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HOUSEHOLDS' WILLINGNESS TO PAY FOR IMPROVED WATER SERVICES IN DEBRE-ZEIT TOWN, E THIOPIA

BY

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Abbreviations

CSA – Central Statistical Office

WTP – Willingness to Pay

WTA – Willingness to Accept

CS – Compensating Surplus

ES – Equivalent Surplus

EV – Equivalent Variation

CV – Compensating Variation

MCS – Marshall Consumer Surplus

TEV – Total Economic Value

HHs – Households

RUM- Random Utility Model

Abstract

Water is vital for life. However, many people especially in developing countries have no access to adequate potable water services. In Ethiopia in both urban and rural areas many people do not get safe clean water. The need for clean potable water is high. Debre Zeit town has high water shortage problem. In this study the contingent valuation survey method is employed to analyze households' willingness to pay for the improved water services.

In this study survey responses of 234 randomly selected sampled households from all kebeles Debre Zeit town were analyzed through descriptive and econometric analysis. The survey result shows that 99.57% of the survey respondents use pipe water. However, only 10.26% of the respondent satisfied with the status quo level. All survey respondents expressed their willingness to pay above the existing tariff level, though the amount of money they are willing to pay varies from individual to individual. That is, if the improved system is implemented the authorities can collect more money from water sale and at the same time the water need of the households would be satisfied.

The survey result also shows that mean willingness to pay for one bucket or for 20 liter of improved water service is 10.2367 and 12.4786 cents according to the dichotomous choice and open-ended survey responses respectively. The total willingness to pay for one bucket or 20 liters of improved water services is 262,781.45 cents or Birr 2,627.82 per day or Birr 959,159.30 per year. Thej Results of both Probit and OLS econometric models show that age,

household size, reliability dummy and the income variables influences households' willingness to pay for the improved water services in the Debre Zeit town. Therefore in designing the improved water supply system for the town policy makers need to take these socio- economic and demographic factors and water attributes into consideration.

CHAPTER ONE

INTRODUCTION

1.1 Statement of the problem

Water is the most crucial and non-substitutable environmental resource. Water services are essential to life and economic development. However, many people especially in developing countries do not have access to safe and adequate water services. Most of the people of these countries depend on unsafe, expensive and inconvenient water services. Even people who do have piped connections do not get enough water. Of the total urban dwellers in Africa 44 million people, in Asia 98 million people and in Latin America and Caribbean 29 million people do not have access to clean potable water services (UN-HABITAT, 2003). Therefore providing adequate and safe water to the people at the right location and at the affordable price is one of the main problems of developing countries.

To address the potable water problem of these countries huge investment in water development project is required. However, these countries lack trained manpower and financial bases required for the water development projects. The governments of these countries have limited potential to make water easily accessible to its people. These

countries need managerial and financial improvements for the provision of adequate potable water services.

Ethiopia like any other developing countries has many constraints to make potable water easily accessible. The country is not able to solve fully the potable water problem of its people. According to Global water and sanitation assessment 2000 report only 24% of the total population, 73% of urban population and 13% of the rural population have access to safe and clean water. As a result, in most parts of the country many people loss most of their time to fetch water from rivers, natural springs and other sources.

To improve access to safe clean water the government of Ethiopia has prepared water and sanitation policy document as an integral part of the Country's water management policy. This document clearly indicates the right of every Ethiopians to get access to adequate and quality water to satisfy their basic needs.

In this policy document to improve the financial bases needed for water development projects and other public undertakings cost recovery is cited as one of the basic water law policy of the country. In this regard two tariff structures are shown in this policy document: urban tariffs and social tariffs. The structures of urban tariffs are progressive and based on the basis of full cost recovery while social tariff rates designed for the

poor communities to cover only operation and maintenance costs. Thus to set the appropriate water pricing or tariff structures which is consistent with government policy investigating the users of the improved water service ability and willingness to pay is important.

The water supply situation of Debre Zeit town this study intends to deal with experiences quantity and reliability problem. According to the information obtained from water supply office of the town the existing water source of the town is ground water. There are a total of seven boreholes currently in use. Six of these boreholes drilled in 1979 and 1980. During this early period the estimated population of the town was 65,000. One bore is new and started operation two years ago. Due to lack adequate there is high leakage problem. For estimated population of the town as of July 2006 was 131,159 the existing supply is unable to meet the current demand. Hence high leakage problem and high population growth aggravated the water problem of the town.

