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Willingness to pay for improved water supply in rural areas of tamilnadu: an econometric analysis using tobit moDEL

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ABSTRACT: *Provision of high quality and sustainable drinking water services for all the citizens, particularly the rural poor, is critical to enhance the economic productivity of any nation. Supply of safe and quality drinking water to the rural community remains a significant issue in the governance in India. It has been estimated that to provide safe drinking water to all rural habitations in the country with minimum satisfactory level of service would require a further investment of about Rs.450 billion. In view of increasing constraints, it would be a difficult task for the Government alone to mobilize such huge investment single handedly. Therefore, a productive and pro-active involvement of user community and other stakeholders in resource mobilization and community participation in the implementation as well as the operation and maintenance of the system has become imperative. To translate the above strategy into practice, it requires massive efforts to transform the prevailing mindset of the major partners – the users, community, local Government, Government agencies, NGO's etc. When users are involved in operation and maintenance of the systems, they are likely to be willing to pay for it.*

The most important factor, in designing any policy framework, is to identify the level of services that people want and for which they are willing to pay. It is assumed that individual households are able to value changes in water supply services in the absence of an explicit market. If water supply improves and consumers believe they are better off in some way, then will be willingness to pay money for securing this improvement. Keeping in view these aspects, this study attempts to estimate the willingness to pay for the improved water supply in rural Tamil Nadu.

The study found that most of the respondents are willing to pay additionally for improved services than what they are paying now. The strong positive relation between the income of the household and the willingness to have private connection to the improved water service implies that there is a need to consider household's income in designing policies related to supply of improved water services. The strong positive relationship between educational level and willingness to pay to the improved water service indicates that there is a need to educate people about the benefits associated with improved water services, in general, and having individual connection to the new improved water supply, in particular. It is also found that there is a positive relationship between willingness to pay and quantity of water consumed per day. This positive relationship implies that in fixing water tariff the quantity of water consumed by the household should also be taken into account. Policymakers should consider socio-economic characteristics and water use patterns of households in designing policies related to supply of improved water services.

Keywords: Willing To Pay; Tobit Model; Improved Water Supply

1. INTRODUCTION

India has a long tradition of managing water, but due to a large and increasing population, industrial growth and agricultural development there has been a tremendous pressure on both qualitative and quantitative dimensions of water resources. The quantity and quality of available water is decreasing over the years. The amount of utilizable water available per person per year is only 1250 cubic meters in 1999 and is likely to decrease further to 760 cum by 2050. The distribution and availability of water is not uniform across the country or through the year.

Table 1. Water Availability in India by 2050

Year	Cum/person/year
1951	3450
1991	1288
1999	1250
2050	760

Source: Ministry of Water Resources, Government of India, 1999.

Provision of drinking water is considered as fundamental to good governance to promote health and welfare of the people. In developing countries like India, bulk of the population lives in remote and rural areas cum no access to clean and safe drinking water.

Drinking water is defined as safe if it is free from bacteria contamination, chemical contamination viz. fluoride, iron, arsenic, nitrate, brackishness in excess or beyond permissible limits.

The quality of safe drinking water is possible only through tap, tube well or hand pump, which are not sufficiently available in rural areas. These sources are often not perennial and villages face severe water problems during summer months. It is true that these three sources are also not free from contamination, they are; however; reasonably better than other sources of drinking water, such as well, river, fountain, canal or lake. In addition to biological contamination, a variety of chemicals due to gioclimatic factors like fluorides, arsenic, nitrates and iron were present in drinking water beyond permissible limits recommended by World Health Organization (WHO) lead to serious health hazards. Moreover, in most case water available from these sources is not clean and causes frequently health hazards.

While India is currently meeting United Nations Millennium Development Goals in providing access to improved water sources, access to safe drinking water remain urgent, as 30 per cent of urban and 90 per cent of rural households still depend on completely untreated surface or ground water. A large number of habitations (2,16,794 habitations) are affected with water quality problems in India (Table. 2) .

Table 2: Water Quality Affected Habitations- All India

Type of Water Quality Problem	Number of Affected Habitations
Excess Fluoride	36,988
Excess Arsenic	3,136
Excess Salinity	32,597
Excess Iron	1,38,670
Excess Nitrate	4,003
Other Problems	1,400
Total	2,16,794

Source: Annual Report-2003-04, Ministry of Rural Development, Govt. of India

Inadequate access to safe drinking water causes infant mortality and intestinal diseases. The most common water – borne diseases in India are:

- Diarrhoea
- Hepatitis
- Round worm
- Hookworm infection
- Trachoma
- Intestinal worms, etc.

