WILLINGNESS TO PAY FOR DRINKING WATER CONNECTIONS: THE CASE OF LARESTAN, IRAN

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Abstract

Water scarcity in Iran has reached a level that calls for the attention of all stakeholders including water consumers. While government as water distributor has made significant efforts in managing water at the supply side, an annual average rainfall of 251 mm (Iran Meteorological Organization, 2008) limits the capacity of this supply-side approach. As a result, policy efforts have increasingly turned towards demand management approaches. The objective of this paper is to estimate drinking tap water demand for the households in Larestan. We determine the willingness to pay (WTP) for drinking taps water connections by the Larestan's households, using contingent valuation method (CVM). We use data from 320 randomly selected households in Larestan, Iran. Our findings show that, once drinking tap water connected, the households are willing to pay US$0.24 on average in addition to their monthly charge for per cubic meter water consumed.

Key words: *willingness to pay (WTP), contingent valuation method (CVM), tap water demand, Larestan, demand-side approach.*

1. INTRODUCTION

The ability to put a value on natural resources like recreation, national parks, water, etc. is a difficult task; especially valuing water, which is the most crucial component of human life, often leads to controversies.

The use of non-market valuation has been proposed (Young, 1996; Hanemann, *et* al., 1991) as one method to value environmental goods. One of those valuation methods is contingent valuation and it has been applied to water-related studies in different parts of the world (Whittington *et al.*, 1993; 2002 and Gnedenko *et al.*, 1998). Whittington, *et al.*, (1993) applied contingent valuation method (CVM) to estimate the WTP for improved sanitation services of 1200 randomly selected households in Kumasi, Ghana. The study found that the majority of households were willing to pay more for improved sanitation services than what they were currently paying for those services at that point in time.

Whittington *et al*., (2002) carried out a contingent valuation analysis to estimate the WTP for improved water supply in the Kathmandu Valley, Nepal. Among those households connected to the distribution channel, their study found a mean monthly WTP of $14.31 for the rich and $11.11 for the poor. For those households not connected to the distribution channel, the mean monthly WTP was $11.67 for a private connection and $3.19 for shared connection, while the mean monthly WTP was $8.61 for a private connection and $3.33 for a shared connection among the poor sub-sample of this group. Studies on water show that the urban poor face higher prices than the rich because they get their water from different sources including private vendors, who are likely to charge higher prices than the water utilities (Faruqui *et al.,* 2001).

Also another study has carried out in Novgorod region (Russia) in February, 1998 (Gnedenko, E, *et al.,* 1998). This study has shown that, on average, a household's WTP for drinking water quality improvement in typical small Russian town makes up to 2% of household's income. This estimate seems to be close to the analogous estimates of the World Bank for some developing countries.

Background of Drinking Water Provision to the household of the Water Market in Larestan

Larestan region is one of the most underprivileged regions of country in the field of drinking water resources and during the history has been suffered form water shortage. People of past ages have solved some of their problems related to annual water shortage, by using their inherent talents in pool construction, tap mouth and ghanat. But however they still have problem. Now using pools is an ordinary affair and although it is not a clean water but they have no other choice. However, Water Supply Company of city of Larestan has been under use since 1959, and developed in 1961, and completed with aid of General Department of Building and Urbanism of Fars province in 1971. But unfortunately despite all of performed actions, now this with a population more than 54688 peoples (Statistical

Center of Iran, 2006) has not good water supply condition; people still suffer form water salinity and Water Organization with establishing drinking water stations in some districts of city has tried to solve citizen's problems so that now people are going to these districts to secure water.

The objective of this paper is to estimate drinking tap water demand for the households in Larestan. We determine the willingness to pay (WTP) for drinking taps water connections by the Larestan's households, using contingent valuation method (CVM).

We use data from 160 randomly selected households in Larestan, Iran. Our findings show that, once drinking water connected, the households are willing to pay US$0.24 on average in addition to their monthly charge for per cubic meter water consumed.

2. METHODOLOGY

The choice of method for valuing non-marketed goods depends on its computational ease and the problem to be studied. The CV method was originally proposed by Ciriacy-Wantrup (1947) who was of the opinion that the prevention of soil erosion generates some 'extra market benefits' that are public goods in nature, and therefore, one possible way of estimating these benefits is to elicit the individuals' willingness to pay for these benefits through a survey method (see Portney, 1994; Hanemann, 1994). However, Davis (1963) was the first to use the CV method empirically when he estimated the benefits of goose hunting through a survey among the goose-hunters. This method gained popularity after the two major non-use values, namely, option and existence values have been recognized as important components of the total economic values in environmental economics literature, especially during the 1960s. While the conventional revealed preference methods such as travel cost method are not capable of capturing these non-use values (Smith, 1993), the only method that is identified for estimating these values is the contingent valuation method (CVM) (see, Desvousges et al., 1993).

