

ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

(FACULTY OF BUSINESS AND ECONOMICS)

ANALYSES OF AFFORDABILITY AND DETERMINANTS OF WILLINGNESS TO PAY
FOR IMPROVED WATER SERVICE IN URBAN AREAS, STRATEGY FOR COST
RECOVERY.

(A CASE STUDY OF NAZARETH TOWN, ETHIOPIA)

BY

ALEBEL BAYROU

July 2002
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A Thesis Presented to the School of Graduate Studies, Addis Ababa
University.

In Partial Fulfilment of the Requirement for the Degree of Master of
Science in Economics (Economic Policy Analysis)

By Alebel Bayrou

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Acknowledgement

I wish to acknowledge with special thanks to my advisor Dr. Tekie Alemu for his invaluable guidance and constructive professional advises throughout my research. My special thanks should also go to the Ministry of Water Resources for sponsoring the program and also its library workers in serving me and getting valuable documents.

I wish also to thank Ato Gulilat Birhane, head of plan and projects department in the Ministry of Water Resources for his personal advise and letting me to concentrate fully in my study. I am grateful to Oromiya Bureau of Water, Mines and Energy, East Shoa zone Water, Mines and Energy department and Nazareth town Water Supply office for their cooperation in collecting data. I also thank those who contributed for the success of my research.

Finally I wish to thank my wife, Tsion, and my child for leaving the family time for my study.

Above all I thank God.

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Abstract

The provision of improved water supply service both in 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. This shows much is remaining to attain full coverage for the people of Ethiopia. Parallel to increasing the coverage we need to consider the 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. In order to implement cost recovery system we need to examine the affordability and willingness to pay of the beneficiaries.

Therefore, the objective of this 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 urban areas of the country.

We used a contingent valuation method to examine the determinants of willingness to pay. The value elicitation method used in our study is bidding game. The total number of households surveyed is 307, and an in-person interview was used to administer the survey.

Unlike most studies, we used a censored LAD estimation for the empirical analyses, which does not need the normality and homoskedacity 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 estimate result showed that wealth, income, education level, source the household is being used, quality and time taken to fetch water from the existing 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 service at a price equal to the average incremental cost of providing the improved water supply service.

CHAPTER ONE

INTRODUCTION

1.1 Statement of the problem

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 diarrhea, 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 in the third world 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 water delivery systems in both the short run and long run is critical to ensure that the population receives adequate water supplies.

As far as the water supply condition in Ethiopia is concerned, it is to be noted that 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 over 90% of the population living in rural Ethiopia has no access to potable water. 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 and unreliable.

Due attention has been given by the Ethiopian government to alleviate these shortcomings and to achieve rapid socioeconomic development through better health care and productivity of its people. To this aspect the country developed a water resources management policy in 1999. The water supply and sanitation policy is an integral part of the country's water management policy. It 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.

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.

This policy, whose overall objective is to enhance the wellbeing and productivity of the Ethiopian people through the provision of adequate, reliable and clean water service that meet the water user's demand, should be implemented so as to achieve its objectives.

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. In order to cover costs and to sustain the service, revenue should be collected from the sale of the water. To get the required revenue, 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, should be considered.

Therefore, the implementation of the country's water supply policy should focus on the demand side. Equally important is the price mechanism and regulatory environment, which must 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. 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 of the households to pay for the improved water services, as a strategy for cost recovery, can be established.

1.2 Objective of the Study

Effective policy and planning must take in to account what consumers want and are prepared to pay for an improvement in the quality of an environmental good. This study intends to look at the values of safe water services by determining appropriate monetary values for such services.

The main objectives of the study are to find out whether it is possible to introduce full cost recovery program to supply improved water services in urban areas of the country and to examine the determinants of willingness to pay.

The specific objectives of the study are:

1. To estimate and analyze household's WTP for improved water services in Nazareth town.
2. To analyze the consumer's actual ability to pay.
3. To analyze and evaluate cost recovery system versus individual ability and WTP for improved water services.
4. To determine the appropriateness of the existing government policy towards urban water supply and draw up some policy implications based on the findings.

1.3 Significance of the Study

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. That is cost recovery is the key requirement for sustainable development in water supply. However, the charge should be based on the ability and willingness to pay of the consumers for such services. Therefore, the study will try to find out whether it is possible to cover the full cost of supplying improved water services in urban areas. That is, it provides the required information on the ability and willingness of the people not only to pay for water services but also to sustain their supplies that include paying for operation and maintenance and investment costs.

The study will also be an additional contribution to the number of studies done in the past to evaluate improved water services. While there have been few studies on the subject in Ethiopia, none has been done for Nazareth town. As Griffin et al (1993) indicated, any attempt to estimate the behaviors and benefit in particular communities and in other settings can lead to serious, misleading and erroneous conclusions, even when natural conditions between communities and the services to be offered are quite similar. In relation to this, there is a need to prove the relevance of the contingent valuation method in Nazareth town. Moreover, this study will differ from the previous studies done on water supply issues because it is aimed at cost recovery issues of improved water supply service by analyzing the ability and willingness of consumers in the target area for the provision of the good.

1.4 Scope of the Study

The study of cost recovery in water supply in developing country requires analyzing a number of elements including ability to pay, WTP, and fee collection and financial management (Kato T. 1989). However, this study focuses on analyzing the first two and relating with the cost of

water. It will not assess the issue of fee collection and financial management due to logistic constraint, limited time and financial constraint and can be considered as one limitation of this study. For the same reason the study is restricted to Nazareth town. Nazareth is selected because the town has serious shortage of water both in quality and quantity, and due to this new improved water supply is under construction. Besides, the town is one of the few towns that are attaining fast growth, and it is recently assigned as a capital of Oromiya region, one of the largest regions in the country. The study is also restricted to analyze the determinants of WTP and analyze the ability to pay of the household only for domestic purpose in the town.

CHAPTER TWO

GENERAL BACKGROUND OF THE STUDY AREA

2.1 Description of the study area

Nazareth is found about 90 km south east of Addis Ababa at altitude 8⁰ 30' N and longitude 39⁰ 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.)

Nazareth is a very big town by Ethiopian standard and an important one due to its administrative and economic role. In 1988, the town became the capital of eastern Shoa administrative region and Since 2000 Nazareth is the capital of Oromiya 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 19⁰c and 22⁰c. Maximum temperature occurs from March to May. The mean monthly maximum temperature exceeds 30⁰ c.

According to the 1994 population census, the population of Nazareth is 127,842, of which the male population is 61,965 and that of female is 65,877. 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%. The population of the town is

composed of different religious, ethnic and linguistic groups. The major ethnic group in the town is the Amharas but Oromos dominate the surrounding region of the town. Other ethnic groups living in the town are Tigre, Gurage and others. The dominant languages spoken in the town are Oromiffa and Amharic. Most of the inhabitants of the town are followers of Coptic Orthodox Church and Muslim comes next to orthodox.

With regard to its infrastructure & economic activity, Nazareth depends for its electricity supply on the national power grid, and no serious problem of power for domestic purposes. The town lies on the main highway to Assab and on the railway line to Djibouti. Automatic microwave, telephone, telegram, telex, Tele fax, communication systems exist in the town. Good road networks exist in the town. Carts and taxis are available to serve the people for their daily activity.

At present there is one hospital and many private clinics (higher, medium & small), pharmacies, one technical college and one teachers training institute. Several intermingled activities are taking place in Nazareth. 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 Oromiya 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.

2.2 Existing Water supply System (WSS)

Based on the information obtained from the town's water supply office and the project document for the feasibility study of supplying water in the town, an outline of the existing WSS is discussed in this section that includes water sources, treatment transmission, distribution, production and consumption and tariff.

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.

Except for the Fluoride level all other chemical constituents are within WHO standard limits. 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 from Melka hida well is pumped by submersible pumps into two collecting chambers that are found at Melka Hida Mountain and in the town near Bekele Mola hotel. Their capacity is 560m³ and 260m³, respectively. Currently these reservoirs are not functioning. Another reservoir with a capacity of 1000m³ is found in the town, to which the water is pumped from the Melka Hida bore holes. Chlorine is added at this collecting chamber

from which the water is pumped by surface pumps through the rising mains in to two reservoirs at an elevation of 1716 m.a.s.l and 1664 m.a.s.l. The wells outside the Melka hida field are not connected to the system. These give service to those with in their surroundings. From the reservoirs the water flows by gravity to the distribution network and to two reservoirs at an elevation of 1620 m.a.s.l. The town has six reservoirs but at present only three are in use. The water is distributed to consumers through 9451connections and 43 public taps.

2.3 Water production, consumption and tariff

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 m³/yr.

Table 2.1 Water productions per year

<i>Year</i>	<i>Total production of water (m³)</i>
<i>1990/91</i>	<i>1,602,376</i>
<i>1991/2</i>	<i>3,058,007</i>
<i>1992/3</i>	<i>1,950,178</i>
<i>1993/4</i>	<i>2,997,105</i>
<i>1994/5</i>	<i>2,607,865</i>
<i>1995/6</i>	<i>2,370,923</i>
<i>1996/7</i>	<i>2,572,640.7</i>
<i>1997/8</i>	<i>2,529,266</i>
<i>1998/9</i>	<i>2,390,012</i>
<i>1999/2000</i>	<i>2,526,568</i>
<i>2000/2001</i>	<i>1,326,523*</i>

* *Only for six months*

Source: Nazareth town water supply office

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

Table 2.2. Type and Number of Connection

Ser 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
	<u>Total</u>	9494	4437	100

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

Nazareth

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/m³. On the other hand, water vendor rates are between Birr 5-7.5/m³.

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 is decreasing. It started to increase only after year 2000 when the regional bureau of water mines and energy increased the tariff from birr 0.5/m³ to at least birr 1.30/m³ of water consumption.

The major problems of the water supply system of the town are shortage of water and high content of fluoride.

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

2.4 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 to be completed in year 2005 and phase II is to be completed 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 cautious since we couldn't get reliable data.

CHAPTER THREE

LITERATURE REVIEW

3.1. Theoretical Literature Review

In this sub section a review of the literature on economic valuation of environmental resources will be presented.

Introduction

Measuring values involves the use of economic theory and technique. The foundation for economic concept of value is neoclassical welfare economics. There are many definitions of the word “value”, but none of them has been universally accepted. Today value is regarded as synonymous with the price of resources though earlier philosophers of the subject made a distinction between the two concepts. Even though there is no one accepted definition of the value of an economic resource, since its definition depends on from which angle one is looking, it is important to have a meaning of the value of a resource to ascertain the "value" a typical household places on the change in the quality of provision of the resources, and it is also possible to determine factors that can influence some one to perceive the value of the resource to be. Therefore, in this study the value of a good is taken as the most an agent is willing to give up in exchange for the good out of the resource it controls, or, in terms of another agent’s resources, the least, the controlling agent is willing to accept in return for giving up the good (Mitchell and Carson, 1989). Coming to the case of water resources, given

its innate characteristics and the market failure inherent in its allocation, the literature suggests that we can determine its value by recognizing how much a typical household will be willing to give up to acquire it.

