

**Analysis of the Determinants of Households' Willingness to Pay
and Demand for Improved Water Services: A Contingent
Valuation Study in Harar town (Ethiopia)**

**A Thesis presented to the school of Graduate studies, Addis
Ababa University**

**In Partial Fulfillment of Requirement for the Degree of Master of
Science in Economic Policy Analysis**

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**May, 1999
Addis Ababa**

ADDIS ABABA UNIVERSITY
School of Graduate Studies

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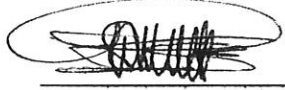
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ACKNOWLEDGEMENTS

My special thank must go to my advisor Dr. Alemu Mekonnen for his invaluable support and detailed professional advice in all process of the research work.

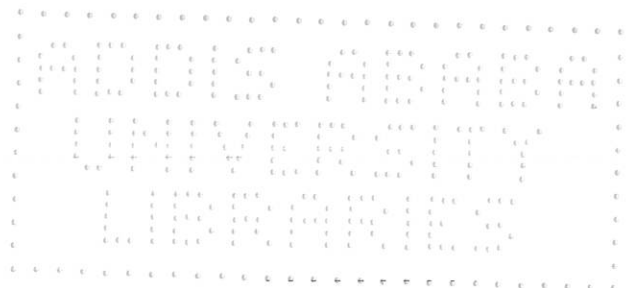
As soon as I got my first degree in mathematics in 1994, I was looking for every possible way to be an economist. It was the late Ato Mekonnen Tadesse who had the quite unusual quality of supporting others not only in times of success but also in times of adversity and who has paved the way for me to meet the target I was yearning for. Let God rest his soul in peace.

I also owe a great debt to Action Aid Ethiopia, Department of Economics, AAU and the African Economic Research Consortium (AERC) for the financial support through out the study.

I am indebted to all those who assisted me directly or indirectly in this work and in my stay in the university. In particular, I would like to thank my Instructors and colleagues. It is a pleasure to express my appreciation to Dr. Meshesha Shewarega, Dr. Assefa Teferi and Ato Sintayehu W/Michael who used to encourage and show concern to every step of this work. I am also indebted to W/ro Martha Negash, Ato kidemachew Tsehay, W/t Tsehay W/michael W/t Misrak Woldu and W/ro Tigabe Akelom.

I wish to thank the region 13 administrative office staff members and Kebele officials for their hospitality and support during my survey in Harar. Thanks should go to all the enumerators for their co-operation in facilitating the data collection.

Finally, the whole-heartedly support of my family particularly my wife Eshet and my brother Tatek is highly acknowledged.



Abstract

In developing countries, millions of people are facing daily problems in obtaining water for domestic purposes.

Recognizing the harm to health economic productivity, and quality of living standard that can result from inadequate water supplies, governments have been establishing policy and planning to correct the problem.

The implementation of such policy decisions should focus on demand side as opposed to the traditional focus on supply side, pricing mechanisms and regulatory measures that have received much less attention. Since need to fill the gap of information on the demand side (such as household socioeconomic and demographic characteristics and characteristics of the existing and new supplies of water) for policy purpose is timely, researching the demand side in order to understand the household improved water demand behavior and what factors determine their willingness to pay verses their affordability for upgraded water service is crucial.

This article, therefore, tries to asses the determinants of households willingness to pay and demand for improved water services in Harar town which will enable policy makers to design an appropriate water pricing structure and viable cost recovery policies like the choices of water supply schemes and tariff system.

Because of the nature of the primary cross-sectional data that we got from our contingent valuation survey in the town, this study used only the direct method to estimate households' willingness to pay for improved water services using the ordinary least squares regression and ordered probit models.

The study shows that the methodology produced some illuminating insights into the relevant information on household willingness to pay, which is shown to vary significantly according to household level of income, education level and sex of the household head, starting point of the bidding game, location of study site, main source of water for the household and perceived quality of the existing water .

The study also reveals that the mean willingness to pay (WTP) for private piped improved water connection is more than 15 times the exiting authority's tariff rate. The tariffs for improved water can be increased substantially with unconstrained supply before insignificant numbers of households would choose not to connect to an improved system. The revenue and households' welfare gains in changing the existing policy (low tariff with few unreliable private service) to a new policy (higher tariff with more and improved private connections) can be huge.

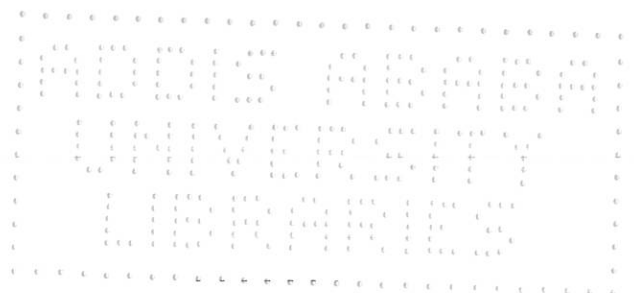
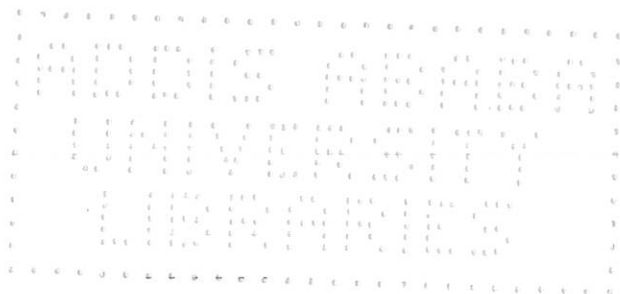


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CHAPTER ONE

Introduction

1.1 Statement of the Problem

With an effort to raise productivity and living standards, developing countries have been making substantial amount of investment. Such an investment coupled with economic infrastructure has a considerable impact on the economic growth and welfare of a nation. Investors have started to invest in the city of Harar and in the region. According to the regional investment office (as indicated by Ernst & Young, 1997) ¹, different projects with a capital of 181.41 million have either started or are due to start in the near future. And also the already existed factories are planning to increase their production.

Adequate infrastructure such as water supply, power, telecommunication needs to be in place first for development projects to take off. But, as most developing countries focus on quantities of investment with the neglect of quantities of other related infrastructures, Harar does not yet have such a water supply system in place. This will have an adverse effect on the investments. According to the World Bank Development Report (1994), low operating efficiency, inadequate maintenance and lack of attention to the needs of users have all played a part in reducing the development impact of infrastructure on investment in the past.

¹ unless otherwise specified, quantitative descriptions in the first two chapters are adapted from the socio-economic base line study by Ernst & Young (1997).

In developing countries, the shortage and poor quality of piped water supply is currently threatening the lives of millions of people. In the year 1990, 600 million urban lives were threatened because of inadequate provisions of safe and sufficient water supplies (Satherth, et al, 1993- as indicated in the work of Assefa). Although the regional government of Harar is making tremendous efforts to narrow the wider gap between the demand and supply of water service in the city, the cost of achieving this objective of increasing the supply of improved water service is very high (See the extent of the cost in the next chapter). Leave alone the cost that is necessary to achieve the above goal, even in the already existing situation, according to the available data in the town water supply office, approximately it costs 1.94 Birr to produce 1 cu.m of water which is sold for 0.50 Birr, implying a 1.44 Birr loss for every cu.m. of water sold. That is there needs to pay a high level of cost to improve the water supply situation in the city. The question is who is going to pay it: the government or waiting for foreign aids?

The fast growing population coupled with the rising cost of providing services and poor performance of the economy make it less promising to rely on government to cover the cost. Also relying on foreign aid is not a sustainable way of development. What else should be done to achieve sustainable water supply development? According to the Federal Water Resources Policy of the country, one of the country's objectives is to gradually phase out all forms of subsidy that are currently in place; especially cost allocated towards operation and maintenance costs and to insure that all future water supply & sanitation undertakings will adequately address the source for costs associated with operation and maintenance and be based on cost recovery principles.

Moreover to establish a "Social tariff" that covers basic services to be borne by the poorest communities to cover operation and maintenance costs and to conduct and launch a natural water supply and sanitation tariff study are among the current policy objectives of the country. That is, the development of sustainable, affordable and effective improved water supply service system should involve the active participation of the local community. The concept that "the user pays" for improved water supply service should be materialized. As noticed by the World Bank Water Demand Research Team (1993) little emphasis has been placed on providing the consumer with suitable options for the kind of services they need and they are willing to pay. Eventhough tremendous efforts have been made by governments in developing countries to develop infrastructure in water supplies and improve the poor access to piped water, most of the policy decisions have been found to concentrate on the supply side. As a result most of the efforts were not successful to alleviate the problem.

To this end the existing policy initiatives in Harar concerning water supply should not neglect the effective demands of the majority of households in the city.

The implementation of such policy decisions should focus on the demand side as opposed to the traditional focus on the supply side, pricing mechanisms and regulatory measures that have received much less attention. Since the pricing of water is the key component of an appropriate incentive for efficiency, sustainability and accountability and since need to fill the gap of information on the demand side (such as household socioeconomic and demographic characteristics and characters on existing and new supplies of water) for policy purposes is timely. Research on the demand side in order to understand the

fundamental importance of the value the consumer places on the improved water services and other forms of user contributions for water services is crucial. Whittington, et al 1991, suggested that policy & planning should be established on a better understanding of what improvement in the water service people need & are willing to pay for. Also it is realized that since the benefits of improved water supplies are greater in terms of health, social & economic benefits, many people in developing countries can & will pay for improved water services.

That is, adequate knowledge is required to understand the household water demand behavior, what factors determine their per capita water use, their willingness to pay (WTP) versus their affordability for improved water service. This study, therefore, tries to assess the determinants of households' willingness to pay & demand for improved water services in Harar city which will enable policy makers to design an appropriate water pricing structure and viable cost recovery policies like the choices of appropriate technologies & tariff system.

1.2 Significance of the Study

Although the government, NGOs and Bilateral & multilateral donor agencies are making tremendous efforts to improve the quality and quantity of water in the city, there is a doubt whether they are active enough to cover all future water funds even in the way they were used to be.

The development of sustainable, affordable and effective water supply system should promote the active involvement of the local communities. In other words, the assurance of

the proper integration of water supply at all levels in a sustainable and coherent framework should promote the concept that "the user pays" for improved water supply services. This study, therefore, will provide the required information on the ability and willingness of the people not only to pay for improved water services but also to sustain their supplies which might include paying for operation, maintenance, replacement and even extension costs for improved supplies (this of course is the policy objective of the Federal Water Resources). That is, our study may help policy makers to design an appropriate water pricing structure and viable cost recovering policies.

Of course, very few studies have been attempted on the subject in Ethiopia. Fisseha (1997), for example, has assessed consumers' WTP for piped water supply of Meki town. And also Assefa (1998) has studied the determinants of households' demand for improved water services, in Addis Ababa City. This study will be a supplement to the past few initiations and applications of methodologies to evaluate improved water services and also contribute as a basis for further empirical research on the subject.

Indeed, according to Griffin et al. (1995), any attempt to estimate behavior and those benefits in a particular community on the basis of results of studies in other communities and in other settings can reach to a seriously erroneous conclusion even with same natural conditions between communities and the service to be offered are apparently quite similar. Thus, there is still a challenge to prove the relevance of the contingent valuation method (CVM) in Harar town.

Moreover the results of the investigation are expected to be of interest to Regional authorities, NGOs, Bilateral and Multilateral donor agencies and in particular the Ministry of Water in neither under designing nor over designing water projects and in implementing policy strategies in meeting the effective water demand of households and sustainable water use.

1.3 Objectives of the Study

Effective policy planning must take into account what consumers want and are prepared to pay for improved quality of an environmental good. That is the implementation of allocation decision should focus on demand management as opposed to traditional focus on supply side pricing mechanisms and regulatory measures that have received much less attention. Hence, this study intends to look at the value of safe water service through the determination of appropriate monetary values for the service. The ultimate objective of this study is to investigate the determinants of households' willingness to pay & the demand for improved water service in Harar town using the contingent valuation method (CVM).

The specific objectives include:

- To investigate the determinants and measure the level of willingness of households to pay for improved water supply services;
- To establish the suitability of the contingent valuation method (CVM) in estimating the WTP for water services;
- To seek information and estimate the demand for improved water services, total benefits and revenue that can be expected from the provision of the improved services;

- To determine the appropriateness of the existing government policy in relation to water supply and draw up appropriate policy implications and recommendations based on the findings.

1.4 Testable Hypotheses

The following hypotheses will be tested in the study:

- WTP depends positively on the income of the household;
- The Educational level is a factor in explaining WTP of the respondents;
- Gender is significant in explaining WTP of the respondent. Women are more willing to pay than men;
- Households with access to direct house connection are less willing to pay for improved water than respondents without access to direct house connection services;
- WTP depends on the problems of existing drinking water services, including water quality, reliability & time spent in fetching water from outside sources.

CHAPTER TWO

General Background

Ethiopia is one of the largest populated country in Africa (with a population size of more than 55 million) covering a vast area part of which covered with water including large lakes & long distance rivers.

The country's real per capita GNP in 1997 was US \$110 which leads only that of Mozambique's GNP per capita of US \$90. The average figure for the same year was US \$350 for low-income countries and US \$500 for sub-Saharan Africa (Berhanu & Seid, 1998). Although the real GNP growth rate has generally increased in recent years, the GNP per capita has been deteriorating mainly due to the fast population growth which has been increasing tremendously in recent years.

Not undermining the government's effort in the provision of social services, the fast growing population coupled with the rising cost of providing services (such as water) & poor performance of the economy has probably made it impossible for the government to provide social services to all people. For example, only 27% of the population of Ethiopia have access to safe water and 10% have access to sanitation while these figures stand at 71% and 30% for safe water and sanitation respectively for low-income countries (Berhanu & Seid, 1998). Domestic water sources for most rural communities are lakes, rivers, ponds, dug wells & springs which are oftenly unsafe, cause health hazards and are at considerable distance from households.

2.1 Description of the study area

Harari Region is among the regions in Ethiopia which consists of the city of Harar with 19 Kebeles and a surrounding rural area of 17 Farmers' Associations. For the purpose of this study only the town of Harar is considered. The projected 1997 population of the city of Harar is 92,000² with a total of 14,727 households (Municipality) & an average household size of 4.1. The city is the seat of the Regional Government and hence many government offices are located there. The economy of the surrounding area is basically intensive small scale agriculture with sorghum, maize and groundnuts being the major food crops. 'Chatt' is the main cash crop of the area. Harar is also an important commercial center, including the trade of contraband goods from Somalia and Somaliland.

As indicated in the Socio-Economic Baseline studies by Ernst and Young (July 1997), with a population approaching 100,000, the ancient city of Harar has suffered from acute water shortages for the last ten years. Although nearly 4,000 Cu.m of treated water is pumped from Lake Alemaya (the only source of water for the city) each day, the town water office estimated that 35% is lost through leakage and illegal connections from a distribution system most of which are 60 years old.

Eventhough Harar enjoys 24 hrs of power supply from the national grid, the time to time interruptions cause a serious problem to the town's water supply as there is no stand by generators at the intake. There is also a high incidence of water borne disease in Harar with

² According to the CSA, the population of the city of Harar was 76,378 with 18,102 households & average household size of 4.1 in 1994. Projected at an average growth rate of 4.11%, the 1997 population is 92,000 but according to the municipal office it is 120,000. The CSA figure is used as it is believed to be more accurate.

amoebic dysentery and helminthiasis being particularly prevalent. Ninety percent of the households do not have any bathing facilities of which that have, 4.6 % have either shared or private showers.

2.2 Water source and distribution system in Harar

Alemaya Lake, which is 20 k.m west of the city, is the only source of piped water supply. The lake, as indicated by Ernst & Young, is approximately 10 Sq.K.m. The intake and treatment plant was constructed in 1966. The town water office supplies about 3, 888 cu.m of water per day (i.e. a per capita consumption of 10.21 lt. per day) from the lake. Of the total number of households in the town only very few have access to private connection. See table-1 for the primary source of water for households:

Table-1: Primary water sources

House Connection	46%
Vendor	24%
Neighbor	12%
Unprotected Spring/well	7%
Protected spring/well	6%
River/pond/dam	2%
Private well	2%
Public foundation	1%

Source: Socio-Economic Baseline studies (Ministry of Water Recourses)

Moreover it has been indicated that the average distance to the water source is 150m. and 60% of households spend 30min. a day collecting water while 21.5% spend 30-60 Min.

The study also showed that 76% of households surveyed said they were not satisfied with the quantity of water they use and 43% want another 40 to 80 liters per day.

2.3 Water Transmission, Treatment and Distribution Network

Earlier water was abstracted via two low lift pumps located in the pump house. But due to the large quantity of water abstracted from the lake to irrigate chatt by the localities, the level of the lake has fallen and hence at present raw water is pumped from the lake by a 60 liter/Sec dewatering pump positioned at the end of a 50 m jetty. Raw water is delivered to clarifying tank where solid settle after aluminum sulphate has been added via a drip feed. Water then flows through three rapid sand filters each with a capacity of 20 lt./sec. in to a clean water tank.

Treatment is done by adding Chlorine by a drip system because the dosing pumps which used to inject chlorine gas has broken down. The distribution network is such that two centrifugal pumps rated at 20 lt/sec. each pump treated water up to a 200 cu.m break pressure tank 460 ms above the town of Alemaya from where water flows by gravity to the Akober reservoir which has a capacity of 1000 cu.m.. From this reservoir water is distributed to the Neguscira, Tassinary, and Ginella reservoirs. Water is then distributed according to a shift system based on five zones. A new generator house is constructed adjacent to the treatment plant. This will allow water to be pumped during power cuts.

