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Willingness to Pay for Improved Quality of Drinking Water

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Abstrat

The quality of water available to households is extremely important. The present study conducts an objective assessment of willingness to pay by households for safe drinking water by contingent valuation approach. The empirical analysis demonstrates that the household's income, family size and source of water are significant determinants of the probability of the willingness to pay for drinking water.
Key words : Willingness to Pay, Contingent valuation, Elasticity, Random error, Logit model.

Water is one of the most important natural resources. It is essential for all human existence and development. Ensuring adequate supplies of safe water sources is therefore of paramount importance in relation to both environment and health issues. Among the various alternative end uses of water, its use for drinking purpose is the most important. Hence, the right to adequate safe drinking water is considered to be the most fundamental of human rights. But this goal has not been achieved, although we have entered the 21st century. More than 4.5 lakh villages do not have proper safe water sources. Though the percentage of population which has access to safe drinking water has increased from 62.3% in 1991 to 77.9% in 2001 (1), it cannot be a standard measurement unless we know the entire distribution pattern and to what extent the disadvantaged group is provided with safe water. Also an urban-rural disparity exists in the provision of drinking water in India (1).

Generally drinking water is liberally supplied to urban areas and within them to higher income groups. Poor people have to depend more on stand posts or hand pumps where the supply is unreliable and the quality is poor. A large part of the households install deep tubewells privately to pump out water from beneath. The inefficient use of water resource through deteriorating quality and depleting quantity can pose serious threat to human wellbeing and sustainable development. Overextraction of water has resulted to an even lower level of ground water thus making the resource more scarce. The basic issue that we address in the paper is that the good quality of water has emerged as a scarce resource. In such a context we set the goal to analyze people's behavior for good quality of water. Valuation of water quality is important in the context of sustainable development paradigm (2). It would be useful to know how the domestic end users value safe drinking water from their stated preference. The objective of this study is to evaluate economic value of improved water quality from consumer's point of view and analyze the main factors that influence the level of the household's potential willingness to pay (WTP) for improved quality of drinking water. The scope of the study is restricted to drinking water quality.

This type of the economic valuation is called non-market valuation. Basic element of the non-market valuation is to estimate the willingness to pay for of some economic agents for some change in the level of provision of a public good. Willingness to pay the quality change in a public good reflects the individual's preferences, so it can be interpreted as a monetary measure of the public good or service. A popular technique adopted for this purpose is the contingent valuation (CV) method in which members of the public goods users are asked in a survey (under a hypothetical market) what they would be willingness to pay for the good in question. The CV is a survey device to elicit directly from the consumer the value he or she places on a particular good or service by creating, for the respondents, an imaginary contingent market in place of a real one.

Contingent valuation is a type of constructed market. Constructed market can be hypothetical or real. The contingent valuation for the valuation of environmental goods was originally proposed by Davis (3). However, it was only after the mid-1970s that the development of the method began in right earnest (4, 5). Since then, the method has become the most widely used and the most controversial of all environmental valuation techniques. Comprehensive accounts of the method may be found in Mitchell and Carson (6), Hanley and Spash (7) and Bateman and Willis (8). James and Murty (9) have applied the CVM to estimate the existence value and bequest value of the Ganga to the urban, educated and employed population of India. Following James and Murty (9), the present study attempts to measure the willingness to pay of respondents for improved quality of drinking water. The empirical exercise, through compilation of data and application of econometric techniques, has beendone to get estimates of consumers WTP for improved water quality and the associated factors determining willingness to pay.

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Methods

The average WTP calculation for a closed ended referendum is different from that of an open ended bid. In case of an open ended bid, since exact information about maximum WTP is available, the average is calculated by using either arithmetic mean or median. For dichotomous choice (DC) closed ended bidding, partial observability poses a serious constraint on the estimation process. Hence, a random utility model (RUM) can be chosen to represent the choice decision where the probability of a yes response to a bid can be derived by applying logit estimation technique. The methodology can be derived as follows :

If, to begin with the i^{th} respondent has $U_i = U(Y_1, \alpha_0)$ where Y_i is his income and α_0 is the state of environment, the researcher cannot observe U_i but can observe only a part of it V_i, such that :

$$U_i = V_i + \Phi_i \text{ where } V_i = \alpha_0 + \beta Y_i, \; i = 1, 2, ..., n$$

Φ_i is a random error term with zero mean.

The i^{th} individual is asked whether he is willing to pay an amount A_i to enjoy an environmental improvement from α_0 to α_1, $(\alpha_1 > \alpha_0)$. The response R_i is a binary or dichotomous variable. For this RUM :

$$Prob\,(R_i = 1) = \text{Prob}\,[\alpha_1 + \beta\,(Y_i - A_i) + \Phi_1 \geq (\alpha_0 + \beta Y_i + \Phi_0)]$$

$$\text{or} \quad P_i = \text{Prob}\,[(\alpha_1 - \alpha_0) - \beta A_i \geq (\Phi_0 - \Phi_1)]$$

$$= \text{Prob}\,[\,\eta \leq \theta - \beta A_i]$$

where $\eta = (\alpha_1 - \alpha_0)$ and $\theta = (\Phi_0 - \Phi_1)$.

η being a linear function of random error terms is also random with logistic distribution. Then the cumulative density function F of n gives :

$$P_i = F_n(\theta - \beta A_i) = 1 - F_n(-\theta + \beta A_i)$$

$$= 1 - (e^{-\theta + \beta A i}{}_i (1 + e^{-\theta + \beta i}$$

$$\therefore \log\left(\frac{1 - P_i}{P_i}\right) = -\theta - \beta A_i$$

When R_i is regressed on A_i to estimate θ and β, then the estimated regression equation can be used to determine P_i for any given A_i . The right hand side measures the change in V_i following an improvement in environmental quality. This change is independent of Y_i and, hence, free from income effect.