These diseases affect 37.7 million Indians annually and over 75% of the affected are children under five. According to Ministry of Rural Development, about 1.5 million children under 5 years die each year due to water related diseases and the country also loses over 200 million person days of work a year because of these diseases. Water related disease have caused a very heavy economic burden. The World Bank has estimated that the annual health costs of water and sanitation – borne diseases in India are between 3.1 to 8.3 billion US $.

Safe drinking water supply and basic sanitation are vital human needs for health and efficiency. There is no doubt, safe drinking water is the basic need of the people and any failure on the part of the Government to provide it will reduce the welfare of the people. A considerable portion of the total plan outlay of the Government expenditure should be set apart towards this purpose. United Nations population projections indicate that, India will be among the 34 countries of the world, which are likely to face severe water shortage problems by the year 2025. As per estimates, the countries annual fresh water requirements (i.e., about 1,050 billion cum) by that year will be almost at poor with its exploitable water resources against the current demand of approximately 600 billion cum. Thus, the additional supply of water would become necessary.

Problems associated with drinking water supply are numerous and complex. Major problems can be listed as, –Resource constraints, under estimation of project cost, lack of suitable low cost technology, poor maintenance of existing schemes, absence of suitable water pricing policy, organizational problems, identification of areas for execution of schemes and centralization of power at state levell. Traditionally, the rural areas have been depended on indigenous water harvesting systems for drinking water purpose. The traditional approach for implementing programmes for supply of drinking water in rural areas was top-driven, the result being that the community involvement was minimal and the problem of providing drinking water in all villages could not be addressed fully.

Provision of high quality and sustainable drinking water services for all the citizens, particularly the rural poor, is critical to enhance the economic productivity of any nation. Supply of safe and quality drinking water to the rural community remains a significant issue in the governance in India. It has been estimated that to provide safe drinking water to all rural habitations in the country with minimum satisfactory level of service would require a further investment of about Rs.450 billion. In view of increasing constraints, it would be a difficult task for the Government alone to mobilize such huge investment single handedly. Therefore, a productive and pro-

active involvement of user community and other stakeholders in resource mobilization and community participation in the implementation as well as the operation and maintenance of the system has become imperative. To translate the above strategy into practice, it requires massive efforts to transform the prevailing mindset of the major partners – the users, community, local Government, Government agencies, NGO's etc. When users are involved in operation and maintenance of the systems, they are likely to be willing to pay for it.

The most important factor, in designing any policy framework, is to identify the level of services that people want and for which they are willing to pay. It is assumed that individual households are able to value changes in water supply services in the absence of an explicit market. If water supply improves and consumers believe they are better off in some way, then will be willingness to pay money for securing this improvement. Keeping in view these aspects, this study attempts to estimate the willingness to pay for the improved water supply in rural Tamil Nadu.

2. OBJECTIVES AND METHODOLOGY

2.1 Objectives

The primary aim of the project is to estimate willingness to pay for the improved water supply at the household level. The specific objectives of the study are:

1. To estimate the willingness to pay for improved water supply among the rural households, and
2. To analyze the factors influencing the willingness to pay for improved water supply among the rural households.

2.2 Methodology

Tamil Nadu is dependent for its water supply mostly on rainfall. It has no perennial rivers and geologically too, the State is mostly covered by hard rock formations where the availability of ground water is uncertain. The population of the State as per 2001 census is 62.11 million with 27.24 million urban and 34.87 million rural. The decadal growth stands at 11.19 per cent. One of the important objectives of the Government of Tamil Nadu during the Tenth Five Year Plan Period is Water Security. Hence, provision of safe drinking water to the people of the State will be accorded the top most priority by the Government. Of the total 81,787 rural habitations in Tamil Nadu, about 48 percent of rural habitations (36,641) are affected by quality. Out of 10,301 no safe-sourced habitations 2,706 habitations are affected by single parameter like dissolved solids, alkalinity, hardness, nitrate, fluoride and iron. The balance 7595 habitations are affected by multiple quality parameters (Table 3).

Table 3: Type of Water Quality Problem and Number of Rural Habitations

Type of Water Quality Problem	**Number of Rural Habitations**
Quality Problem	36,641
Affected by single parameter (like dissolved solids, alkalinity, hardness, nitrate, fluoride and iron.) Affected by multiple quality parameters **Total**	2,706 7,595 **10,301**
Total Number of Rural Habitations	**81,787**

The study was based on a random survey of 125 households in a sample panchayat of Erode district in Tamil Nadu. Primary data on willingness to pay for improved water services and factors influencing the households willingness to pay were collected through schedule.

