data collection

Customization is an issue in the selection of the pecuniary attribute of any good or service in the provision of non-market valuation (Iqbal, 2020a). Under this provision, there should be an attempt to make the preference more realistic by relating pecuniary attributes to proposed goods and services. FGD is one of the best determining approaches to the pecuniary level (Iqbal, 2020b). This study organized three FGDs consisting of 7–8 tourists each at Karamjol, Hiron Point, and Katka Beach during January 11–13, 2019 to determine the base-payment for conservation attributes of the Sundarbans. The participants were selected in a non-random fashion. The concern facilitator helped group members of each FGD to determine the pecuniary values for recreational service. The pecuniary values for conservation were selected at minimum BDT 10, moderate BDT 20, and maximum BDT 30 in local currency (BDT: Bangladeshi Taka) for each tourist, equivalent to US$ using the conversion rate of BDT 84 to US$ 1 corresponding to May 2020.

For sample selection, the tourist spots were chosen purposely, but the representative tourists were randomly selected. This study was carried out by means of tourists' interviews followed by a semi-structured and open-ended questionnaire in different tourist spots of the Sundarbans mangrove forest in Bangladesh. The NOAA guidelines were followed for the layout of its questionnaire. The questionnaire was made in the

English language, but interviews were conducted in the local language, Bangla. The survey questionnaire has a few segments. The first segment was covered by respondents' background information such as age, monthly income, family size, years of schooling, and occupation. The second segment highlighted the travel-related information such as respondents' travel costs and respondents' residential location (res_resi_loca) from tourist spots in the Sundarbans. The third segment was constructed by the current scenario or status-quo of the Sundarbans, such as loss of habitat, no provision of WTP for conservation of the Sundarbans, and destruction of the resource base of the Sundarbans. The fourth segment was covered by hypothetical CV attributes such as the provision of *ecotourism, forest landscape restoration (flr), nurturing mangrove and other native tree species (nmonts), and WTP for conservation.* Before the survey, a pre-test was conducted in May 2019 in Karamjol tourist point, which covered 15 respondents for the interview to test and amend the questionnaire and get appropriate, required, and essential information about WTP and data. After ensuring the appropriateness of the proposed survey questionnaire, the survey was conducted from August 3–21, 2019. The survey involved 221 respondents, of which 195 (88.23%) agreed to participate in the survey process. Tourists were chosen from seven tourist spots (e.g., Hiron Point (Nilkomol), Katka Beach, Karamjol, Kochikhali (Tiger Point), Jamtola Beach, Mandarbaria, and Dublarchar Island) of the Sundarbans because these are the popular tourist spots in the Sundarbans. As much as possible, the selection of tourists was random, but there is a possibility of sampling error and hypothetical bias related to CV. To minimize the sampling error, the survey was conducted by a group of paid and trained enumerators. All respondents were briefed on the motivation, significance, and objectives of this study. Then, they were introduced to double-bounded dichotomous or discrete choices (e.g., "Are you willing to pay BDT 20?"), yes/no. If "yes," "Are you willing to pay BDT 30 > BDT 20,? ", "yes /no." If "no," "Are you willing to pay BDT 10 < BDT 20," "yes/no"). They have informed the status quo scenario of the Sundarbans and the aim of the study is to investigate the stated preferences of respondents towards hypothetical or proposed CV attributes associated with the recreational value of the Sundarbans mangrove forest. The interview of respondents was taken care of for a long time. The enumerators did not indulge in any personal or irrelevant gossip to avoid influence the answers of the respondents. Each enumerator depended on the chief talk script to minimize the hypothetical bias.

2.4. Nature of collected data and econometric analysis

To avoid data entry errors, the data entry was completed manually and cross-checked after the survey was done during the survey period of August 3–21, 2019. Because the data was categorical and dichotomous, transformations were required to facilitate data analysis using the Statistical Package for Social Sciences (SPSS).