2.4 Water Demand and Supply in Harar

In addition to the domestic uses of water in the city, industrial demand for water takes a significant share. The following table can be seen for a sort of comparison between the demand and supply of water in the town:

Table-2: Daily Water Demand and Supply for Harar town

Type of Demand	Demand (Cu.m/day)	Supply (Cu.m/day)
Domestic (106,088 X 37 Lt.)	3,935.25	1430
Brewery	1,200	200
Babile factory	150	50
Flour Mill	15	14
Army	500	486
Hospital & Health Centres	115	95
Schools & Colleges	239	200
Government Offices	77	91
Commercial outlets	861	*
Total	7,082	2,566
Total Daily Production on average	3,888	

*Commercial consumption is included in domestic

Source: Socio-Economic Baseline studies (Ernst & Young)

Note: This data includes Alemaya & Aweday in addition to Harar.

As seen in table-2 there is a significance level of demand for water over the daily production. It has been indicated in the study that there is a leakage or unaccounted for water rate of about 34% (1,322 cu.m) as a result of leaks & illegal connections. And hence the daily production figure is 1322 cu.m plus the total daily consumption figure of 2566 cu.m. That is, practically an excess demand of around 4,516 cu.m. per day is not yet met.

Expressing in percentage terms, only 45% of the target figure is being consumed by the population.

Also the quality of water in the town is not that much reliable. The Alemaya Lake has a PH of 9.16 which is very alkaline. It also has a high mineral content (Gibb Report of 1996). Although the Town water office claims that the chemical quality of the water from Lake Alemaya is an acceptable quality, no report could be found regarding the bacteriological quality. The lake is unprotected. As the watershed is used for intensive cultivation which used chemical fertilizers, it is reasonable to assume a certain flow of nitrates in to the lake which would adversely affect the quality of the water for human consumption. Of course the present treatment system would not remove chemicals like nitrates from the raw water (ERNST & YOUNG, 1997).

The People of Harar are suffering from both the quality and availability of water. It is a day to day practice to see a residue in a bottle of piped water left for some minutes. The incidence of water borne disease is high with amoebic dysentery and helminthiasis being particularly prevalent. While Ernst & Young were studying in 1997, the price at public fountain was one cent for 20 liters although none of the fountains were working.

Consequently, more than 50% of the total population have no access to direct house connection. This forces them to incur an extra cost of buying water from neighbors at a price of 25 cents for a 20 liter jerrycan & from vendors at a price of 15 cents for a 20 liter jerrycan (7.50 birr/cu.m), which is more than 15 times the government tariff of 0.50 Birr/cu.m. While some others were forced to fetch water from unprotected springs and

wells which are usually causes for water related diseases. The study reported that around 60% of households spend 30 minutes a day collecting water.

Of course some of the factories in the town are trying to overcome the shortage of water supply they are facing. The Brewery in conjunction with the Hameressa Edible Oil and Flour Factory, for example, have constructed three boreholes at Finkile near Alemaya University. This also brought up their cost of production & hence they were resulted in relatively lower profit than if they were having enough supply from the authority. Probably this might contributed for increases in the prices of products of the factories in the last few months.

2.5 Future Water Supply Condition in the City

All the above discussion geared to the central conclusion that the present source (Alemaya lake) is unable to satisfy the demand for water in the city and the water quality is also questionable. Though there is no much possibility (according to Geologists) of finding sufficient quantities of groundwater in Harar or its immediate surroundings due to the basalt basemant nature of the rock which yields very little water, considerable efforts have been made and are being made to increase water supply to Harar town. In 1996, a report by Gibb and Partners recommended damming the Mayo Gudo and Erer rivers, building treatment plants and pumping water up to Harar; where the total cost estimated was 445.41 million birr.

In 1996, a decision was taken by the Regional Council to get new water source. This was to drill a series of production boreholes at Asselisso, 25 K.m. from Dire Dawa and pump

water 700m. up the escarpment to Dengogo from where it will flow by gravity to Harar. One of the Boreholes drilled has a high yield but the depth is 268m. And it is indicated by Ernst & Young that the water has a high level of bicarbonate and the total dissolved solids is also high though no chemical analysis had been done.

Another possibility is to drill near Lange, about 60 k.m. west of Harar, where there are sandstone deposits which typically contain high yielding aquifers.

Not only the region is exerting its effort in new water sources but also trying to manage the existing water source. In the three months from January to March 1997, 36 cement asbestos distribution pipelines and defunct water meters have been replaced which is a part of its 4 million Birr scheme to replace. A work to rehabilitate the distribution network is already to start using a large quantity of galvanized iron pipes that have been bought from India. Can you imagine how large is the amount of money necessary to change all the above efforts in to practice?

CHAPTER THREE

Literature & Theoretical Framework

3.1 Theoretical Literature Review

3.1.1 Economic Valuation of Environmental Resources

Numerous concepts of value have been identified by philosophers. However, today value is regarded as synonymous with the price of a resource. Earliest philosopher economists distinguished between market price of an environmental resource & its value. The term value was then thought of as being in some sense as importance, essential or at times godliness. Since “price” & “value” are some how different concepts, the authors could differ (Nicholsen, 1992).

Smith & Ricardo have tried to make a distinction between the “value” & “price” of environmental resources. For instance, to Smith, the value of a resource means its “value in use” while price represents its “value in exchange”. To illustrate the distinction, consider the famous **water diamond paradox**: water which has greater value in use has little value in exchange (low priced) while diamond which has little practical use relative to water, commands a greater value in exchange, which implies that some less-essential items have high prices while certain useful ones have low prices.

The marginalists, between 1850 & 1880, redefined the concept of value. They proposed that it is not the total usefulness of resources that helps to determine its exchange value but

rather, the usefulness of the last unit consumed. Marshall's model (1890) has tried to resolve the paradox which neither Smith nor Ricardo was able to by providing these marginal principles. He showed that, demand & supply simultaneously operate to determine the price that reflects both the marginal evaluation that demanders place on a resource & the marginal cost of producing the resource. Here, water is relatively cheaper because it has both low marginal value & low marginal cost while diamond has both high marginal value & high marginal costs of production (Nicholson, 1992). That is water certainly very useful, it is necessary for all life, but because it is relatively plentiful, consuming one more unit (*ceteris paribus*) has a relatively low value to people.

However, the Marshallian money measure of utility is based on very restrictive assumptions which are likely to be realistic in general terms. An alternative framework to obtain money measures of utility changes has been presented by Hicks (1941). This does not invoke the cardinal utility rather it merely requires that consumers be able to preferentially rank alternative bundles of goods in a manner consistent with certain axioms of rational behavior (completeness, transitivity, convexity & non-satiation).

The economic concept of value, as indicated in the work of Young (1996), refers to measures in money terms of welfare or satisfaction of human preferences. Theoretically the total value/benefits of some environmental improvement such as improved water supply falls into two categories

$$\textit{Total economic value} = \textit{use value} + \textit{non use value}$$

3.1.2 Methods for valuing Environmental Resources.

Economists have in recent decades developed a number of techniques for measuring the economic values or benefits associated with non-market allocation in the subject matter areas relating to the environment & natural resources.

The development of these methods can be traced to the subject of welfare economics & the recent development of environmental economics. Welfare economics concludes that competitive markets will bring an economy to an optimal situation from an economic efficiency point of view. However, the free market with the existence of environmental goods which involves externalities & public goods in contrast to the characteristics that the market need to be competitive rarely produces the desired welfare result.

Indeed to undertake policy measures, economists have come out with a welfare criteria i.e the Pareto criteria (Mitchell & Carson, 1989) which states that policy changes which make at least one person better off with out making any one worse off are Pareto improving and should be undertaken.

Of course, mathematically the benefits of non-marketed goods such as improved water service can be captured through consumer surplus derived from such an improvement. Consumers' surplus is the difference between what one is willing to pay & what one actually has to pay for a service or product.

With the failure of market or in the absence/defective/ perfect market information, although cost benefit analysis is one possibility for the purpose of policy measure, the benefits

expected from the proposed changes in public goods are difficult to measure. In such a case economic evaluation of resource allocation decisions requires that some means of estimating resource value be found.

Various valuation methods are available to put economic values on environmental resources. According to Kneese & Russell (1990), these methods can be divided into revealed preference & direct methods.

3.1.2.1 The Revealed Preference Methods

In some cases, where markets for environmental goods or services are absent, or not well developed, or there are no alternative markets, it may not be possible to value the environmental impacts of a particular project by using the market. Under this circumstance, it is possible to estimate implicit values for such goods or services by means of the price paid for another good which is marketed. The most commonly used methods are hedonic pricing method (HPM) & travel cost method (TCM).

3.1.2.1.1 Hedonic Pricing Method (HPM)

HPM is based on the notion that the price of a heterogeneous good like a house or a job can be decomposed into the price of attributes that make up the good such as water quality in the case of a house. As indicated in the work of Young (1996), to buy a house consumers consider the level of location specific environmental amenities (air or water quality) in addition to characteristics of the dwelling (square footage, age, number of rooms, size of lot) & neighborhood characteristics (crime risks, accessibility to jobs, shopping & parks).

Hoevenager (1994) assumed that people will pay more for a house located in the vicinity of good environmental qualities. This shows the value of the surrounding environmental quality will be embedded in the prices for houses. Evidence from the works of Bah (1997), Ellickson (1981) & Feitelson (1992) also suggested that, *ceteris paribus*, a positive relationship exist between the prices that people are willing to pay for housing & the quality of water services. The main challenges here are the problem of correctly specifying the functional form, data constraints & the absence of competitive market for houses in developing countries. This approach may not be suited to this study because it is very rare for most people of Harar to sell houses. Moreover, unless a set of assumptions holds, the results may end up being unrealistic.

3.1.2.1.2 Travel Cost Method (TCM)

TCM depends on information about the amount of money and time people spend getting to a site to infer a value for that site. Although TCM can in theory be used to value almost any non-market good or service, in practice, however, it is only used for the valuation of recreational sites such as parks & beaches. It can also be used to value changes in environmental quality at recreational sites, such as changes in water & air quality. In general the transportation expenses together with a monetary value for the travel time & time spent at a site must worth the cost that individuals incur to access a resource services. Studies, for example, by Desvougues et al (1983), Faber (1988), Seller et al (1985) & Loomis (1987) have used TCM approach to estimate WTP for different environmental resources (as indicated in the work of Assefa). These studies proved that the method is an appropriate technique of estimating recreational benefits.

Although TCM has improved considerably since the earliest studies were carried out and has primary advantages of measuring benefits based on actual behavior, it is restricted to use values of the resource ignoring non-use values. Moreover the expensive process and time-consuming nature of large data requirements ban it to gain wide acceptance. However, since there are no water recreational sites in Harar, the method is not applicable in the study area.

3.1.2.2 The Direct Approach

Although the revealed preference approaches described above can be used to value many of the benefits associated with environmental resource improvements, there are cases where they cannot be used. For instance they are unlikely to value non-use values because they rely on data from situations where consumers make actual market choices such as when buying a house. As a result, these methods measure the expected consumers' surplus rather than optional price and hence give lower values. This suggests that direct questioning can play a big role in valuing the benefits of water service improvement.

The most common form of questioning on hypothetical markets is called the “**contingent valuation method**” (CVM). CVM is a survey technique that attempts to elicit information about preferences for a good or service by asking individuals questions about how much they value a good or service. This method is based on classical economic theory using either of Hicksian techniques i.e., either compensating variation (willingness to pay (WTP) for improved environmental resource) or equivalent variation technique (willingness to accept (WTA) compensation for environmental deterioration).

There are three basic steps involved in using CV:

a) Designing and administering a CV survey.

During a CV survey, the respondent is faced with a questionnaire that consists of three parts:

- i. a hypothetical description of the terms under which the good or service is to be offered to the respondent;
 - ii. questions which elicit the respondent's WTP for the good or service if confronted with the opportunity to obtain it under the specified terms. The analyst can elicit the respondent's WTP for a good or service in either of the following three general ways: in the form of bidding game or open ended question form or to present the respondent with a list of values in the form of a payment card & ask for their selection from the list.
 - iii. a series of questions about the socio-economic & demographic characteristics of the respondent.
- b) Analysis of WTP responses, &
- c) Estimation of benefit

According to Titenberg (1988), a major concern with the use of contingent valuation is the potential for survey respondents to give biased answers. Five potential types of bias have been identified:

Strategic bias: it occurs when a respondent does not reveal his or her "true" value of the good or service, in the hope of either a "free ride" or in order to ensure the provision of the good.

Compliance bias: Respondents in a particular cultural context may feel it

inappropriate to answer some kinds of questions in specific ways or may attempt to give answers that they think will please the enumerator.

This compliance bias can result in substantial differences between reported & true WTP values.

Information bias: this is the case when the respondent does not understand the

question as the interviewer does. That is, it occurs when the initial explanation of the service or proposed scenario is not very clear to the respondent.

Starting point bias: This is normally associated with bidding games. The choice of a

low (high) starting point leads to a low (high) mean WTP (Bateman & Turner, 1993). This bias is usually countered by using open ended questions .

Hypothetical bias: It occurs when the respondent is being confronted by a contrived,

rather than actual, set of choices. Since he or she will not have to pay the estimated value, the respondent may treat the survey casually, providing ill-considered answers.

The question of which appropriate measure of welfare (i.e whether to use the compensating variation (WTP) or equivalent Variation (WTA)) is also a major problem. Although WTA & WTP are, theoretically, supposed to provide similar results, empirically they give different estimates such that the estimates based on WTA tend to be greater than estimates based on WTP (Turner, 1993). For instance, Russel (1982) held the view that the difference should not be taken seriously. On the other hand Knetsh (1990) perceived

the difference to be significant and argued that people tend to overstate what they must receive free & understate what they must pay for, so as to make a gain.

However, the choice of the method will be determined by the choice decision in question. If the project in question has adverse effects on the residents in an area, WTA is an appropriate measure as the respondents would need to be compensated for their loss in welfare. On the other hand if the project is socially beneficial & the residents were campaigning to obtain it (the case of water project), then the maximum amount each resident would pay to express his need for the project will be described by WTP.

Concluding Remark

It must be noted that in terms of capturing total economic value of the good, CVM can easily be modified to capture both use & some non-use values as compared to TCM & HPM which measure only use values. CVM has strong theoretical basis, which is consistent with many empirical results obtained in practice, with unique advantages that it estimates income compensating welfare measures. The theoretical validity of the CV methodology can be explained based on the concepts of the standard consumer surplus (CS) and the Hicksian compensating surplus. Anthony C.Fisher discussed this issue (See David et al (1996)).

A CV study in a developing country like Ethiopia should generally be administered through in-person interviews. If resources are available to properly train & supervise enumerators so that surveys are properly planned & executed, this approach can provide high quality data and most of the CVM problems can be minimized to an acceptable level.

In relation to this, Whittington et al (1990), suggested that the questions should be designed in to an incentive comparable format such that lying is avoided to minimize the occurrence of CVM problems.

3.2 Empirical Literature Review

CVM technique (together with other methods) has extensive application in recent years in evaluating the benefits of water (i.e in valuing water quality &/or improvement), reduced air pollution, tourism, forestry projects, etc.... This review looks first the at applications of CVM on water & then some of those which have been done in other various areas.

3.2.1 CVM Studies on Improved Water Services

Singh et al (1993) used the CVM to assess the WTP for an improvement in the quality of water service in several rural villages in India. Respondents were allowed to consider hypothetical changes in water supply characteristics and to respond to questions about the effect on cost of connections, monthly service and improved quality of service. The results of this application suggested that the local water authority can lead the way to a better water service by making some critical policy changes; encouraging private water connections by incorporating the price of connection onto the monthly tariff, charging a higher monthly tariff and using the resulting increased revenues to invest in and maintain a higher quality of water service.

A World Bank Water Demand Research team (between 1987 & 1990) set out to investigate the determinants of household demand for improved water sources- including relevant socioeconomic and demographic characteristics of the household as well as the extension

of existing and new water supplies, such as distance, quality and reliability, in Latin America (Brazil and Haiti), Africa (Nigeria: Anambra State, and Zimbabwe), and South Asia (Pakistan and India). In three of the five studies, various sites in several regions of the country were investigated. Sites in Brazil included a relatively well off, water abundant area in the Southeastern state of Parana and poor dry area in the Northeastern state of Ceara. __

In Pakistan, three areas in Punjab were selected; one had easily accessible, high-quality ground water; another had easily accessible but brackish water; the third was in an arid zone where ground water was relatively deep and inaccessible. In India (Kerala), one area had abundant good quality ground water, one area had abundant, but saline ground water and one area suffered from water scarcity.

The researchers employed both revealed preference and direct (contingent valuation) methods to study how households made their choice about water resources. The indirect method used discrete choice econometric technique to derive household's decisions and estimate welfare change for the actual choices that households made. On the other hand the direct approach involved asking people who did have an improved water source whether they would use a new source if it were provided under specific conditions, and how much they would be willing to pay for access to different kinds of improved water system, such as public tap or private house connection.