The Contingent Valuation (CV) technique was employed to elicit information regarding Willingness to Pay (WTP) for improved water supply by creating hypothetical market situation. Evaluation of non-market goods or goods which are not currently on the market like the potential benefits of a particular change in policy is performed by CV. This method is based on the argument that _individual response to hypothetical markets is comparable to actual markets'. In order to get response for the WTP, the hypothetical situation was created. In the first step, households were asked to assume that there would be an improvement in quality and quantity of supply of water services. It was explained to the respondents that the new system would provide assured and adequate water services to meet their needs. Then each respondent was asked to place value on the object of valuation i.e. quantity and quality of water services.
The following information on Socioeconomic and Demographic Factors and availability of water and attitudes and opinion towards water supply were collected with the help of questionnaire for the year 2006 – 2007.

1. Age
2. Education of the household head
3. Employment / Occupation
4. Annual income

5. Size of the household
6. Plot size
7. Households' awareness about water supply and reliability
8. Quantity of water
9. Source of drinking water ,
10. Storage Capacity
11. Monthly bill
12. Increment to water bill , etc,

The data were collected and the collected data were analyzed using tabular, and percentage analyses and Tobit model.

The willingness to pay for an improved water supply can also be considered as continuous variable. Conceptually ordinary least squire analysis is an appropriate model for the continual variable. In our case the dependent the variable amount of willingness to pay stated by the respondent is a continual variable. But a large proportion of respondents were not willing to pay or contribute anything for improved water supply. They reported _zero' willingness to pay in the survey. Thus, the dependent variable amount of the will ingness to pay for improved water supply concerns a continual variable which includes a large number of zeroes. An empirical issue that needs to be considered is that large number of zeroes. In this case, OLS regression analysis is not an appropriate model for the econometric analysis, because the willingness to pay was limited by zero values. Because OLS estimation based on a censored sample would yield biased estimates. In OLS estimation the necessary condition is E (ε i) = 0. This is violated due to the censored nature of dependent variable in our case.

Omitting the limit observations creates bias. Ignoring them would be throwing away information, but including them as though they were ordinary observations also creates bias. An appropriate alternative model for such situation is Tobit model (Tobin 1958) [1]. This is a very novel approach enunciated by James Tobin in 1958 for analyzing situations whenever dependent variable (under variable consideration to be analyzed) can take zero values.

The method of estimation of the regression model to be applied depends on the structure of elicitation technique employed in the CVM study. If the elicitation technique is of open-ended type, the relevant estimation method would be Tobit (Censored Regression) model. Since the Bidding Game was of the open-ended type a Tobit model was estimated. The Tobit model takes the following functional form:

The Tobit model assumes a latent variable Y*, determined by

$$Y_i^* = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + ... + \beta_K X_{Ki} + \varepsilon \quad ...(1)$$

where X_1 , X_2 ,... X_K are observable independent variables comprising personal and socio-economic characteristics, and ε is a normally distributed error term with mean 0 and variance σ^2. The observed variable Y is equal to Y* if Y* is greater than 0, and is equal to 0 if Y* is less than 0. This is basically estimation with censored normal regression model.

In an attempt to test the relationship between willingness to pay and socio-economic factors, demographic factors, present water use behaviour of the sample households and perception of existing water supply, an econometric analysis (Logit and Tobit Model) was employed. In the regression model, WTP for improved rural water supply (both in terms of dichotomous and continual variables) was represented as a dependent variable. Willingness to pay was regressed on following variables:

*WTP = f(*Personal characteristics of the Respondent, Household level factors, Present water use behaviour of the household, etc. *)*
where, WTP is the decision/amount willing to pay by the respondent for improved water supply,
Personal characteristics of the Respondent

1) Education
2) Gender

Household level factors

1) Annual family income
2) Family Size

Present water use behaviour of the household

1) Quantity of water consumed per day
2) Whether purification method adopted

[1] Tobin, J. (1958), -Estimation of Relationship for Limited Dependent Variables‖, **Econometrica**, Vol. 26, No. 10, pp: 24-36.

2.3 Description, Rationale and Expected Sign of Explanatory of Variables

A short description of the independent variables included in the estimation, their expected sign and the rationale for their expected effect on willingness to pay for improved water supply is given in Table 4.

Table 4: Description of the Independent Variables and Expected Sign

Independent Variables	Description	Measurement	Variable Names	Expected Sign
Education	Education of the respondent	Continuous variable in number of years of schooling	EDU	+
Gender	Gender of the Respondent	Dummy variable: 1-Male and 0-Female	GEND	+
Income	Annual Family Income	Continuous variable in thousand rupees	HHINC	+
Family Size	Number of Family members	Continuous variable in No. of persons	HHSIZ	+
Water Consumption	Daily water consumption by the household	Continuous variable in liters	WQUAN	+
Purification method	Whether the household used any purification method	Dummy Variable: 1 = Purification technique adopted, 0 = otherwise	PURIF	+

3. RESULTS AND DISCUSSION

The ability to put a value on environmental resources is a core problem in environmentally sustainable development in industrial countries and developing countries alike. Estimation of water demand function by taking into account the economically relevant variable is not an easy task. Therefore, in the absence of carefully estimated water demand function, usually contingent valuation method is applied to estimate water demand. As such a large number of studies have been conducted on various aspects of demand for drinking water, willingness to pay for drinking water and community participation in drinking water supply programmes contingent valuation approach, etc. An attempt is made here to estimate willingness to pay for the improved water supply at the rura l household level and the factors influencing willingness to pay for improved water supply in the selected panchayats.

