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Estimating Recreational Value of the Foy's Lake: An Application of Travel Cost Count Data Model for Truncated Zeros

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Abstract. To estimate the annual recreational value provided by the Foy's Lake, using the most applicable model for on-site data, is the main objective of this study. To adhere to the objective of this study, individual travel cost method (ITCM) has been applied and zero truncated poisson regression model has been found plausible among other models to estimate the consumer surplus. Based on the estimate, the consumer surplus or recreational benefits per trip per visitor can be recommended as BDT 5,875 or US $ 73.44 and counting the consumer surplus per trip per visitor, the annual recreational value (total consumer surplus) provided by the lake is found to be BDT 321 million or US $ 40.2 million.
Keywords: Individual travel cost method, Zero truncated poisson regression model, Endogenous stratification, Consumer surplus.
JEL. C24, Q26, Q51.

1. Introduction

People, in these hectic days, lead a monotonous life and so, they always try to get rid of that monotony by enjoying outdoor recreation. They, in most cases, go for enjoying environmental amenities with fishing, boating, and hiking etc. They spend their valuable money for enjoying those environmental services. But, the recreational services of the environment are not sold in the traditional market. So, it is important to estimate that environmental recreational value for better environmental decision making.

Travel cost method (TCM) is predominantly used to attach value to the unpriced goods and services provided by the environment. Usually, it is widely used in outdoor recreation modeling, with fishing, boating and forest visiting among other popular applications.

In this study, individual travel cost method (iTCM) has been used to assess the values of the recreational benefits that the visitors get by visiting Foy's Lake, a man-made lake located in the heart of the Chittagong city, Bangladesh. In 2004, the Concord group, one of the conglomerates in Bangladesh, has been given the authority over the lake by Bangladesh Railway and Porjatan Corporation to cater recreational services to its visitors. Since then, the lake provides recreational

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services to its visitors in terms of sightseeing, boating and lake resorting. Moreover, an international amusement park is located inside the lake which also caters recreation to its visitors.

However, single site recreational demand models' estimations depend on many issues. The nature of the sampling and the nature of the raw data exhibit a series of features which need precautions to estimate and interpret the recreation demand parameters. Sampling is the essential component of the construction of the likelihood function (Haab & McConnell, 2003). When sampling frame is used for sampling which includes users and non-users of the recreation site as well, censoring may arise. In such a case, the observations are censored at zero for the people who make no visit to the site. This, if happens, calls for a tobit model for estimating recreational demand. But, the tobit has embedded some unsatisfactory assumptions. Derivation of tobit is based on the inherent non-observability of an underlying continuous unbounded demand function which implies the possibility of negative trips (Haab & McConnell, 2003).

Again, when systematic sampling is adopted as a sampling strategy, the total number of records in the population is not likely to be known in advance of the sampling since the records are to be sampled on an ongoing basis (Lavy & Lameshow, 1991). So, there is no need to consider censoring. But, when the on-site survey is carried out, on-site data are affected by endogenous stratification, because visitors' likelihood of being sampled is positively related to the number of trips they made to the site or the number of days they spent at the site (Martinez & Hilbe, 2008). This may causes over/under dispersion and the problem of truncation. But, if the assumption of equidispersion holds, the truncated poisson regression model can be applied to adjust for both truncation and endogenous stratification (Martinez & Hilbe, 2008). In this study, on-site sample survey has been carried out using systematic random sampling. So, we have records for those populations who visited the lake at least once and hence, the number of trips is a non-negative integer. So, modeling a number of trips, which is random non- negative integers and is dependent on exogenous regressors calls for count data models. With its variety, count data models vary from poisson model to negative binomial model dependent on conditional mean and variance. From the data, it has been found that number of trips each individual takes to the Foy's lake follow poisson distribution (using pearson's goodness of fit test) and hence poisson probability density function has been used to find out the probability of observing that number of trips.

2. Data and Variables

There is no preferred method for administering non-market valuation surveys and significant tradeoffs exist with the various techniques available. We just need to find out an appropriate technique to analyze data in hand. Data, for this study, can be collected using on-site sampling, but estimates of demand functions using on-site samples are subject to possible bias (endogenous stratification) because individuals who go to the site frequently have a higher probability of being sampled.