The finding from the study indicates the following: (a) the income factor was not significant implying that, willingness to pay for improved water supply does not depend

solely on income. The argument is that, income is not often the principal determinant as the percentage of income that a household is WTP may vary widely, (b) the result confirmed the hypothesis that better educated households are more willing to pay for improved water supplies, (c) the gender factor was significant in influencing household's WTP for improved water services, but the direction of that influence depends on specific cultural context, (d) the effects of occupation, family size and composition of household on WTP was mixed , (e) that households will pay more for improved supply when costs in time and money of obtaining water from existing sources are higher than when such costs are low, and (f) that households are willing to pay much more if the water from an improved source is reliable.

The researchers concluded that, the household response to a new improved water system is not due to anyone set of determinants, but to their joint effect. It is this jointness that is modeled in the multivariate analysis. The multivariate analysis of water use in Uganda and Kenya, for example, illustrates how a family there, decides to purchase water from a kiosk rather than buy water delivered to its door by vendors, or draw water from a well (Whittington, et al. 1990).

Whittington, et al 1991 implemented two approaches to estimate WTP for domestic water supplies in Ontisha, Nigeria. They used Survey in water purchases to define the private distribution system and revealed demand for potable water. They also estimated households' water demand behavior using a CV survey on 235 households. 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.

Choe et al (1995) employed a CVM to examine household demand for surface water quality improvements in Davao City, Philippines. The paper examines the question of the magnitude of household demand for environmental quality improvement in the context of a specific proposal: the clean up of the river and sea near Davao City, Philippines. A total of 581 in-person interviews were completed with respondents throughout Davao City in which a referendum kind of question was asked about a City-wide plan for an improvement in water quality.

Statistical methods were used to examine how respondents' answers to the referendum questions were influenced by different randomly assigned monthly fees. They observed that, the support for the water quality improvement plan falls sharply as the monthly fee increases.

Multivariate techniques were also used to see how respondents' answers to the referendum questions were related to socioeconomic characteristics of the household and to estimate the mean willingness-to-pay of different types of households. The results show that household willingness-to-pay for water quality improvement is low, both in absolute terms and as a percentage of income. Not only was household willingness-to-pay for improved water quality low in Davao City, but 15 percent of the respondents refused to pay anything at all.

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

In Ethiopia's water situation, only few applications of the Contingent Valuation Method can be identified. Fisseha (1997) assessed consumers' WTP for piped water supply in Meki town using CVM. His study showed that more than half of the sampled households were unsatisfied with the existing services. And, almost twice the current average price was found to be affordable for improved water services. Another study by Assefa (1998) attempted to provide empirical evidence on the relationship between household WTP for improved water services and the factors determining their WTP in Addis Ababa city using both the indirect approach and the direct (Contingent Valuation (CV)) approach.

The survey data showed that the average WTP bids for private connection was 8.66 cents per *Baldi* (a 20 liter bucket) of improved water and 4.7 cents for public taps. He also underlined that it is possible to suggest the CV survey as a feasible method for estimating WTP for public utilities such as improved water services.

Dunffa (1998) has also applied the contingent valuation method to assess willing to pay of water.

3.2.2 CVM Studies on Other Resources

Contingent valuation has been applied in developed countries on a variety of domains such as on air pollution, outdoor recreation, improvement of national water quality and valuation

of community forests. Of course, now a days developing countries are also using the CV techniques.

Brookshire et al (1982) for instance used CVM to estimate household WTP for an improvement in the quality of air in USA, based on data collected from 290 households. The results suggested that, people were willing to pay for improved air quality, implying that the survey method is valid in measuring the value of “non-marketed good”

The method is also used by Spash & Hanley (1994). They conducted an open-ended CVM survey on WTP for diversity protection in Scotland in order to obtain funds from the donor to preserve biodiversity. The findings revealed that the respondents did not state positive WTP for preservation with an argument that plants and animals had a right to be protected irrespective of cost to society. This result was supported by Stevens (1991) in a CVM study measuring the benefits of wildlife protection in Scotland where by about 24% of his respondents protested the need for protection with an argument that it was a right that is not negotiable.

Coming to the case of Ethiopia only few studies have used the technique. A recent study by Alemu (1997) applied the CV to community forestry in Ethiopia. The results of this contingent valuation study of rural households showed that income, household size, distance of homestead to plantation, number of trees owned and sex of household head are important variables that explain willingness to pay for community woodlots. The study also found that discarding invalid responses leads to sample selection bias. And the results

of the study suggest that community aforestation projects should consider household and site specific factors as determinants of success.

Yitbarek Mengiste (1998) conducted a contingent valuation survey in solid waste collection in Addis Ababa City, Ethiopia. In short, the major contribution of the study is the general demonstration that demand information obtained relatively easily using the contingent valuation method can provide a useful input in planning improved provision of public services. He also suggested that in a country like Ethiopia, where institutional framework for citizen participation is not yet well developed, this type of survey provides a feasible mechanism to implement the objective of citizens' participation in public policy decisions.

3.3 Synopsis

The above literature review based on various Contingent Valuation studies assessed the theoretical & methodological issues of CV survey. Its applications on water and other resources are also discussed. These literature and other literature suggest that CVM has shown promise as a powerful tool to measuring the economic benefits of the provision of non-marketed goods such as improved water services. That is the WTP approach of the CVM seems to be more viable than the other indirect methods on estimating values for environmental goods.

Thus, the overall literature coupled with a few domestic applications of the CVM necessitated the use of CVM in this study.

There is a hope that this study is a contribution to the previous Ethiopian literature & CV applications on the issue and will help come up with concrete policy recommendations regarding improved water services.

CHAPTER FOUR

Survey design, empirical models and variables

In this chapter we included seven sections. The first five sections discuss the type of data used in the study & its sources, the sampling design, the questionnaire design, the procedure in the fieldwork and the scope of the study respectively. In the sixth section, we discuss the specification of the models that we used in our analysis and the last section describes the explanatory variables.

4.1. Data Source & Type

The type of data we used is mainly primary and cross-sectional for the year 1999 obtained from the contingent valuation survey, which we conducted for this study on the selected sample of households in Harar town. This primary data is collected through a face-to-face personal interview with the households by means of CV questionnaire (see the attached questionnaire). The study is also supplemented by other secondary data that we get from relevant studies. In addition, related documents & studies of the Ministry of Water & Resources are used as a source of data.

4.2. The Sampling Design

The study area, Harar town, consists of 19 Kebeles. All kebeles were included in our survey. We intended the survey to include households from each kebele and hence a stratified random sampling technique was used to draw samples from the entire

households in the town. This technique helped to ensure that all sectors of society were surveyed.

It is desirable to have a sample that is representative of the total households as much as possible but limitations, most importantly, in time and costs prohibited the sample size to a total of 270 households.³

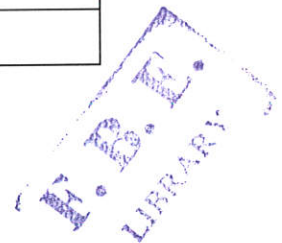
Based on the 1994 population & housing census of Ethiopia, we calculated the proportion of number of households in each kebele to the total number of households in the town. And after obtaining the list of households, we randomly selected the sample households from each kebele on the basis of the proportions.

Table 3: Summary of sample households from each kebele.

<i>Kebele</i>	<i>Total No. of households</i>	<i>Total No. of households (in %)</i>	<i>No. of households in the sample</i>
01	1,229	6.79	18
02	1,013	5.10	14
03	489	2.70	7
04	756	4.18	11
05	1,091	6.03	16
06	499	2.76	8
07	777	4.29	12
08	1,081	5.97	16
09	1,316	7.27	20
10	1,353	7.47	20

³ Flower, F.J (1993) argued that though it was desirable to have a sample size that is representative of the population as much as possible, survey methods, however, do not stipulate a prior percentage of figure that is adequate in any study.

11	646	3.57	10
12	1,475	8.15	22
13	554	3.06	8
14	795	4.39	12
15	810	4.48	12
16	945	5.22	14
17	1,588	8.77	24
18	978	5.40	15
19	707	3.91	11
Total	18,102	100	270



4.3. The Questionnaire Design

With a modification to adapt the study area, the preparation of our contingent valuation survey questionnaire generally followed the Mitchell & Carson techniques (Mitchell & Carson, 1989).

A contingent valuation survey questionnaire, as we have seen in the preceding chapter, involves three basic steps. The first basic step is designing and administering the survey, which includes preparation of a questionnaire. The CV survey questionnaire we used in this study was designed to include (see the attached questionnaire):

- characteristics of household members,
- existing water use practices & problems,
- iterative bidding game on household willingness to pay for improved water service in the town,
- housing characteristics & household income, &

- general questions, such as attitude of households about the responsibility of water supply.

These sections are meant to include a series of questions about the socio-economic & demographic characteristics of the household, hypothetical description of the circumstances under which improved water is made available & questions, which elicit the respondent's WTP for improved water service.

In the elicitation section we used the method of bidding game-where respondents are asked until they say "I am not willing to pay more than a specified price for a 'Baldi' (a 20 litter bucket) of improved water." And that specified price is recorded. Two types of households were involved in this section. One group is those households who already have access to private piped water connection and the other group consists of households who do not have access. The contents of the questionnaire for each of these groups are exactly the same, with the exception of a slight difference in the setting of the hypothetical description of improved water service.

For the group with access to private pipeline, the hypothetical circumstance is:

"Suppose you have an option to be provided with a good quality of water which is safe for health, as much as you want at any time of the day, throughout the year."

While the circumstance for the second group was:

“Suppose you have an option to be provided with a good quality of water which is safe for health, as much as you want at any time of the day, throughout the year. Assume also that you will have an option for private connection to this improved pipe water supply scheme. Notice also that you may not be required to cover the costs of private connection to the new scheme initially. Whatever amount you say, the administrative body will cover the costs connection initially and distribute (amortize) it in the monthly tariff rate.”

4.4. The field work procedure

To achieve the objectives of our study, the proposed research design undertook fieldwork in the study area- Harar town. The questionnaire has been pre-tested before implementation. The pilot-survey we made involved three experienced interviewers and the researcher himself. Twenty-one households from all the kebeles were included in the pre-testing. Each enumerator was given a minimum of three questionnaires per day. And discussions went through each questionnaire filled by the respondents. This actually helped the administration and implementation of the actual survey. It also helped in restructuring the questionnaire formats and also in adjusting some contexts.

One very important contribution of the pilot survey was to set the starting point of the bidding game in the elicitation part of the questionnaire. During the pilot survey, the willingness to pay elicitation part was open ended i.e. “How much are you willing to pay per Baldi to obtain improved water?”. Different answers were observed ranging

from 2.5 cents to 50 cents per Baldi, however the pilot survey reveals that 5 cents, 10 cents & 15 cents per Baldi were the most frequent prices with equal mode. And hence we used these prices as starting points of the WTP bidding game.

We then randomly divided the total sample households in to three groups of equal size (90 households each) and different starting points were assigned to households in different groups. Other questions in the questionnaire remained the same in all the groups.

After all these adjustments, the questionnaire was ready for actual survey. Then a total of 10 enumerators & 3 supervisors, most of which have good previous experience in household surveys, were selected based on their previous experience and were trained on the roles & responsibilities of enumerators and contents of the questionnaire.

Finally the data obtained from the survey was coded and made ready for analysis with a statistical package called SPSS (Statistical Package for Social Scientists)

4.5. Scope of the study

For the obvious reason that this study is primarily academic in nature and that a very limited time is available as well as some other constraints, this study is limited to only the town of Harar. Harar town is selected to be the study area because it is among the

towns in the country with a serious shortage of water both in terms of quantity, quality & reliability⁴

Although there are problems of limited time and other constraints, the need to minimize exposure to a sample bias limited the sample size to only 270 households in the town. Stratified sampling technique was used so that adequate representation of the various types of households is ensured. Moreover, the study is restricted to estimating the value of water only for domestic purposes for a cross section of households in Harar town.

4.6. Model specification

We need to construct a model that links the decision or outcome to a set of factors. In investigating the determinants of household's willingness to pay & demand for improved water services, two approaches are generally being practiced in the literature- **the indirect approach** and **the direct approach**.

4.6.1. The Indirect approach

The principal decision of interest to a water supply planner, in developing countries settings, is the proportion of households that will connect for a given level of services & given prices. In the indirect approach, it is assumed that households have a number of choices in deciding which type of water source to use.

⁴ According to reports from the town's hospital, there is a high incidence of water born diseases in the town with Amoebic dysentery & heliminiasis are being particularly prevalent. And also the study by Ernest & Young Reported that there is an excess demand of 2505.25 of water for domestic use only.

Thus what is needed, in this approach, is a model that describes the probability that a particular household will choose to use an improved water service or not.

First it is assumed, in the indirect approach, that a household chooses between two water source choices-improved water and alternative water sources- based on the utilities that the household can get from each of these alternatives. The first utility, u^a , represents the utility a particular household gains from using the improved water source and the second utility, u^b , represents gains from the alternative source.

The observed choice between the two alternatives reveals which one provides the greater utility, but not the unobservable utilities. Hence the observed indicator, say Y , equals 1 if $u^a > u^b$ and 0 if $u^a \leq u^b$.

That is

$$Y=1 \text{ if } u^a > u^b$$

$$Y=0 \text{ if } u^a \leq u^b$$

The household either connects to the improved system ($Y=1$) or not ($Y=0$).

These choices are influenced by both the household attributes and water source characteristics. A common formulation is the linear random utility model⁵,

$$u^a = \beta'_a X_h + \varepsilon_a \quad \& \quad u^b = \beta'_b X_h + \varepsilon_b$$

⁵The utility function for each household can be specified as

$$U_{ij} = \alpha_0 + \alpha_1 y_i + \alpha_2 T_j + \alpha_3 C_j + \alpha_4 Q_j + \alpha_5 Z_i + e_{ij} \quad i=1,2,\dots,n \quad \& \quad j=1,2$$

where: U_{ij} = the utility for each household, i , of a particular source, j ; y_i = household income; C_j = cost of obtaining water from source j ; Q_j = perceived quality of water from source j ; Z_i = a set of socio- economic variables associated with household i ; T_j = time required to fetch water from source j .

Where:

X_h = vector of explanatory variables – includes socio-economic & demographic characteristics of the household and water attributes.

β 's = parameters of the models and

ε 's = the error terms

Now if we denote the households' choice of alternative **a** by $Y=1$ and that of **b** by $Y=0$, then the probability that a household chooses the improved system is:

$$\begin{aligned}
 \text{Prob}(Y=1 | X_h) &= \text{Prob}(u^a > u^b) \\
 &= \text{Prob}(\beta'_a X_h + \varepsilon_a - \beta'_b X_h - \varepsilon_b > 0 | X_h) \\
 &= \text{Prob}[(\beta'_a - \beta'_b)X_h + (\varepsilon_a - \varepsilon_b) > 0 | X_h] \\
 &= \text{Prob}(\beta' X_h + \varepsilon > 0 | X_h) \\
 &= \text{Prob}(\varepsilon > -\beta' X_h | X_h)
 \end{aligned}$$

If the distribution is symmetric,

$$\begin{aligned}
 \text{Prob}(Y=1 | X_h) &= \text{Prob}(\varepsilon < \beta' X_h) \text{-----}(1) \\
 &= F(\beta' X_h)
 \end{aligned}$$

Where: $F(\bullet)$ is Cumulative Distribution Function (CDF). This provides an underlying structural model for the probability.

For the indirect approach, equation (1) provides the model to be estimated either using probit or logit models⁶. This actually depends on our prior assumption whether the error terms (ε_a & ε_b) have standard logistic or a normal distribution with mean zero & variance one. In these qualitative response models, respondent's response is equal to the indirect utility that the household receives from choosing to connect the improved service rather than continuing to use other alternative sources (Greene, W.HI,1993; Singh et al;1993; Briscoe et al., 1990).

However, the survey indicated that all the 270 households are interested in the provision of the improved water service and are willing to pay a positive amount. In fact the minimum price observed in the bidding game was 2.5 cents for a Baldi of the improved water (which is 2.5 times the existing tariff). This is not surprising as the people of Harar town are suffering from problems related to water quality, quantity & reliability.

Thus, since all the sample households prefer the improved water service, the indirect approach, using the probability model illustrated above, is not appropriate for our analysis. So to estimate the valuation function that relates the hypothesized determinants with the WTP responses, we use the direct approach.

⁶ It is indicated in the work of Folmer & Thijssen that it is difficult to justify the choice of one distribution or another on theoretical grounds. Amermiya (1981) also discuss related issues, and in most applications, it seems not to make much difference.

4.6.2. The Direct Approach

In line with Mitchell & Carson (1989), the theoretical validity of a *Contingent Valuation (CV)* study is obtained by estimating the WTP equation. For the direct approach we used two models to estimate a valuation function that relates the hypothesized determinants with the WTP responses: the **Ordered Probit Model** & the **Ordinary Least Square Regression Model**.

4.6.2.1. The ordered probit model

An extension of the binomial model that we saw in section 4.6.1. is the model called the ordered probit model which is being used in literature⁷. The ordered probit model is here used to estimate the relationship between, the willingness to pay responses with the set of hypothesized determinants.

