AFFORDABILITY AND WILLINGNESS TO PAY FOR IMPROVED WATER SUPPLY IN URBAN AREAS OF ETHIOPIA: STRATEGY FOR FULL COST RECOVERY

Alebel Bayrau[1]

Abstract

The provision of improved water supply service both in the urban and rural areas of the country is essential. Millions of people are facing problems of obtaining adequate potable water supply. When we see the coverage of improved water supply in both urban and rural areas of the country it is very low though it is relatively better in urban areas (about 32%, MoWR (2002)). This shows that much is still remaining to attain the full coverage of this basic service for the people of Ethiopia. Parallel to increasing the coverage we need to consider the efficient management of and proper use of the resources and sustainability of the service.

The policy for increasing the coverage as well as the proper use and sustainability of the service requires implementation of a cost recovery system, which can be either full or partial cost recovery. The issue of cost recovery particularly in supplying drinking water supply consists of affordability of the tariff, willingness to pay for the service and efficient management of the financial assets of the utility office. Therefore, in order to implement cost recovery system, we need to examine at least these three issues. This paper tries to examine and analyze the affordability and willingness to pay of the beneficiaries in urban areas of Ethiopia taking Nazareth town as a case study where new drinking water supply project is under construction.

Therefore, the objective of the paper is to examine the determinants of the willingness to pay of water consumers and to find out whether it is possible to introduce full cost recovery program to provide improved water supply in the

[1] Consultant in the International livestock Research Institute, Addis Ababa (Ethiopia)
Acknowledgment: The author is thankful to the Ethiopia Federal Ministry of Water Resources and the African Economic Research Consortium for funding the research. I also acknowledge to Dr. Tekie Alemu for his invaluable advise and comments.

urban areas of the country. We used contingent valuation method to examine the determinants of willingness to pay. The value elicitation method used in our study was bidding game, and a total of 307 sample households were covered during the survey, which was administered by using an in-person interview.

Unlike most studies, we used a censored least absolute deviation (CLAD) estimation for the empirical analyses, which does not need the normality and homoscadaciticity assumption of the distribution of the error term. We also used the probit model to see the effect of the explanatory variables on the choice of the household to the improved water service. The CLAD estimation result showed gender, income, monthly expenditure for water consumption, quality and time taken to fetch water from existing source significantly affects the respondent's willingness to pay. While the probit estimation result indicated that wealth, income, education level, source the household is being used, quality and time taken to fetch water from the existing water source affect the choice of the respondents to the improved water service. The descriptive analyses result revealed that the mean WTP for improved water service is higher than the existing tariff. And the affordability analyses result also indicated that consumers are able to pay if they are provided the improved water supply service at a price equal to the average incremental cost of providing the improved water supply service.

1. INTRODUCTION

Water is crucial for human survival and economic development. The provision of adequate supply of potable water in urban areas in both developed and developing countries is essential for life. For instance, in developing countries the provision of adequate potable water supply in addition to drinking, cleaning etc, improves health by reducing incidence of water-related illness such as diarrhoea, cholera etc. This also helps to reduce both the mortality and morbidity rates and the number of working days lost that can increase GDP. Reducing the incidence of illness will help to reduce demand for imported medicine and thereby easing balance of payment problem facing least developed countries.

The demand for such resources particularly in the third world countries has been increasing over time, as a result of the rising standard of living and the population increase resulting from natural growth, as well as rural-urban migration. Under such

circumstances planning for efficient and equitable and sustainable water delivery systems in both the short run and long run is critical to ensure that the population receives adequate water supplies.

In case of Ethiopia, over 85% of the livelihood of the people is based on farming and livestock agriculture. This has resulted in subsistence level of economic life and thinly spread out settlements so that providing reliable and safe water at minimum cost becomes very difficult. Hence, only 32% of the population of Ethiopia, 72% of urban population (38% if we exclude Addis Ababa) and 24% of rural population of the country have access to clean potable water supply. In rural areas of the country, people have to travel long distance and fetch unsafe and unreliable water from rivers and other unprotected sources. Even in the urban areas where services are apparently better in relative terms, the supply and quality of water is inadequate, unreliable and unsustainable. Studies indicated that while 20 liter per capita per day is considered as adequate for domestic use (UN, 2002), in Ethiopia average per capita water consumption varies between 10 to 20 liter per capita per day in some urban area and 3 to 4 liter per capita per day in rural areas. The sanitation situation of the country is even worse. Sanitation coverage in the country is estimated to be only 17% (UNICEF, ---); being urban coverage is 46% (Getahun, 2002) and that of rural is &% (MoWR, 2002). As a result, three-fourth of the health problems in Ethiopia are due to communicable disease (such as diarrhea), which is caused by lack of access to safe and adequate water supply and unhygienic/unsanitary waste management (Getahun, 2002)[1].

To fill the gap and achieve full coverage of this basic service requires at least policy commitment and designing key strategy for enhancing its implementation. Considering water supply and sanitation as an integral parts of poverty alleviation programs is an essential issues towards achieving the full coverage. Besides, contemplation of the formulation and implementation of cost recovery policy with due attention be given to a specific socio-economic conditions as well as programs for the provision of water supply and sanitation within the framework of an integrated approach to water resource management are another essential aspects in promoting efforts towards attaining full coverage of the service (UN, 2000).

Before 1999, water resource development, in general, and provision of potable water supply, in particular, have been made without any policy framework and was not well

[1] Access to potable water is broadly defined as the availability of at least 20 liter per capita per day from a source located with in one KM of users dwelling. Sanitation is defined to include connection to a sewer or septic system, pour flush, latrine, simple pit or ventilated pit latrine with allowance again for acceptable local technology (UN, 2002)

coordinated in the country. However, since 1999, it seems due attention has been given by the Ethiopian government to alleviate the problem of access to safe water supply and achieve rapid socioeconomic development through better health care and productivity of its people by formulating the country's water resources management policy in 1999. The water supply and sanitation policy is an integral part of the county's water management policy. According to the policy document, the policy is believed to provide an impetus for the development of water supply for human and animal consumption. It focuses on increasing the coverage, quantity, reliability and acceptable quality, taking the existing and future realities of the country in to consideration. After being implemented, the policy is expected to achieve the objective of enhancing the well-being and productivity of the Ethiopian people through the provision of adequate, reliable and clean water service that meet the water user's demand[2].

The policy of supplying free water to any group except in emergency, leads, in practice, to an unfair situation. Since there never are enough funds to provide such free services, the rural and urban poor are the first to suffer. A better and much more equitable way would be to collect water charges from consumers and then improve and expand the system. Accordingly, the policy envisages supplying improved potable water service for urban area with tariff structures that are set based on "full cost recovery and self reliance". A full cost recovery program has the advantage of providing incentive for proper use; reduce waste and excessive consumption of water resources. Besides, it helps to release funds for other investment programs. The policy considers water as a social and an economic good, and it is an integrated one. Full cost recovery requires charging consumers so as to recover the full cost of project construction as well as the operation and maintenance of providing the service. Water development investments by their nature require huge amount of money. Different feasibility studies made on water supply development projects indicate that huge amount of investment is required to implement the projects, though the cost varies with types of technology used and regions in which the project is implemented. For example, the per capita investment cost of a dug well with hand pumps is from US $20 to $40 in 1984 prices. This cost increases when the system includes distribution and treatment. The cost of surface water with pumped distribution and treated water is from US $110 to $260 per capita (Bastemeyer and Vischer, 1987). The figure increases when operation and maintenance is included.

[2] Following this, strategies and long-term development programs have been designed by the MoWR, which is given the mandate, duties and responsibility to manage the water resources of the country.

Charging consumers for water should be done carefully. Because if prices are set too low revenues may not be sufficient to cover the full costs of supplying water. If, on the other hand, they are set too high, households may not be able to afford consuming the new improved water, and again revenues will not be sufficient to cover the full cost. Therefore, to set the required tariff, information on the ability and willingness to pay of the consumers for such services are essential. In other words, to cover the full cost and sustain the service, revenue should be collected from the sale of the water based on the tariff that considers the full recovery of the cost, on the one hand, and the affordability and willingness of the consumers that are supposed to be served, on the other hand.

Therefore, the implementation of the country's water supply policy should also focus on the demand side. That is, in order to implement the existing policy for the provision of water supply in urban areas of the country, the price mechanism and regulatory environment should receive the necessary attention. Besides, since pricing of water is the key component of an appropriate incentive for efficiency, sustainability and accountability, there is a need to research the demand for the service. This helps to understand the fundamental value the consumer places on the improved water service so that the price that reflects the ability and willingness to pay of the households for the improved water services, as strategy for cost recovery, can be established.

This paper, therefore, aims at finding out whether it is possible to introduce full cost recovery policy to provide improved potable water supply services in urban areas of the country and to examine the determinants of willingness to pay. More specifically, it estimates and analyzes household's WTP for improved water services, analyzes the consumer's actual ability to pay, analyze and evaluate cost recovery system versus individual ability and WTP for improved water services and determine the appropriateness of the existing government policy towards urban water supply and draw up some policy implications based on the findings. The study limits itself on the use of water for domestic purpose for residents of Nazareth town, which accounts for 86.7% of the town's total connection. Issues of fee collection and financial management as well as water for industry and other purpose are not addressed by this study.

2. BACKGROUND OF THE STUDY AREA

2.1 Geography

Nazareth is found about 90 km south east of Addis Ababa at altitude 8^0 30' N and longitude 39^0 12' E. The town is found in the great rift valley of East Africa in flat lowland between two mountain ridges. The average elevation in the town is about 1620 meter above sea level (m.a.s.l.). It is a big town by Ethiopian standard and an important one due to its administrative and economic role. Since 2000, Nazareth is the capital of Oromia region and administered as a special zone. The mean annual precipitation of the town is about 800 mm. Its mean annual ambient temperature is between 19^0c and 22^0c. The population of the town is 127,842, of which the male population is 61,965 and that of female is 65,877 (CSA, 1994). Average number of persons per household is 4.6, and the total number of households living in the town is 26,516. Rate of growth of population of the town is estimated to be 4.7%. Most of the inhabitants of the town are followers of Coptic Orthodox Church and Muslim comes next to orthodox. The dominant activities are industrial, commercial, governmental and recreational. The industries include oil factory, flourmill, printing press, metal, blocket and woodwork. There are more than 3000 commercial establishments in the town. Since the town is the capital of Oromia region, governmental activities form dominant function in the town. There are large numbers of medium and large size hotels, which can serve visitors that travel to Sodere resort area and coming for national workshops and other purpose.

2.2 Existing water supply situation

Based on the information obtained from the town's water supply office and the project document for the feasibility study of supplying water for the town, the existing water supply source is ground water mainly from the Melka Hida well fields about eight km south west of the town on the left bank of Awash river. The total numbers of boreholes at Melka hida are thirteen (13), out of which only eight are functional. In addition to these 13 boreholes, there are eight boreholes in different areas of the town that are not connected to the main line and serve the surrounding people. Some of these boreholes are not functioning. The fluoride concentration varies from 2 to 8 mg/l and the concentration of fluoride in the distribution system is about 5 mg/l. This fluoride content seriously damages the teeth of the inhabitants. The water is distributed to consumers through 9451connections and 43 public taps.

