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Comparison of Normal and Poisson Distribution Regressions in ITCM (Individual Travel Cost Method) Case Study: Darband Site in Tehran (Iran)

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ABSTRACT

One of the methods which were used in order to value most of recreational sites during the recent years is ITCM. The main assumption in this theory is that the costs which are being spent by an individual in order to visit a place indicate a value of that place to some extent. In this article, by using ICTM and 350 questionnaires, the recreational value of Darband over a period (one year to the end of July, 2012) was evaluated by normal and Zero-Truncated Poisson distributions.

In this paper, based on two scenarios, the variable of travel cost was calculated; in the 1st scenario, the time value which is being spent by an individual in the site did not considered in the evaluation of time opportunity cost but in the 2nd scenario, it has been considered. The results were evaluated by normal and Poisson distributions and they were shown that the regression results based on the Poisson distribution are appropriate than the regression of normal distribution.

Based on the 1st scenario, the recreational value of each visitor (for the first time) equals 12.63$ and the recreational value of the whole site is about 31.6-47.4 million dollars. In the 2nd scenario, the recreational value of each visitor (for the first time) equals 15.11$ and the recreational value of the whole site is about 37.8-57.2 million dollars that can be as an appropriate guide for the agents and the planners of municipality and also the country, Iran.

KEYWORDS: Recreational value, Individual Travel Cost Method, Darband Region, Zero-Truncated Poisson Regression.

1. INTRODUCTION

Recreation and entertainment are the important necessities of human needs and their life that they face various problems in order to satisfy them. In addition, the governments must spend more money in order to provide these needs although the bio-environment could satisfy this need to some extent. Natural parks, jungles, coastal regions and mountains are some of the places for humans' recreation which are the sources of the bio-environment.

But the value of these places is not definite for the human and this issue was resulted into the irreversible damages. The reason is that humans, sometimes, evaluate the value of everything or service based on its price, however, there is not any price for the non-marketable services of bio-environment; because the value of goods and services is being determined by the market although the market does not possess the required power and ability in order to value the non-marketable goods and services and therefore, the value of eco-system services to the humans is so less and sometimes, it equals near zero.

For this reason, the scientists of economy by using the non-marketing economical valuation methods have done so many studies and efforts in order to determine the value of services and eco-system non-marketing sources. Economical valuation is a method for evaluating the monetary value of natural services to the potential value of bio-environment sources in developmental programming, decision-making, exploitation management and how to protect the natural eco-systems (Costanza et al., 1997).

Researchers by using different types of valuation methods evaluated the value of most services of recreational sites as the extensive part of economy studies has been allocated to the valuation. By evaluating the studies which were done in this field (evaluation of non-marketing services of eco-system), we come to this conclusion that two methods as Travel Cost (CTM) and Contingent Valuation Method (CVM) have been used in this study.

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During the recent years, the economists stated that TCM is the best tool for evaluation because it is based on Revealed Preference (RP) Contingent Valuation Method (CVM); it refers that this is based on the real behavior of human (Day,2000; Curtis, 2003; Earnhart, 2003; Anderson, 2010).

As a result, this technique has been used in order to value the recreational worth of natural recreational places during the recent years and nowadays, this method is being used in most of the valuation studies (Morgan and Huth, 2010; Anderson, 2010; Blackwell, 2007; Edwards et al., 2011). TC method was used by Hotelling (1931) for the first time and then, it was developed by Clawson and Knetsch (1966).

This technique was being done as Zonal Travel Cost Method (ZTCM) although it was challenged and the individual travel cost has been used as an appropriate option. In this method, an inverse relationship between travel costs and the visits' numbers of visitors for the chosen site in a determined time interval (as a particular year) was used and the travel demand function for that region was evaluated and then the consumer surplus is being estimated as a proxy for the total value of the recreation site.

Based on this, in this study, it has been tried to evaluate the recreational value of Darband site (in Tehran) by using an Individual Travel Cost Method (ITCM) as one of the most important methods of non-marketing valuation of environmental services. Therefore, the main purpose of this study is to evaluate the recreational value of Darband site and by using the Individual Travel Cost Method (ITCM), at first, the function of travel demand must be evaluated.

Also, the other purpose of this study is to select the appropriate distribution in order to estimate the travel demand function among two distributions; normal and Poisson. Indeed, in this study, we try to answer this question; which distributions is appropriate in order to value the natural recreational places by using the Individual Travel Cost Method (ITCM).

In this method, visiting this site and collecting the related questionnaires are required. In this paper, questionnaires were provided, distributed among three months (May, June and July of 2012) between visitors and then estimated by the regression relationships of travel demand function. In these questionnaires, the individuals must express the number of their visits to the chosen site during a last year. In addition, the total amount of travel costs and their socio-economical properties are being asked from the visitors.