The household's maximum willingness to pay for the proposed improved water service is hypothesized to be a function of households socio-economic characteristics and the attributes of the new and the existing water sources. Following the work of Whittington et al (1993), the prior expectation is that WTP is influenced by a vector of several factors such as family size, gender, level of education, age of the respondent, characteristics of the existing water source, etc.... Building the model in the same manner as the binomial probit model, we begin with the underlying response model as

⁷ The ordered probit model was first considered by Aitchison & Sivey (1957) and Ashford (1959). Gurland et al. (1960) also discussed the model. Mckelvey & Zavoina (1975) used the model to analyze the determinants of congressional voting on the 1965 medicare bill. Assefa Chaka (1998) also used this model for the same purpose that this paper is dealing with.

$$W_m = \alpha + \beta'X + \varepsilon \quad \text{-----} \quad (2)$$

$$\varepsilon \approx N[0,1]$$

Where: W_m = represents household's maximum WTP for the proposed improved water service,

X = represents a vector of explanatory variables,

α & β = represent parameters of the model and

ε = represents an error term which is assumed to have a random normal distribution.

In a bidding game, the true willingness to pay, W_m , is not observed. Instead we observe the WTP responses and we know within which range W_m falls such that:

$$Y=1 \text{ if } W_m \leq P_1,$$

$$=2 \text{ if } P_1 < W_m \leq P_2,$$

$$=3 \text{ if } P_2 < W_m \leq P_3$$

.

.

.

$$Y = J+1 \text{ if } P_J < W_m$$

Where: P_1, P_2, \dots, P_J represent the J prices which divide the range of WTP space into $J+1$ categories and Y is a categorical variable.

Thus, generally we observe

$$Y=i \text{ if } P_{i-1} < W_m \leq P_i \quad \text{where } i=1,2,3,\dots,J+1$$

$$\text{or } P_{i-1} < \alpha + \beta' X + \varepsilon \leq P_i$$

$$\text{or } P_{i-1} - \alpha - \beta' X < \varepsilon \leq P_i - \alpha - \beta' X$$

Therefore, the probability that the household's maximum willingness to pay falls in category i is given by

$$\begin{aligned} \text{prob}(Y=i) &= \text{prob}(P_{i-1} < W_m \leq P_i) \\ &= \text{prob}(P_{i-1} - \alpha - \beta' X < \varepsilon \leq P_i - \alpha - \beta' X) \end{aligned}$$

If we let $V_i = P_i - \alpha$, then

$$\text{prob}(Y=i) = \text{prob}(V_{i-1} - \beta' X < \varepsilon \leq V_i - \beta' X)$$

And assuming $\varepsilon \approx N[0,1]$, we have

$$\text{prob}(Y=i) = F(V_i - \beta' X) - F(V_{i-1} - \beta' X)$$

Where: $F(\cdot)$ is the cumulative standard normal distribution.

Estimates are obtained using the method of maximum likelihood by the econometric software LIMDEP (version 7.0). Entering the probabilities

$$\text{prob}[Y_i = k] = \text{prob}[Z_i \text{ is in the } k^{\text{th}} \text{ range}],$$

in to the log-likelihood function we have

$$\begin{aligned} \ln L &= \sum_h \ln L_h = \sum_h \ln \text{prob}(Y_h = i) \\ &= \sum_h \ln [F(v_i - \beta' X_h) - F(v_{i-1} - \beta' X_h)] \end{aligned}$$

Where: h represents each household and i is the appropriate WTP category into which a particular household falls.

Based on this theoretical framework, the ordered probit model is used to estimate the following equation:

$$\begin{aligned}
 p(\text{WTP} = i) = & \alpha_0 + \alpha_1 \text{SZFH} + \alpha_2 \text{INCH} + \alpha_3 \text{AGHH} + \alpha_4 \text{SXHH} \\
 & + \alpha_5 \text{EDUHH} + \alpha_6 \text{OCHH} + \alpha_7 \text{LSS} + \alpha_8 \text{SBID} + \\
 & \alpha_9 \text{MSPROB1} + \alpha_{10} \text{MSWH} + \varepsilon \text{-----} \quad (3)
 \end{aligned}$$

Where: $p(\text{WTP} = i)$ = the probability that the households WTP for improved water service falls with in a specified interval.

ε = the error term.

See the descriptions & specifications of the explanatory variables in section 4.7.

4.6.2.2. *The Ordinary Least Squares method (OLS)*

Alternatively, for the direct approach, the following economic model is regressed using the ordinary least squares (OLS) method :

$$\begin{aligned}
 \text{MWTP} = & \beta_0 + \beta_1 \text{SZFH} + \beta_2 \text{INCH} + \beta_3 \text{AGHH} + \beta_4 \text{SXHH} \\
 & + \beta_5 \text{EDUHH} + \beta_6 \text{OCHH} + \beta_7 \text{LSS} + \beta_8 \text{SBID} + \\
 & \beta_9 \text{MPROB1} + \beta_{10} \text{MSWH} + \varepsilon \text{-----} \quad (4)
 \end{aligned}$$

Where: MWTP = the mid point of WTP interval in bidding game with in which respondent's WTP bid falls.

The later model was used by Altaf et al (1992) in their study of the willingness to pay for water in Rural Punjab, Pakistan. They indicated that since a bidding game is used to obtain the WTP estimates, the observed dependent variable is not the maximum amount the household would be willing to pay, but rather an interval within which the “true” WTP falls. In such an ordinal dependent variable the correct approach is to use an ordered probit model. However, the use of the mid-points of the intervals as a dependent variable in an ordinary least squares model yields results which are consistent with those obtained from an ordered probit model, & the parameters are much easier to interpret (Whittington et al (1989)).

4.7. Description, specification and Rationale of the explanatory variables

The following table (table 4) presents the description, specification, rationale & expected direction of impact, on WTP, of the explanatory variables used in the Multivariate-analysis

Table-4: Description, Specification & Rationale of the explanatory variables

<i>Variable</i> <i>(expected sign)</i>	<i>Description</i> <i>& Specification</i>	<i>Rationale</i>
INCH (+)	<ul style="list-style-type: none"> ▪ Total household income per month (in Birr) 	<ul style="list-style-type: none"> ▪ Households with higher income have a greater ability to pay and have a greater preference for an improved water service. Besides the simple economic theory tells that income & quantity demanded are directly related, except in the case of inferior goods
SZFH (Both to be tested)	<ul style="list-style-type: none"> ▪ Size of the family in the household 	<ul style="list-style-type: none"> ▪ Two rationales are underlined: <ul style="list-style-type: none"> -As the household size is higher, there will be a higher need for water in the family and hence more preference for an improved water provision, thereby more WTP. -Wherever water is primarily fetched from out side the house, the available labor supply assumes critical significance. Households with lower family size (i.e with scarce labor) ought to be more srious of improved water and are willing to pay more.

<p>OSH (+)</p>	<ul style="list-style-type: none"> Ownership of house as proxy to household wealth <p>Dummy variable:</p> <p>1 if house is owned by the household</p> <p>0 otherwise</p>	<ul style="list-style-type: none"> The estimation of household wealth is difficult. However, ownership of house is used as proxy to the wealth of the household. The rationale for wealth is similar to that of income.
<p>EDUHH (+)</p>	<ul style="list-style-type: none"> Education level of the household head <p>Dummy variable:</p> <p>1 if ≥ 8 years of formal education</p> <p>0 otherwise</p>	<ul style="list-style-type: none"> Generally, the higher the education level of the head of the family, the higher the awareness about the benefits of health. Besides educated household heads put higher opportunity cost for time spent for collection water. And hence educated household heads have more preference for improved water service and are WTP more.
<p>SXHH (+)</p>	<ul style="list-style-type: none"> Sex of the household head <p>Dummy variable:</p> <p>1 if head is female</p> <p>0 otherwise</p>	<ul style="list-style-type: none"> In most developing countries, it is generally assumed that women are primarily responsible for the arduous task of fetching water. Hence women household heads are expected to show greater preference for improved water service and hence they are WTP more than men household heads.

<p>AGHH (-)</p>	<ul style="list-style-type: none"> Age of the household head 	<ul style="list-style-type: none"> It is generally believed that younger household heads would express a greater preference for modern conveniences. Moreover, older household heads may be reluctant to prefer and show more willingness to pay for improved water because they might have been using water that is free or has a lower price.
<p>OCHH (+)</p>	<ul style="list-style-type: none"> Main occupation of the household head <p>Dummy variable: 1 if formal sector 0 otherwise</p>	<ul style="list-style-type: none"> The effect of occupational status of the household head on WTP for improved water service is mixed. However, many literatures, for instance studies in Brazil and Addis Ababa, support that household heads employed in the formal sectors show higher WTP than their counter part.
<p>AHRWS (-)</p>	<ul style="list-style-type: none"> Attitude of the household about the responsibility of water supply <p>Dummy variable: 1 if government's responsibility 0 if otherwise</p>	<ul style="list-style-type: none"> Households who feel that it is the government's responsibility to provide them with an improved water service and that they are entitled to free or subsidized water are willing to pay less than similar households who have a less sanguine view of the government's abilities
<p>MSWH (+)</p>	<ul style="list-style-type: none"> Main source of water for the household for domestic purpose. <p>Dummy Variable: 1 if not private piped water</p>	<ul style="list-style-type: none"> Households with out access to private piped water are be expected to express preference for the improved service, since vended water is much more expensive than the authority's tariff, and hence they will be willing to pay more.

	0 if private piped water	
TIM (+)	<ul style="list-style-type: none"> Time(in minute) spent collecting water(per day) 	<ul style="list-style-type: none"> Basic consumer demand theory (& common sense) suggests that households would pay more for an improved supply when costs in terms of time of obtaining water from the existing sources are higher than if this cost were low.
PRICW (+)	<ul style="list-style-type: none"> Price (in cents) per baldi of water when buying form out side sources. 	<ul style="list-style-type: none"> The higher the price of vended water, the more the household shows preference for the improved service, there by willing to pay more.
LEVSAT (+)	<ul style="list-style-type: none"> Level of satisfaction of households with the existing water services <p>Dummy Variable: 1 if not satisfied, 0 if satisfied</p>	<ul style="list-style-type: none"> It is a simple commonsense that, households that are not satisfied with the existing service show greater preference for an improved service which may bear them with a higher level of satisfaction. Thus, they are willing to pay more than those who are already satisfied with the existing service.
MSPROB2 (+)	<ul style="list-style-type: none"> Quantity as the most serious problem of the existing water source. <p>Dummy Variable:</p>	<ul style="list-style-type: none"> Households will be willing to pay more for an improved source if they perceive that the most serious problem with the existing water source is less quantity.

	<p>1 less quantity is the most serious problem</p> <p>0 if otherwise</p>	
<p>MSPROB3 (+)</p>	<ul style="list-style-type: none"> Unreliability as the most serious problem of the existing water source <p>Dummy variable:</p> <p>1 if unreliability is the most serious problem</p> <p>0 if otherwise</p>	<ul style="list-style-type: none"> Reliability is crucial: households are typically willing to pay much more if the water from an improved source is reliable i.e. if they perceive that unreliability of the existing water source is the most serious problem.
<p>LSS (+)</p>	<ul style="list-style-type: none"> Location of study site: <p>0 If Kebele = 1, 2, 3,...,10</p> <p>1 If Kebele = 13, 14, 15, 16, 17.</p> <p>2 If Kebele =11, 12, 18, 19.</p>	<ul style="list-style-type: none"> The variable (LSS) = 0, 1 and 2 are assigned with Kebeles with less serious, Serious and more serious problems of water supply respectively. Households in Kebeles with more problem of water supply are willing to pay more for improved provision of Private water than those households in Kebeles with less problem of water supply.
<p>COMP (-)</p>	<ul style="list-style-type: none"> Composition of the family: <p>Number of adult women (≥ 12 years of age) in the family</p>	<ul style="list-style-type: none"> In most developing countries, women are primary responsible for collecting and using water for domestic water. Hence families with less women (i.e with less labor) are likely to show more WTP for improved water service.

<p>LINT (to be tested)</p>	<ul style="list-style-type: none"> • Length of interview in minutes
<p>SBID (to be tested)</p>	<ul style="list-style-type: none"> • Starting point of the bidding game <p>5 If bidding game starts with 5 cents per Baldi.</p> <p>10 If bidding game starts with 10 cents per Baldi.</p> <p>15 If bidding game starts with 15 cents per Baldi</p>
<p>DRES (to be tested)</p>	<ul style="list-style-type: none"> • Dummy for respondents <p>1 If respondent is household head</p> <p>0 Otherwise</p>

	• Dummy for interviewers
DZEL	1 If Zelalem 0 Otherwise
DHIW	1 If Hiwot 0 Otherwise
DDER	1 If Derege 0 Otherwise
DTED	1 If Tewodros 0 Otherwise
DTSE	1 If Tsehaye 0 Otherwise
DAMB	1 If Ambesse 0 Otherwise
DEMA	1 If Emawayesh 0 Otherwise

Note: In addition the variables WTP and MWTP represent:

WTP = Household maximum willingness to pay for improved water service (cents per Baldi)

MWTP = Mid point of interval in the bidding game with in which respondent's willingness to pay bid falls

Chapter 5

Empirical Results & Discussion

The information obtained from a contingent valuation survey can be analyzed in three ways: by looking at cross-tabulations between WTP responses and socio-economic characteristics of the households, by examining the frequency distribution of responses to the willingness to pay responses and by using multivariate statistical techniques to estimate a function that relates the respondents' answers to their socio-economic characteristics. These will help to determine whether respondents' answers are consistent with theory and commonsense (this increases one's confidence in the accuracy & reliability of the information gathered) and to establish statistical relationships or models that can be used to aggregate responses to the overall population under study.

Therefore, based on these three ways, we organized this chapter in three main sections. Section one summarizes the descriptive statistics of the survey result while the second section emphasizes on the analysis of the determinants of household's WTP for improved water service. Finally estimation of total WTP or consumers' surplus, revenue & demand for improved water service are done in the last section.

5.1. Descriptive Analysis

The questionnaire we used in this study includes five sections. Before getting in to the estimation process, it is necessary to summarize the results of the survey we obtained in each of these sections.

In this part we will briefly review the results of the survey with the help of descriptive statistics. The summary of the descriptive statistics for the variables used in the estimation are presented at the end of this section (Table-9).

5.1.1. Characteristics of household members

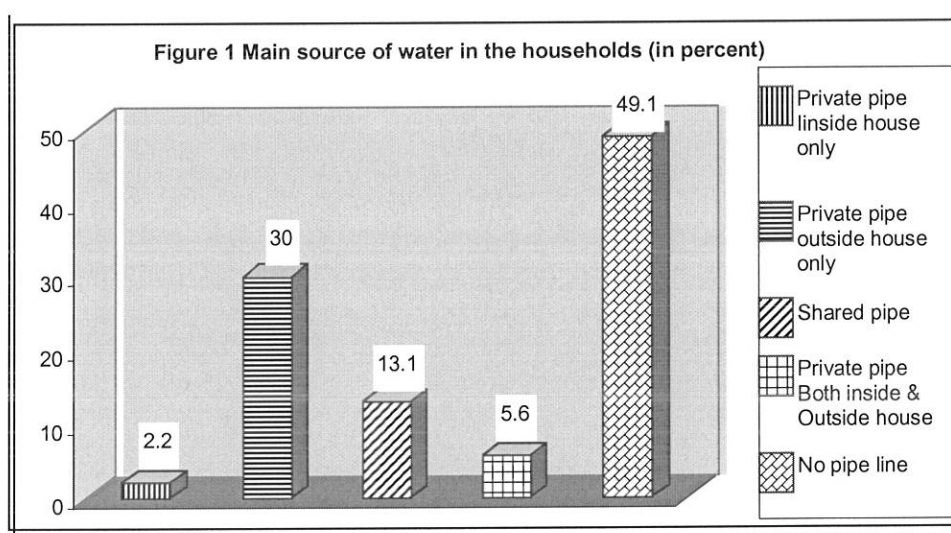
A total of 270 households were interviewed of which 156 (57.8%) are male headed. One hundred thirty-four (49.6%) of the respondents are the household heads themselves. The average family size is 4.82 ranging from 1 to 13. Data on age of the household head reveals that the age of the household head is 46.17 years, on average, which ranges from 20 to 120.

One hundred seventy-four (64.44%) of the household heads have completed at least 4 years of formal education. The result also shows that 189 (70%) of the respondents have completed 4 years of formal education. It was found in the survey that 60(22.2%) of the household heads are government employees, 32(11.9%) are pensioned, 85(31.5%) are running private trade business and 6(2.2%) are unemployed.

5.1.2. Characteristics of the existing water supply

This section is dealing mainly with the existing water use practices and problems. To begin with data on main source of water for domestic purpose indicates that for most of the households (about 87.6%), piped water is the main source of water. And the remaining 12.4% use either springs or wells as their main sources of water. Around 50% of the total households have no access to direct pipe line and are using either public tap or vended water or springs & wells. As to why these households prefer these water sources, 49.6% of them said access to the existing pipe system is difficult while 43.5% said cost of the existing pipe system is not affordable.

This shows that in addition to quality problems of the existing pipe water, half of the total households are incurring additional costs in terms of time and money. The following figure summarizes the percentage of households across their main sources of water for domestic purposes:



The shared tap users (13.1% of the total households) are sharing a single tap with 6.73 households on average. Another observation we made is that 73.42% of the piped water user households' heads have completed at least 4 years of formal education.