Our collected data had many zero responses that revealed the respondents' unwillingness to pay for hypothetical CV attributes for an increase in the conservation of the Sundarbans mangrove forest. The double-hurdle model, also known as the Cragg model, is effectively used for zero responses and a two-step decision such as participation in any particular event and payment decision (Jones, 2000). This model assumes that factors affecting participation in tour activities have a different impact than those on payment (Humphreys, 2013). It is also suitable for covariates to be different for two processes (Chopra and Das, 2019). Generating Double-hurdle model estimators α_0 and β_1 consists of estimating a Probit model for the probability that $Pr\ (yes_j) > 0$ and a truncated regression model for the non-limit observation (Green, 1993). In the first step, a Probit regression model is run for the willingness to participate in the CV is regressed on independent variables (Jones, 2000). The second step is a truncated ordinary least square (OLS) regression to model the payment decision (Chopra and Das, 2019). Out of 195 respondents, 117 agreed to participate in the second decision. The following regression model is associated with the Probit model and truncated OLS.

$$E\left(yes_{ij}\right) = \alpha_0 + \beta_1 X_i + U_i \tag{16}$$

where $E(yes_{ij})$ denotes the expected binary choice of respondent i for CV alternative attribute j, α_0 denotes the vector of unknown parameters, and X_i denotes the vector of the observation's exogenous values. If $U \sim$ standard normal cumulative distribution function, then the equation is treated as a Probit model where U is a dichotomous variable with two possible values, 1 and 0. The study defines for each respondent i a dummy variable $\gamma_i = 1$ indicates the respondent is willing to participate in the hypothetical CV attribute for better conservation of the Sundarbans mangrove forest, and $\gamma_i = 0$ indicates the respondent is not willing to participate in the hypothetical CV scenario for an increase in conservation of the Sundarbans mangrove forest. This equation is also applicable to a truncated regression model for the non-limit observation and further proceeds of parameter estimation after getting the WTP decision towards the hypothetical CV attributes. Under this viewpoint, the Probit and truncated OLS follow the following condition:

$$\Pr\left(yes = 0 / x\right) - 1 - \theta(x\gamma); \log y / (x, y) > 0 \sim Normal\ distribution\ \left(x\beta,\ \sigma^2\right) \tag{17}$$

where θ denotes the standardized normal cumulative distribution, and x is a $(k \times 1)$ vector. The vector of the exogenous values for observation, y in the first tier of the Double-hurdle or Cragg model, is the decision to pay or not, and "*yes*" in the second tier is how much to pay.

3. Results and discussion

A total of 195 tourists from seven tourist spots in the Sundarbans mangrove forest participated in the survey. Of the respondents surveyed, 37.3% were females because of movement restrictions for women in Bangladeshi society. More than 77% of tourists believed that tourists' perception-based hypothetical CV attributes could improve the resource base of the Sundarbans mangrove forest. More than 52% of respondents come from educational institutions, and the rest is covered by businessmen and service sectors. Though all the tourists appreciated the proposed hypothetical CV attributes for conservation of the Sundarbans, 42% of respondents were not willing to pay for these attributes due to their low degree of preference, lower income ability, and ineffective utilization of collected funds. About 72% of respondents believe that proper utilization of proposed attributes can enhance the capacity of WTP for conservation of the Sundarbans. About 57% of the respondents agreed that the Sundarbans mangrove forest has a significant role in increasing the resource base, and about 83% of the respondents strongly agreed that the Sundarbans mangrove forest has lost its natural beauty and resource base. About 19.8% of the respondents possessed an undergraduate degree, 21% were post-graduates including MPhil and Ph. D., 23.5% were higher secondary and the rest, 9.4% of the respondents, stated the secondary level as their highest educational qualification. The mean travel cost and distance from the respondents' residence to the Sundarbans were estimated at BDT 609 and 51 km, respectively. The range of maximum and minimum values of WTP for the conservation of the Sundarbans mangrove forest was recorded at BDT 30 and BDT 10, where the mean bid value is estimated at BDT 17.69.

3.1. Results of regression

The Probit model is as simple as regression on the full sample (n_1=195). It covers coefficients of the status quo, coefficients of proposed attributes for the hypothetical CV scenario, and marginal effects. Likewise, truncated OLS is as simple as regression on the sub-sample (n_2=117). Probit (participation) and truncated regression (value) equations are summarized in Table 1. Probit and truncated regression coefficients describe the direction of the relationship between the

Table 1
Regression results of the survey.