Shaw (1988), in a theoretical article, evaluated the limitations of Individual Travel Cost Method (ITCM) and says that in this method, the Count data models must be used and based on this model, he suggests the Poisson distribution.

Amoako-Tuffour and Martinez-Espineira in 2008 in two articles evaluated the recreational value of National Park, Gros Morne, in Canada by using the Individual Travel Cost Method (ITCM). They studied time valuation in travel cost method in one article and in the other one; they studied the difference of single-purpose sites with multi-purpose sites. And also Anderson in 2010 studied the economical value of Ice Climbing in Hyalite Canyon by using Individual Travel Cost Method(ITCM) which equals about 76-135 $ for each visit.

Morgan and Huth in 2011 estimated Willingness to pay (WTP) for each visit of Cave Daving (about 52-83 $) by using the Contingent Valuation Method (CVM). Also these researchers in the other article estimated the recreational value and its total value for each visit of visitors by using the Individual Travel Cost Method(ITCM) and Poisson distribution which are about 46-167 $ and 575000 $, respectively.

Mwebaze and Bennett in 2011, by using the Individual Travel Cost Method (ITCM) and Contingent Valuation Method (CVM), were estimated the recreational value and Willingness to pay (WTP) of visitors for three parks in Australia which are about 96.6 million dollars and 3-4 $, respectively.

Edwards et al., in 2011 were estimated the economical value of wing migratory shorebirds on the Delaware Bay by using count data model (equals 582-131 $ (in 2008)), but in the other article in 2010 and also by using the Contingent Valuation Method (CVM), this value was about 66-90 $ for the daily visits and 200-425 $ (2008) for the nightly visits.

2. EVALUATION METHOD

Theory of travel cost was taken from the demand rule. Travel demand function from a conditional maximum is presented as the following:

$$Max\ U = U(X, v, q) \quad (1)$$

$$\text{s.t.} \quad w.T_w = X.P_x + P_v.v \quad (2)$$

Where X = individuals' consumption of private goods; V = number of visits during a recent year and q = site's quality based on the visitors' viewpoint. Also, W = wage rate in an hour; T_W = time interval which is being passed by a person for working; P_x = price of private goods; and P_v = the expenses of visitors for each visit of the site. After solving this problems (conditional maximum), the travel demand function is being obtained in which the number of visits is a function of travel expenses, vector of social properties (as age, gender, etc), monthly expense or income of visitors and site's quality based on the view of visitors.

$$V = f(P_v, y, z, q) \quad (3)$$

In this function, P_v is the cost or expenses of each visit (TC) which is accounted as the following:

- ✓ Travel costs to the chosen site (transportation costs).

- ✓ the expenses of each individual in this site as expenses of recreational services, entrance, parking and ... .
- ✓ costs of time opportunity.

$$TC = RTTC + OnEXp + OcTime \qquad (4)$$

Calculating the cost of time opportunity is one of the ambiguous points in ITC method and for this reason, there are various discussions among the researchers and economists. The time which is being passed by an individual in order to visit a site consists of these two points:

- ✓ travel time (time which is being passed in order to go to the site and come back from that site),
- ✓ Time spent on site (time which is being passed or spent by a person in the site).

Now the question is that in estimating the time opportunity cost, which cases must be considered? In this way, some economists believe that calculating the time opportunity cost in not needed in travel cost method (Ward and Beal, 2000) but the other economists said that travel time to the site must be considered in estimating the time opportunity cost and if it is ignored, CS will be less than the real value (Allen et.al, 1981).

Some of the researchers believe that travel time and the time which is being spent by an individual in the chosen site must be considered in evaluating the time opportunity cost (Smith et.al, 1983; McConnell, 1992). The next question is that how we can value the time?

Researchers consider a rate of hourly wage for this case and this rate is between 0 and 1. They discussed about the appropriate rate and used different rates but (%0.33=) 1/3 is the most common rate (Gürlük and Rehber, 2008; Englin and Cameron, 1996; Morgan and Huth, 2010).

Then the travel demand function to the chosen site, by considering the related variables in this study will be evaluated which is being shown in the below equation:

$$Trip = f(TC, Age, DumGender, DumMarried, DumEmp, Ledu, AvMI, Q) \qquad (5)$$

The information of these variables was collected from the questionnaires consist of 14 socio-economical questions. The definition of descriptive variables and statistics was presented in table (1):

Table 1: Variable definition and descriptive statistics (n=385)

Variable	Definition	Mean	Std. dev.	Min	Max
Trip	Number of trips undertaken in the last year	6.53	6.63	1	40
TC1	Travel cost	14258	7385.25	1945.09	56141.73
TC2	Travel cost	1690.9	7572.59	4353.56	58718.69
Age	Age of respondent	32.2	10.91	17	73
DumGender	=1 if male	0.64	0.48	0	1
DumMarried	=1 if married	0.45	0.499	0	1
DumEmp	=1 if employed	0.55	0.498	0	1
Ledu	Level of education	3.98	0.87	1	6
AvMI	Average monthly income	752597.4	376723.1	500.000	2000000
Quality	Level of Quality	3.6	0.83	1	5

Source: Authors' computation

Prior to estimating the travel demand function, considering the dependant variable (number of visits) is essential, because in this variable, there are properties which are important and if we ignore them, our estimates will be skew.