The use of CVM for measuring WTP for social projects is well accepted and widely used in many different circumstances in developing countries. However, there is a very large part of the literature in CVM which discusses the "accuracy" of CVM.

There are various ways of classifying the nature of the biases that may be presented in the CVM. These include strategic bias (see Prince et al. 1992; Brookshire et al. 1976; Rowe et al. 1980; Hoehn and Randall 1987; Milon 1989; Bergstorm et al. 1989; Mitchell and Carson 1989; Evans and Harris 1982), design bias (see Boyle et al. 1986), vehicle bias (see OECD 1995), information bias (see Hoehn and Randall 1976; Boyle 1988; Bergstorm et al. 1989; Whitehead and Blomquist 1991; Hanley and Munro 1994), hypothetical bias (see Bishop et al.

1983; Thayer 1981), starting point bias (see Boyle 1985; Randall et al. 1983), and operating bias (see Cummings et al. 1986).

Obviously, it is possible that some biases may exist when using the CVM. These biases are due to the hypothetical nature of the approach. Nevertheless, careful survey design is necessary to control these sources of bias. The study here attempted to control certain biases.

There are two bidding procedures used in CVM, known as the single-bounded and double-bounded dichotomous choice models respectively. The single-bounded model approach recovers the bid amount as a threshold by asking one dichotomous choice question, while the double bounded offers a second bid following the response to the first bid (Hanemann *et al.,* 1991). Whether the single-bounded is the best method than the double-bounded remains an empirical question. Hanneman *et al.,* (1991) applied both the single- and double-bounded CVM to compare their statistical efficiency. They estimated WTP for protecting wildlife and wetlands habitat in California and found that the double-bounded dichotomous CVM was statistically more efficient than the single-bounded model.

Herriges and Shogren (1996) used a double bounded DC model in which the respondents combined their prior WTP with the first bid amount to form a revised WTP. They compared their results with the initial single bounded DC model and concluded that a single bounded model is the best to estimate WTP in the presence of anchoring bias. However, once they controlled for the anchoring effect, there was little improvements in the results in terms of small efficiency gains.

According to Ready *et al.,* (1996), analysts phrase the valuation question to generate information about the respondents' compensating variation for the increase in the level of provision. In the real world, consumers face prices with limited budget constraints, while contingent valuation makes use of a hypothetical market. It is therefore, important to accurately reflect the terms of the hypothetical market for the particular good being surveyed.

The model most appropriate to analyze the responses to our WTP bids is the conventional of obtaining a "no" or a "yes" response as presented in equation (1):single-bounded dichotomous CVM by Hanneman et al., (1991). This model states the probability:

$$\begin{aligned} \pi^{n}(B) &= G(B;\theta) \Leftrightarrow \Pr\{B > WTP_{\max}\} \\ \pi^{y}(B) &= 1 - G(B;\theta) \Leftrightarrow \Pr\{B \le WTP_{\max}\} \end{aligned} \tag{1}$$

Where $\pi^{n}(B)$ and $\pi^{y}(B)$ is the probability of a "no" and a "yes" response respectively, $G(B;\theta)$ is the cumulative distribution (CDF) of the individual's true maximum WTP, with a parameter vector θ , B is the ultimate bid and $WTP_{\max}$ is the true maximum WTP. Equation (1) implies that consumers are willing to pay a price if the bid is below the true maximum amount they are willing to pay and they are not willing to pay if the bid is higher. According to Hanneman *et* al., (1991), this statistical model can be interpreted as a utility maximization response, within a random utility context.

Theoretically, a logit model can be used to estimate the mean and median values of limited dependent variables (Mittelhammer, 2000; Maddalla, 1983). The logistic model can be presented as follows:

$$P(y=1)=\frac{\exp(X_i.\beta)}{1+\exp(X_i.\beta)} \tag{2}$$

Where *P(Y =1)* shows the probability of obtaining a yes, X_i is a row vector of exogenous variables, and β is a column vector of unknown coefficients. Li *et al.*, (2002) used the model given in equation (3) to estimate the WTP for genetically modified (GM) food products in China.

$$WTP_i = \alpha - \rho B_i + \lambda' Z_i + \varepsilon_i \tag{3}$$

Where *WTP* is the WTP function for GM foods, *B* is the ultimate bid offered to each respondent, *Z* is a vector of individual characteristics, and α, ρ, λ are vectors of unknown coefficients and ε_i is the identically, independently distributed random variable with zero mean, with *i* representing the number of respondents.