The basic premises of welfare economics are that the purpose of economic activity is to increase the well being of the individuals who make up the society, and that each individual is the best judge of how well off he or she is in a given situation. From this it follows that the basis for deriving measures of the economic values of changes in resource-environmental system is their effects on human welfare.

Welfare economics, whose theory relates to the basic theory of individual preferences and demand for goods, seeks to make judgments about the desirability of having government undertake particular policies. Much of the history of welfare economics has been dominated by the notion of a “ a social welfare function” which played no role in applied welfare economics (except used frequently for illustration purpose in economic texts) since it based its definition assuming utility is measurable in cardinal sense, and comparable across individuals. The notion of cardinal utility had been completely rejected in favor of an ordinal definition of utility. This ordinal definition of utility enables consumers to preferentially rank alternative bundles of goods in a manner consistent with certain axioms of rational behavior that include completeness, transitivity, convexity and nonsatiation.

A weaker, but perhaps ethically more neutral, criteria for welfare is Pareto criterion, which stated that policy changes which make at least one person better off without making any one worse off are pareto improving. The applied side of modern welfare economics, benefit-cost

analysis, operationalizes a variant of the Pareto criterion by trying to find ways to place a dollar value on the gains and losses to those affected by a change in the level of provision of a public good. This allows the calculation of net gain or loss from a policy change, and determination of whether the change is potentially Pareto improving. Changes in environmental quality can affect individual's welfare through changes in prices they pay for goods bought in market, changes in prices they receive for factor of production and changes in the quantities or qualities of non-marketed goods or public goods such as improvement in water quality.

Five alternative measures of this welfare changes have been identified in the literature. The first is the change in ordinary consumer's surplus. Ordinary consumer's surplus is measured by the area under a Marshallian ordinary demand curve but above the horizontal price line. This cannot be identified in terms of the underlying utility function. That is, it has a number of problems due to the fact that the ordinary (Marshallian) demand curve does not hold the level of utility constant but rather holds income constant. The other four, which Hicks (1943) suggested are theoretical refinements of the ordinary consumer's surplus (cited by Mitchell and Carson, 1989). These are compensating variation (CV), equivalent variation (EV), compensating surplus (CS) and equivalent surplus (ES). CV and CS are measures of the gains or loss which hold utility constant at the initial level while EV and ES are measures of welfare change which hold utility constant at some specified alternative level. Depending on the consumer's property position vis-à-vis the good in question (in this study improved water supply), each of the four measures may involve either payment or compensation in order to maintain utility at the specified level. EV and CV allow the individual to adjust the quantities consumed in response to changes in relative prices and income levels. The other two measures (the Hicksian surplus

measures) are to be used when the consumer is constrained to buy only fixed quantities of the particular good (Randall and Stall (1980), cited in Mitchell and Carson, 1989).

Policy interest usually lies in the potential benefits as measured from consumer's current or initial level of utility. Further on, if the proposed change is welfare increasing, which is the focus of this study, then the appropriate welfare measure is the compensating surplus. This measure can be interpreted as the consumer's maximum willingness to pay in order to gain the quantity increase and still maintain his initial level of utility (Mitchell and Carson, 1989).

In order to calculate the benefits using the Hicksian demand curve requires correctly estimating the demand function for the improvement of the public good. However, this task is difficult due to the fact that estimation of demand requires substantial methodological efforts as well as due to lack of accurate market data for these goods. An alternative method to this is to use a hypothetical market model, which is a contingent valuation method. This method requires the creation of a market scenario that resembles actual market situation for goods and services, which does not have ordinary market. From the survey data obtained using contingent valuation method, not only a maximum willingness to pay data can be generated, which will be used to construct the demand curves but also used to conduct valuation process of the public good without having to estimate the actual demand curve. This concept can be further emphasized from the relationship between the expenditure function and Hicksian compensated surplus measure as follows.

According to modern consumer theory, the expenditure function is one of the four equivalent ways to represent the constrained utility maximization problem (Varian, 1984). This function is written as:

$$e(p, q, u) = Y \dots\dots\dots \text{EQ 3.1}$$

Where, p is vector of prices, q is vector of fixed public goods, u is level of utility, and Y is the minimum amount of income needed to maintain utility level u given the price and public good vectors.

Letting p_o, q_o, u_o, y_o represent some initial level of those respective arguments and p_1, q_1, u_1, y_1 represent some subsequent levels. We can represent the compensation surplus (CS) by

$$CS = [e(p_o, q_o, u_o) = y_o] - [e(p_o, q_1, u_o) = y_1]$$

$$CS = y_o - y_1 \dots\dots\dots \text{EQ 3.2}$$

If the proposed project brings a welfare gain i.e. the provision of the good increases utility (if CS is positive, which indicate q_1 is preferred to q_o) then the compensated surplus measure tells us how much money the consumers are willing to give up (willing to pay) to ensure that welfare gain. Contingent valuation is capable of obtaining the appropriate Hicksian measure for a proposed change in the level of provision of a public good without having to estimate directly any form of either the Marshallian demand curve or one of the Hicksian compensated demand curves (Mitchell and Carson, 1989).

Methods for Valuing Environmental Resources

Public policy decision-making often involves balancing the costs of a policy with its benefits. When a policy affects goods and services traded in normal markets, costs and benefits result from consumer responses to changes in prices faced and incomes received. Empirical evidence exists that links price and income change to consumer behaviors, which may be employed in a reasonably straightforward fashion to calculate a policy's costs & benefits. On the other hand, when a policy affects the availability of characteristics of public goods, one does not observe price and income changes, and thus must enter the changes in consumer behavior by using more roundabout methods (Mitchell and Carson, 1989).

A number of valuation methods have been developed by economists to estimate the value consumers place on public goods. These include the contingent valuation method, the hedonic pricing method and the travel cost method. According to Kneese and Russell (1990), these methods can be classified into the direct and indirect methods.

The Indirect Methods

The most common methods, which are classified under indirect methods, are the travel cost method (TCM) and the hedonic pricing methods (HPM). These are usually used in a situation where markets for environmental goods or services are absent or not well developed, under which it is hardly possible to value the environmental impacts of a particular project by using the market.

The Travel Cost Method (TCM)

The travel cost method (TCM) is the oldest of the non-market valuation techniques. The method is predominantly used in outdoor recreation modeling, with fishing, hunting, boating and forest visits among the most popular applications. TCM seeks to place a value on non-market environmental goods using consumption behaviors in related market. Specifically, the costs of consuming the services of the environmental asset are used as a proxy for price. The method assumes weak complementarities between the environmental asset and consumption expenditure.

In addition to valuing recreational site such as parks and beaches, TCM can also be used to value changes in the characteristics of a site, such as water and air quality, and unpriced commodities such as estimating the value of fuelwood and water-studies. Studies made by Desvouges et al (1983), Faber (1988), Seller et al (1985) & Doomis (1987), (all are cited in Hanley and Clive, 1995), have used TCM approach to estimate the price of different environmental resources. Most of these studies proved that the method is an appropriate technique for estimating recreational benefits.

Though TCM has primary advantage of measuring benefits based on actual behavior, it is restricted to use values of the resource and ignores non-use values. In addition to this, the method has got its own problems or limitations, which ban it from gaining wide acceptance. These include expensive process and time consuming nature of large data requirements, exclude time cost (though it is common in empirical work to use some proportion of average wage rates as a proxy for travel time cost) and the value non-visitors place on recreation sites, which affect regression estimates.

Hedonic Pricing Method (HPM)

Hedonic Pricing (HP) derives from the characteristics theory of value, which states that any given unit within a commodity class can be described by a vector of characteristics. The method identifies environmental service flows as elements of a vector of characteristics describing marketed goods, typically housing. This method seeks to find a relationship between the level of environmental services (such as noise levels or total suspended particulate levels), and the prices of the marketed goods (houses). It has been used to value such things as the cost of noise around airports (O'Byrne et al, 1985), earth quake risks (Brookshire et al, 1985), urban air quality (Brookshire et. Al. 1982) and amenity values of woodland (Wills and Garrod, 1991), as cited in Hanley and Clive, 1995. The first step in this type of study is to decide which environmental quality variable is of interest, and then to ascertain whether sufficiently disaggregated, spatial data are available, along with data on house prices and housing characteristics. Once this has been verified, the method proceeds in two stages. The first stage is that of estimation of a hedonic price function, in which the relationship between the environmental variable of interest and a related marketed good is estimated. The second stage is estimation of a demand curve for some elements of environmental quality using the information gained from the first stage.

The main challenges of this method are the problem of correctly specifying the functional form, data constraints and the absence of competitive market for houses in developing countries.

The Direct Approach

Despite their use in valuing benefits associated with environmental resource improvements, the indirect methods cannot be used in some cases. They are unlikely to value non-use values that can be obtained from improving environmental resources since they rely on data from situations where consumers make actual market choices. On the other hand, the direct method draws conclusion from responses to hypothetical questions. The most common form of the direct method is the contingent valuation method (CVM).

The Contingent Valuation Method (CVM)

Economic value is measurable in relation to utility functions through the concepts of willingness to pay (WTP) and willingness to accept (WA) compensation, as well as through the related measures of consumers' surplus, compensating variation and equivalent variation. CVM works by directly soliciting from a sample of consumers their WTP and/or WTA for a change in the level of environmental service flows, in a carefully structured hypothetical market. That is, the method is based on classical economic theory using either of Hicksian techniques i.e. either compensatory variation (WTP for improved environmental resource) or equivalent variation techniques (WTA compensation for environmental deteriorations).

CVM survey uses questions to elicit people's preferences for public goods by finding out what they would be willing to pay for specified improvements in them. The essence of the method is aimed at eliciting peoples WTP for a public good in order to circumvent the absence of market. The ultimate aim of CV survey is to obtain an accurate estimate of the benefits from a

change in the level of provision of a public good, which can then be used in Cost-Benefit analysis.

In conducting CVM, there are four main steps to be followed.

