

**HOUSEHOLD DEMAND FOR IMPROVED WATER SERVICE IN
URBAN AREAS: THE CASE OF ADDIS ABABA, ETHIOPIA**

By

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List of Abbreviations

AAWSA- Addis Ababa Water and Sewerage Authority

CVM - contingent valuation Method

NGOs- Non-governmental organizations

WTP-willingness to pay

WTA- willingness to pay

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Abstract

This paper analyzes determinates of households' willingness to pay for improved water service, using the contingent valuation method (CVM). The study used cross sectional data collected from 250 households living in different areas of Addis Ababa, Ethiopia through single bounded elicitation format with an open ended follow up question using a face-to face interview. The empirical models adopted by this study to determine factors influencing households' decisions to connect to the pipe water scheme are Probit and Tobit models.

Results of the study revealed that respondents' WTP is affected by a number of explanatory variables including sanitation facility, water related disease and socio –economic variables like income, age, sex, marital status, education level and family size of the respondent etc. The mean WTP for private connection is found 20 cents per Baldi and 15.79 cents per Baldi from closed ended and open-ended question respectively, which are well above the current subsidized tariff.

The following policy implications are derived from the study. First, the positive and significant relation between sanitation facility and WTP implies that improving sanitation service could not be done alone rather it has to go hand in hand with improvements in piped water supply provision. Finally, the revenue and households' welfare gain in changing the existing policy (low tariff with limited unreliable private service and hence low level equilibrium) to a new (higher tariff with more and improved private connections) can be huge.

Key Words: Willingness-to-pay, improved water service, sanitation facility, contingent valuation method, Addis Ababa, Ethiopia

Chapter One

Introduction

1.1 Background

Development is the integration of economic growth, social, cultural and political conditions. In this regard, most of the sub-Saharan African countries are at a very low stage of development. One of the obvious observations that resulted from the backwardness of those countries is lack of effective and sustainable utilization of the available natural and human resources. Existing capital and labor efficiencies are very low. There is a relatively high rate of growth of population, which decrease the per capita income of countries .The consequence of the very low level of income are poverty, unemployment, low access for health, education, water and low level of investment in social services.

Ethiopia is one of the countries that are at the very low stage of development and is currently facing several social and economic problems .Its cities are confronted mainly with extensive poverty, which is characterized, among other things, by environmental problems and underdevelopment of physical infrastructure.

Addis Ababa, the capital city of Ethiopia, accounting for one third of the country's urban population, is experiencing multiple challenges to be addressed. One of which is the provision for decent life to its residents. Its existing built-up area is characterized by dilapidated structures, congestion, environmental related problems and poor urban image, shortage of and low quality infrastructure, basic services and inefficiencies in land utilization.

In addition to aggravating environmental problems of the city, lack of service provision exacerbates the already poor living and working conditions. It is reported that only less than 65% of the reachable solid waste generated in the city is collected. The remaining being simply dumped in open sites drainage channels, rivers and valleys as well as on streets. About 67% of the people in the city use dry pit latrine and 42 percent of the existing public latrine facilities are used by 4 to 9 households and are characterized by overflow. Rivers and streams have also become open sewers where households' liquid wastes, industrially toxic and hazardous effluents are discharged without being treated hence, negatively affecting animals and people living along the valleys. The existing sewerage system is serving only about 15 percent of the city's population. Like wise, over 25 percent of the residents are without any kind of sanitation facilities where by even the existing latrine are not emptied on time. These glaring shortcomings coupled with low water consumption plus the ever-increasing vehicular traffic posing sever air pollution and noisy conditions have aggregated the sanitation problems of the city. National figures show that these problems are leading causes of cute respiratory infections, skin and parasitic disease, resulting in mortality and morbidity. (Tewodros and Zeleke, 2001)

The existing water price policy in the city concentrate on the supply side and seems to neglect the effective demand of the majority of people in the city. The implementation of such policy decisions should also focus on the demand as opposed to supply side there by adjusting pricing mechanisms and considering the willingness to pay of the residents. Valuation of water service is the key component of an appropriate incentive for balanced and coordinated investment development in the different parts of the city. Moreover the need to fill the gap of information on

the demand side for policy purpose is timely. Therefore, research on the demand side in order to understand the fundamental importance of the value of water service is crucial

1.2 Statement of the Problem

Economic infrastructure has substantial impact on economic development and human welfare of every nation. It is believed to be essential for modernization and diversifying production. It also helps countries compete internationally and accommodate rapid urbanization. With an attempt to raise productivity and improve living standards, developing countries have been making substantial amount of investment in new infrastructure such as transport, water supply, power, sanitation, telecommunication and irrigation.

As part of economic infrastructure, piped water supply is among the main elements of public utilities developing countries are striving to expand .In this regard, millions of people in both urban and rural areas are confronted with the problem of obtaining sufficient clean water and decent sanitation. According to UN- Habitat (2003) each year 2.2 million deaths or 4% of all the death in the world can be directly attributed to inadequate supply of clean water and sanitation.

Poor people in urban slum encounter highly subsidized public water systems due to lack of maintenance and management and public utilities are unable to supply the promised cheap water to the poor, who instead are forced to pay high price for dirty water to private vendors. The problem is those politicians do not allow the poor the opportunity to choose to pay the full cost of public water provision (Stein Hansen and Ramesh Bhatin, 2004). This policy is used as a political tool that is intended to let the people believe that the government cares for their welfare. One

additional fact that is overlooked in this policy is that piped water delivery is not a natural system. It is a man-made infrastructure that needs investment in financial and other resources to build, operate, maintain and sustain. The investments turn water into an economic good and not only as a social service.

The situation of the water supply in Addis Ababa is very similar to that of other developing countries where water supply situation in the town has been deteriorating. Both the per capita quantity and quality of supplied water have decreased over years. Problems associated with inadequate water supply service in urban areas contribute to urban environmental degradation and cause damages to public health. Such problems impose higher costs on producers, consumers and government.

It was indicated that about 96.7% of the housing units of Addis Ababa get their drinking water from taps. Of these taps, 4.4% are located in housing unit, 22.4% are within a private compound, 25.5% are within a shared compound, and 45.3% are outside of the housing compound (i.e. a community tap). The remainder of the housing units in the region (3.3%) receive drinking water from protected wells and springs, as well as unprotected wells, springs, rivers, lakes, and ponds. Despite the high coverage of the water supply system, there is shortage of water quantity supplied to the households (AAWSA, 2004)

Although improving water supply service provision is a priority for the rural and urban development, the strategies of donor organizations and the government so far, have been supply driven. The fundamental importance of the value the consumers place on the environmental good has been ignored. If there is no price for improved water supply use, there would be no control

system in the economy to check an over use of the resource and a distortion will result in the water sector. Since water lies between the two extremes of purely public and private good, the market mechanism cannot be expected to provide these signals in the form of prices. Public policy must therefore intervene in some form. This study calls for the assessment of alternative methods that will elicit the value a typical consumer place on an improved water service. If households are willing to pay for the improved service then the welfare gain may be considerable, otherwise, it might indeed be a waste of public resource to improve the service

1.3 Objective of the Study

The main objectives of the study is to explore if demand side information, willingness to pay, will turn out to be the most important element to improve water supply in Addis Ababa. The specific objectives are

- Examine if households are willing to pay for improved water service and identify the determinants;
- Examine the impact of sanitation facility on the respondents WTP for improved water service;
- Estimate welfare impact of improved water service;
- Draw concluding remarks and policy implications to the existing situations of the city

1.4 Scope and limitation of the Study

The scope of this study is limited to the analysis of demand side information about water supply service obtained from inhabitants of Addis Ababa for domestic purposes for a cross-section of households at a given time. The rationale for selecting this area is because, it is one of the urban centers in the country with immense water and sanitation problem. There is also a growing demand for this service as the growth (expansion) of the city is proceeding at an astonishing rate. This work has used as one of the most popular methods of economic valuation in developed countries, i.e., contingent valuation method. There are many constrains and biases in its application, but it is a first step towards valuation of environmental quality and will allow for making decisions of investment with more and better information in developing cities such as Addis Ababa

Further more, time and financial constrains precluded the possibility of a more rigorous approach for data collection. Therefore, the sample survey carried out for this study is limited in both size and coverage. The sample size was limited to 250 households and all households in Addis Ababa were not covered by the primary survey. In this sense, the data generated for the study should be used with care

1.5 Significance of the Study

The study will impute value to improved water service in Addis Ababa. It will be an additional contribution to few studies that have been undertaken in the past to evaluate environmental goods in Ethiopia. Moreover the results of this study will have an impact on the academic community, governmental and non-governmental organizations, policy makers and the public at large

1.6 Organization of the Paper

The rest of the paper is organized as follows. The second chapter reviews the water supply and demand situations in Addis Ababa. Chapter three deals with theoretical and empirical literature review followed by the fourth chapter, which is devoted to the data and empirical models. Chapter five provides descriptive analysis, estimation results and discussion. Finally, the study provides concluding remarks and recommendations.

Water Supply Situation and Demand in Addis Ababa ¹

2.1 The Existing Water Supply System

Addis Ababa started getting piped water supply during Emperor Menilik in 1901. The first modern water supply system appeared when masonry channel was laid along Kebena River and an earth dam was constructed around sidist kilio from where water was carried down to the desired destination in the city. Due to the increase in demand and consequent shortage of water many springs that originate from Entoto Mountain and other places were developed. Moreover, many boreholes were dug to improve the water supply until the Gefersa dam was constructed in 1942. Meanwhile, due to deterioration of spring water quality most of them were abandoned.

The water supply system has been gradually extended over the years with the main water supply project listed in Table 2-1

Table 2-1 Water Supply Projects Implemented In the Period 1942-2001

¹ Source: -Report of AAWSA in 2004 & 2006 and public relations service of Addis Ababa Water & Sewerage Authority (2001)

Implementation year	Water supply system component
1942/43	Gafarsa dam1 ,gravity, masonry dam 10m high.15,000m ³ /day yield
1955	Gafarsa dam 1 raised by 6m,reinforced concrete pre-stresses to get additional 15,000m ³ /day yield
1950/1960	Gafarsa treatment plant completed in two phases, treating 15,000m ³ /day in each phase
1966	Gafarsa 3 dam constructed, earth fill15m high
1970	Legadadi dam and treatment plant, capacity15,000m ³ /day
1985	Water IIA Legadadi treatment capacity increased to 150,000 m ³ /day
1990	Water IIB improvement of distribution system
1995/2001	Emergency Water Supply Project, Akaki Town and Akaki Ground Water Developed project. Additional 30,000 m ³ /day is obtained
1995/1999	Emergency Water Supply Project, Dire dam project, to supplement Legadai with 40,000 m ³ /day water
1995/1997	Emergency spring development and borehole drilling project

Source: - AAWSA (2004)

Currently around 294,438.92 m³/day water come from Gafarsa, Lagadadi, and Dire reservoirs; Akaki ground water scheme and a number of wells and springs (AAWSA, 2006)

2.2 Existing Facilities

Treatment facilities: the present water treatment plant at Gefersa and Lagadadi have design capacity of 30,000 and 150,000 m³/day respectively

Transmission mains: the Gafarsa transmission line consists of two 400 mm steel pipes, installed in two phases in 1955 and 1960. The length of the pipeline is about 11 Km, most of which is in a poor condition now. The Legedadi transmission line was built in 1970 and originally consisted of a 900 mm steel pipeline. The transmission line is now 6.8Km of 1400mm steel pipe and then 11.5Km of two parallel 900mm and 1200mm steel pipe to convey water from the plant to the Terminal Reservoir.