To improve the water supply situation of the town the old boreholes need rehabilitation. The pumps and all the pipelines also need replacement. The construction of additional boreholes is also needed to fulfill the current demand. However, all these activities require high capital outlays. The service beneficiaries are required to pay for the improved water services. Thus, to improve the water supply situation of the town

demand side information is highly required. This demand side information enables policy makers to design appropriate water tariff that is consistent with government policy and enhance the long-term viability of the service. Therefore, the focus of this study is to estimate the households' willingness to pay for the improved water service by taking Debre Zeit town as a case study.

1.2 Objective of the study

To ensure the sustainability of the water project appropriate water pricing is essential. This requires information on the amount of money the users of the service are willing to pay for the improved water services. Thus, the main objective of this study is to estimate households' willingness to pay /WTP/ for improved water services by taking Debre Zeit town as case study. The specific objectives of this study are therefore: -

- To examine the determinants of households' willingness to pay for improved water services in Debre Zeit town.
- To elicit households' willingness to pay /WTP/ responses for the improved water services from hypothetical market scenario.

1.3 Significance of the study

Due to high investment, operation and maintenance costs it is difficult for the Government to provide safe potable water services free of charge. The services users are required to pay for the water service they get from the improved source. Thus information on the amount of money the service users are willing to pay for the improved service is essential for potable water development projects. In this study the amount of money the inhabitants of Debre Zeit town are willing to pay for water services they get from the improved system and factors that determines their willingness to pay would be assessed. Therefore the findings of this study give useful information for policy makers that may be very important for water development project of the town.

1.4 Research Hypothesis

In this study the following hypothesis will be tested.

- The existing water supply situation determines households' willingness to pay for the improved water services.
- Incomes of households have direct relationship with their willingness to pay /WTP/ for the improved water services.

- ❖ Socio-economic and demographic factors of households such as level of education, sex of the respondent, age etc, influence their willingness to pay for the improved water services.

1.5 Scope of the study

The whole users of the improved water service include public bodies, households, commercials and industrial users. This study, however, deals only with improved water services of households in Debre Zeit town. The water use by public bodies, commercials, and industrial sectors in the town are not addressed in this study. It is beyond the scope of this study.

1.6 Organization of the study

Following this introductory chapter in chapter two theoretical and empirical literatures will be reviewed. In chapter three the existing water supply situation, existing tariffs structures and research methodologies will be explained. In chapter four the findings of

the study will be discussed. Finally in chapter five conclusion and policy implications will be forwarded.

CHAPTER TWO

LITRETURE REVIEW

2. 1 Theoretical literature review

2.1.1 Measure of welfare change

The individuals' utility function is not observable. There is no direct way of measuring individuals' gain or lose from policy change. The indirect methods are used to measure welfare change resulted from policy change, such as welfare gain due to improved water project. The classical tool for measuring such welfare change is consumer's surplus. When consumer's preference is represented by quasi-linear utility function consumer's surplus is an exact measure of welfare change. However, even if utility is

not quasi linear consumer's surplus may be a reasonable approximation to more exact measure (Varian, 1992, pp.163-164). Consumer surplus transforms the unobservable utility gains of consumers obtained from policy change into observable monetary units (Johanson, 1991, pp.40-41).

French Engineer J. Dupit first introduced the concept of consumer surplus in around 1850. Alfred Marshall did the first systematic analysis of the concept. Marshall took the triangular area under the demand curve and above the rectangle representing consumers' actual money expenditure as consumer surplus (Ng Yew-Kwang, 1985, p.84). Hence according to Marshall Consumer surplus is the difference between the maximum amounts of money a consumer is willing to pay and the amount actually paid for the commodity (Ng Yew-Kwang, 1985, p. 86). To Marshall as more of commodity is purchased money yields less satisfaction to the consumer. That is, money provides no direct utility to the consumer (Silberberg, 1990 P.398).

Sir John Hicks introduced more precise measure of consumer surplus. Hicks introduced four measures of welfare change: compensating variation (CV), compensating surplus (CS), equivalent variation (EV), and equivalent surplus (ES).

The compensating variation (CV) and equivalent variation (EV) of utility change are associated with price change. The compensating variation (CV) can be defined as the

change in income that would compensate for price change. Where as equivalent variation (EV) can be defined as the change in income that would be equivalent to the proposed price change (Perman et al., 2003, P.405). Unlike the Marshall consumer surplus (MCS), the CV and EV measures do not rely on any assumption about the constancy of the marginal utility of income (Freeman 1993, PP.55-56).