Variable/Attribute	Cragg model Probit	*P*-value	Truncated	*P*-value	Probit marginal effect	*P*-value	Status quo Probit	*P*-value
Constant	−6.098 (0.782)	0.098	−3.729 (0.784)	0.000			−2.103 (0.423)	0.135
Age	−0.079 (0.001)	0.000	−0.009 (0.894)	0.062	−0.173 (0.563)	0.000	0.007 (0.836)	0.178
monthly income	0.328 (0.472)	0.021	0.126 (0.035)	0.000	0.004 (0.017)	0.000	0.007 (0.078)	0.000
years of schooling	0.032 (0.027)	0.001	0.094 (0.003)	0.078	0.092 (0.783)	0.034	0.395 (0.004)	0.067
family size occupation	−0.139 (0.239)	0.043	−0.004 (0.005)	0.004	−0.006 (0.347)	0.184	−0.348 (0.698)	0.239
	0.124 (0.007)	0.000	0.005 (0.243)	0.075	−0.225 (0.002)	0.003	0.006 (0.673)	0.034
res_resi_loca	−0.28 (0.223)	0.059	0.246 (0.097)	0.109	−0.001 (0.563)	0.157	0.004 (0.239)	0.224
ecotourism	0.347 (0.542)	0.000	0.078 (0.002)	0.000	0.008 (0.460)	0.000		
Flr	0.349 (0.371)	0.047	0.236 (0.230)	0.082	0.064 (0.275)	0.079		
Nmonts	0.064 (0.723)	0.101	0.056 (0.903)	0.000	0.001 (0.528)	0.090		
Wtp	−0.065 (0.006)	0.035	−0.071 (0.954)	0.000	−0.002 (0.752)	0.000		
Observation (*n*)	195		117		195			195
Log-likelihood	−101.66		−207.03					−107.98
MacFadden R^2	0.333		0.245		0.279			0.347

(**Source:** Authors' calculation based on survey, 2019).
Note. Robust standard errors in parentheses; $p \leq 0.01$, $p \leq 0.05$ *and* $p \leq 0.1$ indicate 1%, 5% and 10% level of significance.

explanatory and outcome variables or attributes.

As indicated in Table 1, estimated results guarantee that age, monthly income, years of schooling, family size, occupation, and the distance of the residential location from the tourist spot are found to be significant determinants of WTP, with the value of conservation varying positively with monthly income, years of schooling, and occupation in all models and inversely with age, family size, and the respondents' residential location from the tourist spot. Most WTP studies have found significant contributors (Diswandi and Saptutyningsih, 2019; Zaiton et al., 2019; Ramli et al., 2017; Pham et al., 2018; Yu et al., 2018). Years of schooling have a positive effect on WTP for the conservation of mangrove forest and implies that educated respondents hold a significantly higher predicted probability (Ekka and Pandit, 2012). Tourists' income also has a positive impact on WTP for the conservation of mangrove forest. This proposition is consistent with Salam et al. (2000), which found income motivates tourists towards proper conservation of mangrove forests. Occupation is another leading influential factor of WTP for the conservation of mangrove forests. Ogeh et al. (2016) reported that occupation-free people have less intensity towards WTP for mangrove forest conservation. Age has an inverse effect on WTP for the conservation of mangrove forests and implies that older respondents held a significantly lower predicted probability. Reynisdottir et al. (2008) argued that aging people have the least income generating capacity and less physical strength to travel. Family size and respondents' residential location from tourist spots are significant contributors to recreation and conservation. Large family size and respondents' residential location from recreational places and mangrove forests are also negatively associated with WTP. According to Singh et al. (2020), large families and longer distances make it difficult to arrange and participate in any program, reducing WTP capacity. Provision of ecotourism, forest landscape restoration, nurturing mangrove and other native tree species, and payment for conservation of mangrove forest are found to be significant determinants of WTP, with the value of conservation of mangrove forest varying positively with ecotourism, forest landscape restoration, and nurturing mangrove and other native tree species, and inversely with payment (Do et al., 2018). The implication of a negative sign of payment supports the law of demand (i.e., a higher payment option may reduce WTP and vice-versa). The estimated values of the log-likelihood test suggest that all variables are accepted. The explanatory powers of these models are estimated at 0.33 in the Probit coefficient in the Cregg model, 0.245 in the truncated OLS coefficient in the Cregg model, 0.279 in the Probit marginal effect, and 0.347 in the Probit coefficient in the status quo situation, which supports the addition of the covariates.