Regarding the water production, consumption and tariff system of the existing system, it can be seen that water yield of each bore holes ranges from 2.5

liter/second to 30 liter per second. Leakages are 37.5% of the total water production. The annual total production for the year 1990/91 to 2000/01 is given in Table 2.1. For instance in 1990-91, total water production was 1,602,376 m^3/yr (see Table 2.1).

Domestic water supply is provided through house connections, yard connections and public taps. Table 2.2 shows the type and number of connections in the town for 2000.

Table 2.1: Water productions per year

Year	Total production of water (m^3)
1990/91	1,602,376
1991/2	3,058,007*
1992/3	1,950,178*
1993/4	2,997,105
1994/5	2,607,865
1995/6	2,370,923
1996/7	2,572,640.7
1997/8	2,529,266
1998/9	2,390,012
1999/2000	2,526,568
2000/2001	1,326,523**

*Data for the years 1991/92 and 1992/93 should be taken with care since we cannot get reliable data for these years due to unstable political condition occurred in the country.

** Only for six months

Source: Nazareth town water supply office

The project document indicate that about 32% of the water consumed is used for cooking and drinking, 35% for abolition, 32% for washing and less than 1% for toilet flashing. The per capita consumption varies with income, the lowest consumption being exhibited by the low-income group. The actual water supply coverage of the town is only 32.03%. The water tariff in use by the town's water supply office is given below for different band. Water is sold at the public tap at a rate of Birr 1.00/$m^{3.}$ On the other hand, water vendor rates are between Birr 5-7.5/m^3.

Table 2.2: Type and Number of Connection

S No.	Type of Connection	No. of Connection	Consumption m^3/d	% of total Connection
1	Domestic	8232	3168	86.7
2	Government	206	415	2.2
3	Commercial Enterprise	943	684	9.8
4	Public association	73	61	0.8
5	Public tap	43	112	0.5
	Total	9494	4437	100

Source: Nazareth Water Supply Office & five towns' water supply & sanitation study report volume 1, Nazareth.

Table 2.3: Existing Tariff Structure of Nazareth Town Water supply

Band	Tariff (birr/m^3)
1-5m^3	1.30
6-10m^3	1.65
11-30m^3	2.00
>30m^3	2.50

Source: Nazareth Town Water Supply Office

Table 2.4 shows the cost and revenue of the town water supply office for the year 1985/6 to 2000/2001. As can be seen from Table 2.4, the financial capacity of the town's water supply office was relatively better up to 1988/89 since at least the operation and maintenance (O & M) cost was less than the revenue, but after this year the cost rise and the revenue could not cover even the O & M cost of the utility office. The revenue started to increase and the cost decrease only after year 2000 when the regional bureau of water mines and energy increased the tariff from Birr 0.5/m^3 to at least Birr 1.30/m^3 of water consumption.

The major problems of the water supply system of the town are shortage of water and high content of fluoride. Water is not available at the required time and quantity. Its quality is very low due to its high fluoride content.

2.3 Future Water Supply Situation

Due to the fast growth of the town coupled with the presence of high shortage of water supply service, currently, a new water supply service is under construction in the town. For this, a full project document was prepared by Devecon Engineers and Architects consultant (Water Supply and Sewerage Authority being a client) to alleviate the existing problems, and to supply the town with improved water service. Based on this project document construction of the new system is underway. The total cost of the project was estimated to be (including both investment and operation and maintenance cost) Birr 49,164,000, from which Birr 41,376,000 is for phase-I and Birr 7,788,000 is for phase-II. Phase I is supposed to be completed in year 2005 and phase II is in year 2010.

Table 2.4: Cost and Revenue of Nazareth Town Water Supply Office

Year	Revenue (birr)*	Cost (birr)*
1985/86	783,733	477,370
1986/87	741, 781	455,677
1987/88	786,031	480,479
1988/89	725,402	709,104
1989/90	652,594	833,773
1995/6	1,452,415.89	1,869,754.6
1996/7	1,426,812.42	2,347,299.67
1997/8	3,413,866.90	3,682,130.56
1998/1999	4,106,633.00	5,766,510.61
1999/2000	4,737,038.14	4,735,178.81
2000/2001	5,123,856.05	3,825,505.06

Source: Nazareth Town Water Supply Office and Five Town's Water Supply Project Document (phase 1. vol.2)

* Note that the figures except for the years 1997/98, 1998/99, 1999/'00 and '00/'01 should be taken with care since we couldn't get reliable data.

3. METHODOLOGY

3.1 Data Type and Sources

The data used in this study is mainly primary and cross sectional for the year 2001. The main data source is a contingent valuation survey conducted in Nazareth town. The study employed CVM[2] method to solicit the respondents' WTP for improved water services, using bidding game as an elicitation method. An in-person interview was used to administer the survey. Relevant documents from the Ministry of Water Resources, Nazareth town water supply office and other relevant secondary sources were also used as data sources.

3.2 Developing the Questionnaire

Based on the preliminary assessment of Nazareth town and on the policy issues involved in achieving sound cost recovery practices for the water supply, questionnaire consisting of different sections including household socio-economic

[2] There are few studies on water supply and forest valuation conducted using CVM in Ethiopia (Genanaw, 1999; Fiseha, 1997; Alemu, 1997). Besides, some studies conducted by the world Bank and others in developing countries proved the applicability of CVM in Valuation studies given that one able to carefully done the survey and minimizes the biases that may arise from using CVM. Read Mitchell & Carson (1989) more on the theoretical and practical applicability of CVM.

characteristics and income, existing water supply situation, CV questions on willingness to pay and attitude towards administration of water supply service were developed. In designing and conducting the questionnaire we made an attempt to minimize biases such as strategic, hypothetical and compliance biases which may arise from CV survey.

In order to determine the starting price for the biding game, to enable the enumerators to have practice in administering CV survey and to check the wordings and ordering of the draft questionnaire, we conducted a pretest survey on the three clusters before we started the main survey.

3.3 Sample Design

The town consists of twenty Kebeles, and all were included in the survey. In order to ensure homogeneity in the grouping of households, the town (and thus the twenty kebeles) was divided in to three clusters: areas where high-income households live, middle-income households live and low-income households live. The number of households was obtained from the 1994 population and housing census of Ethiopia for each kebele. The proportion of number of households in each kebeles to the total number of households in the town was calculated and this proportion was used to determine the number of sample households from each kebeles to be included in the sample. Accordingly, out of the total 307 sample households surveyed, 141(45.4% of the sample size) are from low-income areas, 78 sample households are from the middle-income areas and the rest 88 sampled households (28.6% of the total sample size) are from high-income areas.

3.4 Method of Analyses

Model Specification

Definition of Willingness to Pay (WTP)

Mark Yuying (2000), define willingness to pay (WTP) as follow:
For a fixed level of public good provision, a respondent's WTP is defined as the dollar amount Y, which equalizes two indirect utilities:

$$V_1 (I-Y \mid Z , \varepsilon) = V_0 (I \mid Z , \varepsilon) \qquad (1)$$

Where I is disposable income, Z is a vector of observed social demographic characteristics, ε is a scalar variable representing unobserved personal characteristics and V_1 and V_0 are, respectively, the respondents indirect utility with and without the provision of the public good. When two levels of the public good provision are compared, V_1 and V_2 may have the same functional form but include the level as an independent function argument. Assume that for any fixed (Z, ε), V_1 (u$\left|Z\right.$, ε) is monotone increasing in u. Then there exists an inverse function U (v: Z, ε) such that U (V_1 (u$\left|Z\right.$, ε): Z,ε) = u for all u ≥ 0. Therefore WTP can be expressed as:

$$Y = I - U (V_o (I\left|Z\right. , \varepsilon): Z, \varepsilon) \equiv \Phi^* (X, \varepsilon) \qquad (2)$$

Where X = (I, Z)

This definition has two important implications. First, since ε is unobserved, Y = Φ* (X, ε) is a random variable whose distribution, conditional on the observable X, is determined by among other things, the distribution of the unobservable ε. Second, because the commodity in question is assumed to be a "good," V_1 (u|Z, ε) ≥ V_o (u|Z, ε) for any fixed (X, ε) and for all u≥0. It then follows that the distribution of Y is bounded below by 0.

Econometric model

i. The Discrete Choice Model

To capture individual preferences between the old and the anticipated new water system and determine the factors influencing his/her preferences, a discrete econometric model has been used. This approach works with the utility function in that the utility derived from using a new improved water services may be expressed as a function of several attributes such as characteristics of the old source and socioeconomic characteristics of the family. Thus what is needed is a model that describes the probability that a particular household will choose to use a new water source. In this approach, first it is assumed that a household chooses between two sources based on maximizing two conditional indirect utility functions, the first of which describes the utility gained from using the new source, and the second the utility derived from use of the current, old water source.

The probability that a family will decide to use the new rather than the old source is the probability that the conditional indirect utility function for the new sources is greater than the conditional indirect utility function for the old source. Therefore, let U^n represents the utility a household gains from the new source, and U^o represents the

utility a household gains from the old source, the observed choice between the two alternatives reveal which one provides the greater utility, but not the unobservable utility. The observed indicator equals one if $U^n > U^o$ and zero if $U^n \leq U^o$.

The household will connect to the new improved water supply service or not. The choice is influenced by both the household attributes and water source characteristic. The common formulation for this model is

$U^n = \beta_n X + \omega_n$

$U^o = \beta_o X + \omega_o$

Where X = vectors of explanatory variables which include socioeconomic and Demographic characteristics of the household and water attributes

β 's = parameters of the model

ω 's = the error terms

Now we denote Y = 1 when the individual selects the new system, then the probability that a household chooses the improved water service is:

$P(Y = 1|X) = \text{prob}(U^n > U^o)$

$=\text{Prob}\left(\beta_n X + \omega_n - \beta_o' X - \omega_o > 0 \middle| X\right)$

$=\text{Prob}\left[\left[\beta_n' - \beta_o'\right]X + \left[\omega_n - \omega_o\right] > 0 \middle| X\right]$

$=\text{Prob}\left(\beta' X + \omega > 0 \middle| X\right)$

$=\text{Prob}\left(\omega > -\beta' X \middle| X\right)$

If the distribution is symmetric,

$P(Y=1|X)=\text{prob}\left(\omega < \beta' X\right)$……3

$= F\left(\beta' X\right)$

Where F is cumulative distribution function (CDF). This provides an underlying structural model for the probability. This model is to be estimated either using probit or logit model, depending on the assumption on the distribution of the error term (ω). Assuming ω is normally distributed with mean zero and variance one, our model takes a form of probit model. In this qualitative model, respondents' response is equal

to the indirect utility that the household receives from choosing to connect to the new improved service rather than continuing to use the old service (Green, 1993).