Pumping stations: There are 17 pumping stations in the distribution system to transfer or boost water to different pressure zones

Storage facility: The existing water supply has 22 balancing/storage reservoirs ranging in capacity from 100 to 20,000 m³. Most of the reservoirs are made of reinforced concrete and stone masonry and were built as part of the different water supply schemes. The total storage capacity of all the existing reservoirs is approximately 87,000 m³

2.3 Water Demand and Consumption

It is difficult to determine accurately the actual water demand of Addis Ababa. Due to water shortages, consumption is below actual demand. Consumption of water in the city is therefore, driven by the amount supplied rather than the actual demand. Estimates of future demand are therefore uncertain.

The current situation can be summarized as follows

- People with in-house services (about 4% of the population) use on average between 80 and 100 liter/capita per day, while the remaining population with access to safe drinking water (94%) are served by yard connection and use between 15 and 30 liter/capita/day.
- Non-domestic use, excluding industrial water use is substantial and amount to about 25 liter/capita/day
- The industries use about 7 liter/capita per day of which about 40% is provided by AAWSA and the remaining amount is produced by the industries themselves (deep wells)

The water supply system has approximately 200,000 connections

- Actual net demand 80 liters per capita per day
- Water sold is on average of 52 liters/ capita /day

2.4 Water demand projection

The recent water supply master plan study estimate the water demand projection as shown in the Table 2-2

Table 2-2 Water Demand Projections

Year	Percapita demand/day	Total demand m ³ /day
1994	98	206,230
2002	123	326,137
2006	140	455,013
2011	161	616,108
2020	192	978,231
2025	229	1,329,585

AAWSA (2004)

The projection is based on the following condition

- Water demand for residential use is related to per capita demand in various modes of supply and housing standards (house connection, yard connection stand alone, yard connection common and public fountains)
- Commercial, public and institutional demand expressed as 30% of the residential demand
- Industrial demand based on the big industrial consumers limited at a minimum of 40 m³/day and in number of 232
- The industrial consumption is related to the area so designated by the master plan and various assumptions were made on the occupancy in the area designated

- Un accounted for water is decreasing from the present figures gradually within the project period towards 20%.

2.5 History of Water Tariff of Addis Ababa²

It can be observed from documents that piped water supply for Addis Ababa City has started in 1901 during the reign of Menilik II. Initially, piped water was supplied to the public free of charge. It was noted that between 1927 and 1928 a flat rate was fixed and people started to pay for water service. However, the amount of the then fixed rate is not known.

The history of known water rate and fees of Addis Ababa has started from 1945. Water tariff rate and fees were levied in the water rule legal notice number 91 of 1945. The schedule that included water rates and fees was issued in the Negarit Gazeta No.6 of February 28, 1947. The schedule shows two types of rates for volumetric charges. A fixed rate related to the size of the household was laid for water supplied without meter and a flat rate of birr 0.50/m³ was set for water supplied through a meter. The flat tariff rate of birr 0.50 per meter cube had been functional for 50 years and the first change was introduced in July 1995.

Since July 1995 a new tariff structure and rate has implemented. The tariff was based on partial cost recovery (operational and maintenance cost only): meter reading, bill preparation as well as collection of bills were done every two months. However it was proved that the tariff has failed to bear O&M.

² For further information see Annex 1

On the other hand the policy stipulates that the tariff levels should be designed on the basis of purchasing out total subsidy stages by stage. The policy particularly indicates that the tariff levels for urban centers should be based on full cost recovery. The above two conditions necessitated the change of the existing tariff. Accordingly, new tariff was proposed to be implemented starting from July 2001. One of the important features of the proposed tariff is that meter reading, bill preparation and collection will be done every month. The tariff rate proposes what each block recovers and who pays that rate are summarized in the table below

Table 2.3 Water Tariff Structure in Addis Ababa

Tariff Block	What it recovers?	Who pays for it?	Consumption/month
Block one	O&M cost only	Pub. Fountain users Domestic customers	0-7M ³
Block Two	Full cost(Breakeven)	Domestic customers	8-20 M ³
Block Three	Full cost +markup Percentage	Domestic&Non-domestic customers	> 20 M ³ All consumption

Source: -public relations service of Addis Ababa Water & Sewerage Authority (2001)

Chapter Three

Literature Review

3.1 Theoretical Background

3.1.1 Theory of Non -Market Valuation

Theory of environmental resources valuation has encouraged economists, both in intensity and scope, in valuing an increasing number of environmental goods and services around the world. Increasing complexities, in designing procedures and analytical structure, have enhanced the optimism of economists about using non-market valuation as a basic instrument to assist decision-making. Practically, non-market valuation faces a critical problem in understanding how people perceive these services and how they value changes on the genetic, species, regional and global scale. (Hanley et .al, 1997)

Depending on various circumstances, economists place total economic value on either stock or flow of natural resources. Total economic value (TEV) can be divided into three main components, namely, the use value, option value, and non-use value. The use value refers to the direct benefits human beings obtain from environmental resources. The option value reflects the value individuals give to the future uses of environmental resources. That is, it indicates individual's willingness to preserve environmental assets for the future uses even if s/he does not use these resources currently. The non-use value reflects that people are willing to pay to improve or preserve environmental resources that they do not use and will never use. Thus, total willingness to pay for environmental resources is the sum of the use value, option value and non-use value (Tietenberg, 2003).

3.1.2 Valuation Method for Non-Marketed Goods

The relentless effort by economists has brought forth various methods to value non-marketed goods. According to Mitchell and Carson (1993), classification of methods for estimating values is based on two characteristics of the methods. The first characteristic is whether the data come from observations of people acting in real world settings where people live with the consequences of their choices; or come from people's responses to hypothetical questions of the form "Would you be willing to pay...?" The second characteristic is whether the method yields monetary values directly or whether values must be inferred through some indirect technique based on a model of individual behavior and choice.

Thus we have two popular ways (methods) of valuing non-marketed goods: indirect and direct approaches.

3.1.2.1 Indirect Methods of Valuation

The indirect (inferential) approach (or revealed preference method) involves inferring about the unobservable demand for and hence value of the environmental goods and services based on the observable demands for the related marketable goods and services. That is, using information on market transactions for related private goods and services, economists try to infer the demand for environmental goods and services (Freeman, 1993 and Tietenberg, 2003). The indirect method includes travel cost method (TCM), hedonic pricing method (HPM), averting expenditures and household production functions.

The two indirect approaches (TCM and HPM) are not always used to estimate the value of environmental goods or intangible goods. For example, they are unlikely to estimate non-use value because they depend on the actual market situations such as buying a house etc

3.1.2.2 Direct Method

The direct approach (or stated or expressed preference method) refers to the direct expression of individuals' willingness to pay or willingness to accept in compensation for any change in environmental quantities, qualities, or both. That is, direct valuation method involves direct estimation of environmental value based on the responses of individuals to the hypothetical valuation questions and hence it does not depend on market information. The typical example of direct valuation method is the contingent valuation method (CVM). (Freeman, III 1993)

3.1.2.2.1 Economic Theory and The Contingent Valuation Method (CVM)

According to John A. Dixon (1994) in cases, where markets for environmental goods or service do not exist, are not well –developed, or where are no alternative markets, it may not be possible to value the environmental effects of a particular project by using the market or surrogate- market techniques. A viable alternative in these situations may be the use of contingent valuation methods (CVM), sometimes also referred to as hypothetical valuation.

The contingent valuation method enables economic values to be estimated for a wide range of commodities, which are not marketable. Ever since it is originally proposed by Davis (1963), it has gone through a great deal of theoretical and empirical refinements. Even now, there are debates inside and outside the field of economics around this model. The essence of the method

is to directly solicit sample consumers' valuation for a change in the level of environmental service flow, in a carefully structured hypothetical market. The traditional consumer surplus, which is the area underneath the Marshallian demand curve, is impractical in such instances. This is because in almost all cases, environmental goods are found to be unpriced. Thus to come about a correct measurement for welfare change we have to compensate the income effect by holding the real income constant. This will give us what is called the Hicksian (compensated) demand curve.

The final aim of the contingent valuation method is to measure the compensating or equivalent surplus for the good in question. Asking individuals willingness to pay and willingness to accept can derive both compensating and equivalent surplus.

Willingness to pay (WTP) is the amount that must be taken away from the person's income while keeping his utility constant:

$$V(y - \text{WTP}, P, q_1; Z) = V(y, P, q_0; Z)$$

Where V denotes the indirect utility function, Y is income, p is vector of prices faced by the individual, and q_0 and q_1 are the alternative levels of the good or quality indexes (with $q_1 > q_0$, indicating that q_1 refers to improved environmental quality).

In the same manner, Willingness-to-accept (WTA) for a good is defined as the amount of money that must be given to an individual experiencing deterioration in environmental quality to keep his utility constant:

$$V(y + \text{WTA}, P, q_0; Z) = V(y, P, q_1; Z)$$

A possible welfare change can result in a gain or loss in welfare. Compensating variation (CV) asks what payment (that is, an offsetting change in income) is necessary to make the individual indifferent between the original situation and the change. For compensating variation there is restriction in quantity. Equivalent variation (EV) measure asks what change in income (given the original prices) would lead to the same utility change as the change in the price of the good. For equivalent surplus there is restriction in quality.

Thus in this framework we can have four welfare measures. When there is welfare gain, CV shows individuals willingness to pay to enforce the change while EV shows willingness to accept compensation if the given change is not going to happen. The reverse is the case for welfare loss.

We have to take note that instead of EV and CV, ES (equivalent surplus) and CS (compensating surplus) are more relevant welfare measures since environmental goods in almost all cases are limited in quantity implying discontinuity in consumption. .

According to Nick Hanley (1997), a CVM exercise can be split in to five stages. (1) Setting up the hypothetical market, (2) obtaining bids, (3) estimating mean WTP and /or WTA, (4) estimating bid curves, and (5) aggregating data. In the second stage we have several ways to administer a survey once the survey instrument is set up. Telephone interviewing, mail shot, and face-to-face interviewing are ways in which it can be done. Survey through the mail is the least preferred due to the high rate of non-response while face-to-face interview offer the most scope for detailed questions and answers.

The very fact that the method is based on a hypothetical scenario rather than actual behavior is the source of enormous controversy. Thus there will be biases, which systematically understate or overstate true values.

There are a number of types of biases indicated in the literature, but: The four major potential biases in the contingent valuation surveys are: strategic bias, starting point bias, hypothetical bias and information bias (Tietenberg, 2003).

The basic idea of the strategic bias is that a respondent or groups of respondents may give biased information (answer) to influence a particular outcome. Such information may not reflect the actual value of the resource being valued.

The concept of starting point bias refers to survey instruments in which respondents are asked to check of their answers from a predefined range of possibilities. The problem here is that how the survey questionnaire designed may affect the resulting answers. For instance, a survey questionnaire with a range of \$0-\$100 may produce different result compared to a survey questionnaire with arrange of \$10-\$100.

As the name indicates, in the hypothetical survey questionnaires, respondents are confronted by an artificial set of alternatives rather than actual choices. Since the respondents are not actually expected to pay the estimated values, the respondents may treat the survey as providing ill-considered answers.

The problem of information bias may arise in the situation where respondents are asked to value attributes with which they have no or little experiences. Thus, if respondents have no experiences about attributes of resources they are asked to value, the valuation will be based on an entirely false perception.