The first point in this case is that in order to evaluate it, using the common econometric method means Ordinary Least Square (OLS) (1) is not possible and for using this method, the distribution of this variable must be normal and in order to follow the normal distribution, the numerical variable must be continuous; however, the visits' number of a variable is not continuous and for this reason (instead of using the normal distribution), count data models will be necessary and one of the appropriate distributions which was used by Shaw in 1988 in ITCM method is Poisson method.

In this distribution, the dependent variable is a positive (non-negative) non-decimal number (Y=0,1,2,….) as count data model (Grogger and Carson, 1991; Cameron and Triviedi, 1998). The main point in this case is that the evaluation method is Maximum Likelihood (1) and the form of this distribution is like this:

$$Pr(y_i = n) = f(n, X_i\beta) \qquad ; n = 0,1,2,\ldots \qquad (6)$$

$$Pr(y_i = n) = \frac{e^{-\lambda_i}.\lambda_i^n}{n!} \qquad ; n = 0,1,2,\ldots \qquad (7)$$

And its average and variance will be as the following and they are equal:

$$E(Y/X) = Var(Y/X) = \lambda \qquad (8)$$

But the other main point is that; since the questionnaires were filled out by the visitors inside the chosen site, therefore, the dependent variable won't be zero but based on equation (8), this variable in Poisson distribution will be from 0. So, using the normal form of this distribution leads into the skewness results and we should use it as Zero-Truncated method. As a result, the functional form of this model in these two distributions will be as Log-Lin which shows that the dependant variable is a positive number:

$$\lambda = E(y/x_i) = exp(x_i\beta) \qquad (9)$$

Where, x_i is a vector of effective variables on the visit-number of visitors and β refers to parameters' vector. Based on the considered variables in this study, the visit demand function will be as the following:

$$Trip = exp(\beta_1 + \beta_2.TC + \beta_3.Age + \beta_4.DumGender + \beta_5.DumMarried + \beta_6.DumEmp + \beta_7.Ledu + \beta_8.AvMI + \beta_9.Q) \quad (10)$$

By taking the natural logarithm from these two sides, the above mentioned equation will be rewrite as the following:

$$Ln(Trip) = \beta_1 + \beta_2.TC + \beta_3.Age + \beta_4.DumGender + \beta_5.DumMarried + \beta_6.DumEmp + \beta_7.Ledu + \beta_8.AvMI + \beta_9.Q \quad (11)$$

After estimating the travel demand function, evaluating the consumer's surplus by integrating from this function is necessary as this relation:

$$CS = \int_{TC^*}^{\infty} Trip.dTC \quad (12)$$

$$CS = \int_{TC^*}^{\infty} exp(\beta_1 + \beta_2 TC + \cdots).dTC \quad (13)$$

At the end, the consumer's surplus for each visit as an absolute-value will be equal with an inverse of travel cost variable coefficient:

$$CS_{per\ trip} = -\frac{1}{\beta_2} \quad (14)$$

In order to evaluate the whole recreational value of the site, we should multiply the consumer's surplus (for each visit) in the whole number of visits during a particular period:

$$CS_{annual} = CS_{per\ trip} * Trip = \left(-\frac{1}{\beta_{TTC}}\right) * Trip \quad (15)$$

By considering that the effect of travel costs on the number of visits is an inverse relation, therefore, the travel cost variable coefficient is naturally negative and by a negative mark on it, the consumer's surplus will be a positive number.

3. RESULTS

In order to evaluate the travel cost function, at first, the questionnaires consist of 14 socio-economical questions were provided and then were distributed among the visitors of this site. The sample volume in this paper is about 300 subjects. After distributing the questionnaires, the required information was collected.

In order to estimate the time opportunity cost, at first the time valuation was done (without considering the travel time of an individual in the chosen site) and by using the two motioned distributions (Normal and Zero-Truncated Poisson), the value of this model was estimated and models no.: (1) and (3) show the results of related evaluations, respectively.