Therefore, in this study, assuming the probability of a household to make a particular choice is a linear function of his attributes; the following probit model will be used to estimate the household's probability of choosing the new improved water system.

$$P(Y = 1|X) = \beta' X + \omega \ldots\ldots\ldots\ldots\ldots\ldots(4)$$

The dependent variable is the probability of a household/respondent to choose the new improved water service. It is a dummy variable, and takes a value of one if a household prefers the new improved water service, and it takes zero if he/she prefers the old. X is vector of explanatory variables shown in Table A1 in the Appendix (see also the definition and expected sign of the variables), $\beta^{'}$ is regression coefficients and ω is an error term to capture unobserved variable.

ii. **Direct Approach: Determinants of households' valuation to improved water supply**

The usual method of estimation for this approach is either to use the OLS if the dependent variable, WTP, is greater than zero or Tobit model in case when significant fraction of the dependent variable takes the value zero. However these two estimation methods do have their own limitations. For example, the Tobit model assumes normality of the distribution of the error terms in estimation, which is one drawback of the Tobit model. The OLS estimation, given the Gaus-Markove assumptions of homoskedasticity and independence, is only efficient within the (restrictive) class of linear, unbiased estimators. Moreover, in the face of heteroskedacity, the Tobit model yields estimates that are biased up as OLS is biased down. According to Deaton (1997): "there is no guarantee that the attempt to deal with censoring by replacing OLS with the Tobit maximum likelihood estimation will give estimates that reduce bias, and this is not a defense of OLS." Even when there is no heteroskedasiticity, the consistency of the Tobit estimates requires that the distribution of errors be normal, and bias can occur when it is not. Due to these limitations there is no guarantee for one to get a sensible estimated results using OLS or Tobit in the presence of non-normal distribution of the error term and/or heteroskedacity problem. Therefore, one needs some other method for estimating sensible model.

Therefore, in view of the sensitivity of maximum likelihood and least square methods to the assumption of normality, and problem of heteroskedaciticity for the former method, the method used by this study is a simple modification of least absolute deviation, LAD[3], estimation, which yields a consistent estimator independently on the functional form of the distribution of the residuals. This estimation method is Censored LAD, CLAD, which is robust against heteroskedacity of the error terms and which requires only weaker assumption about their distribution.

Hence, following Powel (1986), CLAD is specified as follow:

$$Q_\theta\left[\max\{0, X'_i\beta\}\middle| X\right] = X_i\beta + Q_\theta\left[U\middle| X_i, U_i > -X_i\beta\right] = X\beta \quad (5)$$

Where θ = 0.5 i.e. a LAD estimator corresponding to median regression.
X = Vector of explanatory variables shown in Table 1
β = Vectors of regression coefficients

Fitting our dependent (median WTP of a respondent) and the explanatory variables in to the above model, we will estimate the model following a suggestion by Johnston (1997), and the entire process is done using bootstrap estimation using STATA software.

Testable Hypotheses

Considering evidences from empirical and theoretical literature, the following hypothesis will be tested during the study.

1. WTP depends on the situations of the existing drinking water services. That is WTP depends on quality of the existing water and time taken to fetch water from the existing source.
2. Gender significantly affects willingness to pay for improved water services.
3. Income of a household positively and significantly affects the WTP for improved water service.
4. Educational level of the respondent affects WTP and its influence on WTP is positive.

[3] Let $Y = X\beta + \varepsilon$, to get the consistent estimate, if we minimize the sum of the absolute value of the errors, instead of the sum of the square of the error terms as in OLS, the estimator obtained in this way is least absolute deviation (LAD). I.e. estimates obtained by minimizing: $\min\Sigma|Y_i - X_i\beta|$ or $\min\Sigma (Y_i - X_i\beta)$ sgn $(Y_i - X\beta)$, where sgn takes value of 1,0, -1 as the argument is positive, zero or negative.

5. Attitude of the respondents towards the provision of improved water is significant in the WTP equation.
6. In urban areas of the country, households are able to pay for their water consumptions at the rate equal to the average incremental cost of supplying improved water service.

4. EMPIRICAL RESULTS AND DISCUSSIONS

4.1. Descriptive Analysis

4.1.1 Households' Characteristics

A total of 307 sample households were interviewed in the survey. From the total sample respondents, 201(65.47%) are head of the household, of which 98 are male headed and 103 are female headed. The rest 106(34.53%) of the respondents are not heads of the interviewed families. Out of these, 45 are male and 61 are female. The average family size of the total sample household is 5.86, and ranges from 1 to 13. Data about the age of the respondents shows that 39.67 year is the average age. The maximum is 77 and the minimum is 20.The education level of the respondent ranges from minimum of not able to read and write to the maximum of college graduate. From the total respondents 83(27%) can neither read nor write, 54(17.59%) have completed primary education, 131(42.67%) have completed secondary school and the rest 39(12.74%) have joined higher education. The data about the occupation of the respondent shows that 157(51.14%) work in the formal sector, and 150(48.86%) work under informal sector or are unemployed[4]. The average monthly income of the household of the total sample is Birr 1193.74 ranging from the maximum of Birr 3000 to the minimum of Birr 120 per month (See Table 4.1).

Data regarding the occupation of the respondent reveals that 44(56.41%) are either unemployed or working in informal sector and 34(43.59%) are working in the formal sector.

Data for the wealth of the households, which is proxied by whether the household owns house or not, show that 139(45.28%) of the respondent do not live in their own house where as 168(54.72%) owns the house they live in.

[4] Formal sector workers in this report include those who work in government organization, working in NGO, running legal private trade business while in informal sector are those running small business and daily worker.

The total sample households were given different social services to rank in accordance with their priority of need. Survey results showed that 61.21% rank health service as their first need, 52.44% of the respondent said water supply is their second need and 36.5% of the respondent rank toilet (sanitation) service as their third need. Education, electricity, telephone and road service are ranked from fourth to seventh respectively. This shows that health and related services such as water supply and sanitation are very essential for the town people and reveal their consistent ranking for the different social services given as options. If we see which services are given priority in each group, responses regarding this shows that 73.03% of the low income group said that health is their prior concern, 57.3% rank water supply next to health and 35.96% of the respondent rank toilet service as their third requirement. For the middle-income group, health is their first need and water supply and education services are their second and third need, for which 67.5%, 52.5% and 42.5% of the respondents rank them from first to third respectively. Toilet service and road are their fourth and last need respectively. Responses from high-income group area indicate that 50.36%, 48.92% and 35.25% of the respondent rank health, water supply and education as first second and third need respectively.

4.1.2 Existing water supply situation

1. Source of water supply

Responses regarding type of water supply source the household uses indicate that all the respondent use piped water from the main source supplied to the residents of the town. However, out of the total 307, only 59.61% are connected to water lines through private meters and the rest 40.39% are not. From 40.39%, 21.17% per cent use totally by buying from vender, 9.12% use shared piped water and 10.10% use public tap. Those respondents who privately connected to the existing water supply water were asked whether their water meter is functioning or not, and all of them respond that it is functional.

Households that do not have private access to piped water were asked the reason why they do not privately connected to the existing water supply system. The responses reveal that 51.22% of the respondents said the main reason is due to high connection cost, 21.14% of the respondents said because they do not have their own house and connection to the existing system is difficult and 0.81% said it is due to the above two reason. The other reason, which was given by 26.82% of the respondent, is that the town water supply office told them it is not possible to get private connection at this time due to shortage of water. The rest 6.5 % said they do not need to have private connection. Among the respondents that use public tap, 48% said that

they use this source because it is hardly possible to have access to private meter, 32% respond that they use this source because it is very cheap, 20% of the respondent said that it is near and cheap compared to other source. The other question asked to the same sample households was that whether they have ever applied to the town water supply office to have access to the existing water line. Responses to this question indicate that 23.48% were applied and 76.52% did not apply. Those who did not apply gave different reasons. Among the reasons 11.36% said the water supply office did not accept their application, 54.55% said connection costs are high, 28.41% said they did not have their own house and only 2.27% said piped water is expensive. The rest, 3.42% said that it is both due to the high connection cost and piped water is expensive.

Responses regarding the responsibility of fetching water indicated that 31.18% of the respondents said it is only female member of the family who are responsible to fetch water from outside source whereas only 18.82% said male is responsible, 40.32% said it is the duty of either female or male, there is no sex differentiation and the rest 9.68% said they use daily laborer whenever they want to bring water from other source, particularly from venders.

4.1.3 Qualities, Quantity and Reliability of Existing Water Supply

Concerning the quality, quantity and reliability of the existing water supply system, the survey results indicate that only 25.41% of the total respondent ranked the quality as good, and the rest 68.73% and 5.86% said that it is not bad and very poor respectively. Regarding the quantity of water supply, 58.31% of the total respondents said it is not sufficient and the rest 41.69% said it is sufficient. In terms of reliability, 61.24% said that the existing water supply is unreliable and only 38.76% said it is reliable. A question related to the quality of water was whether the household uses any purification method before they drink or use for domestic purpose. The bulk of respondents, 96.42%, said that they do not use any type of purification method such as boiling the water before they drink. The reasons they give for this are that 87.9% said the water they use is piped water and thus consider as pure, and 11.06% said though the water is not pure it is harmless, and only 1.04% said they do not know whether the water should be purified (boiled) before drinking.

All sample households were also asked whether there is anyone member of the family who has ever been sick by water born disease such as diarrhea, typhoid, cholera or change of color of teeth of member of their family, which arises due to the presence of high percentage of fluoride chemical in the water supply. Survey result show that 78.82% said there is change of color of teeth to yellow, 6.51% respond at

least one family member was sick by diarrhea, 6.84% respond at least one family member was sick by typhoid and only 18.24% of the respondent respond that no anyone member of their family was sick by any of the water born disease mentioned above. The rest were sick by three of these diseases.

4.1.4 Time of water availability

Out of the total sample household, 38.89% said that water is available only during night time, 31.37% said it is available both day and night, 20.92% of the respondent said that the time of water availability is very unpredictable i.e. sometimes it is available during day time or at night. The rest, 8.82% said that they get water only during daytime. When we compare this across the subgroups, only 11.24% from the low-income group areas said that they get water day and night, 37.08% said water availability is unpredictable, 37.71% get water only during nighttime. Responses from the middle-income group areas indicate that 23.08%, 46.15% and 7.69% of the respondent said that they get water during day and night, only during nighttime and only during daytime respectively. The rest, 23.08% said time of water availability is unpredictable. From the high-income group areas, 48.2% of the respondents get water day and night, 38.13% said they get only at night and 4.32% get water during daytime. Only 9.35% said time of water availability is unpredictable. In Nazareth town, a household on average spends 62 minutes for one time fetching of water from outside source.

4.1.5 Existing price of water[5]

Only 1.3% of the respondents were reserved to give response for this question. The bulk of respondents, 98.7%, respond for this question, and from this 32.25% said the price is fair, 23.45% said it is very cheap and the rest 43% said it is very expensive. The reason for this high proportion of the respondent to say it is very expensive may be due to the fact that some of the households buy water from venders whose price is higher than the existing official tariff. Among those who said expensive, 58.96% were from low-income group, 35.9% were from middle-income group and 37.96% were from the high-income group.

As described, high proportion of the low income group use water by buying from venders who sale water at higher price than the existing government water tariff. Average vender price for water in the town is 0.15 cents for a bucket of water

[5] . See the existing tariff rate structure of the town water supply in chapter for " Background of the Study Area " on page 7.

(excluding labor cost) or Birr7.50 for one cubic meter. When this compared to the official tariff rate, which is Birr1.30 for the lowest consumption bundle (1-5m3), it is 500% greater.