3.2 Empirical Review

3.2.1 Water Related CVM Empirical Studies

CV Surveys have been widely applicable methods in valuing reduce air quality, water quality improvement, ecologically important species, etc. Until 1987, the application of CVM was limited in developed countries but few available works suggest that it can be successfully applied in developing countries as well (Whittington et al (1990 and 1998). This sub-section will briefly summarize water services related CVM studies from developing countries in general and Ethiopia in particular.

3.2.1.1 The Ethiopian Experience

Jonse (2005) using the contingent valuation method (CVM) analyzed determinates of households' WTP, estimate of total WTP and derive aggregate demand for non-crop uses of irrigation water. The study used cross –sectional data collected from 260 households in the Abbay (Blue Nile) river Basin of the Amhara regional state of Ethiopia through double –bounded format with open-ended follow up questions .The empirical models adopted by this study are Probit and bivariate Probit models. Results of the study revealed that respondents' WTP is affected by a number of explanatory variables including institutional –related variables and socio-

economic factors. The study also finds that using double bounded value elicitation technique does not improve statistical efficiency over single –bounded format.

Terefe (2000) adopted the CV (contingent valuation) method and TC (the travel cost) models to estimate benefits from establishment of park around Tis Abay waterfalls. Using multiple linear regression, Probit and Tobit models, the CV responses were analyzed. The results revealed that, for the visitors' benefits, the CV produced higher estimates than the TC estimates since CV estimates consider the non- use value of the commodity to be valued unlike the TC estimates. The finding showed that successfully conducted CVM and TCM surveys would give useful information on user demand for public services such as recreation.

Dunffa (1998) adopted a contingent valuation method to estimate the willingness to pay for improvement in water quality, in Adia Liben district. WTP for improved water has a positive and significant relation with income, distance to fetch water, quality of current water source and credit. Education, family size, wealth and female household head have a positive impact on WTP but insignificant

Assefa (1998) used both the contingent valuation survey (direct method) and indirect (revealed preference) methods to estimate household's willingness to pay for improved water service in the city of Addis Ababa, Ethiopia. The research was based on primary cross-sectional data consists of 220 sampled households from different locations in the city. The CV approaches with an iterative bidding game value elicitation format were utilized to investigate the determinants of households' willingness to pay for private connection and public taps. The results of the study revealed that household income, ownership of house, age and education level are significant

determinants' decisions to connect to the piped schemes. The significant variables influencing the WTP responses include income, education level and sex of the household head, household size, time for fetching water and household's attitude towards the responsibility of water provision

Fisseha (1997) used a CV survey to estimate the WTP for better water quality, using 266 respondents, in Maki town. The questionnaire was designed to test for strategic and starting point biases, and they were not statistically significant. Half of the respondents have been satisfied by current water quality and need better water quality provision with higher charge than current price. Income and time spent to fetch water have a significant impact on WTP. Other factors such as education, occupation and number of domestic animals owned are significant.

3.2.1.2 Case Studies from Developing Countries

The CVM has been successfully applied to a variety of water related issues including sanitation, water supply, in-stream and off-stream recreation, flow enhancement and health risks. It has also been used in very different contextual frameworks like lakes and rivers, groundwater, bathing water, fishing sites, urban water parks, wetlands and marine and coastal areas (Day and Mourato, 1998).

Abdalla (2003) attempted to establish the value of water supply services to the people of Zanzibar Town by measuring their Willingness to Pay (WTP) for reliable water supply services, so as to provide basis for change of the financing policy for water supply services management. This study was conducted using the Contingent Valuation (CV) method; 300 people in Zanzibar

Town were interviewed and elicited responses by using the open-ended question. The OLS model is used to evaluate the effect of the socioeconomic variables and the interview responses were then analyzed to establish the value of the water supply services to the town's inhabitants. The results of this study have shown that contrary to the government's belief, the people of Zanzibar Town put value in the water services that they receive. Thus, they are willing to pay for improved water services but will generally be reluctant to pay for the poor services that are currently being provided.

Using multinomial logit model Kaliba et al. (2003) estimated WTP of households' from 30 villages in two regions of Central Tanzania to improve community-based rural water utilities. The study reported that households in both regions are willing to pay the fee, which is higher than the existing tariff charges. WTP is affected by respondents' socio-economic factors like age, wealth and household size. WTP for improved water services is negatively affected by age and wealth as older individuals are not directly involved in water fetching and wealthier households have their own water sources or they delegate others to collect water for them at lower costs. The family size is positively related to WTP as households with larger family need more water and hence they are willing to pay more.

Calkins et al. (2002) estimated WTP of sixty-two households for improved drinking water delivery systems in semi-urban area of Douentza in Mali using linear regression model and a logit model. The later model helps to explain the decision to purchase water or not. The authors asserted that wealth, relative distance to the planned new sources compared to the best existing sources, land tenure security and family size are major determinants of respondents' WTP. The study reported that land tenure insecurity is positively related to WTP implying that tenure

insecurity discourages construction of one's own well and hence households tend to pay more for public water sources.

Hala (2002) analyzed the impact of better water quality on health improvements using two stated preference methods: choice experiments and the contingent valuation Method. These methods were administered to a random sample of 1500 households living in metropolitan Cairo, Egypt. The format of the valuation question was a referendum question, and the payment vehicle used was a proposed increase in the water bill. The results indicate that households living in Metropolitan Cairo have a positive but rather small willingness to pay for reducing Health risks owing to water quality.

Day and Mourato (1998) estimated value of water quality improvement in the Beijing Metropolitan local rivers using the CVM survey analysis. A carefully designed contingent valuation questionnaire was administered to a random sample of 999 people in the Beijing area. The study reported that annual average WTP per household to maintain water quality in all rivers in Beijing Metropolitan region was estimated to be US\$22.

Singh et al (1993) used the contingent valuation method to examine willingness to pay for yard taps or house connections in several rural villages in Kerala state, India. The respondents' choices were modeled within a discrete choice random utility framework, in which an individual's response is equal to the indirect utility that the respondent receives from choosing to purchase a yard tap rather than continuing to use existing sources. This choice is influenced by both the hypothesized water source characteristics and household characteristics, of the variables affecting water use decisions, water policy decisions makers can control only three: the connection charge,

the tariff and the quality of service. An iterative bidding process was used and the results of the analysis suggest that there is potential for water system to rise out of its low-level equilibrium trap. A CVM survey of 1,150 households was carried out, and included both connectors and non-connectors in areas with improved water system, and those living in areas currently without improved systems. The survey found that the constraint to new connections was the high up-front connection charge in combination with unfavorable credit market condition. In addition, once connected, there was a high willingness to pay for improved quality of service

During 1988 and 1989 study carried out to determine households' willingness to pay for improved water service in rural Punjab, Pakistan. The result of the study revealed that, it is the richer and more educated households that demand and are willing to pay for improved rural water supply (Altaf, et al., 1992)

A case study of water vending and WTP for water in a rapidly growing city of Ontisha, Nigeria (Whittington et al, 1991,) implemented two approaches to estimate WTP for domestic water supplies. Survey in water purchase was used to define the private distribution system and revealed demand for potable water. In addition, a CV survey of 235 households is undertaken to estimate household's water demand behavior. The data collected from the CV survey seemed consistent with the data from the water vending surveys and the results appeared sufficiently accurate to be used for decision making of increasing the water authority's revenue

A discrete choice model was used to determine the household water demand decision in Ukunda, Kenya. Logit model was employed using data collected by interview method from 69 sample households. The result of the study suggested that households' source of water choice decisions

were influenced by the time it takes to collect water from different source price of water, and the number of women in the household. However, household's income and education level had statistically insignificant effect and the sign of education level was negative (Mu Xinming, et al., 1990)

In general the above reviewed CVM studies revealed that, none of them have tried to use the sanitation facility as an independent variable and use the single bounded elicitation format with open ended follow up question .As a result this study attempts to have a look at the influence of sanitation facility used on WTP response and use the single bounded elicitation format with an open ended follow up question.

3.2.2 CVM on Other Related Resources

CVM has been widely used to estimate economic values for all kinds of ecosystem and environmental services in both developed and developing countries. Below are summary of some of the CVM studies on other natural resources and environmental protection in Ethiopia and other developing countries: -

Table 3.1 Summary of CVM studies in Ethiopia

Name	Year	Commodity valued	Location of the study	Number of observations	Elicitation Method	Econometric modeling
Biruk	2003	Improved sanitation service	Addis Ababa	440	Bidding-game	Heckman two-step estimator
Tsegabrihan	1999	Small scale irrigation schemes	Tigray	82	Bidding-game	OLS and ordered probit
Shemelis	1997	Economic loss of deforestation	Wolmera Woreda	310	Open-ended; Bidding-game	OLS; Multivariate analysis
Terefe	2000	Economic value of a site	Tis Abay water falls	300	Open-ended; dichotomous	OLS; Tobit; Probit
Essey	2000	Improved air quality	Wonji Town	300	Biding-game	Tobit; Ordered Probit
Aklilu	2002	Solid waste management	Addis Ababa	430	Dichotomous with follow-up	Probit; Tobit

Source: own compilation

Table 3.2 Summary of CVM studies in Developing Countries

Name	Year	Commodity valued	Location of the study	Number of observations	Elicitation Method	Econometric modeling
Belhaj	1998	Improved air quality	Rabat Sale cities, morocco	400	Iterative and dichotomous	Probit and generalized Tobit
Abdarbo	1996	Sewerage provision	Agami district, Alexandria	545	Open-ended questions and payment card	OLS and ordered Probit
Shechter et al	1986	50% reduction of pollution level	Israel	A large-scale household survey	Biding-game	OLS
Whittington et al	1992	Improvement in the quality of sanitation service	Kumasi, Ghana	1633	Biding-game	OLS, Stewart maximum likelihood, ordered Probit

Source: own compilation

In general, these and other CVM empirical studies in developing economies in general and Ethiopia in particular on water quality improvement and other non-marketable environmental goods and services imply that the CVM can be successfully applied to low-income countries. This invalidates the conventional wisdom, which argues that the CVM could not be applied to developing countries with majority of illiterate individuals who could not understand hypothetical CVM questions.

Chapter Four

Methodology

4.1. Data Source and Type

The study mostly relies on primary cross-sectional data for the time period of 2006 that is obtained from a contingent valuation survey. Using simple random sampling from three areas where the problem of water supply is very critical and partly critical, 250 face-to-face personal interview using CV questionnaire were conducted, out of which 240 of them were found usable. The study has also used secondary data from Addis Ababa Water and Sewerage Authority, and other relevant organizations /bureaus.

4.2 Sampling Design and Procedure

The sample for the study was drawn from three³ areas of Addis Ababa. According to Addis Ababa Water and Sewerage Authority Water Supply Situation Map (2005) report, the population of Addis Ababa is segregated to the respective water supply situations (see Annex 2). Among the different areas, three areas were purposively selected where the problem of water supply is believed to be very critical and partly critical. After selecting these areas, we randomly select 250 numbers of households.