1. Designing and administering the survey. During a face-to-face interview, the respondents are presented with a questionnaire, which consists of the following:
 - a) A detailed description of the good/s being valued and the hypothetical circumstances under which it is made available to the respondents. The researcher constructs a model market in considerable detail, which is communicated to the respondents in the form of a scenario that is read by the interviewer during the course of the interview. The market is designed to be as plausible as possible. It describes the good to be valued, the baseline level of provision, the structure under which the good is to be provided, the range of available substitutes, and the method of payment. In order to trace out a demand curve for the good, respondents are usually asked to value several level of provision.
 - b) Questions that elicit the respondents WTP for the good/s being valued. These questions are designed to facilitate the valuation process without themselves biasing the respondent's WTP amounts. The analyst can elicit the respondents' WTP in either of the following ways: either in the form of bidding game or open ended question form or to present the respondents with a list of values in the form of a payment card, and ask for their selection from the list or in the form of closed-ended
 - c) Questions about respondent's characteristics (age, income, and sex),

their preferences relevant to the good (s) being valued, and their use of the good. This information is used in regression equations to estimate a valuation function for the good.

2. Empirical analysis of responses

In this step we analyze the information obtained from the CV survey. There are three ways to analyze the information we obtained. The first is that we examine the frequency distribution of responses to the valuation (WTP) questions. The second way is to perform a cross tabulation between WTP responses and socioeconomic characteristics of the respondents and descriptive statistics. And the third way is to analyze the determinants of WTP of the respondents using multivariate statistical techniques.

3. Estimation and aggregation of benefits

Aggregation refers to the process whereby the mean bid or bids are converted to the population total value figures. The issues to be considered in aggregating benefits: the choice of the relevant population, which should be decided when constructing the sample frame from which the sample is drawn. The second is moving from the sample mean to a mean for the total population. And the third that should be considered is the choice of the time period over which benefits should be aggregated.

4. Evaluating the CVM exercise.

This entails an appraisal of how successful the application of CVM has been in relation to the proportion of protest bids, understanding of the hypothetical market by the respondents, how well did the hypothetical market capture all aspects of the environmental good, the assumption

necessary to produce the mean and aggregate bids and how do the bid figures compare with those obtained in other studies.

The CVM has several advantages compared to other methods. It is inexpensive and quite fast which qualities that are beneficial, particularly in developing countries. However, there has been and still is quite a lot of skepticism concerning the actual reliability of the method. The problems associated with CVM can be classified in to biased estimates of value and choice of welfare measures. With regard to the first, Whittington et al (1987) noted that “hypothetical”, “strategic”, “ compliance” and starting point” and other biases can influence the CVM.“ Hypothetical bias” may be due to the individual who may not understand the characteristics of the good or who may not bother to answer accurately. “ Strategic bias” is related to situations where the individual thinks that he or she may influence the investment or policy decision. The individual may overstate his or her WTP, assuming the government will provide the service with high subsidies in case he/she responds positively. On the other hand the individual may under state his/her willingness by assuming that the investment has already been decided on (Whittington et al 1987).

Compliance bias may occur when a respondent wants to please the interviewer or the sponsor of the study. This problem is strongly culture related.

“Starting point” bias is related to the so-called “ bidding game” the choice of a low (high) starting point leads to a low (high) mean WTP (Bateman & Tumer, 1993). Such a bias is usually encountered when using open-ended questions with variable bids. Other types of bias

that may occur are: information bias (which can occur either as a result of providing too little information about the choice offered or from misleading statement by the interviewer), sampling biases or non-respondent bias.

With regard to problem of choice of welfare measure, the problem is which of the two measures of welfare, WTP or WTA, is most appropriate. Theoretically, these two measures are supposed to give similar estimates, differing only in the effect on income caused by whether payment is made or received, and by the fact that WTP is constrained by income. However, empirically they give different estimates in that the estimates based on WTA are greater than the estimates based on WTP. The reasons could be loss of aversion where individuals value a given reduction in entitlement more highly than an equivalent increase, or WTP is constrained by income whereas WTA bids are not or if the consumers are risk averse that overstates WTA and understates WTP.

However, Hanemann (1991) gave the following three explanations in response to the criticism that stated preference methods should not be used.

- A) The difficulty of applying revealed preference methods especially to a national public good and when non use values are expected to be significant
- B) Revealed preference methods are also not foolproof
- C) Observing human behaviour and asking about behavioural intentions and motives should not be mutually exclusive.

The choice of which measure to use depends on the type of project in question. If the project in question has a social benefit (an improvement in environmental quality, e.g. improves water

supply), then WTP is chosen whereas if the project in question has an adverse effect on the residents in the project area then WTA is an appropriate measure of welfare in which case the respondents need to be compensated for the loss of welfare. Therefore in this study WTP is chosen of the appropriate measure of welfare, and thus the respondents will be asked the maximum amount they are willing to pay for the supply of improved water supply.

To conclude this subsection, compared to other methods (TCM and HPM), CVM is more advantageous since it captures total value of a resource. Total value of a resource consists of use value (expected consumers' surplus) and non-use value (which include option value, existence and bequest value). Option value is a sort of insurance premium an individual would pay to ensure the existence of the environmental good so that it could be available in the future. Existence value is the value people place on the existence of the good. Bequest value is value people give for the existence of the good for future generation.

Given that the study is well designed, carried out and interpreted, then CVM is a useful technique for estimating economic values for some non-market resources. (Hanley & Clive, 1995).

3.2. Empirical Literature Review

The above-mentioned methods have been employed in many studies of valuing public goods both in developed and developing countries. Since this study will employ CVM, few empirical studies (among the many) that used CVM and those relevant to this study will be reviewed in this section.

To mention few studies made in developed countries, Novrud (1988) estimated the social benefits of environmental improvements from reduced acid depositions using CVM in Norway. In the study CVM was used to estimate the social benefits of increased fresh water fish population. Respondents were asked to reveal their WTP for various intensities of lime application to the acidified water bodies, reducing pollution to 30%- 50%. Multiple regressions were used to produce WTP functions, which were estimated using OLS. The result indicates that the Engel elasticity for fresh water fish population is estimated to be in the range 1.447-1.464 and that younger people were willing to pay more than those over 60 years of age. Most of the variables (income, socio-economic variables, etc.) were found to be significant at 1% & 5%.

Jordan and Etnagheed (1992), cited in Bah (1997), made a study on people's WTP for improvements in drinking water in Georgia (USA). In their study they tried to determine the influence of different socio-economic and demographic factors on WTP. Weighted OLS and ML estimation were used in the regression equations. Their results indicate that WTP is positively affected by income; women and younger respondents were found to be willing to pay more than their counter parts. Also, WTP was found to increase with level of education, and on average, a private well owner was willing to pay more than an individual served by public water system. His results confirm the importance of income, sex, education and age in affecting WTP for improved water.

Mitchell and Carson (1993) conducted a study to determine the national benefits of fresh water pollution control in America. The authors estimated the aggregate benefits of meeting the goals of the clean water act using data from a national contingent valuation survey. They

regress total WTP on water quality level, disposable income, taste variable of water-based recreational use (dummy) and environmental attitude (dummy). The result shows that all the coefficients are reasonable in sign and are all significant, confirming the importance of people's attitude towards their WTP for improvement in public good.

With regard to the studies made in developing countries, the following can be mentioned.

Boadu (1992), cited in Bah, used an iterative bidding approach to examine the relationship between the WTP for improved water service and selected socio-economic characteristics of households. Using data collected from selected villages in Ghana, a multiple regression was estimated by OLS. His result indicates that household income is the principal factor influencing the WTP for water. Household's history of water related illness was found to be significant and positive. All other variables (family size, distance of household from the water source, drought etc.) were found to be inconsistent and broad generalizations were not possible.

In Dauoa, Philippines, Choe et al (1995) employed a CVM to examine household demand for surface water quality improvement. A total of 581 persons were interviewed a referendum kind of question about a citywide plan for an improvement in water quality. The result show that the support for the water quality improvement plan fails sharply as the monthly fee increases. The result from the estimation of mean WTP of different households from socio-economic characteristics show that household WTP for water quality improvement is low both in absolute and percentage of income and 15% of the respondents refused to pay anything at all.

Several results from the research suggest that these low estimates of WTP for surface water quality improvement are likely to reflect respondents' true preferences.

The World Bank research team did another study on some countries between 1987-90. The research team set out to investigate the determinants of household demand for improved water services – including relevant socio economic and demographic characteristics of the household as well as characteristics of existing and new water supplies, such as price, distance, quality, and reliability. These issues were carried out in Latin America (Brazil), Africa (Nigeria and Zimbabwe), and South Asia (Pakistan and India). In three of the five studies, various sites in several regions of the country were investigated. Sites in Brazil included a relatively well-off water abundant area in the southeastern state of Parana and a poor, dry area in the northern eastern state of Ceara. In Pakistan three areas in the Punjab were selected: one had easily accessible, high quality ground water; another had easily accessible but brackish ground water; the third was in an arid zone where ground water was relatively deep and inaccessible. In India (Kerala), one area had abundant, good quality ground water, one area had abundant but saline groundwater, and one area suffered from water scarcity.

The researchers used both indirect (revealed preferences) and direct (contingent valuation) methods to study how households made their choices about water sources. The indirect method used discrete choice econometric techniques to model households' decisions and to derive estimates of welfare change from the actual choices that households made. The direct approach involved asking people who did not have an “improved” water source whether they would use a new source if it were provided under specified conditions, and how much they

would be willing to pay for access to different kinds of improved water systems, such as public tap or private house connection. The results of the study indicate:

- The WTP for improved water service does not depend solely on income, but equally on the characteristics of both the existing and the improved supplies. Income is not the principal determinant since the percentage of income that a household is willing to pay may vary widely.
- The result generally confirms those educated households are willing to pay more for improved water supplies. Similarly gender of the respondents proved to be a significant determinant. But effect of occupation and family size and composition on WTP were mixed.
- The households are willing to pay much more if the water from improved sources is reliable. Besides, households will pay more for improved supply when costs in time and money of obtaining from the existing sources are higher than when such costs are low.