If the change in price and/ or income increases the welfare of the consumer both the EV and CV measures have positive signs. On the contrary, if the change in prices and / or income reduces the welfare of the consumer both the EV and the CV measures have negative signs (Johanson, 1991, p.51)

The CV, EV and MCS measures are equal if the utility function is quasi linear and when the income elasticity of demand for the good under question is zero, so that CV=EV=MCS. On the other hand if the utility function is homothetic do not generate such equality. In such cases when the good under question is normal good for the fall in price CV<MCS<EV or WTP<MCS<WTA, and for the rise in price CV>MCS>EV or WTA>MCS>WTP (Johanson, 1991, p.41, 53; Perman et al., 2003, 407). The relationships between the CV/EV welfare measures and the WTP/WTA are shown in table 2.1.

Table 2.1

Summary of the relationships between WTP/WTA compensation and the CV/EV measures for price change:

	CV	EV
Price fall	WTP for change occurring	WTA compensation for change not occurring
Price rise	WTA compensation for change occurring	WTP for change not to occur

(Adapted from Perman et al. p. 407)

The other two-consumer welfare measures of Hicks are the compensating surplus (CS) and equivalent surplus (ES). These measures unlike the CV and the EV measures are not associated with price change but with quality or quantity change.

The compensating surplus (CS) can be defined as the amount of money taken or given to leave an individual just as well of as before the change. It measures the maximum amount of money the individuals' are willing to pay for welfare gain and the minimum amount of compensation the individuals' are willing to accept for welfare loss if the change is implemented.

On the other hand, the equivalent surplus (ES) can be defined as the amount of money taken or given to make the individual as well of as he/she would be with after the change occurred. It measures the minimum amount an individual would be willing to accept compensation to forgo the change and the maximum amount an individual would be willing to pay to avert the change (Ng Yew-Kwang 1985, p.87). The relationships between the CS/ES welfare measures and the WTP/WTA are shown in the following table.

Table 2.2

Summary of the relationships between WTP/WTA and the CS/ES measure for change in quality/ quantity of environmental goods:

	CS	ES
Improvement	WTP for change occurring	WTA compensation for the change not occurring
Deterioration	WTA compensation for the change occurring	WTP for change not to occur

(Adapted from Perman e t al.p.409)

Which consumer surplus measure (MCS, CV, EV, CS or ES) is appropriate welfare measure? It depends on the types of the problem. When the change in environmental preference is chosen by third party welfare change is corresponds to either compensating or equivalent surplus rather than equivalent variation or compensating variation (Hanley e t al, 1997 P.383).

Third party such as government provides the supply of improved water supply. The compensating surplus- the reduction in income that would maintain utility at same level as before the improvement- is used to measure the welfare gains from the improved water supply project (Young, 2005, p.280).

The compensating surplus (CS) can be defined by using the indirect utility function or by using the expenditure function. The compensating surplus (CS) using the indirect utility function can be defined implicitly as a solution to the following expression:

$$V(P, M-rq^{0}, q^{0}) = V(p, M-rq^{1}-CS, q^{1}) \quad (1)$$

Where p is the price of private good, q0 environmental goods and services at the status quo level, q^{1} environmental goods and services after improvement, r is price of environmental goods and services and M is level of money income. Where as in terms

of expenditure function using the restricted expenditure function the compensating surplus (CS) can be defined as follows:

$$CS = e(P, r, q^{0}, U^{0}) - e(p, r, q1, U^{0}) \text{ ---------- (2)}$$

$$= M - e(P, r, q^{1}, U^{0}) \text{ ---------- (3)}$$

(Freeman, 1993, p.75).

2.1.2 Value of environmental resource

The term value has many meanings, which may be used in different sense. The theory of value in economics attempts to explain the worth of goods and services. Classical economists believed labour as true measure of value. For them value equals the amount of labour embodied in the commodity (Srivastava, 1996, p. 140). The neoclassical economists did not agree with classical concepts of value. They defined value as marginal concept. Jevon one of the founder of neo classical economics school defined value as marginal utility. Since then the theory of value developed along this line.

The neo classical economists used marginal utility gained by individuals from the last unit consumed to explain the market prices of the given commodity. The neoclassical

economists mainly focused on explaining the behaviour of prices and the allocation of goods and services in the market. They also replaced the classical notions of absolute scarcity with relative values as determined by the forces of supply and demand (Perman, et al 2003, p. 6).