³ Three areas selected include two areas with a critical water shortage problem (kebele 15 &16 in Asko and kebele 18& 19 in kotebe area) where piped water is supplied for one day/week and supplied for 1-6 hrs/day respectively. The third one refers to partly water shortage area where piped water is supplied for 7-16 hrs/day we have taken kebele 10 & 11 in Gergi area. Finally we have randomly selected 83,83 and 84 number of households from the three areas identified

4.2.1 Design Survey Questionnaire and Elicitation Format

The design of the contingent valuation questionnaire was done following the recommendations of international NOAA panel found in Portney (1994). The most important points were: 1) the interview should be done in person; 2) willingness to pay should be about a future event and not one that already occurred; and 3) the hypothetical facts provided to the respondents must be precise, understandable and constant across the sample. It is not important to clearly define the hypothetical good or service being offered to the people in order to obtain the correct willingness to pay. It is, therefore, necessary to be specific about the environmental benefits of the new improved service because that is what the individual is really paying for. Following these suggestions, the possibility of getting wrong or useless information is minimized or eliminated

The household interviews included questions about socio-economic characteristics, water-use and sanitation practises, willingness to pay for water, housing characteristics and household assets, occupation and monthly cash income. The focus of the questionnaire was on the estimation of the households' willingness to pay for improved piped water supply. The single bounded elicitation format with an open ended follow up question was applied for the elicitation part, as it minimizes the strategic bias and makes the decision most efficient. Thus using single bounded elicitation format has the advantage of giving better information on households' maximum willingness to pay.

4.2.2 The Field Procedure

Before going to the fieldwork we have translated the questionnaire into Amharic, then six interviewers and one-supervisor were employed based on their educational qualification and their previous work experience. All of them were college students and all have previous experiences in both urban and rural surveys. Before going to pre-testing the questionnaire, a day and half long training was conducted. Areas that were thought to lead to misspecification biases by the interviewer were heavily discussed.

A pilot study was made for two consecutive days. From the three areas 15 respondents were interviewed. In this phase three interviewers and the researcher herself have participated. The pre-test has a paramount significance in making appropriate modifications in the content of the questionnaire. In addition, the main purpose of the pilot survey was to set the starting price in the elicitation part of the questionnaire. During the pilot survey, the willingness to pay part was open ended. Of the observed different answers, we took the first quartile, median (second quartile), and third quartile as starting points of the willingness-to-pay.

10 cents (Q ₁)	15 cents (median)	20cents(Q ₃)
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The pre-test results were not included as an input in the final analysis. Considering the changes made in the questionnaire from the pre- test, a final questionnaire was developed. The final survey was implemented from 1 -20 February 2006. The field survey was successfully completed with relatively small number of invalid responses (about 2% protest zeros)

4.3 Empirical Model

Given the nature of the data, two econometric models are used one of which is a Tobit model used to identify factors determining the amount a household is willing to pay for the improved water supply service and for dichotomous (yes/no) responses to the initial bid (β_i^*) the Probit model better fits the problem at hand.

4.3.1 The Probit Model

The main objective of estimating econometric (or parametric) model in WTP survey are to calculate mean WTP and to allow inclusion of respondents' socio-economic factors into WTP functions. Such incorporation of individuals' socio-economic variables into the CV model helps the researcher to gain information on validity and reliability of the CV results and increase confidence in application of results obtained from the CV empirical analysis (Habb and McConnell, 2002)

Hanemann (1984) developed the basic model to analyse dichotomous responses based on the random utility theory. The central theme of this theory is that although an individual knows his/her utility certainly, it has some components, which are unobservable from the view of the researcher. As a result, the researcher can only make probability statement about respondent's 'yes' or 'no' responses to the proposed scenario.

The indirect utility function for the j^{th} respondent can be specified as follows:

$$U_{ij} = U_i(y_j, X_j, \varepsilon_{ij})$$

Where $Y_j = j^{\text{th}}$ respondent's income

$i=1$ denotes the final state and $i=0$ the status quo (or the initial state)

$X_j =$ vector of household characteristics and attributes of a given choice

$\varepsilon_{ij} =$ random component of the given indirect utility

If a payment (also called the initial bid, β_i^*) is introduced due to changes in measurable attributes like quality or quantity of environmental goods, the consumer accepts the proposed bid only if

$$U_{1j}(Y_j - \beta_i^*, X_j, \varepsilon_{1j}) > U_{0j}(Y_j, X_j, \varepsilon_{0j})$$

For the researcher, however, the random components of preferences cannot be known and s/he can only make probability statement of ‘yes’ or ‘no’ responses. Thus, the probability that the respondent says ‘yes’ is the probability that s/he thinks that s/he is better off in the proposed program. For individual j, the probability is:

$$P(\text{yes}) = [u_{1j}(y_j - \beta_i^*, X_j, \varepsilon_{1j}) > u_{0j}(y_j, X_j, \varepsilon_{0j})]$$

This probability statement provides an intuitive basis to analyse binary responses. Assuming the utility function is additively separable in deterministic and stochastic preferences:

$U_i(y_j, X_j, \varepsilon_{ij}) + \varepsilon_{ij}$. Given the additive specification of the utility function the probability statement for respondent j becomes:

$$P(\text{yes}) = [u_{1j}(y_j - \beta_i^*, X_j) + \varepsilon_{1j} > U_{0j}(y_j, X_j) + \varepsilon_{0j}]$$

This probability statement is the point of departure for the linear utility function in income and covariates, which is assumed by our empirical models.

The Probit model can be defined as

$$T_i = \beta'X_i + \varepsilon_i$$

Where

- β' is vector of parameters of the model
- X_i is vector of explanatory variables
- ε_i (the error term) and is assumed to have random normal distribution with mean zero and common variance δ^2 (Greene, 1993).
- T_i =unobservable households' actual WTP for improved water supply service. T_i is simply a latent variable. What we observe is a dummy variable WTP_i , which is defined as:

$$WTP_i=1 \text{ if } T_i \geq \beta_i^*$$

$$WTP_i= 0 \text{ if } T_i < \beta_i^*$$

In the single bounded elicitation format, the j^{th} respondent is asked if s/he would be willing to pay the initial “bid”, (β_i^*), to get, say, a given improvement in environmental quality, quantity or both. The probability of a “yes” response, or a “no” response, $P^{\text{Y or N}}(\beta_i^*)$ can be cast in terms of random utility maximization chosen by the respondent. It is clear from the random utility framework that the individual’s WTP is a random variable from the point of view of the researcher. Thus, while the individual knows his/her own maximum WTP, T_i to the observer is a random variable with a given cumulative distribution function (cdf) denoted by $G(T_i; \theta)$ where θ represents the parameters of this distribution, which are to be estimated on the basis of the

responses to the CV survey. Then, following the work of Hanemann (1984), the response probabilities related to the underlying WTP distribution are:

$$P^Y \equiv p \{ \text{yes to } \beta_i^* \} \equiv p \{ \beta_i^* \leq T_i \} = G(\beta_i^*; \theta)$$

$$P^N \equiv p \{ \text{no to } \beta_i^* \} \equiv p \{ \beta_i^* > T_i \} = 1 - G(\beta_i^*; \theta)$$

The resulting log-likelihood function for the responses to a CV survey using the single –bounded format is

$$\ln L(\theta) = \sum \{ d_i^Y \ln G(\beta_i^*; \theta) + d_i^N \ln [1 - G(\beta_i^*; \theta)] \}$$

Where $d_i^Y = 1$ if the i^{th} response is yes and 0 otherwise, while $d_i^N = 1$ if the i^{th} response is no and 0 otherwise

One of the main objectives of estimating empirical WTP model based on the CV survey response is to derive central value (or mean) of the WTP distribution (Hanemann, Loomis and Kanninen, 1991)

Mean WTP (μ) using the model for the single –bounded probit model format is defined as follows:

$$\mu = -\alpha/\beta$$

Where α = The constant (or intercept) term

β = The coefficient of the bid posed to the respondent

4.3.2 The Tobit Model

Alternative method to OLS when the dependent variable response is zero for a significant fraction of the observation is the so-called Tobit model

Let **MWTP** be a latent variable which is not observed when it is less than or equal to zero but is observed if it is greater than zero. Following Long (1997), the Tobit model for observed **MWTP** is given by

$$\begin{aligned} \text{MWTP}_i &= \alpha + \beta'X_i + \varepsilon_i \quad \text{if RHS} > 0, \\ &= 0 \text{ otherwise} \quad (\text{i.e., RHS} \leq 0) \dots\dots\dots(1) \end{aligned}$$

Where

- **MWTP**= Maximum Willingness to Pay
- **RHS**= Right Hand Side
- α = Intercept
- β' = Vector of Coefficients
- X_i = Vector of Independent Variables
- ε_i = Disturbance term which is independently and normally distributed with mean zero and common variance δ^2 With $\varepsilon_i \sim N(0, \delta^2)$

Then, the estimable model with censored data is:

$$\begin{aligned}
 MWTP_i &= \alpha + \beta_1 WRD + \beta_2 REYS + \beta_3 IB + \beta_4 REAG + \beta_5 REIN + \\
 &\beta_6 REFS + \beta_7 RESX + \beta_8 REMS + \beta_9 REPL + \beta_{10} RESF + \\
 &\beta_{11} REED + \varepsilon_i \quad \text{if RHS} > 0 \\
 &= 0 \text{ otherwise (i.e., RHS} \leq 0) \dots\dots\dots(2)
 \end{aligned}$$

4.4 The CV Scenario

In our survey questionnaires, we provided respondents with detailed description of the good being valued (i.e. piped water) in terms of its uses, reliability, volume and quality .The single-bounded CV questions were asked with open –ended follow up question under the given scenario, respondents were asked to pay for domestic uses of piped water after an improvement is proposed in quality and reliability for domestic uses. The respondent is asked at first whether s/he is interested in the suggested improvement or not and an initial bid (β_i^*) will be proposed if the respondent is interested. The next inquiry after the yes/no answer to the proposed bid is, what is the maximum amount that s/he will be willing to pay.

The payment vehicle for the proposed improvement is based on volume charge of water consumed and folding the initial costs of connection in the volume charge, which is distributed over several years.

4.5 Description of Explanatory Variables and Hypothesis

RESX: The sex of the respondent. It is assumed that women would express more preference for improved water services and would be more willing to pay than men for the reason that women are often around the house with a higher burden of fetching water for domestic uses. A dummy variable for sex will be specified as 1 for female and 0 for male with a positive expected sign.

REED: The education level of the respondent. It is expected that, households with higher educational level are more aware of the different benefits that could be gained from an improved water services thus a positive relationship is expected. A dummy variable 1 is specified for formal education (primary, secondary and tertiary) and 0 otherwise.

REAG: Age of the respondent. This is a continuous variable with a negative expected sign. This is because older people, who used to live with more free water supply and less prices, may be reluctant to prefer new improved and less willing to pay for it.

REIN: Monthly income of the household. This continuous variable is a sum of the head's income and the income of other members of the family. The available literature

suggests that there is a positive relationship between income and improved water service. Theory also supports this intuition that income and quantity demanded are positively related in the case of normal goods. As a result a positive sign is expected on the variables of income

REMS: Respondents Marital Status. This is a dummy variable taking 1 if the respondent is married; 0 otherwise. This variable is expected to have a positive sign since married people are more cautious of the health and other risk involved in poor water supply service due to family responsibility in the future than the single ones.

REFS: Respondents family size. There are two different views concerning the impact of family size on willingness to pay. One study has shown that as the number of family size increases, willingness-to-pay for improved water services will also increase. The rationale given is that, as the number of members increases in a given household, households will be more aware of the risk involved with poor water supply provision. Thus crave for a better service by giving high willingness-to-pay. But in our case with very limited job opportunities in Addis, increase in family size will also increase the number of unemployed members in the family. Thus it will increase household's expenditure and a growing need to match with one's income. Thus a negative relationship is expected in the second case.

REPL: Respondents perception level of quality of the existing supply. Without any theoretical a priori, if households perceive a good quality then there will be no incentive for them to

prefer the improved system and vice versa. A dummy variable 1 will be specified for households who perceive high quality and zero otherwise.