3.1 Willingness to Pay for Improved Water Supply by Type of Connection

Table 5 presents the frequency distribution of the respondents who are willing to pay for improved water supply in the study area.

Table 5: Distribution of Respondents by their Willingness to Pay Responses

	Frequency	Per Cent
Willing to Pay	72	57.6
Not Willing to Pay	53	42.4
Total	**125**	**100.0**

Source: Computed from primary data.

Among the 125 respondents in study area, 57.6 per cent of the households were willing to pay for improved water supply and the remaining 42.4 per cent households were not willing to pay for improved water supply.

3.2 Willingness to Pay in Amounts

The following table presents the amount revealed by survey respondents as their willing-to-pay for improvement in existing water supply system.

Table 6: Willingness to Pay for Improved Water Supply

Willing to Pay (in Rs.)	Individual Connection	
	Nos	Percent
51 to 55	29	40.27
56 to 60	17	23.61
61 to 65	4	5.56
66 to 70	8	11.11
Above 70	14	19.44
Total	**72**	**100**
Mean (Rs)	64.93	-
Maximum(Rs)	100	-

The mean WTP for individual connections was worked out to be Rs. 64.93. The findings reveal that the households in the study area were willing to pay as much as Rs. 64.93 on reliable and improved water supply. But they are not willing to pay more than Rs. 100.

3.3 Tobit Regression Estimates

The factors influencing willingness to pay for improved water supply is estimated using Tobit model and the results of model is reported in Table 7. The likelihood ratio chi-square of 57.26 with 6 degrees of freedom tells us that our model as a whole is a good fit.

Table 7: Results of Tobit Analysis of Factors Affecting Willingness to Pay for Improved Water Supply

Explanatory Variables	**Coef.**	**Std. Err**	**t**	**P>|t|**
Education	1.863**	0.913	2.04	0.044
Gender	-30.680*	11.098	-2.76	0.007
Income	0.357*	0.109	3.28	0.001
Family size	2.314	3.719	0.62	0.535
Water consumption	0.111**	0.0524	2.11	0.037
Purification method	-11.595	8.194	-1.42	0.160
Constant	14.829	21.989	0.67	0.501
_se	40.200	3.754	(Ancillary parameter)	
Number of observations	125			
LR $chi^2(6)$	57.26			
Prob > chi^2	0.0000			
Log likelihood	-406.63529			
Pseudo R^2	0.0658			

Source: Computed from Primary data.

Note: *, ** and *** indicate level of significance at 1, 5 and 10 per cent, respectively.

Income is the most important variable (significant at 1 per cent level) which determines the willingness to pay of the households for improved water supply with the usually expected positive relationship. This result is consistent with basic economic theory, which states that individual‘s demand for most commodities or services depends on income. The result also indicates that the variable gender of the respondent is found to be significant at 1 per cent. This finding implies that, a respondent who is male is willing to pay lower amount for the improved water supply than the female respondent.

Among the explanatory variables, quantity of water consumed by the family per day has positive and significant (at 5 per cent level) effects on the amount that the households‘ willingness to pay for improved water supply. The important variable consistent with a priori expectations is education of the respondent. It is significant at 5 per cent level and has the expected positive sign. This finding indicates that the willingness of educated member‘s to pay for improved water supply is higher than the illiterates.

The practice of water purification has a significant positive impact on the willingness to pay for improved water services. H ouseholds that use purification methods are willing to pay more for improved water service as compared to those that do not practice it.

Similarly, a respondent who is living in large family is willing to pay more amount than the respondent who living in smaller family.

4. CONCLUSION

The study found that most of the respondents are willing to pay additionally for improved services than what they are paying now. The strong positive relation between the income of the household and the willingness to have private connection to the improved water service implies that there is a need to consider household‘s income in designing policies related to supply of improved water services. The strong positive relationship between educational level and willingness to pay to the improved water service indicates that there is a need to educate people about the benefits associated with improved water services, in general, and having individual connection to the new improved water supply, in particular. It is also found that there is a positive relationship between willingness to pay and quantity of water consumed per day. This positive relationship implies that in fixing water tariff the quantity of water consumed by the household should also be taken into account. Policymakers should consider socio-economic characteristics and water use patterns of households in designing policies related to supply of improved water services.

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