Consumption and expenditure

The mean household consumption of water is 4.737 Baldi (or a 20-liter bucket) per day. And the average household expenditure on piped water is around Birr 8.81 per month. As compared to the mean monthly income of households (i.e. Birr 650), households with access to direct pipe line connection spend only 1.38% of their income on water, well below the World Bank recommendation maximum of 5%, which suggests that households can spend more if they are provided with improved water service

Quality of Water

Concerning the quality of the piped water, the result of the survey indicates that more than 79% of piped water users ranked the water as in poor quality and only 5.9% ranked the quality as good. However, only 22.2% of these households are using purification method (such as boiling) to clean the water before drinking. The remaining 77.8% households do not use any purification method. Of these who do not use purification method, only few households (4.8%) believe that the water is clean for drinking but the majority (more than 70% of the households) do believe that the water is not clean for drinking, however, purification for them is costly & time taking. And the remaining 24% believe that the water is not clean but harmless to health.

The occurrence of water born diseases is not insignificant. In about 39.1% of the total households, as reported by the respondents, family members suffered from diseases caused by deficient water quality with amoebic dysentery being particularly prevalent. The reports from the towns' hospitals also share this result.

Quantity & reliability of water

According to the results of our survey, the people of Harar are suffering not only from the poor quality of water but also from its less quantity of supply & unreliability. The statistics indicates that almost all (97.8%) of the households with access to pipe water connection get water service once in 4 days, on average (ranging from 2 to 15 days). Moreover, for 45.5% of these households the supply of pipe water is unreliable while 30% of them usually get water during nighttime.

This makes households to incur an extra cost of buying vended water with a mean price of about 15 cents for a Jerican (20 liters) of water, while the authority's tariff is only 1 cents for a Jerican of water (i.e. 50 cents per Cu.m of water). These households also spend much of their time in fetching water, which could have been used for other purposes.

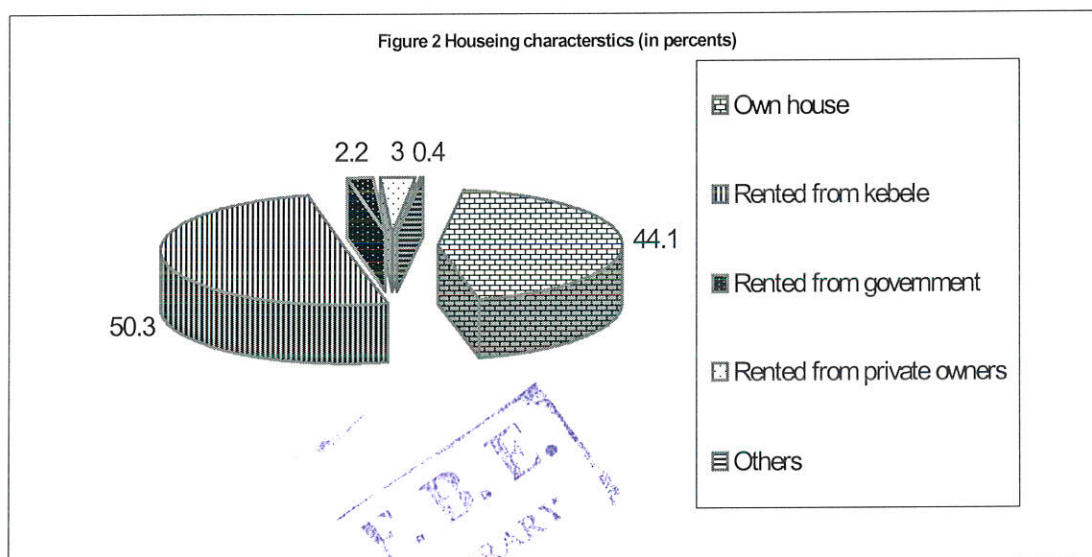
Level of Satisfaction of households with the existing water source

Almost all (90%) of the sample households are not satisfied with their existing water source. For 49.37% of which poor quality, for 15.19% less quantity and for 32.49% unreliability being their primary sources of dissatisfaction.

5.1.3. Housing Characteristics & Household Income

In this study we used house as one form of asset which can measure the wealth of the household.

Concerning the survey result on the house condition of households, the following graph shows the percentage of households in each category:



Average household monthly income is 650 with 58.2% of households having an income of under the average while 13.4% of households have an income of over 1000 Birr and 6.7% have an income of less than 200 Birr a month.

As a means to verify that household income figures are reasonably accurate, the survey was designed to capture household expenditure as well.

Table 6: Households' mean monthly expenditure on different purposes

<i>Purpose</i>	<i>Mean (in Birr)</i>
Electricity	22
Education	17.22
Food	294.83
Transportation	15.4
'chatt'	25.02
Telephone	8.93
Fuel	29.02
Water	8.81

source: survey data

5.1.4. General Attitudes

Of the more than 60% of households who do not have own private pipeline, 13.6% have applied to have access to private pipe line and it has been 26.933 months, on average, since they applied to get the access

Two hundred twenty-nine (84.8%) of the households in the total sample think that the government is mainly responsible for water supply. And almost all households (98.8 %) believe that the administrative body does not give a lot of attention to the problems related to the provision of piped water to households while 45.9% go to the extent of saying that no attention has been given at all.

5.1.5. Willingness to Pay

This study included an assessment on the extent to which households are willing to pay more for improved water services. One of the most revealing findings from this study is that all the households preferred the provision of the improved water service. And hence despite the range of values, all of them are willing to pay for the improved service. The following table (Table 7) summarizes the results obtained during our survey.

Table 7: Willingness to pay by accessibility to pipe line and starting point

<i>Accessibility to direct pipe line</i>	<i>% of the total households</i>	<i>Starting point of the bidding game</i>	<i>Mean WTP</i>			
With access to direct pipe line (either private or shared)	50.9	15.56	5	13.36	14.91	15.22
		17.78	10	13.46		
		17.56	15	17.90		
with out access to direct pipe line	49.1	17.41	5	13.16	15.52	
		15.56	10	16.06		
		16.13	15	17.35		

As we can see from the above table, households were biased by the starting point of the bidding game. The higher the starting point of the bid, the more their willingness to pay is.

Another observation we can make is those with out access to pipe line are willing to pay less than those with out access to pipe line. This might be because that the later households usually buy water from vendors at a price of 15 cents per baldi (which is at least 15 times the authority's tariff for pipe water) and hence show more preference to the improved service than the former households.

The result also shows that households are generally willing to pay more for improved water service. On average, households are willing to pay 15.22 cents (ranging from 2.5 to 50 cent) per 'baldi' (a 20liter bucket) of improved water. Compared to the authority's tariff (50 cents per cu.m or 1 cent for a 'Baldi' of water), households are willing to pay about 15 times more than the existing tariff if they are provided with an improved water service. There are a number of reasons why households are willing to pay such comparatively high prices for this essential commodity. Some of the reasons are:

- *Water supply in the town*

From simple economic theory, a supply/demand friction influences price.

The price push is most evident when water supply is substantially below the recommended minimum 25 lt./capita/day. This study reveals that more than

86% of the households with access to direct pipe line are not satisfied with the existing less supply of water⁸.

- *Value of Time*

People are willing to pay more for water if they see that they can spend their time more profitably doing other things rather than spending time collecting water from a distant water source. In Harar town, a household on average spends 66 minutes per day in fetching water from outside sources.

- *Better Quality of Water*

One of the questions in the household survey questionnaire was: “How would you rank the existing piped water quality?” Across the households interviewed, 79.4% ranked it as in poor quality while only 5.9% ranked as good.

- Besides *income* of the household, *education level*, *occupation status*, *size of the family*, *households’ attitude to wards the responsibility of water supply* and others are also reasons as to why or why not households are willing to pay for improved water service in the town.

⁸ Ernest & Young (1997) reported that there was an excess per day demand of 2505.25 cu.m of water for domestic purposes.

The following table divides the willingness to pay responses obtained in to seven ranges. And also it gives the means of some of the variables (used in the estimation) falling with in each of these ranges.

Table 8: Cross tabulation of the WTP with explanatory variables

<i>WTP(W)</i>	<i>MWTP</i>	<i>% of households</i>	<i>INCH*</i>	<i>AGHH</i>	<i>EDUHH</i>	<i>EDUR</i>	<i>SZFH</i>	<i>TIM</i>	<i>SBID</i>
0 ≤ W < 5	2.5	2.23	318	53.17	3.667	4	4.833	43.1	10
5 ≤ W < 10	7.5	9.67	523.2	50.54	5.808	5.808	5.269	58.41	8.27
10 ≤ W < 15	12.5	26.02	541.4	47.76	6.443	7.129	4.657	81	8.64
15 ≤ W < 20	17.5	29.37	551.9	46.80	6.50	6.31	4.71	53.54	10.48
20 ≤ W < 25	22.5	17.47	550.1	41.68	6.98	7.32	5.02	66.6	11.91
25 ≤ W < 30	27.5	13.75	633.3	40.62	7.68	8.22	4.51	71.62	10.41
30 ≤ W	35	1.49	799.8	42.62	6.87	8.75	4.5	29.17	13.75
		100							

*See the description of variables in section 4.7.

Note: The mid point of the last category is assumed to be 35 cents.

Cross-tabulation of the WTP responses with some of the socio-economic characteristics given in the table above (table-8) can be used to determine whether different groups of households in the same sample give different responses to the WTP valuation question. We now address the question of who (which group of households) is willing to pay the most (and the least) for improved water service.

Based on the information in the above table (Table-8), we can generally observe the following:

As mean income of the households in each group increases, so is the willingness of households to pay for the improved provision of water service. We also generally observe the same direct relationship between WTP bid & education level of the household head. The direction of relationship between WTP bid & age of the household head is negative. However, the cross tabulation doesn't show uniform relationships WTP bid & education level of the respondents, WTP bid & size of family in the household, between WTP bid & starting points of the bidding game, and WTP bids & time spent in fetching water from out side sources.

The above cross tabulation generally reveals the effects that we have hypothesized in section 4.7 based on demand theory and common sense. And this gives us not only greater confidence in the quality of data but also greater insights into the factors that may determine household's willingness to pay.

Table-9: Summary of descriptive statistics for the variables used in the final regressions

Variable	Mean	Std. Deviation	Minimum	Maximum
INCH	650	559	0	4000
AGHH	46.17	16	20	120
EDUHH	0.504	0.5	0	1
SZFH	4.82	2.37	1	13
SXHH	0.42	0.49	0	1
OCHH	0.68	0.47	0	1
LSS	0.7	0.81	0	2
SBID	10.05	4.09	5	15
MSWH	0.62	0.49	0	1
MSPROB1	0.43	0.5	0	1
WTP	15.22	7.83	2.50	50
MWTP	17.15	6.27	2.5	35

5.2 Determinants of WTP for an Improved Piped Water Services

Multivariate analysis can provide better information and greater insight into the factors that affect the willingness to pay responses of households for improved provision of private water service. In our analysis of the hypothetical choice behavior step-wise deletion of variables is used to identify explanatory variables that better influence the explained variable⁹.

The final results of the multivariate analysis are presented based on the Ordered Probit and the Ordinary Least Square regression models, the theoretical framework of which has already been illustrated in the preceding chapter. Such a presentation helps to examine whether or not the WTP bids are related to the explanatory variables systematically or not. The obtained results of

⁹ In order to see the direction of impact of the socio-economic characteristics variables: age of the household head, size of the family and occupation status of the household head are also included in the final regression. This helped our analysis in establishing the suitability of the CVM in estimating the WTP for improved water service.

the multivariate analysis of WTP for an improved piped water service based on the two models are presented in the Table below (Table-10).

For the estimates of the ordered probit model, the chi-square statistic of the Likelihood Ratio ($X^2=52$) shows the overall model as a good fit. And the F-value, 5.51, shows the overall model for the estimates of the OLS regression as a good fit. Also for the estimates of the WTP bids for improved piped water service in the OLS regression model, the adjusted R square (R^2) is 0.17. This illustrates that the regression explains 17% of the total variation in WTP bid which implies that the introduced explanatory variables in the estimated equations are not the only variables, which is certainly the case. A number of other factors can also explain the variations in WTP bid. We also observed that the explanatory variables are economically plausible in both the models.

In both models the household income variable has a positive sign and is highly significant. This confirms the general demand theory that income and quantity demanded are positively related except in the case of inferior goods. The results show that households with high income tend to have more willingness to pay for the proposed improved piped water service and are likely to connect the service. Assefa (1998) and the World Bank Water Demand Research Team (1993) obtained similar results. However, the very low coefficient of income suggests that household income, although important, is not the overriding determinant of WTP for improved pipe water service in the town.

As expected the sign of the coefficient of age of the household head is negative though not significant. This suggests that as age of the household head increases, they would prefer the existing water service system which involves less price. Older household heads may be reluctant to prefer and show more WTP for the improved water service, which involves higher costs than the current system.

Table-10: Estimation results based on OLS and Ordered Probit models

Independent Variable	Result of ordered probit model (Maximum Likelihood Estimates)		Results of ordinary least squares regression model		Mean Values
	Dependent variables: Probability that household's WTP bid for improved piped water service falls within a specified interval. Coefficient T-Ratio		Dependent variable: Mid point of intervals in bidding game with in which respondent's WTP bid for improved piped water service falls Coefficient T-Ratio		
INCH	6.06E-04	1.984* *	3.18E-03	1.721* *	517.1
AGHH	-0.0020936	-0.356	-0.013178	-0.553	45.75
EDUHH	0.42108	2.335* *	2.3111	2.964*	0.54
SZFH	-0.020785	-0.68079	-0.11108	-0.664	4.73
SXHH	0.3369	2.381* *	1.8531	2.472* *	0.46
OCHH	-0.0021933	-0.01519	-0.011634	-0.015	0.68
LSS	0.22761	2.481* *	1.2367	3.130***	0.71
SBID	6.26E-02	4.007***	0.34647	3.873***	10.02
MSWH	0.21761	2.481*	1.318	1.687*	0.62
MSPROB1	0.31626	2.246* *	1.6831	2.361**	0.43
Intercept	0.68407	1.498	8.6569	3.715***	
	No. of observations 269 Log likelihood -404.8813 Restricted log likelihood -430.7970 Chi-squared(Deg. of freedom=10) 52		No. of observations 269 Mean of dep. variable 17.15 Stand.dev. of the dep variable 6.27 F-value [10,258]=5.51 R-squared 0.20 Adjusted R2 0.17		

***significant at 1%, ** significant at 5%, * significant at 10 %.

Note: Results corrected for Heteroskedasticity

. Outliers are adjusted. Using the SPSS software, observations outside the Box Plot are substituted by mean values.

. The description and specification of the variables is given in Table-4

Our empirical results confirm that better educated households are willing to pay more for improved water service than would other households. The coefficient of education level of the household head is both positive and significant in both estimations. This is in line with our prior hypothesis that as level of education of the household head increases, there would be more awareness of the health benefits of improved water supplies in the household. And hence they would be more likely to use the improved service if they were available and show more WTP. The same result has been observed by the World Bank Water Demand Research Team (1993). Their studies in Punjab, Brazil and Kerala (India) confirmed that households that included educated household heads are likely to be willing to pay more for improved water service than were households in which the head of the household had no education. Also a study by Assefa(1998) supports this positive impact of education on the WTP of households' for improved water service in the Addis Ababa City.

The effect of household size on households' willingness to pay for improved service is mixed in many literatures. However, our result suggests a negative but insignificant coefficient for size of the family in the household. One possible explanation for this negative impact, although it is insignificant, might be availability of household's labor supply. Households in which labor is scarce may bid more than households with more labor available to fetch water. This suggests that private piped water supplies have attraction for households with few labor supplies, possibly because private pipes do obviate the need for fetching water from outside the house. Another explanation might be low per capita income among household members. Given the same income among households, members of households with more family size have low per capita income and hence households with large family size tend to show less WTP for an improved provision of water service.

In both estimations, tests for the effect of gender of the household head proved to be a statistically significant determinant at 5% level. The positive coefficient of the sex dummy variable suggests that male headed households are less willing to pay than female headed households. This result actually reflects the existing culture in Harar town that, as is also true in

most developing countries, women are primarily responsible for the arduous task of fetching water and hence likely to show greater WTP for improved water service. The same positive and significant effect of gender was observed by other studies in Tanzania, Haiti and Addis Ababa.

The coefficient of formal sector employment is negative and not significant in our data even at 90% level. However, the negative sign of this coefficient is at odds with the positive coefficient of similar studies in Addis Ababa, Brazil and India. This negative result needs to be associated with the particular job situation of Harar town. In Harar town, household heads that are not involved in the formal sector are mostly engaged in informal private businesses such as the trade of contraband goods from Somalia and Somaliland, and the Chat trade as every day truckloads of Chat are graded in Harar and dispatched to Jigiga, Deghhabur and Kebri Dehar as well as in to Somaliland via Hartechiek. These people earn more money than households employed in the formal sector. And hence households engaged in informal sector might show greater WTP for improved water supply than those engaged in formal sectors¹⁰.

The estimated coefficient of the location of study site variable (LSS) is not only positive but also highly significant. Recall how we introduced this variable: 0 if Kebele = 1, 2, ...,10; 1 if Kebele = 13,14,15,16,17 and 2 if Kebele = 11,12,18,19. This specification is based on our survey result on scarcity of water supply differences among Kebeles. The variable LSS = 0, 1 and 2 are assigned for Kebeles with less serious, serious and more serious problems of water service respectively. Our empirical result confirms that households in kebeles with more problems of water service are willing to pay more for improved provision of private water than those households in Kebeles with less problems of water service.

¹⁰ In a situation where households may not tell their true income, we may expect the income effect to be reflected in other variables, such as in our case, occupation status .