3. STUDY DESIGN AND DATA

This study utilizes the DC questionnaire to measure the individual's WTP in the CV surveys. It involves assigning a single bid from a range of predetermined bids that potentially reflect the maximum WTP amounts of the respondents for a particular good. The respondents are asked to state only "yes" or "no" to that bid on an all or nothing basis (Hadker et al., 1997; Venkatachalam, 2003).

The single-bounded dichotomous choice questionnaire, therefore, was designed for acquiring individual WTP to determine the existence value for drinking tap water in Larestan. This questionnaire for interviews was carefully designed to provide respondents with adequate and accurate information, making them fully aware of the hypothetical market situation. This information from the CV questionnaire was intended not only to help them reveal their true values as accurately as possible, but also to reduce the rate of rejection from the respondents (Hadker et al., 1997).

We ask respondents their willingness to pay for individual drinking tap water connections in a bidding game format, starting with the highest offer of 4000 RIALS per cubic meter followed by 3000 RIALS and finally 2000 RIALS. In our study, we use a starting value of 4000 RIALS based on the maximum value of 4000 RIALS paid by households at present (note that this procedure might lead to starting point bias in responses to the WTP question). From the questionnaire data, we know which of the following four WTP intervals each respondent would fall in: pay at least 4000 RIALS, pay 3000 RIALS but not 4000 RIALS, pay 2000 RIALS but not 3000 RIALS, and, unwilling to pay 2000 RIALS (no to all three bids). For our WTP estimation, we use this observed data to generate a synthetic data set by posing a hypothetical single bounded CV question to each respondent. We divide the sample into three equal sub-sets and determine whether each household would respond yes or no to a bid of 4000 RIALS, 3000 RIALS, or 2000 RIALS. Thus, a person in the second interval above would say no to 4000 RIALS, but yes to 3000 RIALS or 2000 RIALS.

The paper uses primary data on a sample of 320 randomly selected households in Larestan, collected between February and March of 2008. Data on all the variables used in the model are collected from the individual households in face-to-face interviews. Table 2 presents the variables used in the model.

Variable Name	Description
WTP	A dummy variable indicating whether respondents are willing to pay to get tap water connections. WTP = 1, if yes, = 0 if no The amount of money the consumer is willing to pay per month, in addition to his or her current monthly charges for water, once connected.
Bid	The amount of money the consumer is willing to pay per month, in addition to his current monthly charges for one cubic meter of water
Income per capita	The respondent's level of income over family size (Iran Rial)
Age	Age of the respondent
Distance	The distance respondent walk to the water point (Kilometer)
Time	Time consumed for water collection (minute)
Trip	Number of trips for water provision in a month
education	The level of respondent’s education (1 to 5)
House	House size (m^3)

Table 1: *Description of Variables*

4. EMPIRICAL MODEL OF WATER DEMAND

There are three methods to compute the value of WTP: the first method, called mean WTP, is to calculate the expected value of WTP by numerical integration, ranging from 0 to $+\infty$; the second method, called overall mean WTP, is to calculate the expected value of WTP by numerical integration, ranging from $-\infty$ to $+\infty$ and the third method, called truncated mean WTP, is to calculate the expected value of WTP by numerical integration, ranging from 0 to maximum bid. The last method however, is preferable because it satisfies consistency with theoretical constraints, statistical efficiency and ability to be aggregated (Duffield and Patterson, 1991). Thus, the truncated mean WTP is used in this research. The logit model is then estimated using the maximum likelihood (ML) estimation method, the most common technique for estimating the logit model. Once the parameters have been estimated using the ML method then the expected value of WTP can be calculated by numerical integration, ranging from 0 to maximum bid (B) as follows:

$$E(WTP) = \int_{0}^{\max B} \frac{\exp(\alpha' + \beta B)}{1 + \exp(\alpha' + \beta B)} dB = \int_{0}^{\max B} \frac{1}{1 + \exp[-(\alpha' + \beta B)]} dB \quad (4)$$

Where E (WTP) is the expected value of WTP, and α' is the adjusted intercept which was added by the other term to the original intercept term of α ($\alpha' = \alpha + \delta X_i$).

Logit models may be estimated with either linear or logarithmic functional forms in measuring both use and preservation values. However, the linear-logit model were employed in this study because the linear functional form was much easier to compute mean WTP.

The WTP model for water connections in Larestan is presented in equation (5).

$$WTP_i = \alpha + \beta B_i + \delta X_i + e_i \quad (5)$$

Where WTP_i is the WTP function for household *i*, *B* is the bid offered to each household, X_i is the vector of individual attributes defined as X_i = *{Age, Income per capita, Distance, Trip, Time, education, House}*, α, β, δ are vectors of unknown coefficients, e_i is the identically, independently distributed random variable with zero mean and *i* represents the number of households.