The researchers concluded that, the household response to a new improved water system is not due to any one set of determinants, but to their joint effect. It is this jointness that is modeled in the multivariate analysis. The following review indicates the study made in Brazil by John Briscoe and other economists who are members of the World Bank team. The study in Brazil addresses three basic issues. These include "are people's response to WTP questions believable? How much are people willing to pay for water? And is it possible to raise tariff and

increase revenues while protecting the poor? They used a model that describes the probability that a particular family will choose to use a new water source. The variables used as factors which can affect a family's choice between two sources (the new and the old sources) are time and monetary costs of obtaining water from either sources, the perceived quality of its water, household income and a set of socio-economic variables used as proxies for the families' tastes. They used a contingent valuation method to generate data for estimating the model. Bidding games were administered to all families. Different starting prices were used for those yard tap users and for those who used public tap. A discrete choice model (probit model) was used to assess the effects of the independent variables on the probability of connecting to the improved water supply system. The probit estimate showed that all the variables had the expected signs and all but two are highly significant. Dummies for site are only significant at less than 90%. They also used a Tobit model to see the effect of characteristics of the families and the existing source on maximum willingness to pay since the range of the willingness to pay bids was truncated at zero and 200 cruzados. The Tobit estimation results are consistent with those of the probit estimation i.e. the signs of the parameters are consistent with a priori expectations, and the estimates that were significant in the connection-probability model are significant in the willingness to pay model, with only minor exception in the significance of site characteristics. In addressing the issue of whether increasing tariff for yard tap might be accompanied by the provision of free water at public taps, they consider if this raises a concern that the availability of free public taps might act as an incentive for people not to connect to the system and may thus compromise the financial viability of the system. For this they used a multinomial logit model, which is conceptually similar to the probit model except that it allows for more than two possibilities for the dependent variable. In this case the dependent variable takes three possibilities (current source, public tap and yard tap). The estimation result showed

that the effects of income, price and site are generally large and significant, and the direction of the effect is as predicted, which is the probability of using a yard tap increases with income, working in the formal sector and education. These reduce the probability of using current source. In general they conclude that since the price charged for using water from a public tap has little effect on the revenue of the utility, and because of the need to protect the poor and it is difficult to devise mechanisms for collecting payment from public taps, water should be provided free from public tap. Their study showed that well designed and carefully administered surveys of actual and hypothetical water use practices can provide consistent sensible and believable information on willingness to pay for improved water service. Though their empirical results show that tariffs for yard tap can be increased before significant number of households would choose not to connect to an improved system, and providing free water at public tap can protect the poor, these results are specific to Brazil since results of similar studies in Nigeria showed significantly different results. Therefore it is hardly possible to simply conclude the results of one specific area to other areas.

In Ethiopia only few applications of the CVM can be identified, and they are reviewed as follow.

In 1997, Fisseha did a study on the determinants of willingness to pay for improved water services using contingent valuation method in Meki town for his master thesis. The result of his study indicate that more than half of the sampled households were unsatisfied with the existing services. The result also shows that income and the time cost of fetching water proved to be significant determinants of WTP for improved water in Meki town while most of the social variables were not so strong.

Assefa also did another study on the relationship between households' WTP for improved water services and the factors determining their WTP in Addis Ababa city in 1998 using CVM & indirect approach. The result shows that 8.66 cents per Baldi (a bucket which can contain 20 liters) was the average WTP for private connection and 4.7 cents for public taps. Moges (1999) applied a CVM to look at the benefits obtained from the recreational service of lake Tana by analyzing the determinants of appropriate monetary value of the service. The result of the study show that people at higher level of education, with higher income tend to exhibit higher WTP for outdoors recreation service than those with lower level of education & income. The respondents WTP are affected negatively by the increase in family size.

A study on community forestry in Ethiopia has also been done using CVM by Alemu (1997). His study examines the determinants of peasants' willingness to pay (WTP) for community woodlots that are financed, managed and used by the communities themselves. His paper also help to answer the question whether or not management is one important factor by analyzing the determinants of WTP when woodlot are financed, managed and used by the communities. Alemu used a Tobit model with sample selection to test for selectivity bias that may arise from excluding (discarding) invalid responses (protest zero, missing bids and outliers) in his empirical analysis of theoretical validity of responses to the valuation question. The value elicitation method used in his paper is discrete question with open-ended follow up. A total of 480 rural household samples were used, and the survey was administered by in-person interview. He included income, household size, age-sex composition, sex, education of household head, distance of homestead to the proposed place of plantation and other variables as explanatory variables which can affect willingness to pay. The results of his study showed that income, household size, distance of homestead to plantation, number of trees owned and

sex of household head are important variables that explain WTP for community woodlots in rural Ethiopia. The study also found that discarding invalid responses leads to sample selection bias, and suggest that community afforestation projects should consider household and site specific factors as determinants of success. Alemu's paper is one evidence for the use of the CVM to analyze the determinants of household valuation of public goods in developing countries in general and in Ethiopia in particular.

Genanew Bekele (1999) conducted a contingent valuation study to analyze the determinants of households WTP and demand for improved water services in Harar town. He analyzed the information obtained from the CV survey using descriptive statistics and multivariate statistical techniques. The survey indicate 97.8 of households with access to direct piped water get water once in 4 days, on average. One of the findings of the study was that all the households preferred the provision of the improved piped water service and the majority of households are willing to pay more than the existing tariff rate for improved water. The result of the study also shows that the signs of the coefficients of the explanatory variables (income, age, education level, family size, sex etc.) generally are in the expected directions. However, except education level and sex of family head none of the other variables are significant, indicating piped water is basic necessity in the town. Genanaw used an ordered probit model and OLS estimation method in which the dependent variable for the ordered probit model is probability that a household's WTP bid for improved piped water service falls with in a specified interval. In the OLS estimation he estimated the determinants of a respondents' WTP in which case the midpoints of intervals in bidding game are taken as the dependent variable.

The above reviewed empirical studies focused on important aspects for policy formulation. They focused on determinants of WTP for improved water service and the application of CVM i.e. they value and analyze what determines the WTP for the provision of the public good using CVM. They do not relate their findings to the costs that incurred to provide the public good. They also ignore the very important aspects of the provision of water supply, which is issue of cost recovery.

To conclude this chapter, based on the above theoretical and empirical literature review, and other literature, CVM are promising and appropriate method to value environmental resources, in general and to measure the economic benefits of provision of improved water services in particular.

CHAPTER FOUR

DATA SOURCE, SURVEY DESIGN AND PROCEDURE AND MODEL SPECIFICATION

4.1. 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 method to solicit the respondents' WTP for improved water services, using bidding game as an elicitation method. Using bidding game have advantages of capturing the highest price consumers are willing to pay and it will enable respondents to more fully consider the value of the amenity. Relevant documents from the Ministry of Water Resources Development

and Nazareth town water supply office and other relevant secondary sources were also used as data sources. An in-person interview was used to administer the survey.

4.2 Sample Design

The data for this study, as stated earlier, was obtained from a survey of a random sample of urban households in Nazareth town. 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 into three clusters: areas where high-income households live, middle-income households live and low-income households live. Based on the information obtained from the town's municipality: Kebele 09, 10, 11, 16 and 13 are classified as high income area, kebele 03, 04, 12, 14, 15, and 20 are classified as middle income area and kebele 01, 02, 05, 06, 07, 08, 17, 18, and 19 are classified as low income areas. 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.

The total sample size of the survey is 307 sample households. From this total sample households, 141(45.4% of the sample size) are from high-income areas where 45.4% of the town population live, 78 sample households are from the middle-income areas where 25.4% of the household population of the town live and the rest 88 sampled households (28.6% of the total sample size) are from low-income areas where 28.6% of the household population of the town live.

4.3 Developing The Questionnaire

The first step in CV survey is designing and administering the survey. In designing the survey, developing questionnaire is one of the most important parts. Thus in this study, based on the preliminary assessment of Nazareth town and on the policy issues involved in achieving sound cost recovery practices for the water supply, we drafted an English version of the questionnaire consisting of the following main sections:

- Household characteristics and income
- Existing water supply situation
- CV question on willingness to pay
- Attitude towards administration of water supply service

Before we went to test the questionnaire, the English version was translated to Amharic with the help of one professional from the ministry of water resources. In translating the questioner great care was taken to eliminate the nuances in the wording particularly to those questions related to the quality of the existing water supply and to the valuation question.

Furthermore, 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. For instance to minimize strategic bias the following statement was read to all respondents before interviewing began.

“This interview is made to you to undertake a research for the partial fulfillment of the award of M.Sc. degree in economics. I would like to know the existing water supply situation of the town, the problem you faced and

your reaction to possible improvement of the drinking water service. Your response will help policy makers to formulate an informed policy about improved water supply service. The interview will take a few minutes and the answers will be completely confidential and strictly for academic purpose. Thus, please answer the questions honestly and as truthfully as you can.”

Hypothetical bias is unlikely to occur since the service in question is familiar to all respondents of the town. In order to reduce compliance bias, we carefully developed the survey and did the training of the interviewers and we also supervised the fieldwork.

For the willingness to pay question, a bidding game was used as an elicitation method, in which respondents are asked how much they are willing to pay for a baldi (a 20 liter bucket) of improved water supply, until the respondents say “ I am not willing to pay more than the specified amount per baldi” and that specified amount is recorded. The hypothetical description for the services is slightly different for those respondents who have access to private connection to the current piped water service and to those who do not have access to private piped existing water connection. See appendix one for the hypothetical description and the questionnaire used during survey.

4.4 Survey Procedures

The following procedures were involved to undertake the survey: 1. Preparing official letters to stakeholders from Addis Ababa university department of Economics. 2. Employing and training of enumerators and pre-testing the questionnaire, and 3. Undertaking the main survey.

The first procedure was to submit an official letter, which describes the area of research and its objective to the Oromiya regional bureau of water, mines and energy from the department of economics. After the bureau officially informed its subordinates; the next step was to contact the town municipality and water supply office. This procedure helps to make the fieldwork very easy.

The next work was to employ and train interviewers and to pretest the draft questionnaire. Five enumerators who were experienced in conducting face-to-face interviews have been employed. Training of these enumerators was easy and the emphasis of the training was on the technicalities of the questionnaire.

For pretesting the questionnaire all the enumerators including the researcher were participated. It was conducted in the three clusters, and 30 households were included in the pretest of the draft questionnaire. The pretest took two days, and ten questionnaires were asked in each of the three clusters. The main purpose of this pilot survey was to help to determine the starting price for the bidding game, to enable the enumerators to have practice in administering CV survey and to check the wordings and ordering of the draft questionnaire.

One important result of the pretest survey was that the unit of measurement to use for the valuation question. The majority of the respondents can easily understand the unit of measurement proposed by the researcher, which is Baldi (local name for 20 liter container). Regarding the wordings and ordering of the questionnaire, the pretest results indicate no need for adjustments. In pretesting the draft questionnaire, question for the elicitation of the willingness to pay was open ended, and the respondents were asked how much they are willing

to pay for a baldi of improved water supply. The pretest result showed that different prices were given which ranges from five cents for three baldis to twenty cents for one baldi of improved water supply. However the result indicated that 2.5, 5.00 and 10.00 cents for one baldi were the most frequently observed prices, and, thus, these three prices were used as starting price for the willingness to pay bidding game. The other important result obtained from the pilot survey was that the enumerators were fully adapted to the questionnaire. After little adjustment of the draft questionnaire and setting the starting price for the bidegame based on the pretest result, a final questionnaire was developed and ready for the actual survey. All the five enumerators participated in the pilot survey and the researchers were participated in the main survey. Checking of each filled questionnaire was done twice a day: those questionnaires filled before 12.00 o'clock were checked from 12 to 1.00 o'clock, and it is only if the filled questionnaires were correct another questionnaires were given to an interviewer, and those filled in the afternoon were checked at night. This helped to see whether the interviewer has done the given assignments correctly, and it also helps to identify possible misspecification biases by personally debriefing the interviewers and analyzing certain types of response patterns. Finally the researcher ensures that all households who were interviewed during the pilot survey were not included in the main survey.