Our analysis also included a test for the presence of a starting point bias. Such a bias will be manifested if there are systematic differences between the willingness to pay bids of households who were randomly assigned a high or a low starting point. To test for the presence of such a bias we used a starting point variable SBID (see the specification in section 4.7). The coefficient of this variable is positive and highly significant. This suggests that the starting points of the bidding game seem to have determined the households' willingness to pay. Specifically a household who is initially asked to pay a higher bid is likely to show higher willingness to pay for the improved piped water supply than if it were initially asked to pay a lower bid. It is possible that the households consider the bidding games to be an attempt by the administrative body to decide an implementation of improved water supply project. In this case most of the people of Harar; suffering from problems of quality, quantity and reliability of water supply; would be willing to pay at least the amount they are asked to pay in order to influence the implementation decision of the administrative body. Such a bias is also observed by Bateman & Turner(1963). They noticed that the choice of a low (high) starting point leads to a low (high) mean WTP. The important thing in such a bias is to reduce the costs of being misled by poor quality estimates by finding out whether or not a particular bias exists.

This upward starting point bias would suggest that the mean bid received for the improved private piped water system is an overestimate. However, an important observation is that even with this possible upward bias, the mean WTP bid is not above the average price set by private vendors.

As expected, the significant (at 10%) positive coefficient of the main source of water for the household variable (MSWH) suggests that households with out access to the existing private piped water show greater WTP than their counterparts. This could be because households with out access to piped water oftenly use vended water, which is by far expensive than the authority's tariff.

We also found a positive and at 5% significant coefficient for quality as most serious problem of the existing water source variable (MSPROB1). Our empirical results support the expectation that a household would be more willing to pay for an improved source when perceived quality of the existing or an alternative water resources is poor. The World Bank Water Demand Research Team (1993) observed the same positive effect in its studies in Karala, Haiti and Kenya.

Another important finding of our analysis is that the interviewer dummy variables are not significant at all. Which suggests that interviewer difference does not affect the household's WTP bids in our survey.

The overall findings of the results of the ordinary least square and ordered probit models suggest that:

- except some differences in the level of significance of the coefficients of the explanatory variables, all the explanatory variables have the same sign and more or less the same level of significance in both models. This suggests that the WTP bids are related to the explanatory variables systematically;
- the socio-economic & demographic characteristics and attitude of households on the existing water service are generally determinants of households' WTP for improved water services with the expected signs. However, except education level and sex, none of the variables reflecting household characteristics is significant perhaps indicating the fact that improved piped water is not considered discretionary or luxury good but a basic necessity in the town

- the direction of impacts, on WTP bid, of the explanatory variables used in our analysis are consistent with the theoretical expectations. This implies the suitability of the contingent evaluation method (CVM) in estimating the WTP for water services.

5.3. Estimation of Total WTP, Revenue & Demand

The information obtained from respondents' answers to the willingness to pay questions can be better used if it is expressed using frequency distribution. Answers to bidding game elicitation questions place each households' WTP in an interval defined by the last accepted value & the last rejected value. The following table (Table-11) shows the distribution of households' WTP bids for improved private piped water connection obtained from our CV survey.

Table 11: Frequency Distribution of Households' WTP bids (for improved piped water service- private connection)

<i>Interval for WTP(W) bids (cents per 'Baldi')*</i>	<i>S a m p l e</i>	
	<i>No. of Households</i>	<i>% of Households</i>
$0 \leq W < 5$	6	2.23
$5 \leq W < 10$	26	9.67
$10 \leq W < 15$	70	26.02
$15 \leq W < 20$	79	29.37
$20 \leq W < 25$	47	17.47
$25 \leq W < 30$	37	13.75
$30 \leq W$	4	1.49
Total	269	100

*A 'Baldi' refers to a 20 liters bucket

The information in the above frequency distribution can be used in different ways. It can be used to predict the distribution of WTP responses in the total population and also to predict the WTP of households for the improved water service at a specific price. For instance, based on the frequency distribution, the survey reveals that 29.37% of the households are willing to pay between 15 and 20 cents per Balidi of the improved water. We also observed that more than 88% of the households are WTP at least 10 cents per Balidi which is more than 10 times the existing authority's tariff and only 2.23% are not willing to pay at least 5 cents per Balidi.

The frequency distribution of WTP bids can further be used in water project analysis and also to derive demand schedule for improved water services. It can be used in project analysis in two ways: to estimate the total WTP for improved water service & to estimate revenue that can be obtained from providing the improved water service.

5.3.1. Estimation of Total Willingness to pay (WTP)

Total willingness to pay is the total economic benefit of a project of providing improved water service. The total willingness to pay can be calculated by using the general formula:

$$TWTP = \sum_{j=1}^m MWTP_j \left(\frac{n_j}{N} \right) \cdot (\text{total number of households})$$

Where:

TWTP = Total willingness to pay

MWTP_j = Mean willingness to pay of interval j, where j is 1 through m. (m is

the last range of WTP bid, in our case $m=7$)

n_j = number of households willing to pay $MWTP_j$

N = total number of households included in the study, in our case $N=269$

More particularly, the total WTP of the community for improved water connection can be calculated by using the following two steps:

- to get the estimated number of households in each WTP interval, we multiply the % of households in each interval by the total number households in the town (see column 2 of table-12 below)
- assuming the mid-point of each WTP interval as the mean WTP (see column 3 below) we multiply the number of households by this $MWTP$ to estimate total willingness to pay (see column 4 below)

Table 12: Total willingness to pay for improved water service(private connection)

<i>% of households (from table-11)</i>	<i>Total No. of households in Harar Town</i>	<i>WTP mid point (price in cents per 'Baldi')</i>	<i>TWTP for improved water connection (cents per 'Baldi')</i>
2.23	404	2.5	1010
9.67	1750	7.5	13125
26.02	4710	12.5	58875
29.37	5317	17.5	93047.5
17.47	3162	22.5	71145
13.75	2489	27.5	68447.5
1.49	270	35*	9450
Total	100	18,102	315100

*mid-point of last category is assumed to be 35 cents

Table-12 shows the total WTP, if each household consumes only one baldi of water, of the community of Harar town when a project of providing improved water service is implemented. We see that the total WTP(i.e 315,100) in the above table, expresses the amount in cents if each household is consuming only one ‘Baldi’ of the improved water. However, as we saw in section 5.1., the per household daily consumption of water is 4.737 ‘Baldi’ on average. Hence the total willingness to pay or the economic benefit of the project is estimated to be Birr 14,926.29¹¹ per day or Birr 447,788.70 per month.

5.3.2. Estimation of Total Revenue

The information on the frequency distribution can also be used to roughly estimate the expected revenue that can be obtained from providing an improved water service to households at a specified price.

To estimate the revenue expected from the provision of the improved water service, we need to predict first the total number of households that would be willing to pay for the improved service at each specified price (see column 3 of the following table) and then multiply this by the price (see column 5 of the following table)

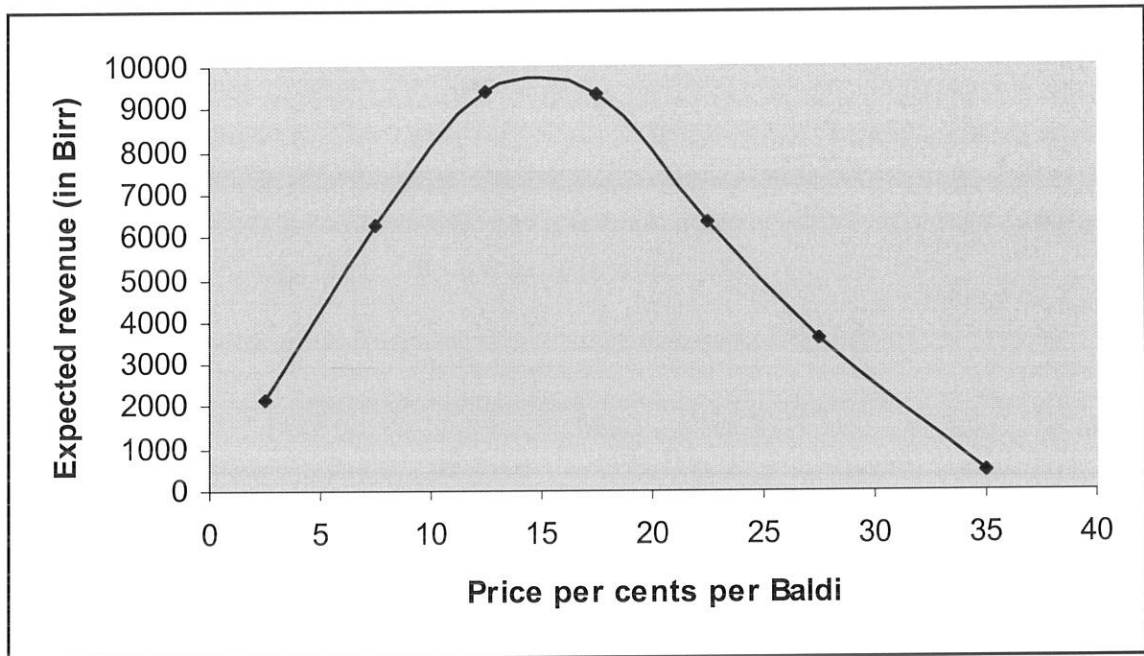
¹¹ $\frac{315100 \times 4.737}{100} = 14926.29$

Table-13: Calculation of expected revenue:

<i>% of households</i>	<i>% of households using the improved water service</i>	<i>Households using the service at different prices</i>	<i>WTP mid points (price in cents per Baldi)</i>	<i>Expected revenue (in cents)</i>
2.23	100	18,102	2.5	45,255
9.67	97.77	17,698	7.5	132,735
26.02	88.1	15,948	12.5	199,350
29.37	62.08	11,238	17.5	196,665
17.47	32.71	5,921	22.5	133,222.5
13.75	15.24	2,759	27.5	75,872.5
1.49	1.49	270	35	9,450

The above table shows the expected revenue at a specific price , for example, if 2.5 cents per Baldi (or 5 cents per two Baldi) is charged for the improved water service, the service giving authority can expect almost all the households to subscribe to the service and revenue of 45,255 cents or Birr 452.55 if each household is consuming only one ‘Baldi’ of water (i.e a revenue of Birr 2,143.73 per day. Figure-3 shows the trend of revenue, at different prices, that can be collected by the service giving authority.

Figure 3: Revenue(per day) collected at different prices



One important finding of this estimation is (as seen in the table above) that the maximum expected revenue, when households are provided with improved water service, is attained at a price of 12.5 cents per ‘Baldi’.

Taking the survey result that the mean per household per day consumption of water is 4.737 ‘Baldi’ in to consideration, the maximum revenue that the authority can collect from providing improved water service is Birr 9443.21 per day¹² or Birr 283,296.29 per month. And this maximum revenue is obtained if the price per Baldi of the improved water is set at 12.5 cents per baldi or Birr 6.25 per cu.m, in which case 15,948 (around

¹² $\frac{199350 \times 4.737}{100} = 9443.2095$

90% of the total households) households are expected to subscribe to the improved service.

The WTP mid points (column 3 of table 12) can be used to estimate the mean WTP of the entire households in the town. This can be obtained by taking the mean of WTP mid points weighted at their corresponding number of households. That is:

$$MWTP = \frac{\sum_j MWTP_j \cdot n_j}{N}$$

Where:

MWTP = Mean WTP for the entire household in the town

MWTP_j = Mean willingness to pay of interval j (column 3 of Table-12)

n_j = number of households willing to pay MWTP_j (column 2 of Table-12)

N = total number of households in the town (i.e N=18102)

Therefore, the MWTP of households is 17.41 cents per baldi of the improved water. And the expected revenue, if each household consumes only one baldi of water, at this mean price is about 196,665 cents. That is Birr 9,316.02 per day. Compared to the optimal price (i.e 12.5 cents), this mean price is high and only 62.08% of the households are expected to subscribe to the new service. That is the mean price will generate less than the maximum revenue. Moreover, a benevolent authority should not set a price as high as this mean WTP.

Cost- Benefit Analysis

The survey result reveals that all the households included in the sample prefer if they are provided with improved water service both in terms of quality, quantity & reliability. It also shows that households are ready to pay, on average, more than 15 times the existing authority's water tariff. These encourage the administrative body to undertake projects which are meant to improve the existing water service in the town. Of course one such projects is being implemented at Asselisso, 25 k.m. from Dire-Dawa (see chapter 2).

An important question is how can such projects achieve their goal sustainably? Experience in many developing countries tells that the development of sustainable, affordable & effective water system should promote the active involvement of the local community in paying for operation, maintenance, replacement and even extension costs for improved supplies.

According to the available 1998 data in the town supply office, approximately it costs Birr 1.94 to produce 1 cu.m of water which is sold for only Birr 0.50. Implying a 1.44 Birr loss for every cu.m. of water in the town. This might be the basic reason as to why the existing water service is in poor condition. That is, if the authority were profiting, it would have had more to pay for operation, maintenance, replacement & even extension costs for improved supplies. In order the provision of improved water service is sustainable, the "users should pay" to cover at least the cost of production. One way of participating the local community in projects meant to improve the water service is to

establish a “Social tariff” that covers at least basic services to be borne by the poorest communities to cover operation and maintenance costs. In this regard our survey indicated that around 90% of households are willing to pay 12.5 cents per ‘Baldi’ (or Birr 6.25 per cum.) if they are provided with a better quality water with reliable supply.

The revenue estimation that we made in table-13 is very important, because it allows the administrative body not only to determine how many connections it can afford to provide but also to undertake cost-benefit analysis of a project meant to improve the water service in Harar town.

Based on our survey result (table-13) and the data made available in the town supply office, we can undertake a simple cost-benefit exercise. If such a project provides the people in the town with a better quality & reliable water and & increases the per cubic meter price to, for example, Birr 6.25 instead of continuing supplying poor quality & unreliable water (according to the available data) with a highly subsidized rate of Birr 0.50 per cu.m, 90% of households will subscribe to the service. And the expected profit at this price will roughly be :

$$\begin{aligned}\text{Revenue} &= (\text{Quantity expected to be sold}) \times (\text{unit price}) \\ &= (15,948 \times 4.737) \text{ Baldi} \times (12.5 \text{ cents per Baldi}) \text{ per day} \\ &= 944320.95 \text{ cents per day} \\ &= 9443.21 \text{ Birr per day}\end{aligned}$$

Production Cost:

Based on the available 1998 data in the town supply office, the costs of production of 1 cu.m. of water is Birr 1.94 or 3.88 cents for a 'Baldi' of water. On the basis of this data and assuming the per cu.m production cost does not depend on quantity, the production cost of 15,948 baldi of the improved water will be:

$$\begin{aligned}\text{Production cost} &= (\text{Quantity of improved water}) \times (\text{unit cost of production}) \\ &= (15,948 \times 4.737) \times (3.88 \text{ cents}) \text{ per day} \\ &= 293117.22 \text{ cents per day} \\ &= 2931.17 \text{ Birr per day}\end{aligned}$$

At these rough estimates of revenue and cost, the profit per day will be Birr 6512.04 (i.e 9443.21 Birr – 2931.17 Birr). Or simply, a profit of Birr 4.31 (6.25-1.94) can be obtained per each cubic meter of improved water sold.

We want to infasize that the above cost benefit analysis is only a rough estimate and is likely overestimate the revenue. The profit that can be obtained from the project may not be as high as the calculated amount because of:

- * the upward starting point bias &
- * the production cost of the improved water is expected to be higher than the 1998 available data.

A better estimation of the current total production cost (including capital, operation, maintenance and extension costs) of the improved water service should be done in order to make a more reliable cost benefit analysis.

However, the overall results suggest that a positive profit can be obtained if such a project is implemented. Even, if we assume the cost of production of the improved water will increase by 100% (i.e. increased to 7.76 cents per baldi), a benevolent service giving authority can set the price as low as 7.76 cents per baldi (break even point) without getting in to loss. At this price, our survey indicates that the majority of the households (about 97.77%) will subscribe to the new improved service.

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The point is that the implementation of the improved water service project not only satisfies the needs of most of the households in providing with the improved water service, but also yields a positive profit to the service giving authority.