Though, the on-site survey is a possible source of bias, but, the availability of proper technique to adjust such bias is the reason for carrying out an on-site survey in September, 2014 for this study using 120 samples (only those are kept who visited the lake discarding samples of multiple purpose trips).

To administer the survey, a systematic sampling scheme is chosen since there was no sampling frame in hand in advance and so the respondents are asked to answer the questions using a structured interview schedule.

In regard to the explained variable, respondents are asked how many trips they have made in Foy's Lake in the last one year. For explanatory variables, typical respondent characteristics, such as age and income are captured. Site characteristics are also important when modeling the demand for recreation. So, opinion about the environmental quality of the lake has been sought from every respondent in five scales from whether they are very satisfied to very dissatisfied. Lastly, the travel

cost variable includes individual round trip travel costs per kilometer and the opportunity cost of round trip travel time plus entree fee. In the case of calculating the opportunity cost of travel time, students and housewives are not taken into account. The inclusion of lodging expenses in the calculation of travel cost is likely to represent a more accurate measure of the variable out-of-pocket expenses, but, unfortunately, it has not collected through the interview schedule and hence, is not taken into account in this study.

3. Theoretical Framework

The domain of valuation of recreational demand stretches its legs into two groups- the stated preference (SP) techniques (e.g., the contingent valuation method) and the revealed preference (RP) techniques (e.g., the travel cost method). But, the economists declared that the individual travel cost method (iTCM) is the best tool in order to value the recreational places (Khoshakhlag *et al.,* 2013). This method is based on the hypothesis that the recreational value of a place is related to the travel costs incurred by the visitors to visit the place i.e., the number of visits by the visitors, due to the increase of travel costs, will decrease. Researchers use this inverse relationship between travel costs and the number of visits with a view to mapping/designing a travel demand function of the place of interest. Then from the demand function, the consumer surplus is calculated which represents the recreational value of the place of interest.
To do so, the objective is to

$$\text{Max } U = U(X, r, q) \tag{1}$$

Subject to two constraints (money and time):

$$M + p_w t_w = X + cr, \tag{2}$$
$$t^* = t_w + (t_1 + t_2)r \tag{3}$$

Where,
U: utility function of the consumer/household, X: bundle of other commodities, r: number of visits to the site, q: an index of quality of the site, M: exogenous income, p_w: wage rate, t_w: hours of work, c: monetary cost of a trip, t^*: total discretionary time, t_1: round trip travel time and t_2: time spent at the site.

Now, substituting the term t_w from the equation (3) into the equation (2), we obtain the following combined constraint

$$M + P_w . t^* = X + c.r + P_w(t_w + (t_1 + t_2)r). \tag{4}$$

The price of recreation, P_r includes the monetary cost of travel to the site, the time cost of travel and the cost of time spent at the site, i.e., $P_r = c + P_w(t_1 + t_2)$. The monetary cost of a trip to the Foy's lake is the monetary cost of travel plus the entry fee, f, in the case of Foy's lake. The cost of travel (two-way) is $P_d . d$, where, P_d is the per-kilometer cost of travel and d is the total distance to the site (two-way) as shown in equation (5).

$$P_r = c + P_w(t_1 + t_2) = f + P_d . d + P_w(t_1 + t_2), \tag{5}$$

From equation (4) and equation (5),

$$M + P_w . t^* = X + r.f + P_d . d + P_w(t_1 + t_2) \tag{6}$$

Now, maximizing (1) subject to (6) will yield the individual's demand function for visits:

$$r = r(P_r, M, q) \quad (7)$$

4. Method for Estimating the Demand Function and Welfare Measurement

The demand function is envisaged in an implicit form. In estimating it, we need to transform it in an explicit form and need to make it stochastic by adding a random error term (Gunatilake, 2003). There are many functional forms one can use in estimating the demand function. But, (Gunatilake, 2003) agreed on by checking the appropriate functional form and asked to use a statistical test to take a decision. Since number of visitors to the lake in last year is a count explained variable, it is plausible to use count data model (truncated poisson model in this study).