Ideally all values would be expressed in monetary terms. Tradable goods since they have only use values their value can easily expressed in monetary terms. Environmental resource provides a complex set of values, such as life support service, amenity services, material resources for the production of goods and services, and used as sink of wastes generated by households and firms.

The value of environmental resource such as improved water resource consists both use and non-use values. Use values, which can be broken down into direct and indirect use values arise from the actual use of environmental resources. The non-use value (or passive use value) arises from independent use of resources. The non-use value (or passive use value) comprises three separable components- option values, bequest value, and existence value. Thus total economic value (TEV) of environmental resource can be cited as the sum of use and non-use values (Hussen, 2000, pp.300-301).

In addition to the above classifications philosophers also developed other classifications of value: extrinsic and intrinsic. Extrinsic refers to values that arise because a thing or an act is instrumental to attain things of intrinsic value. For instance water project can be

valued extrinsically for its contribution for human health. Intrinsic value refers to values assigned to things or actions for their own sake, independent of their own use. Both the extrinsic and intrinsic values are relevant for water policy (Young, 2005, p.24).

As a result of the complexity of environmental resources many environmental resources have no market price. We therefore, require non-market valuation techniques to value environmental goods and services. In the following section we discus the non-market valuation techniques.

2.1.3 Non-market valuation techniques

In a market economy goods and services are allocated by the price mechanisms. Market price reflects people's willingness to pay for marketable goods and services. However, this approach is difficult for environmental resources, for market failures often occur in providing environmental resource due to externalities. Many environmental resources are not traded in markets. The market rarely exists for environmental goods and services (Pearce, et al 2002, P.6). We therefore, require non-market valuation methods to value improvements and /or reduction in environmental goods and services including water resource.

> "Although water is increasingly allocated by market mechanism its unit attributes makes it a classic example of the markets potential failure to achieve an economically efficient allocation. Externalities, public goods, decrease costs in supply, and high transaction costs among reasons why markets will not always best serve society in allocating water resources. Thus we use the non market valuation techniques to provide measures of value and scarcity for economic policy making related to water" (Young, 2005, p.22).

Economists have developed the broad categories of non-market valuation techniques for valuing the value of public environmental resources. These valuation techniques are called revealed preference and stated preference methods. Cross cutting methods, which combines market based and non-market valuation techniques such as benefit transfer and unit day methods also use for valuing public environmental goods, such as water resources. The most widely recognized revealed preference and the stated preference valuation techniques are discussed below.

2.1.3.1 Revealed preference methods:

The revealed preference methods infer the value of environmental goods by studying their actual or revealed behaviour in closely related markets through the application of some model of relationships between marketable goods and environmental services.

The great advantage of the revealed preference methods is that it dependence on the actual behaviour (Bockstael et al 2005, P.538).

However, the application of the revealed preference methods requires weak complementarities between environmental goods and private goods. The revealed preference methods have also some drawbacks. It is used to value only use values. The method is not appropriate for valuing non-use values of environmental goods. The other problems in applying these methods are that it is often difficult to find suitable and reliable links between market goods and environmental amenities. The sensitivity of the estimated results with respect to the assumptions of the models is also another draw back of the revealed preference methods.

The revealed preference methods that are in use in relation with water resource valuation are hedonic pricing method, the travel cost method and defensive (averting) behavior (Young, 2005, pp. 47; 119-134).

2.1.3.1.1 Hedonic pricing methods

The hedonic pricing method is one of the revealed preference non-market valuation techniques. It is derived from the characteristics theory of value and seeks to explain the value of commodities as a bundle of valuable characteristics. The method indirectly

measure people's willingness to pay for change in water attribute when housing prices can be affected by the availability of improved water supply. The hedonic pricing method for it is based on actual market prices its application is straight for ward and uncontroversial (Young, 2005, p.256). The main shortcoming of the method is that it requires real property markets and does not capture non-use values of environmental resource (Bockstael, et al PP.558-563).