REYS: Respondents years of stay in the area. It is hypothesized that the more households stay in a particular area, the more they would be willing to pay for the proposed improvements since they will know more about the benefits. In addition, there will be sentimental attachments to that area. A positive relationship is thus expected.

IB: Initial bid. This is done whether to see if households' responses are very much affected by the initial bid. The relationship is due to be known in the course of the study.

WRD: Respondents or members of the household who suffer from water related disease are expected to be more willing to pay in order to improve piped water service in the city. A positive relationship is thus expected

RESF: Respondents sanitation facility. Based on Addis Ababa water supply and sewerage authority data three sanitation facilities (flush toilet, pit latrine, and public toilet) were selected, which were believed to represent the sanitation facilities available in the city (Addis Ababa). A dummy variable one is given to flush toilet and, 0 otherwise. A positive sign is expected because flush toilet requires the use of water for its function as compared to other sanitation facilities and hence makes households to be more willing to pay for the improved water service.

Chapter five

Empirical Results and Discussion

This chapter deals with the empirical findings and discusses the results obtained. The data from the contingent survey is analyzed in two ways. The first part used descriptive analyses with the help of cross tabulation between WTP and socio-economic characteristics of the respondents and multivariate econometric analysis is imputed to analyze responses in the second part.

5.1 Descriptive Analysis

5.1.1 Socio Economic Characteristics of the Surveyed Households

As previously stated a total of 250 households responses were obtained from different areas of Addis Ababa. Of all the sample population, 5 responses were dropped because some of them lacked the required information and others gave unreliable and inconsistent answers. There were 5(2%) protest answers with willingness to pay zero and they were eliminated from the data set during the analysis of valuation answers. As a result 240 questionnaire were found usable of these, 117(48.7%) of the respondents are female respondents. The average family size is 4.03 with a minimum of 1 household member and a maximum of 9 household members. The data on age reveals a wide range of responses where the average is found to be 39.75 years. The minimum age is 14 years while 85 years is the highest age.

The education figure reveals that 5% can't read and write while 10.8% have attended primary level education, which includes those respondents that can read and write up to those who have attended sixth grade. The majority of the interviewed respondents 46.2% have attended secondary level where 38% have attended higher education. The marital status figure reveals that

62.9% of the respondents are married while the rest are not. Concerning the employment structure in the area, 22% run their own business, 33.7% are government employees, and 15 % are employed in private companies, while the rest reported that they are unemployed, housewives or students. In relation to the years of stay by a specific household, a number of responses were observed. From one-month stay up to 50 years of stay in a particular house were seen. The average year of stay is 11.23 years. Regarding the housing situation of the survey area, the data indicated that at least 64% are currently living on government/kebele, 10% are rented from private house ownership and 24% live in their own house

The most difficulty was the inquiry on the level of income the household earns. Most respondents were not keen to state their earnings and others don't really know their average monthly income. But due emphasis was given in the training session to this part and the enumerators were able to come up with a fair estimate of households' average monthly earnings. The average monthly income of the sample household is birr 1319. The income level ranges from a minimum of birr 50 to a maximum of birr 6000 per month

To cross check the income figure, respondents were asked to state their major average expenditures in a month. The data shows that, food expenditure constitute the major expenditure share, then comes housing and expenditure on education.

Tape recorder is currently owned by almost all of the respondents' household. Data for possession of television show that 45% of the respondents own TV set. Most of the households, even with a visible antenna on rooftop of their compartment, said that they don't have a TV set. The reason is they are very skeptic about the confidentiality of the information they give, and

may be required to pay taxes for the government. Thus the above percentage figure is believed to be an underestimate. Of the interviewed respondents 33 % of the respondents have Refrigerator. Car seems to be the least owned by households. Of the interviewed households only 32.8% have Car.

5.1.2 Rank for Various Social Services

To explore households' preferences in terms of priority, they were required to rank different social services in accordance to their need. Seven different social services were listed: education, health, water, sanitation, electricity, road and telephone. The survey result shows that, 56.2% of the respondents reveal Water supply as their first priority. Then comes Health with 25.4% of the interviewed respondents saying that it is their first need. 8.3% said that Sanitation is their prior need. Education, road, electricity, and telephone were ranked from fourth to seven respectively.

Table 5.1: Households' Rank for Social Services

Variable	Rank	Total (%)
Health	1 st	25.4
Water	1 st	56.20
Sanitation	1 st	8.30
Road	1 st	2.90
Education	1 st	3.20
Electricity	1 st	1.00
Telephone	1 st	3.75

Source: survey result

In an overall assessment, we can clearly see that, respondents in Addis have consistently ranked water supply as one of their first priority services.

5.1.3 Current Water Use Patterns and Problems

Almost all of the households surveyed (97%) used piped water as the main source of water for domestic purpose. Only (3%) of households used dug well as a source of water. Sources of piped water in the survey area consisted of house connected, private tap in compound, pipe shared in compound, from private vendors and public taps. The table below indicates that 28 % of the total households obtain piped water purchasing from private vendors who have connection to the existing piped water system. Those who have private connection to the system (in the house or in compound) account only about 30 percent while 22% have Pipe in compound (shared). And 17 percent said they get water from public taps.

Table 5.2 Households Major source of water

Source of water	No of households	Percentage
Piped in the house	30	13
Pipe in compound (private)	42	18
Pipe in compound (shared)	53	22
Private vendors	68	28
Public taps	40	17
Dug wells	7	3
Total	240	100

Source: survey result

Households average monthly water consumption is about 113.85 baldi (a 20 liter bucket) with average per capita consumption of 18.97 liter per capita per day using the average family size obtained from the survey. Price per baldi of water ranges from three cents (official tariff) to those connected up to fifty cents to those buying from private vendors. The above table shows that

private connection (in house or shared connection) constitutes a high share. This only indicates the existence of facility (pipe line connection), even those households who are privately connected are buying water from private vendors due to unreliability of the existing supply. As a result we will conclude that though households are actually connected, the majority are using private vendors.

The level of satisfaction of respondent with the existing level of water service is extremely low. Only ten percent of the respondents said they are satisfied with the existing service. Cross-tabulating the results confirmed that those who have dissatisfaction are seeking more improved services and are more willing to pay for such service

Unreliability of supply, higher costs of water, poor quality and quantity of water and higher connection charges are mentioned by different respondents as the most serious problem with the current water service in the city. More than half of the respondents (70%) mentioned unreliability of water supplies as the most serious problem. In addition 35% of the respondents reported that they have encountered disease of family members in relation to deficiency of water quality in the past one-year

Another important variable concerns household's attitude towards the responsibility of improved water provision, 82% of the respondents expresses that the government should provide free or subsidized improved water service to the citizens, while the rest 18% said that either the community, private or all should be responsible.

The subsidized tariff, and the recurring shortage of water would have encouraged those connected households to sell water at higher price to those who have no access to the system. Other important opinion variables are the intensity of current water problems and the efforts made by government in solving them. All most all of the respondents have opined the current water problem as a very serious one. And sixty seven percent said that the government paid not too much attention in solving water problems to household

5.1.4 Existing Household Sanitation Practices

The data shows that, 35.4 % of the respondents are currently using flush toilet, while the majority 47.9% are using pit latrine the corresponding figure for users of Off-site sanitation (Public toilet and forest) shows 16.66%. The data seems to support the information we have from AAWSA that the majority of the city’s population is currently using pit latrines for their sanitation needs.

Table 5.3 Existing Household Sanitation Practices

Type of Sanitation	Existing Sanitation Technology	Number of HHs.	Percentage
On-Site	Flush	85	35.4
	Pit Latrine	115	47.9
Off-site	Public	30	12.5
	Forests	10	4.16
	Rivers	-	-

Source: survey result

5.1.5 WTP and Starting Bids

In the final survey, three starting bid prices for the corresponding valuation question were given. These were set following what we have obtained from the pilot survey. Starting from respondents who were asked for willingness to pay for the improved system, the data revealed that 63.7% have said “yes” to the first price that they have been given and the rest have refused and gave a lower bid than the initial price.

5.2 Regression Result of WTP

As we have described earlier, in addition to the descriptive analysis, multivariate econometric analysis puts us in a broader framework, as to which factors are responsible for the willingness to pay for improved water service. The WTP question for private connection is presented for all respondents (for both who have a private access to the existing pipe system and those who have not). The general approach of this technique is to estimate a valuation function that relates the hypothesized determinants with the WTP responses. The variables to be included in the models were mainly based on the degree of theoretical importance, and their significant impact on WTP.

But before estimation was done, data exploration is an important step. To start with, whether multicollinearity is present or not a simple correlation coefficient matrix was conveyed. Gujarati (1995) establishes a rule of thumb, which says that multicollinearity is a serious problem when the correlation coefficient is 0.8, or above. Thus though correlation is present, multicollinearity is not a serious problem in our data. The asset of the respondent is omitted because multicollinearity problem was observed between income and asset of the respondent (See Annex 3)

Econometric theory tells us that we are likely to encounter heteroscedasticity frequently in econometric data, particularly with cross-sectional data. Before passing in to the analysis of the result of the estimation of the models, test on the possible existence of heteroscedasticity is important for this study. The violation of the homoscedasticity assumption in the general linear model, OLS estimates are consistent but inefficient. However the problem for non-linear models such as Tobit is more severe, i.e. the resulting estimates are not even consistent (Maddala 1983). Since our data is cross sectional by its nature we are likely to encounter with the problem of heteroscedasticity. One of the important methods used to test the existence of heteroscedasticity in Tobit model is the log-likelihood ratio (LR) test (see Annex 4). This test shows that the null hypothesis of homoscedasticity is rejected, i.e. heteroscedasticity is the problem for the model. Because of this we cannot use a simple Tobit model for this study rather we use heteroscedastic Tobit model.

Goodness of fit of the Tobit model is measured using Likelihood ratio index (LRI) (see Annex 4). The estimates of the heteroscedastic Tobit model (result corrected for heteroscedasticity) using LIMDEP (version 7) are presented below.

TABLE 5.4 Heteroscedastic Tobit estimate of determinates of WTP for private connection

Variable	Coefficient	Standard Error	b/St.Er	P[Z >z]	Mean of X
WRD	-0.2408	0.1083	-2.2240**	0.0261	0.3375
REYS	-0.0030	0.0061	-0.4850	0.6278	11.2333
IB	0.0146	0.0143	1.0270	0.3047	14.8958
REAG	-0.0122	0.0040	-3.0340***	0.0024	39.6167
REIN	0.0002	0.0001	2.1040**	0.0354	1226.4583
REFS	0.0095	0.0376	0.2530	0.8002	3.9625
RESX	0.0758	0.1297	0.5850	0.5588	0.4750
REMS	-0.0677	0.1305	-0.5190	0.6039	0.6708
REPL	-0.2212	0.1326	-1.6680*	0.0953	0.3125
RESF	0.2227	0.1216	1.8310*	0.0671	0.3708
REED	0.6758	0.1137	5.9420***	0.0000	0.4417

***Significant at 1%, ** Significant at 5%, * Significant at 10%

The variable income is significant at 5% level of significance as expected. Which is consistent with economic theory that says income is positively related with demand in the case of normal goods.

Education is highly significant at 1% level of significance. It has also the expected positive sign. This suggests that education increases the awareness of the health dangers involved in poor quality water supply and thus leads to higher WTP.

The other significant variable at 1% is age of the respondent. With negative sign showing that older people, who used to live with more free water supply and less prices, may be reluctant to prefer new improved and less willing to pay for it.