4.5 Model Specification

Definition of willingness to pay (WTP)

Mark Yuying An (2000) defined willingness to pay 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:

$$V_1(I - Y | Z, \varepsilon) = V_0(I | Z, \varepsilon) \dots\dots\dots(4.1)$$

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) , $V_1(u | Z, \varepsilon)$ is monotone increasing in u . Then there exists an inverse function $U(v; Z, \varepsilon)$ such that $U(V_1(u | Z, \varepsilon); Z, \varepsilon) = u$ for all $u \geq 0$. Therefore WTP can be expressed as:

$$Y = I - U(V_0(I | Z, \varepsilon); Z, \varepsilon) \equiv \Phi^*(X, \varepsilon) \dots\dots\dots(4.2)$$

Where $X = (I, Z)$

This definition has two important implications. First, since ε is unobserved,

$Y = \Phi^*(X, \varepsilon)$ 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,” $V_1(u|Z, \varepsilon) \geq V_0(u|Z, \varepsilon)$ for any fixed (X, ε) and for all $u \geq 0$. It then follows that the distribution of Y is bounded below by 0.

Econometric model

As Mitchell and Carson (1989) indicated, whenever CV studies are designed with the intent of gathering data to be used for policy purposes, it is highly desirable that they take in to account the need to produce theoretically based regression equations. In line with this, we used two approaches to assess the water supply services people want and the amount they are willing to pay for them. The first approach is used to examine the influence of the socio-economic and demographic characteristics of a household in choosing between given alternatives of different level of provision of the public good. This approach uses discrete choice model. The second approach is the “direct approach”(usually called the contingent valuation method), which draws conclusion from responses to hypothetical questions.

1.The Discrete Choice Model

To capture individual preferences between the old and the anticipated new water system, a discrete econometric model will be 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:

$$\begin{aligned}
P(Y = 1|X) &= \text{prob}(U^n > U^o) \\
&= \text{prob}(\beta_n' X + \omega_n - \beta_o' X - \omega_o > 0|X) \\
&= \text{prob}([\beta_n' - \beta_o']X + [\omega_n - \omega_o] > 0|X) \\
&= \text{prob}(\beta' X + \omega > 0|X) \\
&= \text{prob}(\omega > -\beta' X|X)
\end{aligned}$$

If the distribution is symmetric,

$$\begin{aligned}
P(Y = 1|X) &= \text{prob}(\omega < \beta' X) \dots\dots\dots 4.3 \\
&= F(\beta' X)
\end{aligned}$$

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.

$$P(Y = 1|X) = \beta' X + \omega \dots\dots\dots(4.4)$$

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 4.1, β' is regression coefficients and ω is an error term to capture unobserved variable.

2.Direct Approach

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 draw back of the Tobit model. The OLS estimation, given the Gaus-Markove assumptions of homoskedasticity and independence, is only efficient with in 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 heteroskedasticity, 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 heteroskedasticity for the former method, the method used by this study is a simple modification of least absolute deviation, LAD¹, 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 heteroskedasticity of the error terms and which requires only weaker assumption about their distribution.

The censored regression model, or censored Tobit model can be written in the form:

$$Y_i = \max\{0, X_i' \beta_o + U_i\} \dots \dots \dots (4.5)$$

Where the dependent variable Y_i and the regression vector X_i are observed for each I, while the parameter vector β_o and error term U_i are not observed.

The definition of the LAD estimator for this model will be used on the fact that, for any scalar random variable Z , the function $E[|Z - b| - |Z|]$ is minimized by choosing b to be median of the distribution of Z . Hence if the median of Y_i is some known function $m(X_i, \beta_o)$ of the regressors and unknown parameters, a sample analogues to the conditional median can be defined by choosing β_i so that the function $\frac{1}{I} \sum |Y_i - m(X_i, \beta)|$ is minimized at the value

¹ Let $Y = X\beta + \epsilon$, 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: $\min \sum |Y_i - X_i\beta|$ or $\min \sum (Y_i - X_i\beta) \text{sgn}(Y_i - X_i\beta)$, where sgn takes value of 1,0, -1 as the argument is positive, zero or negative.

$\beta = \beta_o$. But suppose the error term U_i is continuously distributed with median zero, and that the density function is positive at zero (so that the median of U_i is unique). Then the median function for Y_i takes a particularly simple form, namely,

$$m(X_i, \beta_o) = \max\{0, X'_i \beta_o\}.$$

Thus, the LAD estimator for the censored regression model minimizes the sum of the absolute deviations of Y_i from $\max\{0, X'_i \beta\}$ over all β in the parameter space (denoted B).

Algebraically, the censored LAD estimator β_i minimizes

$$S_i(\beta) \equiv \left(\frac{1}{I}\right) \sum_{i=1}^I |Y_i - \max\{0, X'_i \beta\}| \dots\dots\dots 4.6$$

The above definition is based on the simple relationship between the median of the censored dependent variable and the regressors and parameter vector. Thus this estimation method is just median (LAD) regression for Y_i using the non-linear regression function $\max\{0, X'_i \beta_o\}$. But neither the median nor any other measure of location will completely characterize the conditional distribution of Y_i given the regressors X_i (except in special cases), so other statistics can be expected to provide additional information about the unknown coefficients β_o . That is, the median is not the only percentile to bear a simple functional relationship to the unknown parameters in the censored regression model, and calculation of other percentiles may reveal a great deal about β_o . Therefore the more general formulation of the censored LAD estimation is given as follow.

The first step in the definition of CLAD's estimator is the determination of the functional form of the quantile for the dependent variable Y_i . Suppose $F_y^{-1}(\theta|X_i, \beta_o)$ denote the θ^{th} quantile of Y_i for $\theta \in (0, 1)$; for example, $F_y^{-1}(0.5|X_i, \beta_o)$ is the conditional median (50th percentile). Now, let $F_y^{-1}(\theta|X_i, \beta_o)$ denotes the θ^{th} quantile of Y_i for $\theta \in (0, 1)$, suppose the distribution function $F(\lambda)$ of the error terms $\{U_i\}$ is continuously differentiable with positive density at $F^{-1}(\theta)$, the θ^{th} quantile of independently and identically distributed (iid) sequence U_i , then the equivariance of population percentiles with respect to monotonic transformations implies that the θ^{th} conditional quantile of Y_i is just the value of the right hand side of the censored regression model when U_i is replaced by its θ^{th} quantile, i.e.

$$F_y^{-1}(\theta|X_i, \beta_o) = \max\{0, X_i' \beta_o + F^{-1}(\theta)\} \dots\dots\dots(4.7)$$

The median of Y_i is the special case of (4.7), provided the median of $U_i, F^{-1}\left(\frac{1}{2}\right)$, is zero.

Further more, if the first component of the parameter vector β_o is an intercept term, the θ^{th} quantile of Y_i can be written as

$$F_y^{-1}(\theta|X_i, \beta_o) = \max\{0, X_i' \beta_o(\theta)\} \dots\dots\dots(4.7')$$

Where

$$\beta_o(\theta) \equiv \beta_o + F^{-1}(\theta).e^1, e^1 \equiv (1, 0, \dots, 0) \dots\dots\dots(4.8)$$

Hence each quantile of Y_i varies with the non-constant regressors in the same way the median does.

To use data from a censored regression model to obtain an estimator of $\beta(\theta)$ for a particular value of θ , we require a LAD estimator for the censored regression model. The censored LAD

estimator $\hat{\beta}$ for censored regression model as defined in Powel (1984) is that value of β that minimizes the sum of absolute deviation of Y_i from $\max\{0, x_i'\beta\}$ over all β in the parameter space $B(\theta)$. Algebraically, the censored LAD estimator $\hat{\beta}(\theta)$ of $\beta_0(\theta)$ is defined as that value of β minimizing²

$$Q_i(\beta, \theta) \equiv \frac{1}{T} \sum \rho_\theta(Y_i - \max\{0, X'_i \beta\}) \dots\dots\dots(4.9)$$

Over all β in some parameter space $B(\theta)$.

Where $\rho_\theta(\lambda) \equiv [\theta - 1(\lambda < 0)]\lambda$, and $1(\cdot)$ is indicator function, which takes 1 if (\cdot) is true, zero otherwise.

The censored LAD estimator $\hat{\beta}$ (4.9) is a special case of the median if $\theta = 0.5$.

The assumptions on the distribution of the error term U_i required for consistency are much weaker than those maximum likelihood or least squares estimators for the censored regression model. It is the fact that the median of the censored variable Y_i does not depend on the functional form of the density of the error term that makes censored LAD a “distribution-free” estimator, which is a property not shared by mean of Y_i . For the slope coefficients in β_o , consistency of the θ^{th} regression quantile estimator will require the θ^{th} quantile of the error distribution to be uniquely defined (more precisely, the error distribution will be assumed to be absolutely continuous with positive density at the θ^{th} quantile). Also the conditional quantile

² Loss function to be minimized in this case is (koenker and Bassett, 1978):
 The θ^{th} regression quantile, $0 < \theta < 1$, is defined as any solution to the minimization problem of

$$\text{Min } [\Sigma \theta |Y_i - x_i \beta| + \Sigma (1 - \theta) |Y_i - x_i \beta|]$$

 The least absolute error estimation is the proper median regression (i.e. $\theta=0.5$).
 Where x_i ($i=1 \dots I$) is sequence of K vectors of known design matrix, Y_i ($i=1 \dots I$)
 is random sample on regression process $U_i = Y_i - x_i \beta$ having distribution function F .

function of (4.7) must be informative about the parameter vector, which requires $X'_i \beta_o + F^{-1}(\theta) > 0$ for a positive fraction of the observations, and the regressors, which satisfy this condition must be sufficiently variable to identify β_o .

Therefore the consistency of CLAD estimator does not require knowledge of the distribution of error term, nor is it assumed that the distribution is homoskedastic, only that it has median zero.

Hence, for estimation purpose the following censored LAD is specified:

$$Q_\theta [\max\{0, X'_i \beta\} X] = X_i \beta + Q_\theta [U | X_i, U_i > -X_i \beta] = X \beta \dots\dots\dots(4.10)$$

Where $\theta = 0.5$ i.e. a LAD estimator corresponding to median regression.

X = Vector of explanatory variables shown in table 4.1

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 (4th ed. P. 445), and the entire process is done using bootstrap estimation using STATA software.