Statistical analysis of variables, estimating parameters of logit model and mathematical calculations are carried out by SPSS, Eviews and Maple softwares, respectively.

5. INTERPRETATIONS OF RESULTS

First we prepared 320 questionnaires and filled them through direct interviewing with the respondents. All of these questionnaires are filled during the period of February and March of 2008. 292 pieces of these questionnaires were accepted and what was remaining eliminated due to incorrect and unrelated answers.

Due to the hard condition of drinking water provision and also people cultural and religion characteristics, almost all the people who refer to tank are men and as a result all the respondents were men. 91.1 percent of respondents were caretaker of family. All the respondents are 23 years old or older and 16 of them were illiterate, 34 have primary education, 64 guidance education, 106 have diploma and 72 have bachelor and higher education.

Average of family dimension was 4.3 people and average of drinking water consumption of families under question was 75.27 liters per week.

Now for per two months 133 people of respondents are paying less than 50000RLS. 57 people between 50000 to 100000RLS. 57 people between 100000 to 1500000RLS, and finally 45 people are paying more than 1500000 RLS. According to questionnaires, 40 families have less than 40 liters water consumption per week. At the same time 142 families have water consumption between 40 to 80Li., 64 families between 80 to 100Li., and finally 46 families have more than 100Li. Water consumption.

Eq. (6) shows the expected value of mean WTP, which represents the existence value of the drinking tap water. It was calculated by numerical integration, ranging from 0 to maximum bid (Eq. (4)) after parameters from logit models were estimated using the ML method (Table 2). The socioeconomic term of δ was estimated and added to an adjusted intercept together with the original intercept term of α:

$$\int_0^{4000} \frac{1}{1+\exp[-(2.51+0.001\times B)]}\,dB = 2399.7 \text{ RIALS} \approx \text{US\$}0.24 \qquad (6)$$

The median WTP of about 2399.7 RIALS indicates that, on average, water consumers in Larestan are willing to pay 2399.7 RIALS for drinking tap water connections in addition to their monthly water consumption. Though this bid is supported by the data, and it falls within the interval of 2000 to 4000 RIALS offered as the bid. Table 2 presents the general results of the WTP function.

From the interview responses, 69.2% of the respondents were willing to pay a bid to get drinking tap water connections. The results from the model given in equation (6) are presented in table 2.

Variable	Coefficient	Z-value	P-value
Intercept	0.183	0.149	0.882
Bid	-0.001	-4.345	0.000
Income per	0.000	5.130	0.000
education	0.700	4.933	0.000
Age	-0.030	-1.907	0.057
Distance×Trip	0.015	2.682	0.007
Time	0.021	2.528	0.012
House	0.002	1.689	0.091
Log likelihood		-114.14	
Percent of right prediction		75.88	
McFadden R^2		0.367	
Probability(LR stat)		0.000	

Table 2: *WTP results*

The results show that an increase in the bid reduces the consumers' WTP for connections, which is consistent with theory and previous studies (Li, *et al.,* 2002). All variables are significant at 90% significance level and the coefficients shows that increases in the level of income, level of literacy, the distance walked to collect water, and number of trips to collect water, and time takes to reach tank and decrease in respondent's age increase consumers' WTP for connections. The impacts of income and age on WTP is consistent with other studies (Li *et al.,* 2002; Loureiro *et al.,* 2001). WTP for connections increases with the difficulty of drinking water provision. The longer it takes to collect water (more distance, more number of trips to collect water and time takes to reach tank), the more the consumers are willing to pay for connections. This is in line with findings from the primary survey, where consumers indicated that they would rather pay for connections instead of walking a distance. The P-values shows that we have enough evidence to reject the hypothesis that all the coefficients are zero.

6. CONCLUSION

The paper estimates demand for drinking tap water in Larestan, Iran. Using CVM, we find that on average, consumers are willing to pay about 2399.7 RIALS in addition to their monthly water charge to get drinking water connected to their homes. This amount falls within the range of 2000 RIALS to 4000 RIALS offered as ultimate bids and it also falls within the range of 2100 RIALS to 3700 RIALS currently paid by most of the households.

An increase in the bid offered to households reduces the WTP for connections, which is consistent with theory and other findings (Li et al., 2002). Variables, such as income per capita, level of literacy, the distance walked to collect water, numbers of trips to collect water and time takes to reach tank have positive impacts on the households' WTP for drinking tap water connections. At the same time variable age has a negative impact on it. This is in line with previous findings and findings from the survey.

A median WTP of about 2399.7 RIALS in addition to monthly charges indicates that the households are willing to pay more than they are currently paying, to get individual drinking tap water connections. If the policy makers take affordability and demographic characteristics of the households into account, maybe an additional US$0.24 a month is not so cheap to the households, given their average reported income of 3756849 RIALS a month.

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