The initial bid, which is used to test for the existence of starting point bias, showed that it is insignificant but has positive sign. The positive sign implies that respondents' willingness to pay amount is upwardly biased but in this study it is found insignificant this phenomenon partly reflects the efficiency of using single bounded elicitation format than iterative bidding which mostly leads to starting point bias

The variable perceived existing water quality is found to be significant at 10%. Its negative sign shows that, households who perceive the quality of existing supply as low will be more willing to pay than a household who perceive better water quality

The variable water related diseases has unexpected sign and is significant at 5%. This implies that households members who suffered from water related disease have a negative and significant impact on WTP in the Tobit model. This is surprising since they were expected to understand the problem more than the non- affected. This implies that

- Those who are affected may expect some compensation from the authority
- May be less concerned about future generation

The last variable sanitation facility of the respondent is also positive and significant at 10% level of significance. As expected, those households who use a better quality of sanitation facility i.e. flush toilet are more willing to pay than those who use pit latrine and public toilet.

In order to analyze the effects of each explanatory variables on the probability that respondent accepts or rejects the initial bid (β^*), the partial derivatives of discrete responses to the initial bid

with respect to explanatory variables must be taken (Greene, 1993). These partial derivatives give us the marginal effect of independent variables on the dependent variable (i.e. the probability that a household will connect to the new improved system). The marginal effects of the probit model estimation results are reported below

Table 5.5 Marginal Effect Estimates of the Probit Model after Correcting its Heteroscedasticity

Variable	Coefficient	Standard Error	b/St.Er	P[Z >z]	Mean of X
Constant	0.0712	0.2299	0.3100	0.7568	-
WRD	0.1955	0.0881	2.2170**	0.0266	0.3375
REYS	0.0107	0.0047	2.2810**	0.0226	11.2333
IB	-0.0377	0.0106	-3.5690***	0.0004	14.8958
REAG	-0.0042	0.0029	-1.4610	0.1439	39.6167
REIN	0.2552	0.6609	3.8614***	0.0001	1226.4583
REFS	-0.0030	0.0250	-0.1190	0.9050	3.9625
RESX	0.0750	0.0783	0.9570	0.3385	0.4750
REMS	0.3935	0.0896	4.3920***	0.0000	0.6708
REPL	-0.1137	0.0890	-1.2780	0.2012	0.3125
RESF	0.0978	0.0927	1.0550	0.2914	0.3708
REED	0.1846	0.0847	2.1790**	0.0293	0.4417

***Significant at 1%, ** Significant at 5%, * Significant at 10%

Equivalent to R^2 in a conventional OLS regression model the likelihood ratio index is used to measure the goodness of fit for probit model. The computed ratio shows that the model seems adequate it explains 50% of the variation in explained variable. (See Annex 4)

The marginal effects of the probit model indicate the change in the probability of an event due to a unit change in the continuous explanatory variables and the change of dummy variables from 0 to 1 for discrete variables.

The variable income of the household is positive and significant at 1% while the reason is mentioned in the Tobit model, the marginal effect show that a one Birr increase in income will increase the probability of accepting the initial bid proposed after the improvement is introduced by 25.5%, *ceteris paribus*. This implies that a household with higher income is willing to pay more to get private connection to the improved system

The education level of the respondent is significant at 5% level of significance. Holding other things constant, change in education level of the respondent from illiterate to formal education (primary, secondary and tertiary) increases the probability that respondents are willing to pay for the proposed bid by 18.4%. This indicates that as people get more educated their awareness for the environment and health impacts of improved water system will also increase.

The variable marital status is positive and significant at 1%. As hypothesized, married people are more cautious of the health and other risk involved in poor water supply service due to family responsibility in the future than the single ones. Looking at the marginal effect, being married will increase the probability of saying yes to the bid by 39.3%.

Unlike the Tobit model the variable water related disease has the expected sign and is significant at 5% indicating that those households members who are affected by disease are more willing to connect to the improved system. The marginal effect reveals that being affected by water related

disease will increase the probability of saying yes to the initial bid by 19.5% while the other factors are held constant.

The variable year of stay in the area is again positive. It is significant at 5% level of significance. The reason is that the more households stay in a particular area the more they would be willing to pay for the proposed improvements since they will know more about the benefits. In addition, there will be sentimental attachments to that area. The marginal effect reveals that staying long in the area will increase the probability of saying yes to the initial bid by 1% while the other factors are held constant.

The initial bids showed that it is significant at 1% level of significance with negative sign implying that an increase in the initial bid reduces the likelihood that respondents are paying the proposed bid, which is logical

The main objective of using the probit model is to roughly compare the results of the two willingness to pay elicitation methods (dichotomous and open –ended). The results of the two willingness to pay elicitation methods as indicated in the above two tables, the direction of the effect of the explanatory variables (income, education, perceived water quality, quality of sanitation facility, family size and age of the respondent) on the dependent variable is the same but there is a difference in the magnitude and significance level of the effects. The variables year of stay in the area and water related disease have a negative sign in the Tobit model however the sign of these variables is as expected in the Probit Model. Marital status of the respondent has a negative sign and is insignificant in the Tobit model while it is positive and highly significant in

the Probit model which implies that marital status only affect the probability of saying yes to the initial bid and did not affect the actual willingness to pay of respondents.

The important explanatory variable in our model is sanitation facility of the respondent .It has positive sign in both models but insignificant in the Probit model and significant in the Tobit model. Which implies that respondent who use a better sanitation facility (i.e. flush toilet) are more willing to pay for the improved water service than those using pit latrine and off site sanitation.

Therefore, based on the above discussion households currently living on government/kebele or private rented houses are affected by their socio-economic and environmental characteristics in their decision for the improved water service.

The overall results of the valuation indicated that respondents took the interview seriously and well understood the single bounded elicitation technique. The enumerators evaluation revealed that more than 95 percent of the respondents have well understood the valuation process and have given careful considerations in their responses.

5.3 Total Willingness-to-Pay and Total Revenue

In the previous section we have seen the factors that are influential for willingness-to-pay if there is improvement in water supply service. So theoretically, what comes next is aggregation, which is the last part of the CV survey. In this section, total households willingness to pay and total

revenue at various prices for a 20 liters container (Baldi) in the selected areas is calculated below.

It shows, if improvements are underway the possible benefits that could accrue.

According to Addis Ababa Water and Sewerage Authority water supply situation map (2005) report, the population of Addis Ababa is segregated to the respective water supply situations (see Annex 2). The estimated population of areas supplied for one day/week, supplied for 1-6 hrs/day and supplied for 7-16 hrs/day is 89,671, 419,914 and 1,408,865 respectively. Since the sample is drawn from these areas, aggregation is made to the sum of these areas population, which is 1,918,450. And from the survey we have found that the average family size is 4 in the selected areas. Dividing the population by average family size and after rounding, we found that there are 479,613 households in the above-examined areas of Addis Ababa.

Table 5.6 Total WTP and Total Revenue for Improved Water Service (cents per Baldi)

WTP interval (cents per Baldi) (1)	Frequency dist. (sample)		Mid WTP (3)	Total No of HHs (4)	Total WTP (5)
	(2) No.	(3) (%)			
0-10	114	48	5	227816.2	1139081
15-25	94	39	20	187816.5	3756330
30-40	22	9	35	43932.55	1537639
50-60	5	2	55	10071.87	553952.9
70-80	3	1	75	5995.163	449637.2
90-100	2	1	95	3980.788	378174.9
Total	240	100		479613.00	7814815.00

⁵computed by multiplying (3) by (4)

Source: survey result

One of the main objectives of estimating empirical WTP model based on the CV survey response is to derive central value (or mean) of the WTP distribution (Hanemann, Loomis and Kanninen, 1991)

Mean WTP (μ) using the model for the single –bounded format is defined as follows:

$$\mu = -\alpha/\beta$$

Where α = the constant (or intercept) term

β = the coefficient of the bid posed to the respondent

Then mean WTP (μ) can be computed using this formula and the results from the single bounded model. Thus mean WTP for private improved water connection is 20 cents per Baldi, With a Std.error of 5.05, which is more than 6 times the existing authority’s tariff rate. The mean WTP computed using the open-ended elicitation format is as follows:

Variable	Mean	Std.Dev	Minimum	Maximum	Cases
WTP	15.7917	11.9008	0	100	240

We can see that the mean WTP from the open-ended format is 15.79 cents per Baldi and is lower but closer to the closed ended format with Std.error of 11.9. Generally respondents are willing to pay in the range of 15-20 cents per Baldi.

The study also used the survey to estimate the demand curve for the proposed improved water service in terms of the total number of households and their associated maximum WTP. The following figures were used to estimate consumers' surplus and revenue at different tariff rates. Figure 5.1 shows the possible revenue and consumers surplus obtained if the service authority improves the water service and uses the existing tariff rate (3 cent per Baldi) and the number of connections unchanged.

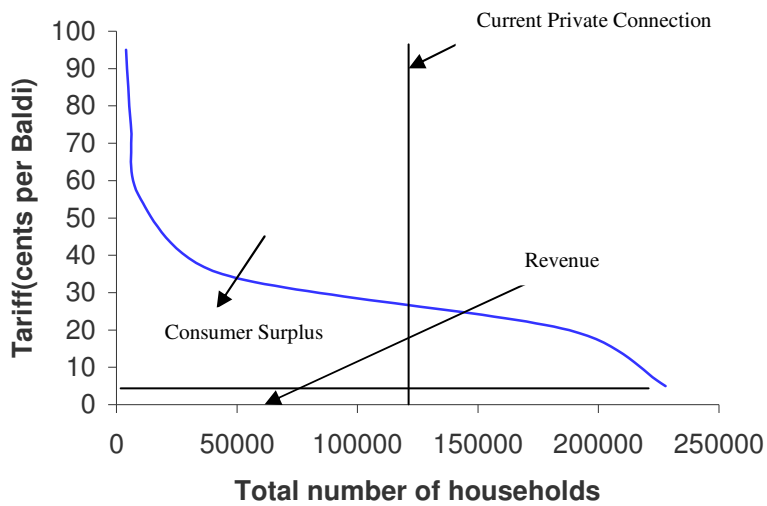


Figure 5.1: Current revenue and consumers' surplus

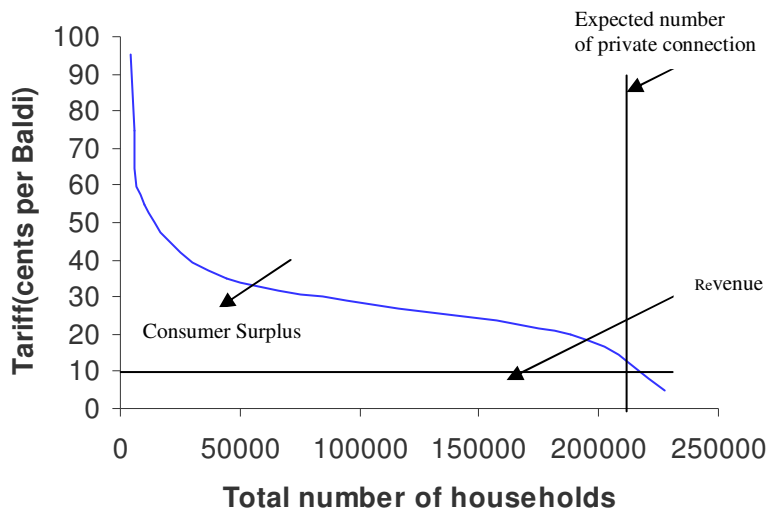


Figure 5.2 Expected revenue and consumers surplus

However, as illustrated in figure 5.2, if the tariff rate for the improved water is set at 10 cents per Baldi (which is just half of the mean WTP from the single –bounded Probit model) with supply left unrestricted, the study suggested that the number of households subscribing to the proposed improved private piped water service will substantially increase. And the increase in the consumers surplus as a result of the large increase in the number of private connections by far offsets the loss in consumers surplus of the already connected households

The result of this CVM application show that the tariffs for improved water can be increased substantially with unconstrained supply before an insignificant number of households would choose to an improved system. The revenue and households' welfare gains in changing the existing policy (low tariff with limited unreliable private service and hence low level equilibrium) to a new policy (higher tariff with more and improved private connections) can be huge.