3.2. Results of WTP

Monetization is essential for measuring WTP under the CV. The double-bounded dichotomous choice is one of the best and most effective approaches to monetizing goods and services for a particular service. This study has conducted a double-bounded dichotomous choice for the proposed attributes of the CV of the Sundarbans mangrove. The bid price varies across the survey respondents due to the existence of heterogeneity in levels of awareness, SED characteristics, and attitudes towards conservation value. The payment for proposed attributes varies within a range of BDT 10 - 30. Table 2 highlights the estimated value of WTP only for the ratio of proposed attributes (e.g., ecotourism, forest landscape restoration, and nurturing mangrove and other native tree species) of coefficients and payment.

Estimated results from Table 2 reveal that tourists could be ready to pay 8.09 for lower payment cases and 26.18 for the upper payment case in the Probit model. These payments lie in the value of a confidence interval ranging from 7.07 to 9.70 for the lower payment case and 25.13 to 26.41 for the upper lower case. On the other hand, it is 8.25 and 25.02 for both payment cases in the truncated model where the payment values lie in the confidence interval from 7.82 to 9.76 for the lower payment case and 24.01 to 27.09 for the upper payment case, respectively. The upper payment in both models indicates that tourists to the Sundarbans prefer recreational values like green, ecological balance, and dense mangroves. The lower pay does not necessarily imply low demand for conservation, as the findings from WTP illustrate potential demand for conservation of this forest.

4. Conclusions

Reclamation of mangrove forests draws greater attention to ecosystem balance and disaster risk reduction. This study used survey data that was effective in raising conservation practice through the provision of WTP, ecotourism, forest landscape restoration, and nurturing mangrove and other native tree species. Findings from the study indicated that a large number of surveyed respondents were highly concerned about the Sundarbans. They have deeply expressed their interest in paying for further conservation of this forest. SED characteristics, along with other characteristics such as the distance of respondents' residence and travel costs, are found to be important contributors to WTP. Hence, any policy aiming to undertake conservation of the Sundarbans mangrove needs to take into consideration these factors for a greener Sundarbans. This study has important implications for informing policies on improving recreation and conservation of Sundarbans mangrove in Bangladesh. The measured value of WTP for the conservation of the Sundarbans is supported by respondents'

Table 2
WTP for conservation of mangrove forest .

Payments	Probit model Estimated value	Std. error	*P*-value	Truncated model Estimated value	Std. error	*P*-value
Lower payment	8.09 [7.07, 9.70]	0.632	0.031	8.25 [7.82, 9.76]	0.496	0.000
Upper payment	26.18 [25.13, 26.41]	0.357	0.101	25.02 [24.01, 27.09]	0.771	0.000

(**Source:** Authors' calculation based on survey, 2018).
Note. $p \leq 0.01$, $p \leq 0.05$ *and* $p \leq 0.1$ indicates 1%, 5% and 10% level of significance; 95% confidence intervals presented in […..,…….].

preference. The study findings can serve as policy inputs not only for the conservation of the Sundarbans but also pave the way for undertaking similar projects like biodiversity control management to mitigate the extinction of species on red alert. The estimated value of WTP per visitor ensures a greater return from investment in the conservation of the Sundarbans.

An important limitation of this study is that it fails to separate heterogeneity preference in terms of tourists' perception, choice, and ability to pay for the conservation of the Sundarbans. This remains an area where further research is warranted as proper management of forest in addition to conservation value can be different between spatial and temporal viewpoints. Thus, it will be valuable to better understand its sole effects. This study offers findings within these caveats.

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