Then, this time was considered in order to estimate the time opportunity cost and for these two distributions, models no.: (2) and (4) were nominated. Also for time valuation, this rate, 0.33, was used. The results of these evaluations were presented in table (2):

Table 2: evaluation of travel demand function to Darband and calculation of visitor's surplus[1]

Variable	(1)	(2)	(3)	(4)
Constant	3.11288 (1.11)	1.60884 (0.58)	1.31610*** (7.25)	1.07220*** (6.07)
TTC	-0.00002076*** (-4.53)	-0.00001892*** (-3.86)	-0.00000402*** (-11.40)	-0.00000336*** (-9.29)
Age	0.02205 (0.53)	0.0278 1 (0.67)	0.00297 (1.15)	0.00363 (1.40)
DumGender	-1.21320* (-1.75)	-1.26024* (-1.80)	-0.17818*** (-4.16)	-0.18815*** (-4.39)
DumMarried	-1.381439* (-1.73)	-1.43634* (-1.79)	-0.20697*** (-4.15)	-0.21356*** (-4.25)
DumEmp	-0.23618 (-0.31)	-0.36764 (-0.48)	-0.04942 (-1.03)	-0.06450 (-1.34)
Ledu	0.02962 (0.07)	0.19482 (0.45)	0.00823 (0.31)	0.03323 (1.28)
AvMI	$3.06e^{-06}$*** (2.85)	$3.96e^{-06}$*** (3.45)	$4.25e^{-07}$*** (6.88)	$5.68e^{-07}$*** (8.53)
Quality	1.32870*** (3.34)	1.42352*** (3.57)	0.23164*** (8.54)	0.24370*** (9.02)
R^2	0.1294	0.1168		
Adjusted R^2	0.1108	0.0980		
Pseudo R^2			0.1133	0.0981
F statistic	6.98	6.32		
Log Likelihood	-1247.396	-1250.1480	-1426.0849	-1450.4954
Jarque-Bera	1085.1441	1032.5738		
CS per trip	48169	52854	248756	297619

Source: Authors' Computation

Note: the numbers in the brackets for models no.: 1 and 2 and also for 3 and 4 show t and z statistic, respectively.

*, ** and *** denote significance at 10, 5 and 1% level respectively.

[1] The results are obtained by Stata11

After evaluating the travel demand function of Darband, estimating the consumer's surplus for each visit is necessary as for the first model, second one, third one and for the fourth one, it equals 48169 Rials (2.44$), 52854 Rials (2.68 $), 248756 Rials (12.63$) and 297619 Rials (15.11$), respectively. Then, this number in order to determine the total recreational value of this site must be multiplied in the total number of visits during a particular year.

And due to the lack of required statistics in this case, assumed scenarios were used; by considering that Darband is a recreational place and the number of visits to this place is so high as most Tehranian people prefer this place during a particular year, so we assumed that during this time interval, most people from Tehran visit this site as 0.2, 0.25 and 0.3, respectively (the population of Tehran based on the statistics is about 12505705 individuals). Therefore, the recreational value (total value) of this site will be as the following:

Table 3: total value (recreational value): Rials

	0.2	0.25	0.3
Model (1)	120477460829	150596813994	180716215328
Model (2)	132195306414	165244119804	198292986048
Model (3)	622173830596	777717226056	933260870272
Model (4)	744387083279	930483779694	1116580773728

Source: Authors' Computation

Based on table (3), the recreational value of this site in the 1st model, 2nd model, 3rd one and in the 4th one is about 120-181 milliard Rials (6.1-9.2 million dollars), 132-199 milliard Rials (6.7-10.1 million dollars), 622-934 milliard Rials (31.6-47.4 million dollars), 744-127 milliard Rials (37.8-57.2 million dollars), respectively.

4. CONCLUSION

By considering the above mentioned points, dependant variable in travel cost method is the visit-number of visitors during a particular year which is a non-continuous number and it is not possible to use the common econometric method means Ordinary Least Square (OLS), and instead we should use the distributions like Poisson in which the evaluation method is the maximum likelihood method.

On the other hand, since the questionnaires are being filled by the visitors inside this site, therefore, the dependant variable won't be zero (0) and we should use the Zero-Truncated distribution. At the end, this model is being evaluated by Zero-Truncated Poisson Regression and the recreational value (total value) of this site for one model will be 31.6-47.4 million dollars and for the other one will be 37.8-57.2 million dollars (based on the prices of 2012 and by using this relation; 1 dollars = 19700 Rials in July). Then, the results will be as the following:

1- The researcher in order to evaluate the recreational value of places like Darband by using the travel cost method must consider the dependant variable as a non-continuous one; and when he (she) wants to use the Ordinary Least Square (OLS), one of the main assumptions is that the distribution of dependant variable must be normal but in the studies related to the Individual Travel Cost Method (ITCM), this assumption is being rejected and the regression must be evaluated by the non-continuous distributions a Poisson. Therefore, there are considerable differences between the results and in a case of normal distribution and Ordinary Least Square (OLS) method; the results are associated with high skew.

2- Based on the resulted number, it can be concluded that Darband is a valuable site for the visitors and this results was taken from their real behavior. These results can be as a good guide for the planners, and decision makers of municipalities and also Iran.

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