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Estimating the Value of Drinking Water for the Households in Larestan by Using a Contingent Valuation Method

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Water scarcity in Iran has reached a level that calls for the attention of all stakeholders including water consumers. While the government as water distributor has made significant efforts in managing water on the supply side, an annual average rainfall of 251 mm limits the capacity of this supply-side approach. As a result, policy efforts have increasingly turned towards demand management approaches. The subjects of this research are the determination of existence value of drinking water for the households in Larestan, and a measure of an individual's willingness to pay (WTP) based on Contingent Valuation Method (CVM) and dichotomous choice (DC). The logit model was used for measuring the individuals' WTP. Estimation parameters of the model are based on the method of maximum likelihood (ML). We used data from 320 randomly selected households in Larestan, Iran. Our findings show that once drinking tap water is connected, the households are willing to pay an average of US$0.24 (per cubic meter) in addition to their monthly charge for the water consumed.

Keywords: willingness to pay (WTP), contingent valuation method (CVM), tap water, Larestan, demand-side approach.
JEL Classification: C25, D12, Q21, R22.

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

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the most crucial component of human life that 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, which 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 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. Their study found a mean monthly WTP of $14.31 for the rich and $11.11 for the poor (among those households connected to the distribution channel). 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 was carried out in the Novgorod region (Russia) in February, 1998 (Gnedenko, E, *et al.,* 1998). This study shows that, on average, a household's WTP for drinking water quality improvement in a 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 Iran in the field of drinking water resources and has often suffered from water shortage. In the past people have used pool construction, tap mouth and ghanat to deal with water shortages. Although pool is not clean and safe, it is often used as there is no other choice. The water Supply Company of the city of Larestan was set up in 1959, and completed with the aid of the General Department of Housing and Urbanism of the Fars Province in 1971. But unfortunately, despite all the above mentioned developments, the city with a 54,688 population (Statistical Center of Iran, 2006) still suffers from water salinity. The Water Organization has tried to solve the citizens' problems by establishing drinking water stations in some districts of the city, so people go to those districts to secure water.

The subjects of this research are the determination of existence value of drinking water for the households in Larestan. We determine the willingness to pay (WTP) for drinking taps water connections by the Larestan households, using contingent valuation method (CVM).

We use data from 320 randomly selected households in Larestan, Iran. Our findings show that once drinking water is connected, the households are willing to pay an average of US$0.24 per cubic meter in addition to their monthly charge for 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 that 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 were 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 asked respondents their willingness to pay for individual drinking tap water connections in a bidding game format, starting with the highest offer of 4000 RLS per cubic meter followed by 3000 RLS and finally 2000 RLS. In our study, we use a starting value of 4000 RLS based on the maximum value of 4000 RLS 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 RLS, pay 3000 RLS but not 4000 RLS, pay 2000 RLS but not 3000 RLS, and, unwilling to pay 2000 RLS (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 randomly into three equal sub-sets and determine whether each household would respond yes or no to a bid of 4000 RLS, 3000 RLS, or 2000 RLS. Thus, a person in the second interval above would say no to 4000 RLS, but yes to 3000 RLS or 2000 RLS.

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.

Table 1: Description of Variables

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	The respondent's level of income (Rial)
Distance	The distance a respondent walks to the water point (Kilometer)
Time	Time consumed for water collection (minute)
Trip	Number of trips for water provison in a month
Education	The level of a respondent's education
House	House size (m^3)

4. Empirical Model

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, 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:

$$(4)\quad E(WTP) = \int_0^{\max B} \frac{\exp(\alpha' + \beta B)}{1 + \exp(\alpha' + \beta B)} dB = \int_0^{\max B} \frac{1}{1 + \exp[-(\alpha' + \beta B)]} dB$$

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 = *{Distance, Income per capita, Time, Trip, 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 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 questionnaires were accepted and the nest was remaining eliminated due to incorrect and unrelated answers.

Due to the hard condition of drinking water provision and also cultural and religious norms, almost all the people who collect water are men and as a result all the respondents are men. 91.1 percent of respondents are the head of family. The respondents are 23 years old or older 16 are illiterate, 34 have primary education, 64 high school education, 106 have diploma and 72 have bachelor degree or and higher education.

The average family size is 4.3 and the average drinking water consumption of families is 75.27 liters per week. 133 people of respondents are paying less than 50000RLS. 57 people between 50000 to 100000RLS (per two months) 57 people between 100000 to

1500000RLS and 45 people more than 1500000 RLS. According to the survey results, 40 families have less than 40 liters water consumption, 142 families between 40 to 80Liters, 64 families between 80 to 100Liters, and 46 families have more than 100Liters.

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

$$(6) \quad \int_{0}^{4000} \frac{1}{1+\exp[-(2.48+0.001\times B)]} dB = 2362.6 \text{ RIALS} \approx \text{US\$}0.24$$

The median WTP of about 2362.6 RLS indicates that, on average, water consumers in Larestan are willing to pay 2362.6 RLS for drinking tap water connections in addition to their monthly water consumption. This bid is supported by the data and it falls within the interval of 2000 to 4000 RLS offered as the bid. Table 2 presents the general results of the WTP function.

From the interview responses, 69.1 percent of the respondents are willing to pay a bid to get drinking tap water connections. The results from the model in equation (6) are presented in table 2.

Table 2: WTP results

Variable	Coefficient	Z-value	P-value
Intercept	-1.33	-1.35	0.17
Bid	-0.001	-4.13	0.00
Income per capita	1.59E-06	4.2080	0.00
Distance× Trip	0.015	2.682	0.007
Time	0.021	0.021	2.528
Education	0.700	4.933	0.000
house	1.6010	3.9752	0.00
Log likelihood		-30.82	
Percent of right prediction		83.9	
McFadden R^2		0.82	
Probability(LR stat)		0.0000	

The results show that an increase in the bid reduces the consumers' WTP for connections, which is consistent with the theory and the previous studies (Li, *et al.,* 2002). The Z-value shows that increases in the level of income, level of literacy, difficulty of drinking water provision, the distance walked to collect water, and number of trips to collect water all, increase consumers' WTP for connections. The impact of income 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 and more number of trips to collect water), 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 show that we have enough evidence to reject the hypothesis that the coefficients are zero.

6. Conclusions

The paper estimates existence value of drinking tap water in Larestan, Iran. Using CVM, we find that, on the average, consumers are willing to pay about 2362.6 RLS in addition to their monthly water charge to get drinking water connected to their homes. This amount falls within the range of 2000 RLS to 4000 RLS offered as ultimate bids and it also falls within the range of 2000 RLS to 4000 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, level of current drinking water consumption, level of literacy, difficulty of drinking water provision, the distance walked to collect water, and numbers of trips to collect water have positive impacts on the households' WTP for drinking tap water connections. This is all in line with previous findings.

A median WTP of about 2,362.6 RLS 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.

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