From this fitted binary response model, at the next step we develop a methodology to measure the average WTP. The respondent's maximum buying price (W_i) for an improved environmental quality, with income $Y_{i,}$ is chosen as follows :

$$U(0, Y_i + W_i) = U(l, Y_i) = U(l, Y_i)$$

$$\text{where } W_1 = \max WTP_i$$

$$\text{Or, } \alpha_0 + \beta\,(Y_i + W_i) + \Phi_0 = \alpha_1 + \beta\,Y_i + \Phi_1$$

$$\text{Or, } W_i = \frac{(\alpha_1 + \alpha_0)}{\beta} + \frac{(\Phi_1 + \Phi_0)}{\beta} = \frac{\theta}{\beta} - \frac{\eta}{\beta}$$

So, W_i is also random and partially observable.

The mean can be obtained as :

$$\overline{W} = E\,(W_i) = \frac{\theta}{\beta}, \text{ since } E\,(\eta) = 0$$

Estimates of θ and β, obtained from the logistic regression, can now be used to quantify $\overline{W}$. Thus,

$$\overline{W} = \text{mean WTP} = \frac{\theta}{\beta}$$

Suitable methods can also be developed to estimate the median WTP. Since lower bids are more common than higher bids, the distribution of W_i would be positively skewed and the median being less sensitive to extreme observation, would be a more reliable indicator of majority preference.

Empirical Evidence

To estimate the willingness to pay behavior of the households, we need information on household's income, various socio-economic variables and water related information of the households. Ward number 18 of Gayeshpur municipality in Nadia district of West Bengal is our study area. In general this ward consists of upper, middle and lower classes and bears a good deal of diversification in various aspects like income distribution, standard of living, educational attainments. A total of 82 households were surveyed, that is 15% of the 540 households residing at the survey areas.

We have used logit model to examine the nature of the relationship between WTP of the households for improved quality of drinking water and various factors relating to WTP. As the estimation is a logit exercise, the coefficients cannot be interpreted directly in terms of their magnitude. However, the signs and significance levels are important for our explanation. The results of logit maximum likelihood estimation are given in Table 1. The dependent variable in the logit model is willingness to pay – it takes a value of 1 if the household reports willingness to pay for improved quality of drinking water, otherwise it is 0. Three logit models are shown in our study depending on the number of explanatory variables.

Average per capita income is significant as a determinant of WTP. As expected, and in consonance with the finding of an earlier study (2), per capita income is positively related to the WTP. Households with higher incomes are associated with an increased WTP. It possibly captures the effects of related socio-economic variables, which have not been quantified otherwise. Better-off households are in a better position with regard to adopting alternative choices for improved quality of drinking water and better living conditions.

The source of drinking water is significant and positively related to WTP indicating that households who are dependent on non-piped sources of water have a higher probability of reporting willing to pay. This supports the hypothesis underlying the need to provide piped water supplies to those infrastructurally deficient areas.

Next we find that water related variable such water quality plays a significant role in determining the WTP. The coefficient of family size has the expected sign

Table 1. Logit maximum likelihood estimation results. *, ** or *** indicate that a coefficient estimate is significantly different from zero at 1, 5 or 10% level, respectively.

Variable	Model 1	Model 2	Model 3
Constant term	-7.75 (-2.53)*	-10.52 (-2.40)**	-10.58 (-2.54)*
Average per capita income	2.12 (2.47)*	2.59 (2.20)**	2.52 (2.13)**
Family size (total members of the family)	0.48 (2.44)*	0.56 (2.58)*	0.58 (2.61)*
Quality of drinking water (= 1 if water quality is average and better than average)	-0.23 (-0.45)	-0.26 (-0.48)	-0.27 (-0.49)
Source of water (= 1 if non-piped water)		1.19 (1.80)**	1.17 (1.77)***
Location-specific dummy 1		1.76 (1.89)***	2.17 (1.93)***
Location-specific dummy 2		-0.22 (-0.30)	0.17 (0.19)
Educational attainment of head of household (on a 5 point scale)			0.69 (0.76)

and is a statistically significant determinant of the WTP bids. This indicates that the feeling of urgency of meeting water needs embodied in WTP increases with the number of members in the household and this is more likely. Certain other factors theoretically important for explaining WTP are found to play a much less significant role. The location specific dummies do not show a significant result in our estimation. Educational attainment of the head of the household does not play a significant role among the determinants of WTP. Higher educated households have mostly solved their problem of safe drinking water by investing in better purified technique or purchasing water from water vendors.

Conclusion

The present study can be viewed, at one level, as an empirical investigation on the relation between income, level of environmental quality, and willingness to pay for improved quality of drinking water. The basic model of individual preference and demand, with environmental quality included as an argument in the utility function provides a framework for examining an individual's demand for environmental quality. The calculations on the basis of primary data broadly confirm theoretical predictions. The income level and the environmental quality do influence the respondent's decision making on his or her willingness to pay for improved quality of drinking water.

Estimates support the hypothesis of positive relationship between willing to pay and per capita income. The coefficient of income variable indicates positive elastic income elasticity. However, the magnitude of the income coefficient greater than one may be used to categorize drinking water quality (following Engel's law) as a luxury item in household basket. The positive influence of education on WTP implies that the awareness level increases as educational level rises. These findings have important policy implications. Majority of the households are willing to pay for better quality of drinking water. It supports the feasibility of a public policy to supply quality drinking water through implementation of a water charge. However, non-willingness to pay among low income families may be taken care of through alternative pricing mechanism like block pricing instead of flat pricing and cross subsidization.

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