4.1.6 Consumption and Expenditure for Water Supply

As can be seen from Table 5.1, the average monthly consumption of water for a household is 4.77m^3, which ranges from a minimum of 0.06m^3 to the maximum of 30m^3 per month. The average monthly expenditure of a household is Birr 16.40 ranging from Birr 1.00 to Birr 75.00. When this average monthly expenditure is compared to the average monthly income of a household (Birr 1193.74), an average household spends 1.37% of his monthly income on water supply. Though this is within the range of the World Bank's recommendation, which states a household should not spend more than a maximum of 5% of his monthly income on water; it is far below as well. This implies that a household living in the study area can spend more if it is provided with improved water supply.

The survival result reveal that households from the low income areas consume 3.55m^3 and spends Birr 15.44 per month whereas households from the middle and high income areas consume 3.97m^3 and 5.95m^3 per month, and spends Birr 13.20 and Birr 18.77 per month respectively. Alternatively, this is to say that households from low-income areas spend, on average, 3.58% of their monthly income, whereas from that of middle and high income areas spend 1.49% and 1.02% of their monthly income on water per month. This shows that households from the low-income areas spend more but consume less compared to the middle-income areas. The reason is that since water is not available at the required time and amount, relative to the other area, these households usually buy water from venders (whose price is higher than the official tariff) and most of them incurred additional labor cost of one to two Birr per one tanker (a 200 liter container) to fetch water from this source.

Regarding the use of the existing water supply of the town, the result indicated that all the respondents use the existing water supply for drinking, washing, bathing and cooking and other domestic uses. In addition to using for these purposes, 34.43% of the total respondents use for gardening and livestock drinking. Out of this 34.43%, 48.92% of the respondents are from high-income group, 24.36% are from middle-income group and 20.2% are from low-income areas.

4.1.7 General Attitude of the Respondents

Responses regarding the attitude of the respondents towards the management of the water supply service indicate that out of the 307 respondents, 259(84.36%) think that the government should be responsible to the administration of the water supply service. From the remaining 48 respondents, 40(13.03% of the total) said that the administration should be given to the people of the town and the rest 8(2.61%) said it should be given to the private sector. Besides, almost all the respondents said that the current management system of the water supply service should be improved as they think that the management does not treat people equally and some of them applied to get access to the existing system before ten years ago but did not get access yet.

4.1.8 Willingness to Connect and Willingness to Pay

a. **Willingness to Pay (WTP) for Improved Water Service**

Responses for the valuation question (willingness to pay, WTP) reveal that the average willingness to pay for the whole sample is 6.80[6] cents per bucket of water, which implies that the residents of the town are willing to pay more than the existing tariff rate which is 3.00 cents per bucket for the lowest consumption bundle and 5.00 cents per bucket for the highest consumption bundle[7]. Of the three clusters, we obtained the highest mean WTP of 8.39 cents in area where high proportion of the residents are classified under high-income group, the mean WTP obtained from areas where the middle and low income group live are 5.67 and 5.33 cents per bucket respectively (See Table 4.1). This result goes in line with the theory that higher income households are more willing to pay for improved water service than low-income households.

Table 4.1 indicates that the mean income of households living in high-income group areas are highest. And from the table we can see that as average monthly income of a household increases, the willingness to pay for the improved water supply services also increases. We can also generally observe that there is a direct relationship between the education level of a household and willingness to pay.

6 When this compared to results of Genanaw who made his M.Sc. research on Harar town, it is lower. This may be due to the fact that water supply problem is more serious in Harar town than in Nazareth town.
7 The existing consumption bundle and the corresponding tariff rate is given on page 6.

From the total sample of 307, only 11(3.58%) are not willing to pay any amount. To know the reasons why they are not willing to pay any amount, and thus to decide whether their response is protest zero or true zero, a follow up question was asked. Accordingly, the reasons given by the respondents are that they are satisfied with the current service and the government should pay. Therefore we can say that the responses are considered as true zeros.

Table 4.1: Means of WTP and Selected Independent Variables

Variable Name	Nazareth town	Low Income Areas	MiddleIncomeArea	High Income Areas
Household population	26,516	7600	6737	12,178
Household Sample Size	307	88 (28.6)	78 (25.4)	141(45.9)
WTP/Bucket (cents)	6.8	5.33	5.67	8.39
Monthly Average Income (Br.)	1193.74	431.88	886.71	1842.39
Average Family Size	5.86	5.39	5.91	6.13
Education	7.39	5.02	7.61	8.77
Age	39.67	41.43	38.41	39.27
Sex				
Male	143 (46.58)	35 (39.77)	34 (43.59)	74 (52.48)
Female	164 (53.42)	53 (60.23)	44 (56.41)	67 (47.52)
Status of Respondent				
Not head	106 (34.53)	63 (71.59)	43 (55.13)	95 (67.38)
Head	201 (65.47)	25 (28.41)	35 (44.87)	46 (32.62)
Wealth				
Not own house	139 (45.28)	65 (73.86)	43 (55.13)	31 (21.99)
Own house	168 (54.72)	23 (26.14)	35 (44. 87)	110 (78.01)
Average consumption of water/month (M^3)	4.77	3.55	3.97	5.95
Average water expense/month (Br.)	16.4	15.44	13.20	18.77

Source: study result

The frequency distribution for WTP responses is indicated in Table 4.2. As can be seen from the table, of the 307 respondents, 13.68% are willing to pay between 0.00-2.49 cents per bucket, 18.57% between 2.5-4.99, 36, 16% between 5-9.99, 20.19% between 10-14.99, 10.09% between 15-19.99 and only 1.3% are willing to pay more than or equal to 20 cents per bucket. This reveals that 68.41% of the total sample households are willing to pay less than 10 cents per bucket and 88.61% are willing to pay less than 15 cents per bucket.

Table 4.3 shows a cross tabulation of mean of some of the independent variables within the range of WTP given in Table 4.2. From the table we can see that the mean income of those respondents whose WTP is between zero and 2.49 is birr 863.81, and the table shows us that as mean of income increases the willingness to pay also increases. The variable education level of the respondents is positively related to the willingness to pay value. The other variable that is generally positively related to WTP is time taken to fetch water. Which generally implies that as the cost of fetching water in terms of time increases respondents are willing to pay more for improved water services. The variable gender is inversely related with the WTP value, i.e. male are willing to pay more than female, in which case, on average, female respondents are

less willing to pay than male respondents. For the variables like age we cannot generalize the direction of relation with WTP at this time.

Table 4.2: Frequency distribution of WTP

WTP/bucket (cents)	Frequency	Relative frequency (%)	Cumulative (%)
0- 2.49	42	13.68	13.68
2.5 -4.99	57	18.57	32.25
5 - 9.99	111	36.16	68.41
10 -14.99	62	20.19	88.61
15 - 19.99	31	10.09	98.71
20 - ∞	4	1.3	100
Total	307	100	

Source: Study result

Table 4.3: Range, Frequency of WTP and Mean of some selected Variables

Range of WTP	Number of respondent	Mean of income	Gender	Age	Family size	Status of respondent	Water consumption/month	Water expense/month	Education	Time	Starting bide (cents/bucket)
0-2.49	42	863.81	0.643	41.55	5.52	0.62	3.69	11.68	6.21	12.0	0.05
2.5-4.99	57	903.81	0.614	43.65	6.02	0.73	4.96	16.4	6.07	11.3	0.08
5-9.99	111	1216.67	0.586	37.26	5.87	0.63	4.78	18.19	7.87	18.5	0.05
10-14.99	62	1267.58	0.419	39.06	5.92	0.61	5.23	16.58	7.03	18.9	0.05
15-19.99	31	1891.61	0.290	39.87	5.61	0.74	4.68	14.85	9.97	13.8	0.07
20-∞	4	1600	0.5	37.75	8	0.5	5.85	25.75	11.0	58.8	0.08
Total				307							

Source: Study result

The result also indicated that those who are unable to read and to write give a mean value of 5.2 whereas those who complete primary, secondary and who joined higher education give mean WTP of 7.89, 7.21 and 7.42 respectively. This implies that there is no much difference among those joined formal education. The result reveals that the difference is observed between those who did not have any formal education (unable to write and read) and those who get formal education

b. Willingness to Connect to the New Improved Water Service

Responses about whether or not the household is willing to have private connection to the new improved water supply under the given hypothetical market show that 273(88.93%) of the total sampled household are willing to have private connection to the new improved water supply services, and only 34(11.07%) are not willing to have access to the new system (see appendix Table A3). Out of this 34, 14(41.18%) are from the low income group areas and constitutes 15.91% of the subgroup, 14(41.18%) are from the high income group areas, and constitutes 9.9% 0f the subgroup and the rest 6(17.64%) are from the middle income group areas and constitutes 7.7% of the subgroup. The two major reasons why they are not willing to have private connection to the new improved system are income and ownership of private house. Out of the 34, 70.5% (24) do not have their own house at the time of the survey.

c. WTP and Starting Bid

For the valuation question three starting values were chosen based on the modes of their occurrence during the pre-test survey. These prices are 2.5, 5.00 and 10.00 cents per bucket, and 100, 106 and 101 respondents were randomly selected and given the respective starting price for the biding game. From the survey, out of 100 respondents who were given 2.5 as a starting price, 69% respond a yes and 39% a no answer for the first bid. Out of 106 respondents, 79 (74.53%) gave a yes and 27(25.47%) a no response for the first price of 5.00 cents per bucket. Whereas out of 101 respondents 51(50.5%) and 50(49.5%) gave a yes and no answer for the starting price of 10. cents respectively. The mean willingness to pay for each starting price and for the whole sample is given in Appendix TableA2. From the table we can see that 6.32, 6.96 and 7.13 are the mean willingness to pay for the starting price of 2.5, 5.00 and 10.00 cents per bucket respectively. The overall mean WTP is 6.8.

The following (Table 4.4) shows a descriptive statistics of the variables used in the multivariate regression analysis

Table 4.4: Summary of Descriptive Statistics of Variables

Variable	Observation	Mean	Std.Dev.	Min	Max
Gender	307	0.53	0.4996	0	1
Status of respondents	307	0.65	0.4762	0	1
Family size	307	5.86	2.4336	1	13
Age	307	39.67	13.14	20	77
Education	307	7.39	5.31	0	15
Wealth	307	0.55	0.4986	0	1
Occupation	307	0.51	0.5007	0	1
Income	307	1193.74	719.8239	120	3000
Source of water	307	0.59	0.4927	0	1
Quantity of water consumed	307	4.76	3.7423	0.06	30
Monthly expenditure	307	1.4	12.2617	0.1	75
Quality of water	307	0.93	0.2528	0	1
Reliability	307	0.39	0.4902	0	1
Information	307	0.95	0.2226	0	1
WTP	307	0.068	0.0440	0	0.2
Attitude	307	0.84	0.3638	0	1
Starting price	307	0.58	0.0309	0.025	0.1

Source: study result

B. Regression Results and Discussions

1. Direct Approach: Determinants of Willingness to Pay to the New Improved Water Supply

In this section results obtained from regression estimation of equation 4.10 are presented. Before directly going to the estimation process, we explored selected variables. Here, we examine the distribution of each variable including the mean, median and other percentiles and the skewness and kurtosis of each variable. The results indicate that none of the continuous variables including: willingness to pay, average monthly income of the household, monthly water expenditure and water consumption of the household, have normal distribution. We checked whether the residuals are normally distributed or not using Jack-Bera test for normality. The results show that the residuals are not normally distributed since the P-value we obtained is equal to 0.0075 for the calculated χ^2, which is sufficiently low to reject the null hypothesis that the residuals are normally distributed.