4.1. The Truncated Poisson Model

In our study, on-site sampling has been used. The main feature of the on-site sample is that the respondents must have taken at least one trip to the site. But, the sample will not reflect the true population and hence those that visit the site more frequently than others will most likely be to be sample visitors. Since, the sample is not reflective of the population, the conditional mean is not reflected by E(Y/X). So, it is important to correct this endogenous stratification problem and to do so, we can employ zero-truncated poisson regression model of which probability density function is of the form,

$$\text{prob}(Y_i = y_i / y_i > 0, x_j) = \frac{e^{-\mu}}{(y_i - 1)!} \cdot \mu^{y_i - 1} \; ; \; y = 1,2,.. \quad (8)$$

Where, the parameter $\mu>0$. The parameter μ is both the mean and the variance of the distribution. Because it is necessary that $\mu > 0$, it is common to specify it as an exponential function:

$$\mu = \exp(X_j \beta), \quad (9)$$

Given this specification, we can then get the likelihood function in terms of the parameters β. The truncated poisson likelihood function is straightforward. We observe the number of trips each individual takes, and then use equation (8) to write the probability of observing that number of trips. Then the sample likelihood function becomes,

$$L\left(\beta / X_j, y_i - 1\right) = \prod_{i=1}^{n} \frac{\exp\left(-\exp(X_j \beta)\right) \exp(X_j \beta)(y_i - 1))}{(y_i - 1)!}$$

and the log-likelihood function is

$$\ln\left(L\left(\beta / X_j, y_i - 1\right)\right) = \sum_{i=1}^{n} [-e^{X_j \beta} + (X_j \beta)(y_i - 1) - \ln(y_i - 1)!] \quad (10)$$

4.2. Welfare measurement

The poisson model can be used to calculate the willingness to pay for access to the recreational site by taking the area under the expected demand function. The

observed explained variable is assumed to be a random draw from a truncated poisson distribution with mean μ_i. That is, each individual has a distribution of trips from which a single draw is observed. In the poisson model, all derivations are based on the expected demand function,

$$E(y_i) = \mu_i = \exp(X_j\beta).$$

If access to the recreation site were closed, then the individual would lose his/her entire consumer surplus from taking positive trips. The loss in consumer surplus can be approximated by the area under the demand curve between the individual's current price and a choke price. Formally, the consumer surplus for overall trips is given by,

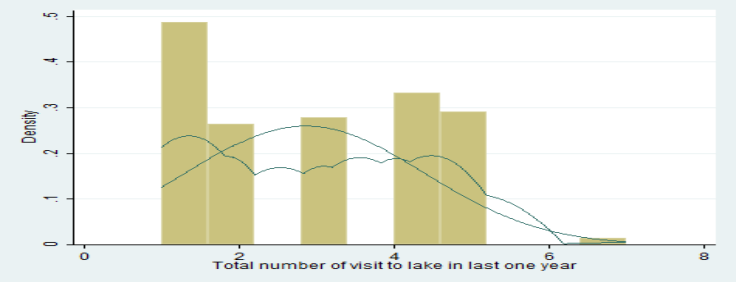
$$CS = \int_{P_{TC}^{0}}^{P_{TC}^{choke}} \exp\left(\beta_0 + \beta_{TC}\,TC + \beta_{age}\,age + \beta_{Income}\,Income + \beta_{env\ qual}\,env.quality\right) dTC = -\frac{r}{\beta_{TC}}$$

Where, r indicates the mean number of trips to the site and TC indicates travel costs.

So, consumer surplus of an individual per trip is, $CS = -\frac{1}{\beta_{TC}}$. However, total surplus can be accrued by all the visitors in a given year by multiplying total number of visitors (as reported by the Foy's lake authority) by $-\frac{1}{\beta_{TC}}$.

5. Results and Discussion

The density function of explained variable (i.e., the number of trips to the site in last one year) is always vital. To find whether a variable follows normal distribution, we can use several graphical techniques e.g., normal Q-Q plot, Normal P-P plot or non-parametric kernel density plot. From non-parametric kernel density plot, from Graph 1 (using data from field survey, 2014), it is evident that the number of trips to the site does not follow normal distribution (e.g., not a bell shaped curve).



Graph 1: *Kernel density of number of trips to the site in last one year*

For being a count variable, hence, the plausibility of application of poisson model as a count data model can be examined by exploring the explained variable (number of trips to the site in last one year). In poisson regression, it is assumed that the conditional mean is equal to the conditional variance. The failure of this assumption is like the presence of heteroskedasticity in linear regression (Montgomery *et al.,* 2001). It is observed from Table 1 (using data from field survey, 2014) that the mean and the variance are almost equal which suggests the plausibility of poisson model in this study.