Table 4.1 Variables included in estimation, their expected sign and rationale

No.	Variabl e	Description	Expected sign	Rationale
1	Monthly income of household (INC)	Continuous variable (Birr)	Positive	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
2	Family size (FS)	Continuous variable (in number)	Negative	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)	Its Proxy is ownership of house. It is dummy variable. 1 if the household owns house 0 otherwise	Positive	Wealthy households are more willing to pay and prefer to have private connection to the improved water service
4	Education level of the household (Dedu)	Dummy variable 1 if the respondent gets formal education 0 otherwise	Positive	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 (Gen)	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 (Age)	Continuous variable (in year)	Negative	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 (OCC)	Dummy variable 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 (ATT)	Dummy variable 1 if the respondent says the government should Administer 0 otherwise	Negative	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 (SRC)	Dummy variable 1 if the household uses private piped water 0 otherwise	Positive	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 (T)	In minute	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 (R)	Dummy variable 1 if the respondent says reliable 0 otherwise	Negative	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 (QLTY)	Dummy variable 1 if the quality of the existing water supply is poor 0 otherwise	Positive	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 (LSS)	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	Dummy variable 1 if the respondent has the information	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

	construction in the town (INF)	0 otherwise		response
15	Monthly expenditure for water consumption (WE)	Continuous variable (In Birr)	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 labour 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 (CNM)	Continuous variable (in M ³)	Negative	More water consumption means more monetary expenditure, which lead to state less value.
17	Starting price for the bide game (ST)	-	-	To be tested
18	Status of the respondent (RS)	Dummy variable 1 if the respondent is head 0 otherwise	Negative	Since head of the household has a responsibility, 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.
19	Length of interview	In minute	-	To be tested
20	Interviewer bias	Dummy variables 1 if Asrat 0 otherwise 1 if Bayu 0 otherwise 1 if Gizaw 0 otherwise 1 if Birhanu 0 otherwise 1 if Abebe		To be tested

		0 otherwise		
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4.6 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.
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.

CHAPTER FIVE

EMPIRICAL RESULTS AND DISCUSSIONS

In this chapter we presented the empirical findings of our contingent valuation survey, and discuss the results obtained. We used both descriptive analyses and multivariate regression analyses. In the descriptive analyses, cross tabulation between WTP and socio-economic characteristics of the respondents and the frequency distribution of responses for the valuation question have been done.

In the multivariate regression analyses, for reasons explained before, we use a censored LAD (censored quantile) regression. Before we do the estimation, an exploratory data analyses (EDA) for some selected variables have been done.

In the discussion of the results obtained using the above analyses method, we tried to relate our study results to those from similar studies so as to see if our study results are consistent with others.

The rest of this chapter is organized as follow. The first section summarizes the results from the descriptive analyses. In section two, we discuss the regression

results. The total WTP for improved water service and affordability analyses will be discussed in the third and fourth sections, respectively.

5.1 Descriptive Analysis

A descriptive summary of the survey results is presented in accordance with the different sections included in the questionnaire as follows.

5.1.1.Characterstics of Respondents

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 unemployed³. 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 5.1).

Since the survey was done by dividing the town in to three clusters, income being a stratifying variable, it is essential to describe some selected variables for each group of household. In areas where low income group households live, which constitutes 28.6% of the town household population, 88(28.66%) sample households were interviewed of which 63(71.59%) are head of the household and the rest 25(28.41%) are not. In this sub group, 35 (39.77%) are male respondent and 53(60.23%) are female respondents. Data about the occupation of the respondent show that 68(77.27%) are either working in the informal sector or they are unemployed whereas 20(22.73%) are working in the formal sector, all of which are government employees. Regarding the education level of the respondent, 41(46.59%)are unable to write and read, 13(14.77%) have completed primary school, 30(34.09%) have completed secondary education and the rest 4(4.55%) have joined higher education. The average family size of this subgroup is 5.39 ranging from 1 to 12, and their average monthly income is Birr 431.88, which ranges from Birr 120 to birr1880. The median income in this subgroup is birr 400. Only one respondent reported birr 1880. The average age of the respondents in this subgroup is 41.43 years.

³ 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 second cluster includes areas where high proportion of middle-income group live in. Since 25.4% of the total population of the town lives in this cluster, 78(25.4%) households are included in the sample. The survey results reveal that out of 78 respondents, 43(55.13%) of them are head of the family and 35(44.87%) are not. Regarding the status of the respondent, 44(56.41%) are female respondent and 34(43.59%) are male respondents. The average family size of the household and average age of the respondent in this subgroup is 5.91 ranging from 2 to 13, and 38.41 years, respectively. Birr 886.7 is the average monthly income of the household; the maximum being 1500 per month and the minimum is Birr 150 per month. The median income for this group is 817.5. Only one respondent reported an average monthly income of birr 150.

Data for education attainment show that 22(28.21%) of the respondent are unable to read and write, 9(11.54%) have completed primary education, 33(42.31%) have completed secondary education and the rest 13(16.67%) have joined higher education.

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.

Survey results from areas where high proportion of higher income households (45.9% of the total population of the town) live show that from the total sub sample size of 141, 95(67.38%) of the respondents are head of the household and 46(32.62%) are not. Responses about sex of the respondent shows that 67(47.52%) respondents are female and 74(52.48%) are male respondents. The average family size of the household is 6.13 ranging from 1 to 13. The average age of the respondent is 39.25 years, and average monthly income of the household is Birr 1842.39 ranging from Birr 800 to Birr 3000. The median income is birr 1800. Only one

respondent reported average monthly income of birr 800. Data about the occupation of the respondent show that 103(73%) are working in the formal sector whereas only 38(27%) are working in the informal sector. Results of the educational level of the respondents for this category show that 20(14.8%) are unable to read and write, 31(21.99%) completed primary education, 68(48.23%) completed secondary school and the rest 22(15.6%) joined higher-level education.

5.1.2.Housing characteristics

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. Questions related to this are whether the household owns some facilities including Tape recorder, Refrigerator, radio and are connected to telephone. Survey results regarding facilities the household owns reveal that 61.24% of the total respondent are connected to telephone line, 86.32% and 47.56% of the respondents own tape and refrigerator, respectively, and only 6.51% of the respondents do not have radio in their house .The other question related to the housing character of the respondent is the type of light used; and data shows that 71.66% are connected to electricity through private meter, whereas 27.69% and 0.66% of the respondents use shared meter and kerosene, respectively.

When this data is seen across the sub groups, 65(73.86%), 43(55.13%) and 31(21.99%) of the respondents from low income, middle-income and high income areas do not own house, respectively. Only 8.99% of the low-income group reported to have refrigerator and 37.5% and 77.7% of the middle and high-income group reported to have refrigerator respectively. Data for

possession of tape recorder show that 66.29%, 87.5% and 98.56% of the low, middle and high income group have tape recorder while 84.72% of the high income and 60% of the middle income group are connected to telephone line whereas only 25.84% of the low income group are connected to telephone line.

5.1.3. Rank for Different Social Services

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.

5.1.4. Existing water supply situation

5.1.4.1. 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.

5.1.4.2. Quality, 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.

5.1.4.3. 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 out side source.

5.1.4.4. Existing price of water⁴

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 vendors 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 vendors 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 (excluding labor cost)

5.1.4.5. Consumption and Expenditure for Water Supply

As can be seen from Table 5.1, the average monthly consumption of water for a household is 4.77m³, which ranges from a minimum of 0.06m³ to the maximum of 30m³ 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. This is below the World Bank's recommendation, which states a household should spend a maximum of 5% of his monthly income on water. This implies that a household living in the study area can spend more if it is provided with improved water supply.

⁴ . See the existing tariff rate structure of the town water supply in chapter for “ Background of the Study Area “ on page 12

When we see a household's monthly consumption and expenditure on the existing water supply across the subgroups, the survey result reveal that households from the low income areas consume 3.55m³ and spends birr 15.44 per month whereas households from the middle and high income areas consume 3.97m³ and 5.95m³ 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.

5.1.4.6. Existing Water Supply Use

All the respondents use the existing water supply for drinking, washing, bathing and cooking. 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.

5.1.5. 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%) 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.

Table 5.1. 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 (M3)	4.77	3.55	3.97	5.95
Average water expense/month (Br.)	16.4	15.44	13.20	18.77

Source: study result

5.1.6. Willingness to Connect and Willingness to Pay

Survey results concerning the respondents' willingness to connect to the new improved water supply system and their willingness to pay are discussed as follows.

5.1.6.1. 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 6.80⁵ 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 bundle⁶. 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 5.1). This result goes in line with the theory that higher

⁵ 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.

income households are more willing to pay for improved water service than low-income households.

In table 5.1 we note that the mean income of households living in high-income group areas is 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.

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.

The frequency distribution for WTP responses is indicated in table 5.2. 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 5.3 shows a cross tabulation of mean of some of the independent variables with in the range of WTP given in table 5.2. 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

6 The existing consumption bundle and the corresponding tariff rate is given on page 12.

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 5.2. 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 5.3 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 bid (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

When we see the mean WTP of respondents by their level of education, we find 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 (See appendix 2 table A2-1).

5.1.6.2. Willingness to Connect to the New Improved Water Service

Responses about whether 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 2 table A2-2). 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% of 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.

5.1.7 WTP and Starting Bid

For the valuation question three starting values were chosen based on the modes of their occurrence during the pretest 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 bidding 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 2 tableA2-3. 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 (Table5.4) shows a descriptive statistics of the variables used in the multivariate regression analysis

Table 5.4: 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

5.2. Regression Results and Discussions

5.2.1 Direct Approach:

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 (see appendix 2 Table A2-8 for the test matrix). As can be seen from the appendix, 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 heteroscedasticity problem in our model was also done. The test result shows that the null hypothesis of homoskedasticity 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 heteroskedasticity problem in our model, which is expected from survey data.

Therefore, the normality and heteroskedasticity test for our model data set falls to accept the null hypothesis of normal distribution of the error term and the homoskedastic 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 (See appendix 2 table A2-1 for the test result).

The censored LAD, CLAD, estimation is shown in table 5.5. In the table we reported only those variables that are significant at conventional test level. The estimation is done following procedures described in Johnston (4th ed. P. 445) 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 5%, 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. Genanaw 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 bidding 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 25th, and 75th percentile, in addition to the median distribution (see Appendix 2 table A2-5). 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 25th percentile regression. They have also the expected sign except for the status of the respondent on the 25th 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 75th 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 tableA2-4).

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 R² 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 2 tables A2-6 and A2-7. 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 5.5 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%

5.2.2 DISCRETE APPROACH

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 heteroscedasticity 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 $\chi^2(15)$ 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 5.6. 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 5.6: 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: GEN, RS, FS, AGE, OCC, CNM, R, and WE are found to be insignificant at conventional test level.