The estimated willingness to pay model was also tested for problems of multicollinearity since it was felt that a number of socio-economic variables used to characterize households might themselves be correlated. A simple technique, which involves calculating the simple correlation coefficient matrix for the independent variables, was used to test the multicollinearity. The results show that multicollinearity is not a serious problem in our data set. Except for variable income and location of the study area, LSS, (as expected), no value whose R^2 is greater than or equal to 0.8, which is, according to rule of thumb, an indication for the presence of serious multicollinearity problem (Gujarati, 1995).

A test for the presence of heteroscedaciticty problem in our model was also done. The test result shows that the null hypothesis of homoskedaciticity is rejected since the calculated χ^2 we obtained from the estimated model is 8.96 with p. value of 0.0028. This implies that there is heteroskedaciticity problem in our model, which is expected from survey data.

Therefore, the normality and heteroskedaciticty test for our model data set falls to accept the null hypothesis of normal distribution of the error term and the homoskedasitic error term. These indicate that the use of OLS or Tobit model in our estimation of the model does not guarantee to get sensible results. Remember from the descriptive analyses, we obtained that eleven observations are censored to zero since we get a zero response to the valuation question from 11 respondents, which implies our model is censored to eleven observation. Therefore, the use of censored quantile regression (censored LAD) estimation is the alternative method to get sensible results. (Deaton, 1997).

In order to specify the variable education level of the respondent, we classify the response into illiterates, primary, secondary and higher education level, and test the mean difference. The result indicates that there is a mean difference only between those who are illiterates and those who get formal education (primary, secondary and higher education). Thus we give a dummy variable zero for those illiterate and one for those who get formal education**.**

The censored LAD, CLAD, estimation is shown in Table 4.5. In the table we reported only those variables that are significant at conventional test level. The estimation is done following procedures described in Johnston (1997) or following a repeated application of the median regression, which is suggested by Buchinsky's (1994, P.412), as cited in Deaton (1997). A bootstrapping estimation is done on whole procedures.

The pseudo R^2 for the censored LAD estimation is 0.19. This value of R^2 indicates that 19% of the variation in the WTP is explained by the explanatory variables specified in our study. This low value of R^2 is expected from regression estimation results obtained by using cross sectional CV studies. Mitchell and Carson (1989) proposed," The reliability of a CV study which fails to show an R^2 of at least 0.15, using only a few key variables, is open to question" In line with this standard, ours is reliable.

The coefficient of gender is negative and significant at 1%, indicating that male respondents are more willing to pay than female respondents. A priori we do not specify the sign since it depends on the specific culture of the people under study. The reason could be due to the cultural effect, where women do not have equal control over or access to the household's cash resources. Therefore when asked how much they are willing to pay for improved water services, they may be reluctant to give a response though they may give more worth to the improved water service. The result reflects the actual existing condition prevailing in Nazareth town, where we obtained both women and men are responsible for fetching water, which is proved from the descriptive analyses. Our result is similar to other results obtained in similar areas done by Bah in Sierra Leone and by World Bank team in Nigeria and India.

The other variable, which has the expected positive sign and is significant, is monthly expenditure for water by a household. This result indicates that those households who spend more on the current water system are more willing to pay to the new improved water system. This result is also confirmed from the descriptive analyses, where we have seen that, since there is shortage of water and availability of water is unpredictable, people are spending more by buying from vendors and incur additional labour costs. Hence, they are willing to pay more for the new improved water system in order to avoid these additional costs. The sign for monthly water expense is similar to other studies done in other countries in Sierra Leone by Bah and in India, Brazil and other developing countries done by World Bank team. Their results showed that high monetary cost for the existing water supply system lead to high willingness to pay for the new improved service.

The variable used for the perceived quality of the existing water supply has the expected positive sign and is significant at 1%. This indicates that people are willing to pay more if they are provided with better services. The result is also consistent with other empirical studies done in similar areas such as studies done by the World Bank team in Haiti and Kenya.

The other variable consistent with a priori expectations is monthly income of the household. It is significant at 5% and has the expected positive sign. This result confirms with economic theory, which states that an individual/household demand for a particular commodity depends on his/her income, and that income and quantity demanded are positively related, except in the case of inferior goods. The result shows those higher income households are willing to pay more for an improved water service than lower income households. The result is also consistent with other studies done in similar areas both in Ethiopia and other developing countries. Genanew and Fiseha, who made similar studies in Harar and Meki town, found positive and significant (at 5%) result in their study.

The variable time taken to fetch water is positive and significant at 5%, which is as expected. The result is consistent with the idea that people are more willing to pay for the new improved water service if they incur high cost in terms of time for the existing water supply service. In other words, it confirms the economic theory, which suggests that the less an improved water service costs in terms of time, the more likely a households would be to choose it. We get the same result with other similar studies done in other developing countries (Brazil, India, Haiti) by World Bank team.

Variables including family size, age of the respondent, and consumption of water per month of the household have the expected negative sign but they are insignificant. The same is true for the variables wealth, occupation of the respondent and education level of the respondent, and have positive sign as expected. This implies that these variables are not such an important explanatory variables in WTP by households in our study area though they have the expected sign.

The variable reliability of the existing water system and the source the household uses are found to be negative and insignificant. Thus these variables are not that much important in explaining WTP of the respondent.

The variable starting price for the bid game was included in the estimation to see whether the starting price creates a bias on the response for the WTP question, i.e. to see whether there was a systematic difference between the WTP bids of households who were randomly assigned a high or low starting price. The test result shows that it is found to be insignificant at the conventional test level. This indicates that the starting price used in the biding game did not influence the value the respondents' place on the public good. This is an interesting result compared to what is expected from a CV survey using a bidding game as an elicitation method for the valuation question. From Mitchell and Carson (1989), "one of the disadvantages of using a

bidding game, as an elicitation method is that the starting price used may lead to a bias results."

The variable location of the study site (LSS), which is included to capture the clustering effect, is found to be insignificant and has a negative sign as expected. Remember we give 1 for high-income areas, 2 for middle-income areas and 3 for low-income areas, indicating WTP decreases when we go from high-income area to low-income area. Though the sign has consistent result, clustering is not so important for the valuation of improved water service.

The other variables supposed to have an influence on the WTP of an individual for improved water service are the attitude of the respondent towards the management of the water supply system and whether the respondents have an information about the new improved water supply project under construction in the town. These two variables are found to be insignificant, though they have positive sign, and indicate that they did not influence the value the respondent place on improved water supply service.

We also tested whether the length of interview (in minute) affected the respondent's WTP and whether there was an interviewer bias during the survey. The result indicated that the length of interview did not influence the respondent's WTP since it is found to be insignificant at the conventional level of significances. The same is true for the test for interviewers bias, in which case all dummies for the five interviewers are found to be insignificant at the conventional level of significances.

One of the advantages of using quantile regression is that we can estimate the WTP equation at different distribution, and examine whether the effect of each explanatory variables are different or not on the dependent variable at different distribution. In line with this, we estimated the 25^{th}, and 75^{th} percentile, in addition to the median distribution (see Appendix Table A4). The regression result indicates that the variables gender, status of the respondent, age of the respondent, income of the household, monthly water expenditure and time taken to fetch water are found to be significant at 5%, 10%, 10%, 5%, 10%, and 1% respectively for the 25^{th} percentile regression. They have also the expected sign except for the status of the respondent on the 25^{th} percentile regression. From the table we can see that the WTP at this distribution is 3 cents for one bucket. These variables influence for the low value of the WTP. While the regression result for the 75^{th} percentile distribution indicate that family size, income of the household, source of water the household is being used, quality of the existing water supply, information about the water supply project under construction in the town and starting price are found to be significant at 5%, 1%, 10%,

5%, 5%, and 10%, respectively. The WTP for this distribution is 10 cents per bucket. We can say that these variables influence for this higher value of WTP. The positive sign of starting price indicate that higher WTP at the 75th percentile is influenced by the starting price for the bidding game.

Each variable is tested across the three estimated results whether each has different or the same effect at the three distributions. We reported only those variables that have different effect on the dependent variable in the three distributions. Thus, based on the result, the variable quality of the existing water system is found to be significant on the median estimation but not on the 25th percentile estimation, though it has the expected sign. In order to confirm this, we tested the variable across these two estimations and the test result obtained is F (1, 288) equal to 3.27 and a P-value of 0.07, which enable us to reject the null hypothesis of the same effect at 10% level of significance (See Appendix 2 Table A2-4).

The variable age of the respondent and starting price have different effect on WTP of the respondent on the 75th percentile and median regression. The test result we obtained is F (1, 288) equals 5.64, implying the different effect of the variables age of the respondent between the two distributions. The test result for the variable starting price indicate that we reject the null of the same effect of this variable on the WTP at 50th and 75th percentile since we obtained F (1, 288) of 6.59 and P-value of 0.01.

When we examine the different effect of the variables on the 25th and 75th percentile, the variables status of the respondent, age of the respondent, source of water the household is being used, information and starting price have different effect, and we reject the null since we obtained F (1, 288) equal to 2.91, 3.73, 3.10, 5.02 and 4.04, respectively and the corresponding P-value of 0.08, 0.05, 0.07, 0.02 and 0.04 for the test result. The different effects of these explanatory variables lead to have higher value for the improved water service at the 75th percentile, which is 10 cents/bucket, than at the 25th percentile, in which case it is 3cents/bucket.

The pseudo R^2 for the 25th and 75th percentile is 0.16 and 0.15, respectively.

Before finalizing this section, we also estimated the OLS and Tobit model so that we can compare the result with CLAD estimation. The result is reported in appendix Tables A6 and A7. From the reported result we can see that in the OLS estimation the variables gender, monthly income, monthly consumption of water, monthly expenditure for water, quality and reliability of water and time taken to fetch water from the existing water source are found to be significant. While in the Tobit estimation the variables gender, monthly income, quality and reliability of water and

time taken to fetch water are found to be significant. In both cases the variable reliability of water is found to be significant but not in the CLAD estimation. Monthly consumption of water is significant in the OLS estimation but not in CLAD and Tobit estimation. Besides, time taken to fetch water from the existing source and monthly income of the household are significant at 5% in CLAD estimation but in OLS and Tobit estimation it is significant at 1%. Gender is significant at 5% in CLAD but at 1% in OLS and Tobit estimation. Monthly expenditure for water is significant at 1% in CLAD but at 10% in OLS estimation but not in Tobit estimation. According to J. Scote (1997), OLS estimation, with censored data included, over estimates the slope thus produces inconsistent estimates. The Tobit estimation, as explained before, assumes normal distribution of the error terms in estimation. Therefore we are not confidence to use the OLS and Tobit results for conclusion and policy implication given the nature of our data.

Table 4.5: Censored LAD estimation Result

Dependent variable $WTP_{0.5}$

Variable	Coefficients	t- ratio
Gen	-0.013	-2.237***
Inc	0.00002	2.085**
We	0.0005	2.345***
Qlty	0.0284	2.875***
T	0.0003	1.890**
CONST.	0.0334	1.061
No. of observation = 307 Pseudo R^2 = 0.19 Median WTP = 6.00 cents/bucket		

Source: study result

*** Significant at 1%

** Significant at 5%

2. Discrete Approach: Determinants of Willingness to Connect to the New Improved Water Supply

The rationale of using the discrete approach is to determine the key factors that explain the probability of a household to choose the new improved water supply system. In order to examine this, we estimated a probit model. The estimation of the probit model is done by assuming normality of the error term, and to correct the heteroscadasiticity problem we estimated a robust estimation using STATA software. Though we are interested only in the effect of the explanatory variables on the dependent variables, we report both the coefficients and the marginal effect of each independent variable that are found significant at conventional test level.