Table 1. *Summary statistics of number of trips to Foy's Lake in the last one year*

Summary Statistics	Value
Mean	2.84
Variance	2.35
Skewness	0.21
Kurtosis	1.85

Moreover, the goodness of fit test using chi-square (χ^2 = 94.62, p-value = 0.89 where the H_0: data came from poisson distribution) brings testimony to apply the poisson model in this case. To estimate the consumer surplus, it is required to estimate the coefficient of travel cost and to do so a truncated poisson regression model has been used of which results are articulated in Table 2.

Table 2. *Results from truncated poisson regression model*

Variable	Coefficient $\hat{\beta}$	Robust Std. error	z-value	95% CI	
				Lower limit	Upper limit
Travel Cost	-.00017*	.0000918	-1.83	-.0003	1.18e-06
Household Income	1.01e-06	9.8e-07	1.09	-8.5e-07	2.92e-06
Age	-.0015	0.007	-0.22	-0.015	0.0122
Environmental Quality					
[Very dissatisfied[a]]	-	-	-	-	-
[Dissatisfied]	0.3239	0.636	0.51	-0.923	1.571
[Indifferent]	-0.0523	0.604	-0.09	-1.236	1.131
[Satisfied]	-0.1056	0.587	-0.18	-1.257	1.046
[Very satisfied]	0.2392	0.596	0.40	-0.930	1.408
Number of observations	120				
Prob> Chi 2	0.026				
Log pseudo likelihood	-205.54				
Pseudo R2	0.030				

Notes: * p<0.10, **p<0.05, ***p<0.01; [a]Reference value

From Table 2 (using data from field survey, 2014), it is found that the estimated coefficient of Travel Cost, is -0.00017 which is significant (at α=10%). This indicates a significant, but negative relationship between a number of visits to Foy's lake and related travel costs. This relationship conforms to the theory of demand.

Now, the consumer surplus per trip can be estimated as, $\widehat{CS} = -\frac{1}{\widehat{\beta_{TC}}} = -\frac{1}{-0.00017} = \text{BDT } 5{,}875 = \$\ 73.44$ (considering 1$ = BDT 80). In the case of estimating total consumer surplus, we need to know a total number of visitors that visit the site annually. It is reported by the Foy's lake authority that it keeps the business open for 365 days. Moreover, it is also reported that on an average, 1500 visitors visit the lake every day. Hence, a total number of visitors have been counted as 5, 47,500 annually.

So, the total consumer surplus (annually) may be estimated as,
TCS = BDT (5,875* 5, 47,500) = BDT 321, 65, 62,500 = $ 4, 02, 07,031.25 = $ 40.2 million (approx.)

6. Conclusion

The travel cost method yields estimates of the per-trip-value that visitors get from visiting Foy's lake. From these estimates, it can be said that an individual gets a estimated surplus of BDT 5,875 ($ 73.44) and the lake generates an estimated surplus of total BDT 321 million ($ 40.2 million, approx).

These calculations represent the value of access to the site by measuring the recreational value that would be lost if the lake were disappeared or, equivalently in the case of recreation, if no visitors were allowed to visit the lake. However, it will help the government to know the recreational value of the lake. Though the

lake has been leased to the Concord group since 2004 and we are yet to know the leased value, these estimates can serve as a constituent for future decision making.

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Annexure

Descriptive Statistics (Using data from field survey, 2014)

Variables	Mean	St. Dev.	Min.	Max.
Travel Cost (BDT)	1200	1084	0	5864
Income of the respondent (BDT)	52440	63260	0	300000
Educational attainment (in years)	14	2.25	10	17
Age (yrs.)	33.50	9.081	18	60
	Description	Freq.	Percent	
Gender	Male	83	69.2	
	Female	37	30.8	
Marital Status	Single	42	35.0	
	Married	77	64.2	
	Divorced	1	.8	
	Student	19	15.8	
Occupation	Gov. Employee	26	21.7	
	Private job	30	25.0	
	Businessman	31	25.8	
	NRB (Non-resident Bangladeshi)	9	25.8	
	Housewife	5	4.2	

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