5.3 Total Willingness to Pay and Total Revenue

One of the main steps in analysing data obtained from the CVM is estimating and aggregating benefits. In line with this we estimated the total WTP and total revenue from our survey results

5.3.1. Estimating Total Willingness to Pay

The total WTP (aggregate benefit) is the total economic benefit of a project of providing improved water service. Mitchell and Carson (1989) discuss four issues related to sample design and execution, which should be examined in order to assess viability of benefit aggregation. These are population choice bias, sampling frame bias, sample non-response bias and sample selection bias. Among these four issues, none of them are occurred in our study. Therefore, the estimated aggregate WTP for Nazareth town is shown in table 5.7.

In the estimation, we used the following two steps:

1. To get the estimated number of households in each WTP interval,

we multiply the percent of households in each interval by the total number of households in the town(column two of table 5.7)

2. assuming the mid point of each WTP interval as the mean WTP (column three) we multiply the number of households by this MWTP to estimate TWTP(column four of table 5.7)

From the table we can see that the total WTP for Nazareth town is 223,235 cents, assuming each household consumes one bucket of water. Using the average monthly water consumption of the household obtained from the survey (4.77m³), the total willingness to pay is estimated to be Birr 532,415.48 per month.

5.3.2. Estimating Total Revenue

An estimate of the total revenue expected from the provision of the improved water supply service can be obtained from the frequency distribution of WTP bids given in table 5.2.

Table 5.7: TWTP for improved water service

% Of households	Total number of households*	WTP: mid point (cents/bucket)	Total WTP for improved water connection (cents)
1	2	3	4
13.68	3627	1.25	4,533.75
18.57	4924	3.75	18,465
36.16	9588	7.5	71,910
20.19	5354	12.5	66,925

10.09	2676	17.5	46,830
1.3	345	25**	8,625
Total	26,516		223,235

* Figures are rounded to their nearest whole number.

** Mid point of the last category is assumed to be 25 cents

Table 5.8: Expected Revenue

% of households	%age of the household using the improved water service	Households using the improved water service at different prices	WTP mid points (cents/bucket)	Expected revenue
13.68	100	26,516	1.25	33,145
18.57	86.32	22,889	3.75	85,833.75
36.16	71.34	17,965	7.5	134,737.5
20.19	31.60	8,379	12.5	104,737.5
10.09	11.41	3,025	17.5	52,937.5
1.3	1.32	350	25.0	8,750

The above table (Table 5.8) shows the expected total revenue at a given price. For example, if the water utility wants all the household to get the improved water service, it charges 1.25 cents for one bucket of water service, and earn a total revenue of 33,145 cents (or birr 331.45),

provided that all the household consume only one bucket of water. If the water utility sets the price at 25.0 cents for one bucket, it can earn revenue of only 8750cents (or birr 87.50), which is the least amount of revenue. The water utility can earn maximum revenue of 134,737.5 cents (or Birr 1,347.38), assuming each household consumes one bucket of water, if it charges 7.5 cents for one bucket of water. This expected revenue can also be shown using graphs. Figure two shows the expected revenue per month that can be collected at different price. From the figure we can see that the maximum expected revenue is obtained when the households are provided the improved water service at a price equal to 7.5 cents per bucket. At this price the maximum expected revenue that the water utility can collect per month is Birr 321,348.94, provided that an average household consumes 4.77m³ per month that is obtained from our survey.

The mean WTP of the entire households in the town can also be obtained from table 5.2 using the following formula.

$$MWTP = \frac{\sum MWTP_j * n_j}{N}$$

Where MWTP is mean WTP for the whole households

$MWTP_j$ is mid point of each interval

n_j is number of household willing to pay $MWTP_j$

N is total number of households in the town.

Using the above formula we obtained mean WTP of 8.42 cents per bucket, which is not too far from the price (7.5cents/bucket) at which the maximum revenue is earned.

The information obtained from the CV survey can also be used to draw a demand curve for the improved water service. The demand curve can be derived in terms of the total number of households and their associated maximum WTP bids (figure one shows the demand curve for the improved water service). Any point on the curve indicates all the households that prefer the improved water service at the corresponding value of the WTP. The area under the curve shows the total value of consumers' surplus. Using a simple areas formula for triangle and rectangle, we calculated the total consumer surplus to be 265,136.25 cents, assuming each household is consuming only one baldi of the improved water supply.

The above table (table 5.8) can be used to undertake a cost benefit analysis of providing an improved water supply service in Nazareth town. However, we are not going to do this, instead we perform an affordability analysis of the households of residents of Nazareth town. This enables us to examine whether a household is able to pay if he is provided improved water supply service at a rate equal to the amount that enable to recover the full cost of providing the service

Figure 1 Demand Curve

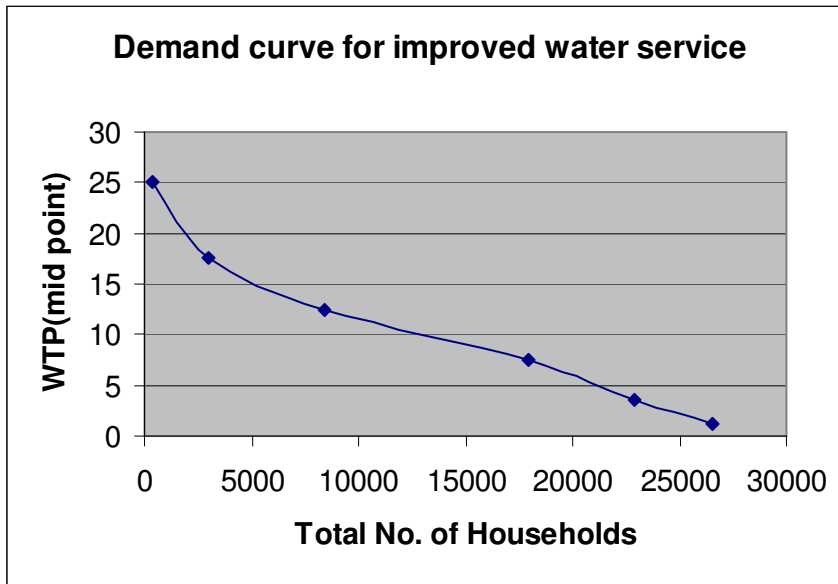
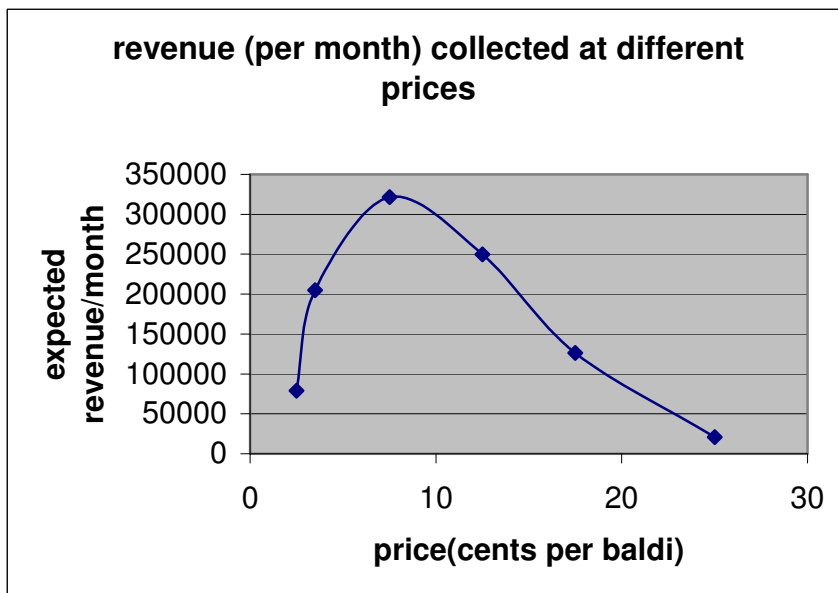


Figure 2. Expected Revenue



5.4. 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. The appropriate cost for users to

pay, so as to cover the full cost of providing improved water supply, is the “ long run marginal cost⁸” 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.

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.

For reasons mentioned above 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:

7 . 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).

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

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

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

TC_{wp} and TC_{wop} are total cost with and with out project respectively

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

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

WP_{wp} and WP_{wop} are water production with and with out 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 m³ 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 m³ 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 1m³ 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 m³ 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 m³ 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 6.27m³ 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.

CHAPTER SIX

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.

Unlike most other studies, we used a censored LAD estimation method, which does not need the normality and homoskedasticity 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. A descriptive analysis is also used.

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 m³ 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 25th, 50th and 75th 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. Further more, 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 can not 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 relation ship 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.
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.

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. Further more, 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. Finally it must be also noted that this research paper did not include non-domestic use of water.

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Appendix

Appendix 1

**Contingent Valuation Survey
Questionnaire**

Code:

Place of interview:

(Write kebele number)

Name of interviewer.....

Date of interview:

Time:A.M P.M

(Circle)

Length of interview:Minutes

INTERVIEWER: *Read the following before you start interviewing*

“This interview is made to you to undertake a research for the partial

fulfillment of the award of M.Sc. degree in economics. I would like to know

the existing water supply situation of the town, the problem you faced and

your reaction to possible improvement of the drinking water service. Your response will help policy makers to formulate an informed policy about improved water supply service. The interview will take a few minutes and the answers will be completely confidential and strictly for academic purpose. Thus, please answer the questions honestly and as truthfully as you can.”

The next few questions are about you and your household's member.

1. Sex of the respondents ----- (OBSERVATION)

1 if female

0 if male

2. Are you the head of the household?

1 if yes

0 if no

3. How many people live in this house? -----

No. of female -----

No. of male -----

4. How old are you? ----- Years.

5. Have you ever been to school? 1. Yes 2.No

If "yes" what level you completed? -----

Now I would like to ask you about your housing conditions, income and expenditure

I. Housing Characteristics, income and expenditure

6. Who is the owner of the house?

a. Your own house

b. Rented from kebele

- c. Rented from government
- d. Rented from private
- e. Other (please specify).

7.If rented, how much is the amount of rent per month (in birr)? -----

8.What type of light do you use?