The likelihood ratio for the estimation model of χ^2 (15) equal to 42.2 indicates that the overall model is a good fit. The pseudo R^2 of 17% shows that the regression explains 17% of the total variation, implying there are other explanatory variables, in addition to those included in our study, which can also have an effect on the probability of connection to the new improved water service.

The coefficients obtained from the probit estimation (for equation 4.4) are reported in Table 4.6. As can be seen from the table, the variables wealth of the household, monthly income of the household, current source of water the household is being used, quality of the existing water, time taken to fetch water and the education level of the respondent are found significant.

The variable wealth, whose proxy is house ownership, has the expected positive sign and is significant at 5% level of significant. This implies that those households who are living in their private house are more willing to have access to be connected to the new improved water service. This result is also confirmed by the descriptive analyses, where we have seen that the major reason given by the high income group for their unwillingness to have private connection to the new improved water service was that they do not own private house. This result is consistent with other studies done in similar areas such as studies done by World Bank team in Brazil and India.

The variable education level of the respondent has the expected positive sign and is significant at 1%, indicating that people who get formal education prefer the improved water supply system. This implies that, *citrus paribus*, if people get formal education, the probability that they choose the new improved water service will increase. Our result is also consistent with other study results done by the World Bank in similar areas of Brazil and India and in Sierra Leon done by Bah (1997).

The other variable that is significant at 5% level of significant is the source of water the household is being used currently. The result indicates that those who are connected to the current system are more willing to have access to the new improved water service. The possible explanation for this is that households that already had piped water know the use of having private connection to the system more than those who had not.

The variable monthly income of the household is inconsistent in sign but found to be significant at 5% level of significance. The possible explanation for this negative sign is that results from the descriptive analyses indicate that out of the 34 respondents who are unwilling to have private connection to the new improved service, 20 are from middle and high-income group. And the reason they gave for their unwillingness to connect was that they do not have their own house. Besides, even if they prefer to have private connection, they need to ask some other body to get the permission i.e. they have to ask those who rent them the house. Therefore they prefer using other

source to having private connection to the new improved water service. This effect is reflected through the income variable since their income as well as their number outweighs those from low income group, whose reason for their unwillingness to have private connection to the new water service is income constraint. This is also reflected by the significance of the variable wealth. The related variable that is included in the estimation to handle clustering effect (remember we use income for clustering) is location of study (LSS) and this variable is consistent in sign, though it is insignificant, indicating that those who are living in high income area are more willing to connect to the new improved water service.

The variable quality of the existing water supply is found to be positive and significant at 5%, which is consistent and as expected. This implies that people are more willing to have private connection if they are provided with more quality of water supply. This result also supports the findings of others such as studies done in Tanzania.

The variable time taken to fetch water is significant at 10% and has the expected positive sign. This indicates that households perceive that by switching to the new system, they stand to save time (in minute) spent in fetching water from the existing water source, and thus the probability that they will choose the new system increases. Our study result confirms the economic theory, which suggests the less an improved water source costs in terms of time, the more likely a household would be willing to choose it.

Table 4.6: Probit Estimate Result

Variable	Coefficients	t-ratio	Marginal effect
W	0.53	2.217**	0.0774
Inc	-0.0006	-2.336***	-0.00008
Src	0.66	2.095**	0.102
Qlty	0.578	1.696**	0.113
T	0.005	1.282*	0.0007
Dedu	0.5	3.193***	0.0833
LSS	-0.241	-1.225	-0.0337
Const	1.227	1.227	
No. of observation = 307 Log likelihood = -89.012 Wald χ^2 (17) = 42.2 Prob. > χ^2 = 0.00 Pseudo R^2 = 0.17			

Source: study result

* Significance at 10%

** Significant at 5%

*** Significant at least at 1%

The other variables: gender, status of the respondent, family size, age of respondent, occupation, monthly water consumption, reliability of water, and water expenditure are found to be insignificant at conventional test level.

5. AFFORDABILITY ANALYSES

For any project to be financially sustainable, consumers must be able to afford to pay the price charged and the total monthly or annual bill. That is financial "adequacy" will be achieved only if the average financial cost can be recovered from users. An affordability analysis typically compares the household cost of water consumption with measures of household income. Since, from both economic theory and common sense, household water consumption varies with income, family size and quantities used for basic need (drinking, cooking and cleaning) to non-basic need such as watering lawn, washing cars e.t.c, the affordability analysis is done for each of the three income group. In order to do the analyses we use the average family size and average monthly income of the household obtained from our survey. And since the existing water supply service of the town does not satisfy the demand, we will use the per capita consumption of water proposed by the project. This also justifies the use of the cost data from the proposed project for the affordability analyses. However, one conceptual problem with such analyses is whether to use 'average cost' or 'marginal cost' concept as a price of water for our analyses.

The appropriate cost for users to pay, so as to cover the full cost of providing improved water supply, is the "long run marginal cost[8]" which includes both the investment and operation and maintenance costs. This is approximated by the average incremental cost (AIC). This cost will be taken as the appropriate target for charging water users where a project stands alone and if the project is designed on least cost basis. Therefore, for our analyses purpose, we used the average incremental cost as price of water for the analyses purpose. Average incremental cost (AIC) is defined as the present value of incremental investment and operation and maintenance cost of the project divided by the present value of incremental water production of project. Algebraically, to calculate the AIC we used the following formula:

8. Using marginal cost pricing has problems. For instance, lack of appropriate market price. Since marginal cost pricing is based on some assumption of competitive models such as complete knowledge of future condition, economic rationality of decisions by suppliers and consumers and existence of many buyers and sellers. Such conditions do not exist in developing countries. Besides government interferences with the market force is extensive. (United Nations water conference, 1980, cited in Katko T, 1989).

$$AIC = \frac{\sum_{t=0}^{n.}\left(\frac{IC_t}{(1+r)^t}\right)}{\sum_{t=0}^{n}\left(\frac{IWP_t}{(1+r)^t}\right)}$$

Where IC_t is incremental investment and operation and maintenance cost in year t. It is obtained using the following formula.

$$\boldsymbol{IC_t = TC_{wp} - TC_{wop}}$$

TC_{wp} and TC_{wop} are total cost with and without project respectively

IWP_t is incremental water production in year t. It is obtained using the following formula:

$$\boldsymbol{IWP_t = WP_{wp} - WP_{wop}}$$

WP_{wp} and WP_{wop} are water production with and without project
n is project life in years, which is assumed to be 22 years.

r is discount rate. We used a discount rate of 10.5%, which is usually used by large public investments project such as water supply, road and health projects in the country. The reason why we use the discount rate is that when a government decides to spend money in improving a facility, it losses the opportunity to invest the money elsewhere. That rate at which money could be invested elsewhere is sometimes described as the opportunity cost of capital. This opportunity cost of capital is accepted as the appropriate discount rate for use in economic study.

The data for cost and water production is obtained from both the project document and the town's water supply office.

Based on the above formula the AIC calculated is Birr 1.315 per m^3 of water produced. Thus the affordability analyses for the three sub groups and the town is done as follow.

1. For low-income group

From the survey result the average family size of this group is 5.39 and the average monthly income of a household is Birr 431.88. Using the average per capita water consumption of 35.66 liters, an average household in this sub group will consume 5.766 m^3 of water. The total money expenditure for water is, thus, Birr 7.58, which is

1.76% of the monthly average income of the household. This percent is less than the 5% of the average monthly income of the household, implying that if an average household in this sub group consumes the proposed per capita amount of water and buy 1m^3 water at a price equal to AIC, it can afford the price based on the 5% rule of thumb of the World Bank.

2. For middle-income group

Using 5.91 average family and birr 886.71 of the average monthly income of this sub group obtained from our survey, and per capita water consumption of 35.66 liters, we obtained monthly water consumption of 6.323 m^3 by an average household. The monthly expenditure is birr 8.31, which is 0.94% of the average monthly income of an average household in this sub group. This is also much less than the 5% rule of thumb of the World Bank.

3. High-income group

For this group we also used the average family size of 6.13 and average monthly income of Birr 1842.39 which are obtained from our survey result. Using the average per capita consumption from the project of 35.66 liters, we obtained the monthly water consumption and expenditure of 6.56 m^3 and Birr 8.62, respectively. When this monthly expenditure is compared to the monthly average income of an average household it is 0.47%, which is much less than the 5% rule of thumb.

4. For the town

The average family size and monthly income of a household for the town is 5.86 and Birr 1193.74 respectively. Using the per capita water consumption of 35.66 liters, we obtained a monthly water consumption and expenditure of 6.27m^3 and Birr 8.24 by an average household living in the town respectively. This expenditure is 0.69% of the average monthly income, which is much less than the 5% rule of thumb.

6. CONCLUSION AND POLICY IMPLICATION

6.1 Conclusion

This paper analyzed the determinants of willingness to pay for improved water service and affordability of the household in urban areas of Ethiopia. The study used primary data obtained from a contingent valuation survey of 307 households in Nazareth town. The elicitation method used was a bidding game, and we administered the survey using an in-person interview.

We used both a descriptive and econometric analytical technique. Unlike most other studies, we used a censored LAD estimation method, which does not need the normality and homoskedacitcity assumption of the distribution of the error term, to examine the influence of different socioeconomic, demographic and water service variables on the willingness to pay of the respondents. We used a probit model to study the influence of some of the variables on the decision of the household to choose an improved water supply service.

The results of our study showed that about 42% of the respondents reported that they do not have private connection to the existing water service. About 61% of the respondents said that the existing service is not reliable. These facts imply that the main problem of the existing service is accessibility and reliability.

Responses to the valuation questions revealed that 96.4% of the respondents expressed their willingness to pay for the improved water service, with a mean WTP of 6.8 cents per bucket. This implies that, on average, the respondents are willing to pay birr 3.40 for one m^3 of improved water service. Only 3.58% of the respondents are not willing to pay for the improved water service. Moreover, only 11.1% of the respondents are not willing to have private connection to the improved water service.
The results of the CLAD regression showed that gender, income, monthly water expenditure, quality of water and time taken to fetch water from the existing source are important variables that explain willingness to pay for improved water service. WTP is positively affected by household income, implying that higher income households are willing to pay more than lower income households. Monthly water expenditure also positively affects respondent's WTP, indicating that more costs for the existing water system means more willing to pay for the improved water service. Quality of the existing water and time taken to fetch water from the existing source also affect respondent's WTP positively. Sex of the respondent is found to have a negative influence on the respondent's willingness to pay, implying that males are willing to pay more than females.

A comparison of regression results for the 25^{th}, 50^{th} and 75^{th} percentile distribution indicated that some of the variables have different effects on the respondent's willingness to pay.