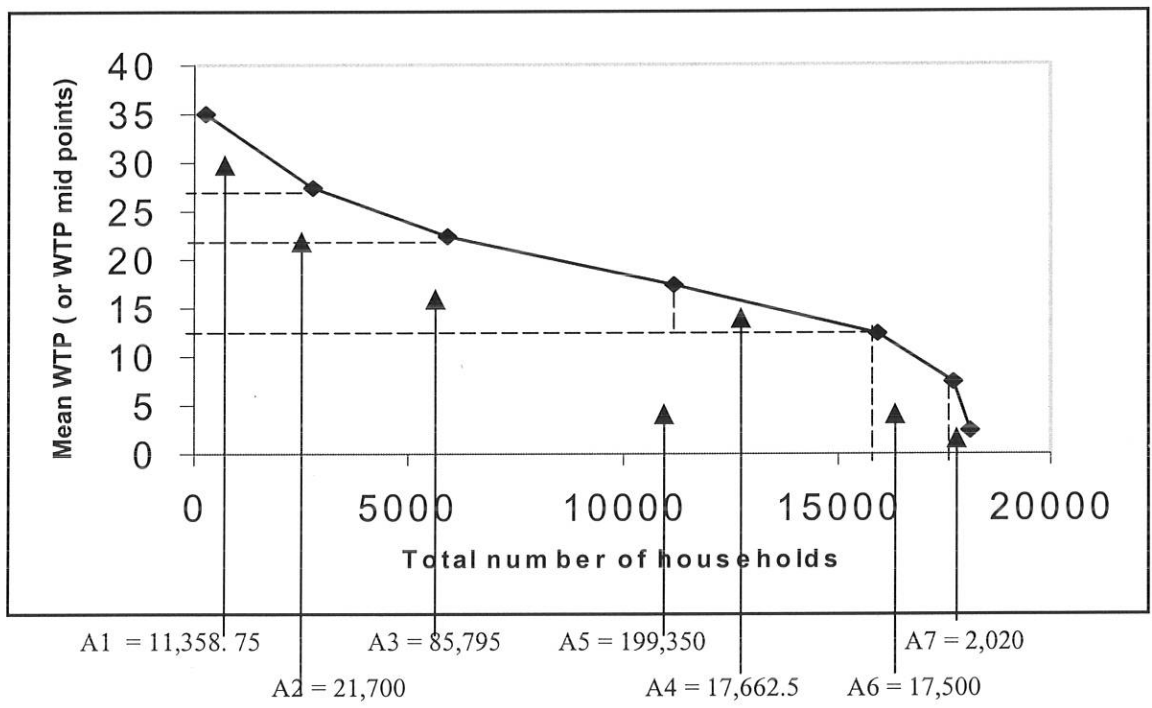
5.3.3. Estimation of Aggregate demand & Consumers' surplus for Improved water services

Demand schedules and consumers' surplus obtained from our survey are basic information for policy makers. The information helps them to make sound water tariff decisions and investment. The information on the frequency distribution of WTP bids is also a useful information in estimating the demand for improved water services in terms of tariff versus number of households.

The demand curve for the proposed improved water services is derived in terms of the total number of households (in the horizontal axis) and their associated maximum WTP

bids (in the vertical axis). The following figure shows the aggregate demand curve for the improved piped water connection using the actual observations in the study.

Figure 4 : Aggregate demand for improved water service



Any point on the curve shows all the households that prefer the improved water service but do not bid more than the corresponding value on the WTP axis. The area under the demand curve represents the gross value of consumers' surplus (i.e. at zero price). Simple area formulas for triangle & rectangle are used to find the area under the demand curve and obtained results are shown above (see the Ai's). The sum of all the areas under the demand curve is 355,386.25. Hence, the gross consumer surplus is

estimated to be 355,386.25 cents if each household is consuming only one baldi of the improved water i.e Birr 16,834.65 per day¹³ or Birr 505,039.40 per month.

Effect of tariff charge on consumers' surplus and revenue:

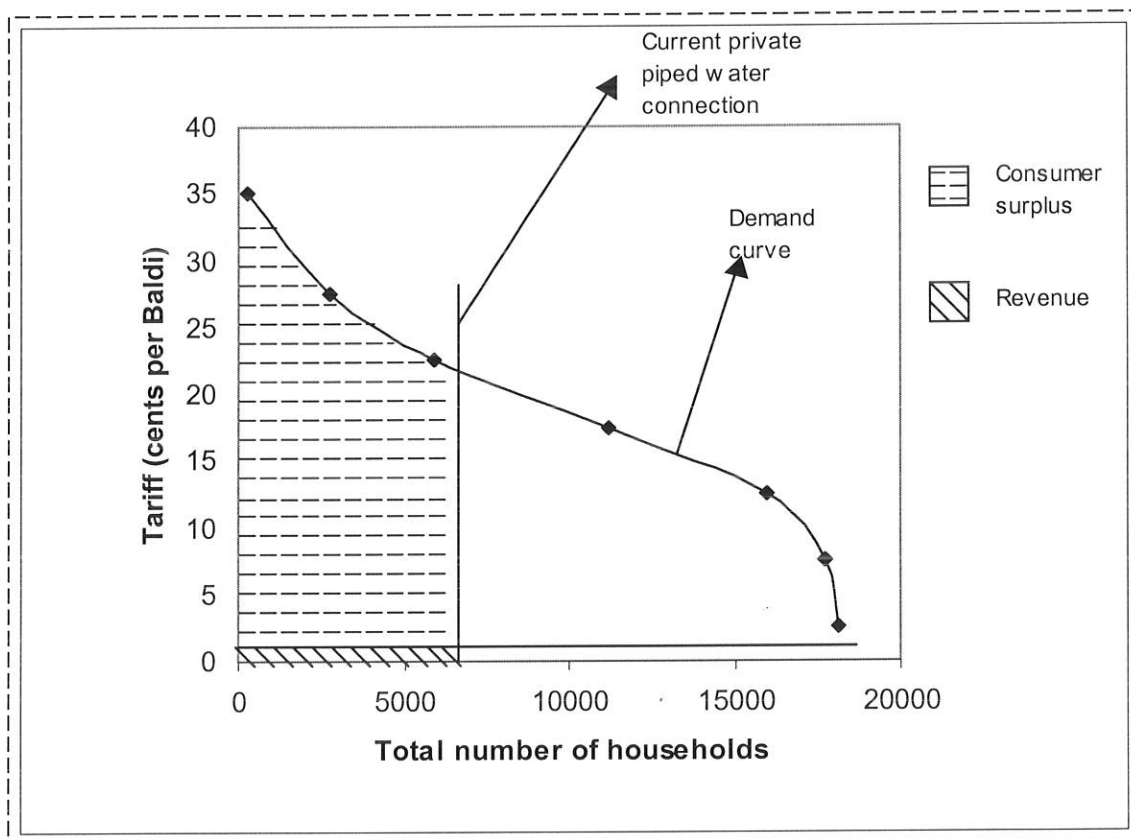
Consumers' surplus is the excess in monetary value of household's WTP for an improved water service over & above the total expenditures that would be made at a fixed price. Change in consumers' surplus associated with changes in tariff of improved water is the primary basis for measuring economic benefits.

The consumers' surplus calculated above is the gross consumers' surplus captured by the households if the improved water service were provided freely. However, the total benefit of the provision of the improved water service will be reallocated between the consumers and the service giver authority when the improved water is provided with fees. The following figures use the estimated demand curve of the proposed improved private connection to estimate consumer surplus and revenue at different tariff rates.

¹³ To get consumer surplus per day we used the survey result that the mean per household per day consumption of

Figure 5: Current revenue and consumers' surplus

The number of the current private piped water connections for the existing water, based on our

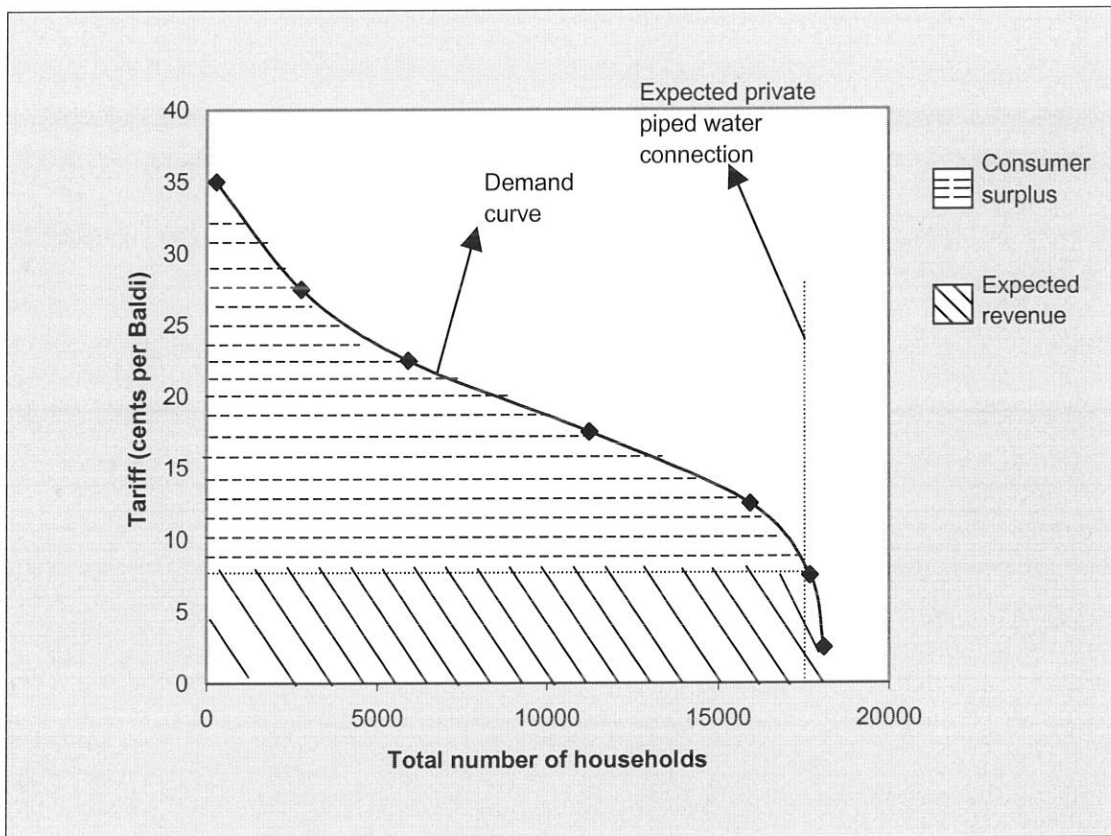


survey, is constrained at about 6843(37.8%) households only. And the existing authority's tariff rate is 1 cents per baldi (i.e Birr 0.50 per cu.m). Hence, the above figure shows the possible revenue and consumer surplus obtained if the service giving authority improves the water service and leave the existing tariff rate & the number of connections unchanged.

But the current tariff rate, as we have seen, is not sustainable. However, if the tariff rate for the improved water is set at 7.5 cents per baldi(or Birr 3.75 per cu.m) which is well below the mean WTP with supply left unrestricted , our research suggests that the number of households subscribing to the proposed improved private piped water service increases to 17,698(see the figure below).

water is 4.737 Baldi. Hence, gross consumer surplus will be $(355,386.25 \times 4.737) \div 100 = 16,834.65$.

Figure 6: Expected revenue and consumers' surplus



This shows that there will be a rise in the expected revenue and a large increase in the Consumers' surplus as well- a potential for implementing improved water project. We also note that the increase in the consumers' surplus as a result of the large increase in the number of private connections offset by far the loss in consumer surplus of the already connected households.

The results we obtained in this chapter helps not only to determine the appropriateness of the existing government policy in relation to water supply but also to draw appropriate policy recommendation.

Chapter 6

Conclusion and Policy Implications

6.1 Conclusion

Improving the quality and adequacy of water supply is a priority for urban development in countries like Ethiopia.

Policy and planning on development of sustainable, affordable and effective improved water supply service system should be established on a better understanding of what improvement in the water service people need and are willing to pay for . That is the implementation of allocation decision should focus on demand management as opposed to the traditional focus on supply side pricing mechanisms and regulatory measures that have received much less attention. Hence, this study intended to investigate the determinants of households' willingness to pay and the demand for improved water services (including relevant socioeconomic and demographic characteristics of the household as well as characteristics of existing and new water supplies) in Harar town using the Contingent Valuation Method (CVM). An observation that Harar is among the towns in the country with a serious shortage of water both interms of quantity, quality & reliability motivated the study area to be at Harar town.

The type of data used in this study is mainly primary and cross sectional obtained from the contingent valuation survey we made on 270 households of Harar town for the year 1999. To ensure that all sectors of society are surveyed, we used stratified random sampling technique. With a modification to adapt the study area, the preparation of our CV survey questionnaire generally followed the Mitchele and Carson techniques

(Mitchele and Carson, 1989). And this includes a series of questions about the socio-economic and demographic characteristics of the household, hypothetical description of the circumstances under which the improved water is made available and questions which elicit the household's willingness to pay (WTP) for improved water service using the bidding game method.

The information obtained from the CV survey was analyzed in two ways: by using descriptive statistics and multivariate statistical techniques. In the multivariate statistical techniques two approaches are generally being practiced in literature: the indirect and direct approaches. However, because of the nature of the survey result we found that the indirect approach, which uses the binomial probability model, is not appropriate for our analysis. Hence we used the direct approach to estimate the valuation function that relates the hypothesized determinants with the WTP responses. The ordered probit and the ordinary least squares regression models are used for the analysis. Tests for the potential starting point bias and interviewer bias are also conducted.

The survey data reveals that households of Harar are not only suffering from the poor quality of water but also from its less quantity supply and unreliability. Seventy-nine percent of piped water users ranked the piped water as in poor quality and about 40% of the total households reported that members of their family have suffered from water born diseases with amoebic dysentery being particular prevalent. The reports from the town's hospitals supplements this result. Our survey also indicates that almost all (97.8%) of households with access to direct piped water get water service once in 4 days, on average.

As compared to the mean monthly income of households (i.e. Birr 650), direct piped water accessed households spend only 1.38% of their income on water per month, well below the World Bank recommendation maximum of 5%. This implies that households can spend more if they are provided with an improved water service.

One of the most revealing findings from this study is that all the households preferred the provision of the improved piped water service and the majority of households are willing to pay more than the existing tariff rate for improved water. On average, households are willing to pay about 15 cents per a 'Baldi' (a 20 liter bucket) of water which is about 15 times more than the existing authority's tariff (i.e. 50 cents per CUM or 1 cent for a 'Baldi' of water) for piped water. Another observation was households with out access to direct piped water generally show more WTP than households with access.

The information on the frequency distribution of the survey result on the WTP bids is used to estimate the total economic benefit and possible revenues that can be collected if a project is implemented to provide improved water service to the people of Harar.

The estimated total WTP or the economic benefit of the project is Birr 447, 788.70 per month. And the maximum revenue is estimated to be Birr 283,296.29 per month. And it is attained at a price of 12.5 cents per Baldi (or Birr 6.25 per cu.m). In which case 15,948 (around 90% of the total households) households are expected to subscribe to the improved service. Based on the data made available in the town supply office and our study result, we also undertook a rough cost-benefit exercise of such a water supply project. The cost-benefit exercise reveals that at the optimal price, a profit of Birr 4.31 per cu.m can be collected by the service giving authority from implementing such a

project. Moreover, a price less than the breakeven point may lead to a loss and hence unsustainability.

The frequency distribution of the WTP bids is also a useful information in estimating the demand for improved piped water service. The information from the estimated demand schedule helps policy makers to make sound water tariff decisions and investment. The gross consumer surplus is estimated to be Birr 505,039.40 per month. It is also observed that raising the current tariff with unlimited supply of the improved direct piped water could lead to more connections, higher surplus and revenue for the service giving authority than the existing situation.

Multivariate regressions based on the ordinary least squares and the ordered probit models are used to analyse the determinants of WTP for improved piped water service. This actually provided us with a better information and greater insight into the factors that affect the WTP responses. Step -wise deletion of variables is used in our analysis to identify explanatory variables that better influence the explained variable. And only the variables: household income, age, education level, size of the family, sex, occupation, location of study site, starting point of the bidding game, main source of water and most serious problem of the existing water service are included in the final estimations. The overall findings of the results of the two models suggest that:

- All the explanatory variables have the same sign and more or less the same level of significance in the two models , suggesting the WTP bids are related to the explanatory variables systematically,
- The signs of the coefficients of the explanatory variables generally are in the expected directions. However, except education level and

sex of the household head none of the household characteristics variables is significant, perhaps indicating the fact that improved piped water is not considered a discretionary or luxury good but a basic necessity in the town,

- The positive and high significance of the starting point of the bidding game variable indicated the presence of upward starting point bias in the WTP responses, suggesting the mean WTP bid received for an improved private piped water service might be an over estimate. And also our result suggests no interviewers' bias.
- The direction of impacts, on WTP bid, of the explanatory variables are consistent with the theoretical expectations, implying the suitability of the contingent valuation method (CVM) in estimating the WTP for water services.

Finally, we want to be more specific that what people say they will behave in our contingent valuation survey and what they will actually behave in reality are two different things. And the former is what our research dealt with. Actual behavior survey on the households of Harar once the improved water scheme is made may be required to test the results of our survey.

6.2 Policy Implications.

The major empirical evidence of this study is that contingent valuation surveys can provide policy relevant information which is vital to judicious decisions, both technical such as the choice of appropriate technology or level of service and financial such as

the monthly tariffs and connection fees to be charged for private house connection. This study addressed few questions that are critical in guiding water policy in Harar town: What type of improved service should be provided, how should these improved services be paid for, how much is households are ready to pay, what possible benefits can be obtained from the provision of improved water at specific prices and what determines the willingness of households to pay for improved water service.

The existing situation in Harar town illustrates there is a serious problem of water supply service both in terms of quality, quantity and reliability. The service giving authority and the community are caught in a kind of "low-level equilibrium trap".

Because people demand more water than the system can provide, the water authority reduces the number of household service (i.e. ration supplies). Because the systems are unreliable, people are not willing to pay much for the existing service and hence the benevolent authority cannot charge realistic prices and does not collect sufficient revenues to manage the system properly, and reliability deteriorates further.

Our survey reveals that almost all the households in the town show high WTP (on average 15 times more than the existing tariff) to improved private piped water connection and no WTP bid is observed for public tap. The mean WTP of households with out access to the existing private pipe connection is lower than those with access. Moreover, the number of private connections is much lower than would have been possible if people are provided with improved water service and charged with higher tariffs. The revenues collected by the water authorities are only a small fraction of the potential. The survey also indicated that households' welfare gains in changing from the current policy (low tariffs with few unreliable private services) to a new policy (higher tariffs with more and improved private connections) can be huge.