- a. Electricity with private meter
- b. Electricity with shared meter
- c. Kerosene
- d. Other (please specify) -----

9. Do you have

- | | | |
|-----------------|--------|-------|
| a. Radio | 1. Yes | 2. No |
| b. Tape | 1. Yes | 2. No |
| c. Television | 1. Yes | 2. No |
| d. Refrigerator | 1. Yes | 2. No |
| e. Telephone | 1. Yes | 2. No |

10.How much do you spend per month on

- a. Food -----
- b. Education (fee for pen pencil, exercise book, etc)-----
- c. Electricity-----
- d. Telephone -----

11. What is your occupation? -----

12.1. Would you please tell me your household's income per month? (If the respondent can not tell the household's income please ask his own income) -----

13 Please list the following services in order of importance (list as first, second, etc)

- | | | | |
|----------------|--------------------|-----------------|---------------|
| 1.School ----- | 2. Water ----- | 3. Health ----- | 4. Road ----- |
| 5. Power ----- | 6. Telephone ----- | 7. toilet ----- | |

The next few questions are about your water use conditions including quantity, quality reliability cost of water and the associated problems

II. Existing water use practice and problems

14. What is the main source of water?

1. Piped water → **GO TO Q15**
2. Other (specify) → **GO TO Q.27.1**

15. If piped, what kind of water service is your household using?

- a. Tap inside your house
- b. Tap outside your house, private
- c. Tap outside your house, shared with neighbors.
- d. Water from Vendor

16. If private piped, is your water meter functional? 1.yes 2. No

17. For what purpose you use the water?

1. Drinking and cooking 2. Washing clothes 3. Bathing
4. Watering livestock 5. Other (specify)

18 Do your present water source provide as much as water as you are willing to buy

1. Yes 2. No

19. If No are you willing to buy the amount of water you want if you are provided from the water service office?

1. Yes 2. No

20. **FOR THOSE WHO do not have access to private connection:** why don't you have your own private pipe? Because

1. It is too expensive
2. The house is not mine
3. I don't want it
4. Other (specify) -----

21. How much does your household consume water per day? -----(In bucket)

22. How much do you pay per bucket? (**For those who buy from vendor**) -----

23. How much do you spend, on average, per month for water consumption?

----- Birr per month

24. What do you think about the cost of water supply?

- a. Expensive
- b. Reasonable
- c. Cheap

25.1. How do you rank the existing water supply?

- | | | | |
|--------------------|---------------|-------------------|---------|
| 1. Its quality | a. poor | b. satisfactory | c. good |
| 2. Its quantity | a. sufficient | b. not sufficient | |
| 3. Its reliability | a. reliable | b. not reliable | |

25.2. Do you use any purification method (such as boiling) before you drink?

1. Yes 2.No

25.3.If " No", what is the reason?

- a. The water is clean
- b. The water is not clean but it is expensive and time consuming
- c. I do not know whether there is purification method or not
- d. Though the water is not good it is harmless.

25.4. Have you/ your family member/ ever suffered from any of the following disease, which are caused by poor quality of water?

- a. Diarrhea
- b. Typhoid
- c. Cholera
- d. Change of color of your teeth
- e. Other (identify) -----

If yes which is the most serious? -----

26.1. During which time is water available?

- a. Only during the day time
- b. Only during night time
- c. Both day and night
- d. It is unpredictable

26.2. When piped water is not available, where do you get water/, which other sources do you use?

- a. From my reserve
- b. From other pipe where water is available
- c. Consume less
- d. Other (specify)

26.3. Do you pay for this?

1. Yes 2. No

26.4. If yes how much do you pay per bucket?

-----Cents

26.5. how much time do you spend to collect water from this source?

-----Minute

27.1. If the household uses other sources than pipe, which source does the household use?

- a. Public
- b. Well
- c. Other (specify)

27.2. What is the reason to use this source?

- a. Access to the existing pipe system is difficult
- b. The source is reliable
- c. The source is cheaper
- d. Shorter distance than other sources
- e. Other (specify)

28.1. Have you applied to have private piped water?

1. Yes 2. No

28.2. If yes, how long is it since you applied to get the access?

28.3. If No, why? Because

- 1. The water supply office say not possible
- 2. Connection fee is expensive
- 3. It is not my house and the owner of the house will not allow
- 4. Piped water is expensive

29. Ask Q21, Q22, Q23, Q24, Q25.1, Q25.2, Q25.3, Q25.4, Q26.1,

30a. Who fetch water from the source you use?

30b. How long does it take to fetch the water?

----- Minute

31.1. Do you satisfy with this source of water?

1. Yes 2.No

31.2. If "No", what is the reason?

- a. Poor quality
- b. Low quantity
- c. Unreliable
- d. High charge
- e. Far from home
- f. Other (specify)

III. Willingness to pay

Once again, I want to remind you that this interview is for purely for academic purpose, and your honest reply is very essential. The following questions are about how much you are willing to pay for improved water service if you are provided with this good. By improved water service, I mean:

- the provision of good quality of water which is safe for health,
- the provision of enough quantity of water at any time through out the year, and
- provision and collection of water would not take much of your time and effort.

32. Do you know about the water construction and rehabilitation program that is going on in this town?

1. Yes 2.No

33. What is the main source of water for this household for domestic purpose?

- a. Private piped water → **SKIP TO Q37**
- b. Shared piped water → **GO TO Q34**
- c. Other → **GO TO Q34**

34. Assume you will be offered a better water service, which means a good water quality, quantity and a reliable source through out the year and assume further that you may not require to pay a connection fee to the new system because the government will pay initially, and add this cost to the bill by amortizing with insignificant amount, would you be interested to have a private connection from this new water system?

1. Yes → **GO Q 37**

2. No → **GO TO Q 35**

35. If the answer for Q34 is "No" what is the reason?

- a. Satisfied with the current system
- b. I would not have enough money to pay for the new system→ **GO TO Q 36**
- c. Other (specify) ----- **GO TO Q 36**

36.If the answer for Q35 is b or c, are you interested in the provision of public tap?

- 1.Yes
- 2.No

37. Suppose you will be presented with the new improved water service, would you be willing to pay ----- to obtain the new improved water service?

- 1. Yes
- 2.No

IF "YES," REPEAT THE ABOVE QUESTION BY INCREASING THE BID BY 5 cents per Bucket (baldi).... UNTIL THE RESPONDENT SAYS I CANNOT PAY MORE.

IF " NO", REPEAT THE ABOVE QUESTION BY DECREASING THE AMOUNT BY 5 Cents.

If the response is zero ask the following:

Are you totally not willing to pay because?

- a. You are satisfied with the existing service
- b. You can not afford
- c. The government should pay.
- d. Other (specify) -----

38. If the answer for Q36 is "Yes", ask the following:

" Suppose that an improved water service is provided using a public tap as near as possible to your house at any time of the day throughout the year, would you be willing to pay -----cents for ----- baldi of water from such public tap?"

- 1.Yes
- 2.No

IF THE ANSWER FOR Q38 IS "YES", REPEAT THE QUESTION BY INCREASING THE BID by ----- CENTS PER BALDI, ----- UNTIL THE RESPONDENT SAYS I CANNOT PAY MORE THAN THIS.

IF THE ANSWER FOR Q38 IS "NO", THEN REPEAT THE QUESTION
BY DECREASING THE BID TO ----- CENTS PER -----BALDI, ...
UNTIL THE RESPONDENT SAYS five cents per five baldi

RECORD THE RESPONSE AS

----- Cents per baldi (for those who say "yes")

-----baldi for 5 cents(for those who say "N0")

ASK THE FOLLOWING TO ALL RESPONDENTS

39. Who do you think is mainly responsible for water supply?

- a. Government
- b. Private
- c. Community
- d. Other (specify)

40. What do you like to suggest how to ensure safe improved water for all households?

THANK YOU VERY MUCH FOR DEVOTING YOUR PRECIOUS TIME

Appendix 2

TableA2-1. Test for Mean difference in WTP between educational level

Group	Mean WTP	t-test result
Illiterate	5.2	-4.1307
Primary	7.9	(0.0001)
Primary	7.9-	-0.945
Secondary	7.2	(0.3457)
Secondary	7.2	-0.2393
Higher	7.4	(0.8111)
Illiterate	5.2	4.0066
Formal education level	7.4	(0.0001)

Source: study result

Figures in () are P.values

TableA2-2: WTP by study site

Range of WTP/bucket	Nazareth TOWN	LOW INCOME AREAS	MIDDLE INCOME AREAS	HIGH INCOME AREAS
0 - 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 A2-3: Starting bids and mean WTP

Starting price for the bidding 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.

Table A2-4: Test results of effects of the variables across two distributions

<i>Variable</i>	<i>The calculated F value</i>		
	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

TableA2-5: Estimation results of the 25th and 75th percentile distribution

Variable	25 th percentile regression		75 th percentile regression	
	<u>Coefficients</u>	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)
Qty	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

*** Significant at 1%

** Significant at 5%

* Significant at 10%

Table A2-6 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***
CONS	0.0162	2.394**
No. of observation = 307 F (18, 288) = 6.01 Prob > F = 0.000 R ² = 25.91		

Table A2-7 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%

Table A2-8

Test for Multicollinearity between variables

A simple correlation coefficient test

	Gen	RS	FS	AGE	W	OCC	INC
Gen	1.0000						
RS	-0.0601	1.0000					
FS	-0.0956	-0.0212	1.0000				
Age	0.0022	0.5013	0.1988	1.0000			
W	-0.0623	0.0001	0.3636	0.1276	1.0000		
OCC	-0.2204	0.1947	0.0925	0.0994	0.1975	1.0000	
INC	-0.1448	-0.0191	0.2237	-0.0296	0.5100	0.4940	1.0000
SRC	-0.0888	0.0347	0.3237	0.1611	0.5980	0.2442	0.4757
CNM	-0.0642	0.0586	0.4523	0.2084	0.4317	0.1675	0.3516
WE	-0.0132	0.0420	0.3268	0.1097	0.2078	0.0767	0.1450
QLTY	-0.0461	-0.0068	0.0803	0.1122	0.0905	0.0191	0.0431
LSS	0.1104	0.0219	-0.1271	0.0694	-0.4485	-0.4304	-0.8490
R	0.0911	0.1417	0.0156	0.1246	0.1369	0.1812	0.2423
INF	-0.1014	-0.0162	0.0411	-0.0216	0.0222	0.0640	-0.0037
T	-0.0413	-0.0155	-0.0562	-0.0977	-0.1893	-0.2198	-0.2852
ST	0.0396	0.0067	0.1126	0.0066	0.1702	0.0360	0.0886
Dedu	-0.2450	-0.1181	-0.0826	-0.4471	0.1535	0.2560	0.3120

	SRC	CNM	WE	QLTY	LSS	R	INF
SRC	1.0000						
CNM	0.4090	1.0000					
WE	0.1480	0.4717	1.0000				
QLTY	0.0625	0.0739	-0.0040	1.0000			
LSS	-0.4441	-0.2821	-0.1316	-0.0553	1.0000		
R	0.1769	0.0880	0.0304	-0.0700	-0.2827	1.0000	
INF	0.0427	0.0441	0.0742	-0.0635	0.0214	-0.0492	1.0000
T	-0.4624	-0.0800	0.0860	0.0641	0.3066	-0.2508	-0.0166
ST	0.1491	0.1018	0.0807	-0.0315	-0.0914	0.0025	-0.1265
Dedu	0.1481	0.0612	0.0493	-0.0487	-0.3062	-0.0002	0.1212

	T	ST	Dedu
T	1.0000		
ST	-0.0265	1.0000	
Dedu	-0.0155	0.0686	1.0000