Chapter Six

Conclusion and Recommendation

Most developing countries are entangled by acute shortage of basic infrastructure facilities. Especially, urban centers of these nations are facing multi-dimensional problems due to the immense population pressure and poor urban planning. As supply side problems are in fact eminent, demand side issues have revealed of much significance. Lack of knowledge about people's preferences and WTP for public services has been deemed a major obstacle. Coming to water supply service in Addis Ababa, capital city of Ethiopia, again the above-mentioned problem is highlighted. The alarmingly increasing population coupled with the increasing urban poverty and poor living standard shows that the current deteriorated condition will be even unbearable in the future. Recognizing the poor current condition of water supply service, the government of Ethiopia (through AAWSA) is planning to minimize the problem through implementing its water three project with the help of donors and other NGOs through encouraging alternative means to piped water such as Rain Water Harvesting. As supply side features seems to be overdone, there is almost nothing that is being done to study the demand side. Therefore, this paper is intended to bridge the gap in information for policy initiatives.

Therefore, this study aims to analyze households' valuation of improved water supply service in specific areas of Addis Ababa. The study used both primary and secondary data. A contingent valuation survey was conducted to obtain data from 250 sample households. Other relevant secondary data are also used as a source of information. The elicitation method used was single bounded format with an open-ended follow up question, and we administered the survey using an in-person interview. We used both a descriptive and econometric analytical technique. We used

probit and Tobit model to analyze the determinants of households' willingness to pay for improved water service

The descriptive analysis shows that only 30% of the respondents reported that they do have private connection to the existing water service. About 70% of the respondents said that the existing service is not reliable. These facts imply that the main problem of the existing service are unreliability of supply, higher connection costs, poor quality and quantity of the existing piped water services in the sampled areas.

Multivariate analysis using Tobit and Probit model were estimated for the WTP scenario. The heteroscedasticity problem is corrected using appropriate (LIMDEP version 7) econometrics software. In summary there were eleven explanatory variables included in the final regression models based on the degree of theoretical importance, and their significant impact on WTP. In general, except for water related disease, the sign of the coefficients of the explanatory variables are in the expected direction. Income, education, perceived water quality, sanitation facility, age, and water related disease have significant impact on WTP. The variables Years of stay in the area and marital status of the respondent have negative sign and are insignificant or seem to have less influence on WTP in Tobit model.

Concerning the Probit model, income, education, marital status, water related disease; years of stay in the area positively affect the probability of responding to the initial bid. The value of the initial bid has a negative and significant effect on the probability of saying yes to the proposed bid implying that an increase in the initial bid reduces the likelihood that respondents are paying the proposed bid.

The mean WTP is found to be 20 cents per Baldi (20 liters container) from single-bounded Probit model estimates and 15.79 cents per Baldi from the open-ended format. This implies that, respondents are willing to pay in the range of 15 to 20 cents per Baldi for improved water service which is well above the existing official tariff for piped water.

The positive and significant relation between sanitation facility and willingness to pay in the Tobit model as well as the positive sign of sanitation facility in the probit model shows that there is a strong relation between sanitation facility and improved water service.

The possibility of driving demand schedule for improved water model clearly reveals that raising tariff with unconstrained supply could lead to increased connection, higher consumer surplus and possible rise in revenue for water authority.

The overall results demonstrate that the WTP responses from the CV survey using the single bounded elicitation technique are not adhoc but they are systematically related to the independent variables suggested by theory. Hence, it is possible to suggest the CV survey as a feasible method for estimating WTP for improved water service.

Based on the findings that we have, we can draw the following *policy implications*:

- 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.

- One of the major problems indicated by respondents is the higher cost of connection to the existing pipe system. From the WTP bids, households are willing to pay higher than the current tariff if the costs of connection are distributed in the tariff and if more reliable and high quality water is provided.. Therefore, folding the connection costs in tariff could lead to a potential for revenue and opportunities for financing new water supplies as the number of connection rises, if the WTP bids and payment conditions are considered.

- The strong positive relation between sanitation facility and willingness to pay implies that improving sanitation service could not be done alone rather it has to go hand in hand with improvements in other infrastructure provisions. Especially adequate water supply has to be secured. Therefore when thinking of improving sanitation services, it has to be done in a broad urban development framework of the city. If not it will inhibit effective and efficient improvements in sanitation service since availability of water supply complements the sanitation facility.

- An important policy implication from the strong positive relationship between educational level and willingness to connect to the improved water service is that there is a need to educate people about the benefits associated with improved water services, in general, and having private connection to the new improved water supply, in particular. .

- The strong positive relation between the income of the household and the willingness to have private connection to the improved water service imply that tariff setting should consider the poor income group not to be devoid of from access to the minimum water requirement to sustain their life. Furthermore, it implies that designing income-generating programs that address the poor households can help to sustain the system to function well.

- 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

- Finally, the WTP bids could be used to predict the level of private connection demanded by households. This information is vital for relating standards of services and design criteria. This will undo what may come from misuse of resources by over design or unsatisfied demand by under designing schemes. Therefore, it is suggested that the relevant authority could use approaches such as CVM to emanate information on the level of demand especially in the design of the master plan. The possibility could help to get out of the current supply dominated policy and set out design criteria for improved water supply projects and programmes.

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Annex 1

Addis Ababa Water and Sewerage Authority 5 years Tariff for Water supply and Sewerage Disposal Services

BLOCK	First year Tariff July 8,2002 to July 7,2003			Second year Tariff July 8,2003 to July 7,2004			Third year Tariff July 8,2004 to July 7,2005			Fourth year Tariff July 8,2005 to July 7,2006			Fifth year Tariff July 8,2006 to July 7,2007		
	Tariff / M ³ (In Birr)			Tariff / M ³ (In Birr)			Tariff / M ³ (In Birr)			Tariff / M ³ (In Birr)			Tariff / M ³ (In Birr)		
	Water	Sewerage	Total	Water	Sewerage	Total	Water	Sewerage	Total	Water	Sewerage	Total	Water	Sewerage	Total
Public fountain	1.15	-	1.15	1.30	-	1.30	1.45		1.45	1.60	-	1.60	1.75	-	1.75
Domestic customers (Monthly water Consumption in Cubic meter)															
0-7M ³	1.15	-	1.15	1.30	-	1.30	1.45	-	1.45	1.60	-	1.60	1.75	-	1.75
8-20M ³	1.60	0.35	1.95	1.85	.40	2.25	2.10	0.45	2.55	2.35	.50	2.85	2.60	0.55	3.15
	2.30	0.35	2.65	2.60	.40	3.00	2.95	0.45	3.40	3.25	.50	3.75	3.25	0.55	3.80
>20M ³	2.30	0.35	2.65	2.60	.40	3.00	2.95	0.45	3.40	3.25	.50	3.75	3.25	0.55	3.80
Non Domestic customers	2.30	0.35	2.65	2.60	.40	3.00	2.95	0.45	3.40	3.25	.50	3.75	3.25	0.55	3.80

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Addis Ababa Water and Sewerage Authority Water Supply Situation Map (2005) report

Annex 3

Correlation Matrix for Explanatory Variables

	WRD	REYS	IB	REAG	REIN	REFS	RESX	REMS	REPL	RESF	ASST	REED
WRD	1	-0.15219	-0.02473	-0.15371	0.31582	0.17522	0.15043	0.23745	-0.044	0.182	0.3249	0.2169
REYS		1	-0.00366	-0.10242	0.14417	0.14754	0.14543	0.01827	-0.1558	0.15	12984	0.131
IB			1	-0.1028	-0.22006	-0.06839	-0.08735	0.06839	-0.0375	-0.13	-0.202	-0.1507
REAG				1	-0.13996	-0.0941	-0.36955	-0.1479	20011	-0.21	-0.183	-0.2579
REIN					1	0.42978	0.2974	0.30395	-0.1488	40371	0.8676	35289
REFS						1	0.23865	0.29056	-0.2326	0.423	0.2944	0.3918
RESX							1	0.15137	-0.2093	0.341	0.2322	0.2294
REMS								1	-0.3121	0.336	0.2565	0.3016
REPL									1	-0.28	-0.119	-0.0566
RESF										1	0.4774	0.3247
ASST											1	0.351
REED												1

Annex 4

Test for Heteroscedasticity and Goodness of Fit

1.1_Tests for Heteroscedasticity

The LR statistics of testing the null hypothesis of homoscedasticity assumption is obtained by

$$\lambda_{LR}=2[\text{Log } L_u-\text{Log } L_r]$$

Where $\log L_u$ is the value of unrestricted log-likelihood function and L_r is the value of restricted log –likelihood function

λ_{LR} has a $X^2(n)$ distribution with n degrees of freedom where n is the number of independent restriction. If the data do not support the null hypothesis (homoscedasticity assumption), then the value of the test-statistic became large and null hypothesis is rejected $\lambda_{LR} \geq X^2(n)$. The result of the test for the model is shown below

$$\begin{aligned}\lambda_{LR} &= 2[\text{Log } L_u - \text{Log } L_r] \\ &= 2[-853.3735 - (-934.4304)] \\ &= 2[81.0569] \\ &= 162.1138\end{aligned}$$

The critical value of the chi-square at 11 degree of freedom is 19.68 at 95% level. Comparison of the results (test statistics) with critical table value shows that all of the test statistics (computed values) are found to be larger than the critical table value.

1.2_Test for Goodness of fit

Equivalent to R^2 in a conventional OLS regression model the likelihood ratio index is used to measure the goodness of fit for probit model. It is computed using the formula

$$LRI = 1 - \ln Lr / \ln Lo$$

Where $\ln Lr$ is the value of unrestricted log-likelihood function and $\ln Lo$ is the value of loglikelihood function. Its value lies between 0 and 1. If it is one implies” perfect” fit. According to Green (1993) values between zero and one have no natural interpretation but as LRI approaches one it shows improvement in goodness of fit

a) Then the computed value of LRI for our probit model is:

$$\begin{aligned} LRI &= 1 - (-79.87260 / -159.7614) \\ &= 0.50 \end{aligned}$$

The computed ratio shows that the model seems adequate it explains 50% of the variation, which is common for cross-sectional data.

b) The computed value of LRI for the Tobit model is

$$\begin{aligned} LRI &= 1 - (-853.3735 / -934.4304) \\ &= 0.086 \end{aligned}$$

The LRI is 0.086 this means that the model explains about 8.6% of the variation in explained variable.

Annex 5

A CONTINGENT VALUATION SURVEY QUESTIONNAIRE

Code _____

Interviewer _____

Place of Interview: _____ (Write Woreda and Kebele Number)

Date of interview _____

Length of interview _____ Minutes

Supervisor _____

ATTENTION: UPPER CASE LETTRS =INSTRUCTIONS FOR INTERVEIWER

Lower case letters=questions and statements to be read aloud to the respondent

INTRODUCTION TO THE REPONDNET

Hello. My name is _____. I am assisting an on-going research by Medhin Fissaha, in partial fulfillment of her M.Sc degree at Addis Ababa University. We are talking to selected sample households in Addis Ababa city about the improvement in water services

First, let me begin by saying that most of the questions have to do with your attitudes and opinions, and there are no correct or wrong answers. This interview is completely confidential and strictly for academic purposes. And your name will never be linked with your answers. Therefore, honest discussion is the best way ahead

SECTION A: EXISTING WATER USE CONDITIONS AND PROBLEMS

A1.what is the main source of water for the members of this household?