Results from the probit model show that wealth of respondent, source of water the household is being used, quality of water, time taken to fetch water from the existing source and educational level of the respondents has positive effects on the respondents' choice for improved water services. Respondents who get formal education are more likely to choose improved services. It also indicated that people

who spend more time in collecting water from the existing water system are more likely to have demand for private connection to the improved water service. Those who have private house and private connection to the existing water system are more likely to have private connection to the improved system than those who do not. And also those who consider the quality of the existing water as poor prefer to have private connection to the new improved water service. However, there is a tendency for higher income households not to choose the improved water service, as reflected by 'wealth' variable.

The affordability analyses show that households of Nazareth town are able to pay for the new improved water service, if they are provided the service at a price equal to the average incremental cost of supplying the new improved water service. Furthermore, if they are provided with the price of AIC, there is also a possibility of sustaining the improved service. The respondents' willingness to pay is higher than the AIC of supplying the improved water service, implying that the town's water supply office can earn more revenue if it sets the price of improved water equal to the willingness to pay amount. It is possible to sustain the improved water service if the beneficiaries are provided either at price equal to AIC or the beneficiaries' WTP amount

6.2 Policy Implication

Since the existing water supply system cannot satisfy the existing demand, which lead to the availability of water only for some hours per day or makes the availability unpredictable, people of the town are forced to buy water from vendors or waste time in fetching water. However if improved water services are supplied to the households, and the water utility install meters or increase its connections, it can increase its revenue by increasing the water tariff, since households are willing to pay more than the existing tariff. By setting the tariff equal to the average incremental cost (AIC) of providing improved water services, the water utility can recover the full cost of providing the service. The town's water utility can even charge more than the AIC since the respondents' WTP is more than the AIC so that it can earn more revenue than recovering the full cost of the improved water service.
More specifically, based on our findings, we can draw the following policy implications:

1. An important policy implication from the strong positive relationship between educational level and willingness to connect to the improved water service is that there is a need to educate people about the benefits associated with improved

water services, in general, and having private connection to the new improved water supply, in particular.

2. The strong positive relation between the wealth of the household and the willingness to have private connection to the improved water service imply that there is a need to consider household's wealth status in designing policies related to supply of improved water services.

3. Given that what people say today remained the same for tomorrow, an important policy implication of the high amount of WTP we obtained in our study is that the existing tariff is set below the people's WTP, which implies that in setting tariff for water supply the willingness to pay of the beneficiaries should be taken into consideration. Besides, since WTP is affected by income of the household, tariff setting should consider the poor income group not to be devoid of from access to the minimum water requirement to sustain their life. Furthermore it also imply that designing income generating programs that address the poor households can help to sustain the system to function well.

4. Our study result showed that people are more willing and can afford to pay for an improved water service at a price equal to the AIC of supplying the improved service. This implies that if least cost method is used in formulating projects for improved water supply service, it is possible to set tariff that enable to recover the full cost of providing the improved water supply.

5. The high WTP amount and the ability of the consumers to pay for the price of the improved water supply equal to the AIC imply that the town's water supply officials not only can establish full cost recovery, it can also attain an efficient and proper utilization of the water supply resources since one of the advantages of implementing cost recovery program is efficient and proper utilization of the water resources.

6. In our study we found that most of the respondents able and are willing to pay the full cost of providing the improved water supply. An important policy implication from this finding is that it is advisable for the water utility to set objective which can abandon the low-level equilibrium trap, which is the cycle of poor service, little revenue and low reliability, and which can lead to attain high level equilibrium, which is high private connections and high reliability of the service given the improved water supply service is provided.

7. It must be noted that this paper did not study the financial management aspects. Thus the full cost recovery policy implied by this study may be questioned unless the fee from the sale of water is collected and utilized only for activities related to the water supply service. Besides, since investment cost for water supply construction depends on the technology used and the region where the water supply is constructed, our study findings of full cost recovery is also subjected to these constraints. Furthermore, since the respondents are provided with the amortization of fee for connection, the town's water supply officials should look for means to cover the connection fee a priori so that the beneficiary will pay the connection fee in the form of amortization. That is the local utility office should look for a means to promote flexible payment structure especially for connection fee so as to maximize the number of consumers for private connection. Finally it must be also noted that this research paper did not include non-domestic use of water.

References

An Y.M. 2000. "A semiparametric distribution for willingness to pay and statistical inferences with dichotomous choice contingent valuation data." *Journal of American Agricultural Economics Association.*vol. 82: 487-500

Alemu Mekonen. 1997. "Valuation of Community Forest in Ethiopia: A contingent Valuation Study of Rural Households." *Environment and DevelopmentEconomics* Vol.5: 289-308

Amemiya, Takeshi.1981. "Qualitative Response Models: A survey," *Journal ofEconomic Literature* Vol.19 Pp. 1483-1536

Asian Development Bank, 1998. Handbook of Guidelines for the economic Analyses of Water Supply Projects.

Bah, I. 1997. "Estimating Household Valuation for Water Services in Urban Areas: the Case of Freetown, Sierra Leone." (Dissertation)

Batemen. I.J and R.K. 1992. "Evaluation of environment:" the CVM, CSERGEGEC Working paper

Bestemeier, T, and Visscher, J. T., 1987. "The operation and Maintenance of Water Supply systems in Developing Countries. A cost Study." (Research Triangle Institute.)

Briscoe. John, Paulo Furtado de Castro, Chareles Griffin, JamesNorth, and Orjon Olsen. 1990. "Towards equitable and Sustainable Rural Water Supplies: A Contingent Valuation Study in Brazi.l" *The World Bank Economic Review.* Vol. 4(2).

Central Statistics Authority, 1995. "The 1994 Population and Housing Census of Ethiopia: Results for Nazareth Town," Volume I Statistical Report.

CES Consulting Engineer, 1998. "Tariff Study Oromiya, Benshangul-Gumuz and Gambela region," Ministry of Water Resources. Addis Ababa.

Crane, Randall, 1994. "Water markets, market reform and the urban poor: Results from Jackarta, Indonesia." *World Development* Vol. 22 No. 1 Pp 71 – 83.

Deaton, Angus, 1997. *The analyses of household surveys: a Microeconometric Approach to Development Policy*. (Published for the World Bank, the johns Hopkins University.)

DEVECON ENGINEERS and ARCHITECTS. "Five Towns Water Supply and Sanitation study." Phase I Report.Vol. 1, Nazareth.

DEVECON ENGINEERS and ARCHITECTS. "Five Towns Water Supply and Sanitation Study." Phase I Report.Vol.2, Nazareth.

Fissiha Abera, 1997. "Estimating WTP for water: A case Study on Meki Town." (M.Sc. Thesis, Department of Economics, AAU.)

Freeman A.M., 1993. *The Measurement of Environmental and Resource Value*: *Theory and Methods*. (Washington, D.C Resource for the future,.)

Genanaw Bekele, 1999. "Analysis of Determinants of Household's WTP and Demand For Improved Water Services: A
Contingent Valuation Study in Harar Town, Ethiopia." (M.Sc. thesis, Department of Economics, AAU.)

Green W.H, 1993. *Econometric Analyses*. (New York, Macmillan publishing company.)

----------, 2000. *Econometric Analyses* (New York, Macmillan publishing company.)

Grifen. C, et al, 1995. " A Contingent Valuation and Actual Behavior: Predicting Connections to New Water Systems in the State of Kerela, India." *The World Bank Economics Review.* Vol. 9(3)

Gujarati, Damodar N.1995. *Basic Econometrics*. International edition. (McGraw-Hill international edition)

Hanley N. and Clive L.S., 1995. *Cost-Benefit Analysis and the Environment.* (*Department* of Economics, University of Stirling Press, Scotland).

Hanman W.M. 1991. "Willingness To Pay and Willingness To Accept: How much can they differ." *American Economic Review.*

Heckman, J.J. 1979. " Sample Selection Bias as a Specification Error," *Econometrica* Vol.47 Pp. 153-161

Howe, C.W., 1971, "Benefit-cost Analyses for Water System planning. Water Resources Monograph." No 2, *American Geophysical Union*, Washington, D.C.

http://www.ats.ucla.edu/stat/stata/faq/cap_qreg.htm

http://www.quantlet.de/scripts/xag/htmlbook/xploreapplichtmlnode4.html

http://www.quantlet.de/scripts/xag/htmlbook/xploreapplichtmlnode5.html

http://www.quantlet.de/scripts/xag/htmlbook/xploreapplichtmlnode6.html

http://www.quantlet.de/scripts/xag/htmlbook/xploreapplichtmlnode7.html

http://www.quantlet.de/scripts/xag/htmlbook/xploreapplichtmlnode8.html

Johnston, J. 1997. *Econometric Method*. 4th ed. London. (McGraw-Hill)

Koenker, R.and Bassett, G.W., 1982. "Robust tests for heteroskedaciticty based on Regression Quantile," *Econometrica* Vol.50:43-61

----------, G.W, 1982. "Test of linear hypothesis and L1 estimation." *Econometrica*. Vol.50: 1577-1584.

----------, G.W, 1978. "Regression Quantiles," *Econometrica.* Vol.46: 33-50

Katko T., 1989. The Role of Cost Recovery in Water Supply in Developing Countries. (Temper University of Technology. Department of Civil Engineering. Institute of Water and Environmental Engineering.)

Knetch J, 1989. " The endowment effect and evidence of non reversible indifference curves." *American Economic Review*, December 1277-1284.

Maddala G.S, 1983. *Limited Dependent and Qualitative Variables in Econometrics*, (New York Cambridge University Press)

Maria R.S and Dinar A., 1997. "Satisfying Urban Thirst. Water supply Augmentation and Pricing Policy in Hyderabad City, India." World Bank Technical Paper No.395.

Mary Riddel & John Loomis, 1998. "Joint estimation of Multiple CVM scenario Under a Double Bounded Questioning Format." *Journal of Environmental and Resource Economics.* Vol. 12: 77-98.

Ministry of Water Resources, 1999. *Federal Water Resources Policy*. (Addis Ababa.)

Mitchell, R.C. and Carson R.T., 1989. *Using Survey to Public Goods: The Contingent Valuation Method*. (The Johan Hopkins University Press, Washington D.C.)

Navrud,S, 1988. WTP for the preservation of Species. An Experiment with Actual Payment, Mimeo*,* (Agricultural University of Norway, Stockholm.)

Powell, J. L.1986. "Symmetric Trimmed Least Squares Estimation for Tobit Models." *Econometrica,* Vol.54, No.6, 1435-1460

----------, 1986. "Censored Regression Quantile." *Journal of econometrics*. Vol.32: 143-155

----------, 1984. "Least Absolute Deviations Estimation For the Censored Regression Model." *Journal of Econometrics* Vol.25: 303-325

Rashid M.Hassen, 1997. "Conserving and Efficiently Allocating Water Resources Through Demand Management: The Potentials of Emerging Policy Instruments:" *Resource Policy Briefs Series* Vol.1

Robert and A. Young. 1996." Measuring Economic Benefit for Water Investment and Policies," Technical Paper No. 338, The World Bank, Washington, D.C.

Scott L. L J., 1997. *Regression Model for Categorical and Limited Dependent Variable*. (SAGE Publication, California.)

TAHAL, CES and Tropics consulting Engineers, 1998. "Water Supply Development and Rehabilitation projects. Tariff Studies." Final Report

Tassew Woldehanna, et al, 2000. "Off farm work decisions on Dutch cash crop Farms and the 1992 and Agenda 2000 CAP reforms." *Journal of the International Association of Agricultural Economists.* Vol.22 No2.