Thus, one way to get out of the low-level equilibrium trap is to provide the people with an improved piped water service and charge higher prices.

The policy implications in such a scenario might be: provide the people with an improved piped water service and increase tariffs and use the increased revenues to improve system efficiency and reliability. This will enable the service giving authority to get out of the low-level equilibrium to a "high-level equilibrium"

We also observed two additional key issues to affect water policy in the town:

- > First , for many households the costs of connection to the improved private piped water is very high. However the contingent valuation survey suggests that households stand to obtain large welfare gains and are willing to pay WTP higher if the water authority has access to cover the costs of private connection to the improved scheme initially and distribute (amortize) in the monthly tariff.
- > Second, when developing appropriate social tariff structure, the tariff policy should encompass social objectives and also the ability to pay of the poorer community needs to be born in mind. In Harar town the needs of the lower income water consumers may be met by providing lower priced improved water at communal standpipes. The question of how availability of such a lower priced improved communal water might affect the demand for private connections needs to be further investigated. However, a research by the World Bank Research Team suggested that the availability of such a communal stand pipe affect the demand for private connections in Brazil.

The determinants of the households' WTP bids could be used to identify future trends. The Significance of the socio-economic characteristics implies that water demand projects should not only depend on population of the town but also on the trend of education level in the future. The study site variable also indicates that the authority should distribute the available water supply evenly among all households in the town.

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**ADDIS ABABA UNIVERSITY
DEPARTMENT OF ECONOMICS
A CONTINGENT VALUATION SURVEY QUESTIONNAIRE**

**(FOR WILLINGNESS TO PAY & DEMAND FOR IMPROVED WATER
SERVICES IN HARAR CITY, ETHIOPIA)**

Code: _____

Interviewer:- _____

Date of Interview: _____ Time: _____ to _____ (local time)

Supervisor _____

INTERVIEWER:- NOTICE THAT UPPER CASE LETTERS ARE REFERED AS INSTRUCTIONS FOR INTERVIEWER WHILE lower case letters are questions & statements to be read aloud to the respondent.

INTRODUCTION TO THE RESPONDENT:

Hello, how are you. I am _____. This interview is a main body of a research Mr. Genanew Bekele is working with. Mr. Genanew Bekele is currently studing at the Addis Ababa University. This research is in partial fulfillment for the award of M.Sc. in Economics. ~~We are~~ talking to some households in Harar town about the current situation of drinking water; their reaction to possible improvement in drinking water services both interms of quality , quantity & reliability.

Your views will be used to help policy makers make informed decisions about the supply of improved water service in the town.

Let me first begin by saying that most of the questions have to do with your attitudes and opinions, and there are no right or wrong answers. This interview will take a few minutes and is completely confidential and strictly for academic purposes. Your name will never be associated with your answers. Therefore, honest discussion is the best way ahead.

SECTION A: CHARACTERISTICS OF HOUSEHOLD MEMBERS

The next few questions concern about you & Your household members' personal characteristics.

A1. Sex of the respondent (OBERVATIONS) _____
1. Male
2. Female

A2 . Are you the head of the household? _____
1. Yes
2. No

If "No" ASK Q. A2a & Q A2b
If "Yes", SKIP TO QA3.

A2a. Who is the head of the household? Ato/W/o _____

A2b. What is your relation with the head of the household? _____

A3. How many people - both adults & children - live in this household including yourself?
_____ (Number)

RECORD THE ANSWERS FOR Q.A4 IN THE HOUSEHOLD TABLE (TABLE 1) BELOW. START RECORDING FROM THE RESPONDENT HIM/HERSELF.

A4. Would you please tell me the age, education level & occupation of every member of your household, and their relationship to you .

SECTION B: EXISTING WATER USE PRACTICES AND PROBLEMS

Now I would like to ask you about your water use conditions, including the quantity, quality, reliability of water supply and also the cost of collecting the water.

- B1. What is the main source of water for the members of this household for domestic purpose? **READ THE CHOICES AND CIRCLE.**
- a. Piped water → **GO TO Q.B2**
 - b. Others (specify) → **GO TO Q.B 12**

IF "PIPED WATER" TO Q.B1 ASK Q.B2 . OTHERWISE SKIP TO Q.B 12

- B2. What kind of piped water service is your household using?
- a. Tap inside your house → **SKIP TO Q. B4**
 - b. Tap outside your house, private → **SKIP TO Q.B4**
 - c. Tap outside your house, shared with neighbours → **GOTO Q. B3**
 - d. Other stand pipe → **SKIP TO Q.12**
 - e. *If both a & b.*

IF "TAP IS SHARED" TO Q.B2 ASK:

- B3. How many households use the shared tap?
 _____ households.
- B4. How much water does your household consumes per day?
 _____ Baldi (or a 20 - litter bucket)
- B5. How much is your household paying per month, on average, for using this source?
 _____ Birr per month.
- B6. For what purpose(s) is the water from this source mainly used by your household?
TELL THEM TO RANK WITH THE MAIN PURPOSE.
- a. _____ Drinking
 - b. _____ Washing clothes
 - c. _____ House keeping (gardening, cleaning the house,etc...)
 - d. _____ Others(specify).....
- B7. Concerning its quality, amount & reliability, how would you rank the existing water services from this source?
- a. Quality: _____ 1. Good 2. Satisfactory 3. Poor
 - b. Quantity: _____ 1. Good 2. Satisfactory 3. Poor
 - c. Reliability _____ 1. Reliable 2. Unreliable

QUALITY ASSESSMENT (Q.B8 - Q.B9a)

B8. Does your household uses any purification method (such as boiling) to clean the water before drinking?
_____ 1. Yes
 2. No

B8a. If "Yes" , what method (s) do you oftenly use?
a) Boiling
b) Others(specify).....

B8b. If "No", what is/are/your main reason/s/ not to use any purification method?
COUNTER CHECK THE ANSWER TO Q.7
a) The water is clean for drinking.
b) The water is not clean but it is costly & time taking to use purification method.
c) The water is not clean but harmless to health.
d) Others(specify).....

B9. Have any of your household members suffered from diseases caused by deficient water quality such as cholera, diarrhea, or typhoid in the past one year?
_____ 1. Yes
 2. No

B9a. If yes, which disease is the most serious? **IDENTIFY AND RANK**
a. _____ diarrhea
b. _____ typhoid
c. _____ cholera
d. others (identify)

ASSESMET ON RELIABILITY & AVAILABILITY (Q. B10- 10d)

B10. How often does your household gets water service?
a) All the time → **SKIP TO Q.B11**
b) Once in ___ days (on average) → **GO TO Q.B10a**

If "b" TO Q.B10, ASK

B10a. During which time is water usually available?
_____ 1. During day time
 2. " night time
 3. Unpredictable

- B10b. When pipe water is not available, which alternative water source does your household usually use?
- a. Your own reserve
 - b. Other pipes where water is available
 - c. Springs & wells
 - d. Others (specify).....

B10c. How much do you pay for this service?
 _____ birr per Jerican.

INTERVIEWER: IF NO PAYMENT WRITE ZIRO

B10d. How much time (travel & collection time), on average, do you spend to get this service at a time?
 _____ minutes.

B11. Generally, are you satisfied with the existing water services?

 1. Yes
 2. No

B11a. If No, What is/are the cause(s) of your dissatisfaction? **RANK STARTING FROM THE MOST SERIOUS CAUSE.**

- A. _____ Poor quality
- B. _____ Less quantity
- C. _____ Unreliability
- D. _____ Higher connection charges
- E. _____ Higher service charges
- F. _____ others(specify).....

IF "OTHERS " TO Q.B1 & Q.B2 ASK::

B12. Which source/s/ of water does your household use for domestic purposes most oftenly ?

a. Public tap	c. Spring	e. River
b. Private vendors	d. Well	f. Others(specify)

B13. Why do you prefer this source?

- a. Access to the existing pipe system is difficult.
- b. Costs to the existing pipe system is not affordable.
- c. This source is reliable.
- d. This source is cheaper.
- e. Shorter distance than other sources.
- f. Other (specify).....

B14. For what major purpose(s) do you use water collected from this source?
IDENTIFY AND RANK.

- a. _____ Drinking
- b. _____ House Keeping
- c. _____ Washing clothes
- d. _____ Others(specify)

B15. How much do you pay per Baldi? **IF RESPONDENT DO NOT PAY, WRITE ZERO)**
 _____ cents.

B16 Water collection & use

INTERVIEWER: ASK THE RESPONDENT TO TELL YOU WHO, AMONG THE MEMBERS OF THE HOUSEHOLD, GO TO FETCH WATER FROM THIS SOURCE. AND FILL THE FOLLOWING TABLE (TABLE 2) FOR EACH OF THEM. USE THE HOUSEHOLD MEMBER'S NO (IN THE FIRST COLUMN OF TABLE 1 ABOVE) AS AN ID. NO.

Tabel - 2

I.D.No	Trips*/day	Quantity/trip (in Baldi or in Jerican)	Travel Time/ trip (in hours)	Collection time/trip (in hours)

* One **Trip** refers to both ways (going to collect water & coming to home)

B17. Is your household satisfied with this source of water?

- _____ 1. Yes
- _____ 2. No

B17a. If "No" , why is your household dissatisfied? **IDENTIFY AND RANK**

- a. _____ Because of poor quality
- b. _____ " " low quantity
- c. _____ " " unreliability
- d. _____ " " high charge
- e. _____ " " far away from home
- f. _____ Others(Specify).....

THE FOLLOWING QUESTIONS WILL BE ASKED TO ALL RESPONDENTS

SECTION C: ITERATIVE BIDDING GAME ON WILLINGNESS TO PAY (WTP)

This section concerns on how much value you are prepared to pay for an improved water provision. That is it concerns on how much the provision of improved water worths to you, in monetary terms.

INTERVIEWER: READ THE FOLLOWING INTRODUCTION FIRST

By an improved provision of water, we mean:

- the provision of good quality of water which is safe for health,
- the provision of good quantity of water where an increased amount of water is available for use any time you want, throughout the year; and
- collection of water need not take much of your time & effort.

Suppose you have an option to such an improved water supply scheme. Let us assume that in this new improved system you will be provided good quality water as much as you want at any time of the day, through out the year.

Once again, I want to remind you that the purpose of this valuation is to shedlight to policy makers in policy decisions.

WILLINGNESS TO PAY (WTP) QUESTIONS

- C1. What is the main source of water for this household for domestic purpose?
- a. Private piped water
 - b. Shared piped water
 - c. Others

IF "Private piped water" TO Q.C1 ASK Q.C2 OTHERWISE SKIP TO Q.C3

- C2. Suppose the administrative body presented the improved water service, would you be willing to pay **5 cents per Baldi** to obtain improved water from this new scheme?

- _____ 1. Yes
- _____ 2. No

IF THE RESPONDNET SAYS "YES" TO Q.C2, REPEAT THE QUESTION BY INCREASING THE BID BY 5 CENTS (TO 10 CENTS? 15 CENTS? ETC...) UNTIL THE RESPONDNET SAYS I CAN'T PAY MORE.

IF THE RESPONDNET SAYS "NO" REPEAT THE QUESTION BY DECREASING THE BID BY 1 CENTS (THAT IS TO 4 CENTS? 3 CENTS? ETC) UNTIL THE RESPONDENT SAYS I AM WILLING TO PAY. AND RECORD THE RESPONSE,

_____ Cents per Baldi IF ZERO BID IS RECORDED TO Q.C2, SKIP TO Q.C4

IF "b" OR "c" TO Q.C1 ASK C3

- C3. Assume also that you will have the option for private connection to this improved piped water supply scheme.
Notice also that you may not be required to pay the costs of connection to the new scheme initially. Whatever amount you say, the administrative body will cover the costs with insignificant increase in the tariff rate.

Suppose the administrative body presented the improved water service, would you be willing to pay **5 cents per Baldi** to obtain improved water from this new scheme?

- _____ 1. Yes
_____ 2. No

IF THE RESPONDNET SAYS "YES" TO Q.C3, REPEAT THE QUESTION BY INCREASING THE BID BY 5 CENTS (TO 10 CENTS? 15 CENTS? ETC...) UNTIL THE RESPONDNET SAYS I CAN'T PAY MORE.

IF THE RESPONDNET SAYS "NO" REPEAT THE QUESTION BY DECREASING THE BID BY 1 CENTS (THAT IS TO 4 CENTS? 3 CENTS? ETC) UNTIL THE RESPONDENT SAYS I AM WILLING TO PAY. AND RECORD THE RESPONSE,

_____ Cents per Baldi

IF ZERO BID IS RECORDED TO Q.C3 ASK

- C4. Are you totally not willing to pay because you believe that:
- a. the existing system is satisfactory
 - b. you can't afford the new scheme
 - c. the government should pay
 - d. others(specify)
- C5. Are you interested in the provision of public tap?
- _____ 1. Yes
_____ 2. No

C5a. If "Yes", suppose that a new scheme of improved water system will be provided using a public tap as near as possible to your house. With this public tap a good quality water will be provided as much as you wish at any time of the day throughout the year.

Would you be willing to pay 5 cents for two Baldi (2.5 cents per Baldi) of water from such public tap? _____ 1. Yes
2. No

IF THE RESPONDENT SAYS "YES I WILL PAY 5 CENTS FOR TWO BALDI", THEN REPEAT THE QUESTION BY INCREASING THE BID TO 5 CENTS PER BALDI (THEN TO 10 CENTS PER BALDI ? TO 15, ETC....) UNTIL THE RESPONDENT SAY I CANNOT PAY MORE .

IF THE RESPONDENT SAY "NO I WILL NOT PAY 5 CENTS FOR TWO BALDI", THEN REPEAT THE QUESTION BY DECREASING THE BID TO 5 CENTS FOR 3 BALDI (THEN TO 5 CENTS FOR 4 BALDI, TO 5 CENTS FOR 5 BALDI) UNTIL THE RESPONDENT SAY 5 CENTS FOR 5 BALDI.

AND RECORD THE RESPONSE:

_____ Cents per Baldi (USE FOR THOSE WHO SAY YES)

_____ Baldi for 5 cents (USE FOR THOSE WHO SAY NO)

SECTION D: HOUSING CHARACTERISTICS & HOUSEHOLD INCOME.

Now, I would like to ask you about your house conditions:

- D1. Who is the owner of the house?
 - a. Your own house → SKIP TO Q.D3
 - b. Rented from Kebele → GO TO Q.D2
 - c. Rented from government → GO TO Q.D2
 - d. Rented from private owners → GO TO Q.D2
 - e. Others (specify).....

D2. If rented, how much is the monthly amount of rent?
_____ Birr/month.

- D3. What type of lighting does **your** house have?
 - a. Electricity (meter private)
 - b. Electricity (meter shared)
 - c. Lantern
 - d. Kerosene
 - e. Others (specify).....

D4. Do you have a bath room in your house?
_____ 1. Yes
_____ 2. No

- D5. Do you have the following in your house?
 - a. _____ Radio 1. Yes 2. No
 - b. _____ Tape 1. Yes 2. No
 - c. _____ Television 1. Yes 2. No
 - d. _____ Telephone 1. Yes 2. No

D6. How much does your household spend, on average , on the following items?

- a. Electricity _____ Birr per month
- b. Education _____ Birr per month

INTERVIEWER : HELP THE RESPONDENT IN IDENTIFYING POSSIBLE EXPENSES ON EDUCATION. SUCH AS BUYING PENCILS, EXERCISE BOOKS, AND PAYING FOR EXTENSION CLASSES AND CHILDREN SCHOOL FEE.

- c. Food _____ Birr per month.
- d. Transportation _____ Birr per month
- e. Chat _____ Birr per month
- f. Others(specify).....

- D7. Please tell me how much your (respondent's) average monthly income is ?
Birr _____.
- D8. How much total income, on average, does your household (you & all other members of this household) earns per month?
Birr _____.

INTERVIEWER: IF THE RESPONDENT FINDS DIFFICULTY TO ESTIMATE THE TOTAL INCOME OF THE HOUSEHOLD, ASK HIM/HER EACH MEMBER'S MONTHLY AVERAGE INCOME. AND ADD TO GET THE TOTAL.

SECTION E: GENERAL QUESTIONS

E1. Do you have your own private pipe line?

- _____ 1. Yes
2. No

E1a. If "No" have you applied to have your own pipe line?

- _____ 1. Yes
2. No

E1b. If. "Yes" how long is it since you applied to get the access?

_____ months.

E2. To what extent do you perceive the current provision of piped water as an issue worth discussion?

- a. Critical
- b. Very serious
- c. Serious
- d. Less serious
- e. Not important

E3. Who do you think is mainly responsible for water supply?

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

E4. Do you believe the administrative body so far done enough in solving the problems in the provision of piped water to households?

- a. a lot of attention to the problem
- b. some attention to the problem
- c. not too much attention to the problem
- d. no attention at all

E5. What do you like to suggest how to ensure safe improved water for all households?

CLOSING: Thank you for your precious time & cooperation.

Declaration

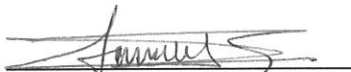
I, the undersigned, declare that this thesis is my original work, and that all sources of material used for the thesis have been duly acknowledged.

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Signature

Place and date of submission:
Faculty of Business and Economics
Department of Economics, June 1999