1. ____Piped water _____GO TO Q.A2
2. ____Others (specify) _____SKIP TO Q.A33

A2.what kind of piped water services do you use currently?

1. ____Tap inside the house _____SKIP TO Q.A4
2. ____Tap in the compound, private _____SKIP TO Q.A4
3. ____Tap in the compound, shared _____GO TO Q.A3
4. ____Tap outside compound _____SKIP TO Q.A10

A3.how many households use the shared tap in the compound? _____Households

A4.how much water do you consume per day on the average? _____Baldi/insira (or a 20-liters bucket)

A5.how much are you charged per month, on the average, for using this source?

_____Birr/month

A6. For what purpose (s) is the water from this source used? IDENTIFY AND RANK

STARTING WITH THE MAIN PURPOSE

1. . ____ Drinking
2. ____ Housekeeping
3. ____ Washing clothes
4. ____ Others (specify) _____

A7. In relation to its quality, amount and reliability, how do you rank the current status of water service from this source?

1. Quality: 1__ Good 2. ____ Satisfactory 3. ____ Poor
2. Quantity 1__ Good 2. ____ Satisfactory 3. ____ Poor
3. Reliability 1__ Reliability 2. ____ Unreliability

A8. Are you satisfied with the arrangement of the existing water service?

1. ____ Yes
2. ____ No GO TO Q. A9

A9. What is (are) the cause(s) of your dissatisfaction? IDENTIFY AND RANK STARTING

WITH THE MOST SERIOUS CAUSE

1. ____ Poor quality
2. ____ Unreliability
3. ____ Higher connection charges
4. ____ Higher volume charges
5. ____ Others (specify) _____

A10.From which sources do you get water currently?

1. ___ Public tap_____GO TO Q.A11
2. ___ Private vendors_____SKIP TO Q.A22
3. ___Other organizations (specify)_____

A11.From what major purpose(s)do you use water collected from public tap? IDENTIFY AND RANK

1. _____Drinking
2. _____House keeping
3. _____Washing clothes
4. _____Other (specify)_____

A12.Why do you prefer this source?

1. ___No access to the existing system
2. ___I cannot afford the costs to the existing system
3. ___Its reliability
4. ___Lower volume charge
5. ___Other (specify)_____

A13.How much time do you spend to collect water from this source at a time? ___Minutes

A14.How often do you go to the public tap per day? _____Times

A15.How many persons from your household go to fetch water at a time? _____Persons

A16. Who goes to the public tap?

1. ___ Girls
2. ___ Boys
3. ___ Both
4. ___ Others (specify) _____

A17. How much water do you collect on the average on a day? ___ Baldi/insira

A18. How much do you pay per Baldi/insira? _____ Cents

A19. How much money do you spend per month to collect water from this source? _____ Birr
per month

A20. Are you satisfied with this source of water?

1. ___ Yes
2. ___ No

A21. If no, why are you dissatisfied? IDENTIFY AND RANK

1. . ___ Poor quality
2. ___ Unreliability
3. ___ Higher volume charge
4. ___ Far away from home
5. ___ Others (specify) _____

A22.From where do you get water?

1. ___Private vendors
2. ___Other organization (specify)_____

A23.Why do you prefer this source? IDENTIFY AND RANK

1. ___No access to the existing piped system
2. ___I cannot afford to existing system
3. ___Its reliability
4. ___Lower volume charge
5. ___Other (specify)

A24.How much time do you spend for collecting water at a time? _____Minutes

A25.How many persons go to collect water at a time? _____Persons

A26.Who goes to collect water from this source?

1. ___Girls
2. ___Boys
3. ___Both
4. ___Others (specify)_____

A27.How often do they go per day? _____Times

A28 How much do you pay per Baldi /insira? _____Cents

A29.How much water do you collect on the average on a day? _____Baldi/insira

A30. how much do you spend per month on the average for buying water from this source?

___ Birr per month

A31. Are you satisfied with the service from this source?

1. ___ Yes
2. ___ No

A32. If "No", why are you dissatisfied? IDENTIFY AND RANK

1. ___ Poor quality
2. ___ Unreliability
3. ___ High volume charge
4. ___ Far away from home
5. ___ Others (specify) _____

ASK THE FOLLOWING QUESTIONS TO ALL RESPONDENTS

A33. To what extent do you perceive the current provision of piped water is an issue worth discussion?

1. ___ Critical
2. ___ Very serious
3. ___ Serious
4. ___ Less serious
5. ___ Not important

A34. Who do you think is responsible for water supply?

1. Government
2. Community
3. Private
4. Others (specify) _____

A35. So far, has the administrative body done enough in solving the problems in the provision of piped water to household?

1. A lot attention to the problem
2. Some attention to the problem
3. Not too much attention to the problem
4. No attention at all

A36. Do you think that leaving a better environment to future generation is some thing

1. Very important
2. Important
3. Less important
4. Not important at all

A37. Has any one of your household members suffered from disease caused by deficient water quality such as diarrhea, or typhoid, in the past one year?

1. Yes
2. No

SECTIONB: THE EXISTING SANITATION PRACTICE

B1.What type of sanitation system does this household use?

- a. Facility in house
 - a.1. Flush toilet
 - a.2. Pit latrine
 - a.3. Other (specify)
- b. No facility in house
 - b.1. Use public latrine
 - b.2. Bush
 - b.3. Streets
 - b.4. Other (specify)

ONLY FOR THE HOUSEHOLD USING PIT LATRINE AND FLUSH TOILET

B2.Do you share the pit latrine/flush toilet with other in the house?

- 1 .Yes
2. No

B3.If yes, how many households use the pit latrine/flush toilet?

_____ Number of households.

B4.How satisfied are you with the pit latrine/ flush toilet you have?

1. Very satisfied
2. Satisfied
3. Not satisfied at all

B5.How would you describe the relationship between the use of pit latrine and availability of water?

- 1 Very related
- 2 Related
- 3 Not related at all

ONLY FOR HOUSEHOLDS USING PUBLIC TOILET

B2.How far is the public latrine from your home?

_____ KMs (Meters).

B3.Is the public latrine usually on service?

- 1 Yes
- 2 No

B4.How satisfied are you with the public latrine you use?

1. Very satisfied
2. Satisfied
3. Not satisfied at all

B5.How would you describe the relationship between the use of public toilet and availability of water?

1. Very related
2. Related
3. Not related at all

SECTIONC: WILLINGNESS TO PAY QUESTIONS

BACKGROUND INFORMATION

In the next section of the questionnaire, I would like to ask you how much it is worth to you in money terms, the provision of improved water service

The provision of improved water service among other things means, good quality of water which is safe for health and an increased amount of water available for use .It also means a highly reliable source at any time (7 days a week, 24 hours a day) moreover; the family need not have to spend its time and effort in fetching water from distant sources

Now, let us assume that you have an option for a private connection to such an improved piped water supply scheme. The improved system will provide you with as much water as you wish at any time of the day, through out the year .Let us also assume that you will be charged a monthly water fee based on the volume of water your household consume in a month (the tariff is progressive), the more you consume the higher will be your monthly bill. The tariff per volume will be the same for all consumers. You may not be required to pay initially the costs of connection to the new scheme. In stead, it will be distributed over several years in your monthly bill (The payment will be built-in the monthly water bill).

THE WILLIGNESS TOPAY (WTP) QUESTIONS

C1. Are you willing to pay any amount to the proposed scheme?

1 __ Yes GO TO Q.C2

2.__ NO

C2. If the price (tariff) your household pays for obtaining water from this system is ____cents per baldi/insira (20 liters), would your household choose to connect or prefer using other sources of water?

1____ Yes

2____ NO

C3. What is the maximum price (tariff) you are willing to pay per baldi/insira for the mentioned scheme?.....(cent)

ASK Q.C4 ONLY IFA ZERO BID WAS RECORDED FOR Q.C3

C4. Are you totally not willing to pay because you believe that:

1____ Water should be provided free of charge

2____ You are satisfied with existing source(s)

3____ I would not have enough money to pay for the new system

4____ Others (specify)_____

WILLIGNESSS TO PAY QUESTION FOR PUBLIC TAPS

ASK Q.C5 AND Q.C6 ONLY IF A ZERO BID WAS RECORDED IN Q.C3

C5.Are you interested in public provision?

1____ Yes GO TO Q.C6

2____ NO

C6.If yes, let us assume that a new scheme of improved water system using a public tap will be provided to you. The public tap will be in your kebele as near as possible to your house. You will be provided a good quality water as much as you wish at any time of the day through out the year .You will be charged per volume charge based on the volume of water you consume at a time if

the price you pay for use of water from this source is 5 cents per baldi will you be willing to use this source?

1____ Yes

2____ NO

C7. What is the maximum price (tariff) you are willing to pay per baldi/insira for the mentioned scheme?.....(cent)

ASK Q.C8 ONLY IF NO ANSWER IS RECORDED FOR Q.C6

C8. If respondent's WTP for such improved water for domestic uses is zero, ask for reasons not to pay like:

1. Has no income to pay (i.e., can not afford).
2. The government should pay
3. Non-governmental Organizations (NGOs) should pay
4. Others please specify_____

SECTION D: HOUSING CHARACTERISTICS AND HOUSEHOLD INCOME

***For the Sex Column:**

-Write 1 if female
0 if male

***For Education Column:**

-Write 1 for illiterate
2 for primary
3 for secondary
4 tertiary and above

(Encircle the level completed for 2,3, and 4)

***For Occupation Column:**

-Write 1 if trade
2 if housewife
3 if student
4 if unemployment

***For the Remark Column:**

-Write 1 if self employed
2 if employed in private companies
3 if government employed
4 if unemployed and specify if any other.

Name	Sex (M&F)	Monthly income of HH (in birr)	Age	Educational Level	Occupation	Monthly expenditure (in birr)	House type	Household asset	Remark
						School			
						Electricity	Gov	Car	
						Food	Private	Television	
						Medical	Rented from	Radio	
						Water	i) Private	Refrigerator	
						House rent	ii) Kebele	Video	
						Transport		Stove	
						Telephone		Telephone	
						Other expenses (Ekube Edir, etc)			

D1. How long have you been staying in this house? _____ Years.

D2. Please list the following services in order of importance (list as first, second, etc.)

- | | |
|--------------------|----------------------|
| 1) School _____ | 2) Health _____ |
| 3) Water _____ | 4) Sanitation _____ |
| 5) Road _____ | 6) Electricity _____ |
| 7) Telephone _____ | |

D3. What is your opinion for improved water services and sanitation practice in the future?

SECTION E :INTERVIEWER'S EVALUATION

INTERVIEWER: COMPLETE THESE QUESTIONS IMMEDIATELY AFTER THE INTERVIEW

E1.in your judgment, how well did the respondent understand what s/he was asked the above questions?

1. ____ Understood completely
2. ____ Understood somewhat
3. ____ Understood a little
4. ____ Did not understood at all
5. ____ Others (specify)_____

E2. Which of the following describe best the degree of efforts the respondent made in the valuation process?

1. ____ Prolonged and careful consideration
2. ____ Some consideration
3. ____ Very little consideration
4. ____ Others (specify)_____