Tegene Gebre Egziabher, 1999. "Willingness to pay for Environmental Protection: An Application of Contingent Valuation Method (CVM) in Sekota District Northern Ethiopia." *Ethiopian Journal of Agricultural Economics.* Theresa Kundy, 1998. "An Analysis of the Determinants of individual WTP for Improved Water Services in Rural Areas: a Strategy For Cost Recovery.

The Case of Kilimbero District, Tanzania". (M.A. Thesis.) Varian, H.R., 1994. *Microeconomic Analyses*, (New York Norton,)

Whittington K. and Lauria D.1995. "Household Demand for Surface Water Quality Improvement in the Philipines: A Case Study of Davaco City." *The vironment*, World Bank, Washington D.C.

Whittington, D, et al., 1991. "A study of Water Vending and Willingness to Pay in Onisha, Nigeria," *World Development* Vol.19, No. 2/3.

----------. 1990. "Estimating the Willingness to pay for Water Services in

Developing Countries. A case study of the contingent Valuation Method in Southern Haiti." *Economic Development and Cultural Changes* 38, No. 2

Whittington, D., Lauria, D.T. and Mu, X., 1987. " Cost recovery in community water supply sanitation." Report of the second informal consultation on institutional development. Geneva, 5-9 oct 1987. WHO/CWS/87. 5. 41

Whittington, D.,Briscoe, J and Mu., 1987. "Willingness to pay for water in rural areas:methodological approaches and an application in Haiti." WASH field report No. 213 93p

World Bank Water Demand Research Team, 1993. "The Demand for Water in Rural Areas. Determinants and Policy Implications." *World Bank Research Observer,* Vol. 8, No. 1

World Bank. 1994. "Infrastructure for Development:" World Development Report l994: Oxford University press

W.S.J.Rewet and R.K.Sampath, 2000. "Performance Evaluation of urban Water supply in Tanzania: the case of Dareselam city." *Journal of Water Resource Development*, Vol.16, No.3.

Appendix

TableA1: Variables included in estimation, their expected sign and the rationale for their expected effect on willingness to pay and willingness to connect to the new improved water supply.

1. **Monthly income of household**: Total monthly income of the household. It is a continuous variable measured in Birr. Based on empirical results done in similar areas and economic theory that shows quantity demanded and income are positively related in case of normal goods, we expect Positive sign
2. **Family size:** number of people living under one-roof and share common resources. We expect negative sign As the number of family size increases; the need for water will be higher. Thus we expect lower WTP. The preference for private connection to the improved water is indeterminate since if the family is larger size we expect negative since there is excess labor to fetch water. But if the family is small it prefers to have private connection to the improved water service.
3. **Wealth (W):** It's Proxy is ownership of house. It is a dummy variable.1 if the household owns house; 0 otherwise Wealthy households are more willing to pay and prefer to have private connection to the improved water service, and thus we expect Positive sign.
4. **Education level of the household:** Dummy variable. 1 if the respondent gets formal education; 0 otherwise its effect is expected to be Positive since educated households are more aware of the health benefit of improved water service and may have higher opportunity cost of time spent for collecting time. Thus they are willing to pay more and have more preference to improved water service.
5. **Gender of respondent**: Dummy variable. 1 if female; 0 otherwise. Studies on household water use hypothesize that women would attach more importance to improved supplies than would men, and thus women would be willing to pay more for such services. However in Africa culture women do not have equal control over or access to the household's cash resources. Thus when asked how much they are willing to pay for improved services, they may be reluctant to give a response though they may give more worth to the improved services. Thus we cannot determine its sign a priori.
6. **Age of respondent**: Continuous variable in number of year. This variable will be expected to be negative since older people are traditionally used to free water services so that they may be less willing to pay and may have low preference for a new source that will require fees.
7. **Occupation of the respondent**. It is dummy variable, and takes 1 if the respondent works in formal sector; 0 otherwise. Studies made in different country (Haiti, Brazil, Pakistan and Nigeria) show that the effect of this variable on WTP for improved water services was mixed. Studies made in Brazil and India support that those respondents employed in formal sector are willing to pay more than those employed in the informal sector. But in Haiti they are willing to pay less. Thus we cannot determine its sign a priori.
8. **Attitude of the respondent towards the administration of the water utility**. It is a dummy variable, and takes 1 if the respondent says the government should administer; 0 otherwise. We expect negative sign. If the respondent says the government should administer the water utility, he/she may expect that the government will provide the service at less price and thus less willing to pay.
9.**Source of water the household is being used**: it is dummy variable, and takes 1 if the household uses private piped water; 0 otherwise. We expect Positive sign since Those respondents with private connection to the existing service is more willing to pay than those not connected since they are more aware of the benefit they get.
10. **Time taken to fetch water from the existing water service in minute**. We expect positive. In areas where there is inadequate amount of water compared to its demand, people may spend much time to fetch water. One benefit of providing improved and adequate water service is saving time, which has an opportunity cost of using the time for other activities. Besides, consumer demand theory suggest that household would pay more for an improved supply when costs in terms of time of obtaining water from the existing sources are higher than if this cost were low.

11. **Reliability of the existing source of water**: Dummy variable, and takes 1 if the respondent says reliable; 0 otherwise. We expect negative sign reliability refers to the availability of water at the required time and amount. People are willing to pay more for the improved water if the existing water supply is unreliable. If the household/respondent considers the existing water supply in the town is reliable, we expect a negative relation between this variable and WTP for the improved water service.
12. **Respondents perception about the quality of the existing water supply**: Dummy variable 1 if the quality of the existing water supply is poor 0 otherwise. Our expectation is that a household would be more willing to pay for an improved source when the perceived quality of the existing water source is poor.
13. **Location of study areas**: Categorical variable 1 if the household/respondent live in high-income area 2 if he/she lives in middle-income areas 3 if he/she lives in low-income area. Negative The rationale is similar to income variable.
14. **Information about the improved water supply under construction in the town**: Dummy variable, and takes 1 if the respondent has the information 0 otherwise. We expect Negative. If the respondent has the information, he/she may understate the value since he/she may think that the tariff for the improved water service may be influenced by his/her response
15. **Monthly expenditure for water consumption**: Continuous variable in Birr. We expect Positive Some households living in Nazareth town are buying water from vendors, whose price is higher than the official tariff. They also incur additional labor cost. But this is not the same for all households. Since some of them do not buy from vendors and some other do not pay labor cost. Thus the monthly expenditure for water consumption may vary among households though the volume of water consumed is the same. Hence, more cost in terms of money for the existing service may lead the respondent to state more value for the improved water service.
16. **Monthly water consumption by the household**: Continuous variable. We expect Negative More water consumption means more monetary expenditure, which lead to state less value.
17. Starting price for the bide game: To be tested
18. **Status of the respondent**: Dummy variable, and takes 1 if the respondent is head; 0 otherwise. We expect Negative sign since head of the household has a responsibility of managing the family; he is more intimate with financial matters. And the financial resource available to the households is competed for alternative ends. Thus we expect he/she is less willing to pay for the improved water service.

Table A2: Starting bids and mean WTP

Starting price for the biding game (cents/ bucket)	Number of respondent	Mean WTP	
2.5	100(32.57%)	6.32	6.8
5.00	106(34.53%)	6.96	
10.00	101(32.9%)	7.13	
Total	307		

Source: study results

() is percentage from the total sample.

TableA3: WTP by study site

Range of WTP/bucket	Nazareth TOWN	LOW INCOME AREAS	MIDDLE INCOME AREAS	HIGH INCOME AREAS
- 2.49	42 [13.68]	17 [19.3] (40.48)	18 [23.08] (42.85)	7 [4.96] (16.67)
2.5 - 4.99	57 [18.57]	26 [29.5] (45.6)	12 [15.38] (21.05)	19 [13.48] (33.33)
5 - 9.99	111 [36.16]	24 [27.3] (21.62)	35 [44.87] (31.53)	52 [36.88] (46.85)
10 - 14.99	62 [20.19]	19 [21.6] (30.65)	9 [11.54] (14.52)	34 [24.11] (54.84)
15 - 19.99	31 [10.09]	2 [2.3] (6.4)	2 [6.5] (6.5)	27 [19.15] (87.1)
20 - ∞	4 [1.3]	--	2 [2.56] (50)	2 [1.4] (50)
TOTAL (column)	307	88	78	141
INTERESTED TO CONNECT	273 [88.93]	74 [84.1]	72 (92.3)	127 (90.1)
NOT INTERESTED TO CONNECT	34 (11.07)	14[15.9] (41.18)	6[7.7] (17.6)	14[9.9] (41.18)

Source: study result

[ ] Shows column percentages, ( ) shows row percentage.

Table A4: Test results of effects of the variables across two distributions

Variable	The calculated F value		
	Between 25th and 50th percentile	Between 25th and 75th percentile	Between 50th and 75th percentile
RS		2.91 (0.08)	
AGE		3.73 (0.05)	5.64 (0.01)
SRC		3.1 (0.07)	
INF.		5.02 (0.02)	
ST		4.04 (0.04)	6.59 (0.01)
QULTY	3.27 (0.04)		

Source study result

Ho : the same effect across distribution

Figures in () are P.values

Table A5: Estimation results of the 25th and 75th percentile distribution

Variable	25th percentile regression		75th percentile regression	
	Coefficients	t- ratio	Coefficient	t-ratio
Gen	-0.009	-1.825**	-0.006	-0.805
Rs	0.0097	1.476*	-0.008	-0.0699
Fs	-0.0011	-0.870	-0.0026	(-1.763)**
Age	-0.0003	-1.696*	0.001	(1.253)
Inc	0.00002	1.981**	0.00003	(3.365)***
Src	0.005	0.647	-0.0163	(-1.461)*
We	0.0004	1.327*	0.0003	(0.971)
Qlty	0.0122	1.255	0.0289	(2.146)**
INF	-0.0026	-0.366	0.026	(2.031)**
T	0.0004	4.105***	0.0003	(1.253)
ST	-0.0724	-0.859	0.261	(1.464)*
CONST.	0.0125	0.474	-0.024	(-0.645)
No. of observation	307		307	
Pseudo R^2	0.16		0.15	
WTP (cent/bucket)	3.00		10.00	

Source: study result

Table A6: OLS estimation result

Variables	Coefficients	t-ratios
GEN	-0.0098	-2.420***
INC	0.00003	7.702***
CNM	-0.0011	-1.9*
WE	0.0003	1.788*
QULTY	0.0197	2.182**
R	-0.0089	-2.042**
T	0.00035	4.312***
ONS	0.0162	2.394**
No. of observation = 307 F (18, 288) = 6.01 Prob > F = 0.000 R^2 = 25.91		

Table A7: Tobit estimation

Variables	Coefficients	t-ratios
GEN	-0.011	-2.428***
INC	0.00003	3.957***
QULTY	0.022	1.673**
R	-0.0097	-2.104**
T	0.0004	4.231***
CONS	0.007	1.79*
No. of observation = 307 LR chi 2(18) = 86.8 Prob > chi2 = 0.000 Log likelihood = 525.62 Pseudo R^2 = 9.0 %		

Note:*** is significant at 1%
** is significant at 5%
*is significant at 10%