2.1.3.1.2 Travel cost method:

Travel cost method is originated with a letter sent to the U.S.A national park by Harold Hotelling. It is the oldest environmental valuation technique and is used to assess the value people place on recreational activities such as parks, lakes and other areas which host a good deal of recreational activities. The travel cost method estimates the demand function of recreational site and the site's consumer surplus. The site's consumer surplus found by this way, however, is only use value. It does not include non-use values. The method failed to estimate non-use values. The other draw back of the method is that its application is limited only for valuation of recreational sites (Seller, Christine, et al 1985)

2.1.3.1.3 Defensive (Averting) behaviour

This method is the less frequently used valuation techniques. The method is used to infer value from household expenditure to avert environmental problems, such as water pollution. The method is used to measure peoples' willingness to pay for welfare gain from the improved environmental resource such as from clean water. The general premise of the method is that a rational person will adopt defensive or averting behaviour as long as the value of the damage avoided is greater than aversive expenditure. The method is used for valuation of water quality improvements to protect against polluted drinking water (Young, 2005, p.133; Hussen, 2000, p.298).

2.1.3.2. Stated preference methods

The stated preference methods are the direct valuation methods used to solicit value measures by asking individuals hypothetical questions. In the stated preference techniques individuals are directly asked to state their willingness to pay (WTP) and/ or willingness to accept (WTA) compensation for change in public environmental resources from hypothetical market scenario (Frey et al. 2004, p.1).

The stated preference methods used for valuing both use and non-use values of environmental resources. The original and the most commonly used stated preference

method is the contingent valuation method (CVM). Other forms of stated preference methods include conjoint analysis, choice experiment, contingent ranking, and contingent rating (Bockstael et al 2005, pp.539-540) .We discuss only the contingent valuation method for it is the most widely used stated preference methods.

2.1.3.2.1 Contingent valuation method (CVM)

The contingent valuation method is the earliest technique of the stated preference method of non-market valuation approaches. The CVM involves asking people directly what they would be willing to pay or willing to accept compensation for change in preferences. This method is called contingent valuation for it is contingent on the hypothetical market. The contingent valuation method is preferred to the revealed preference methods for it deals with both use and non-use values and survey responses to willingness to pay or willingness to accept hypothetical questions go directly to the monetary measures of utility change (Perman et al, 2003, P.420).

S.V Ciriacy-Wanstap first proposed the contingent valuation survey method as a method of valuation for non-marketed environmental public good in 1947. However, Robert K. Davis who did the first empirical research in 1961 in valuing out door recreation. Since then the method become one of the widely used valuation approach in water and sanitation services, urban air pollution, soil erosion, deforestation,

biodiversity, water shed management and ecosystem valuation (Whittington, 2002, p.345).

In designing good CVM study we must follow certain methodological procedures. They include:

1) Creating survey instruments. This can be seen as having three components:

   a) Designing hypothetical scenario; b) deciding whether WTP or WTA questions have to be asked; and c) Creating hypothetical scenario about the means of payment or compensation (Perman et al., 2003, p. 421)

2) The service of environmental good to be valued must be limited geographically and should be defined in terms of characteristics that can enter respondents' utility function.

3) Methods of asking questions. The elicitation methods can be open ended, iterative bidding approach, the payment card approach and dichotomous choice format. To improve the precision of the estimates in recent years researchers have introduced dichotomous choice format followed by the dichotomous choice format. Some researchers to get the advantage of both dichotomous choice format and the open ended format they use the dichotomous choice format followed by open ended format (FAO Corporate Document Repository, 2007, pp. 6-7; Shyue-Cherng Liaw and Wan Jiun Chen 2006).

4) Data collection technique. Survey responses can be gathered by face-to-face interview, telephone interview or mailed questionnaire. Face to face interview method is superior to telephone interview and mailed questionnaire, but the use of the face to face interview method is very expensive as compared to telephone and mail survey.

5) Analyzing survey responses. This includes estimating average WTP/WTA of the population, computing total WTP/WTA of the population, and assessing the survey result so as to judge the accuracy of the estimates.

The application of the method, however, requires extreme care to get reliable result. The CVM despite its wide application it suffers from number of biases. Such as hypothetical bias, information bias, strategic bias, sampling bias, circumstantial bias, present generation bias, instrumental bias, bias arise from respondents to please the interviewers and bias due to partials (Tisdell, 1993, p.101). These potential biases make the reliability of the method questionable. However, well-designed and soundly executed CVM studies can provide high quality and policy relevant information.

> " Well- designed and carefully administered survey of actual and hypothetical water use practices can provide consistent, sensible and

believable information on willingness to pay for improved water service" (Briscoe, et al., 1990, p.133)

So to minimize the potential biases of the method and to get reliable information from the CVM studies it is advisable to design survey instruments including the use of focus group discussion and pre-testing carefully and to use well-trained and experienced interviewers (Whittington, 2002, p.304).

2.1.4 Concluding Remark on Valuation Techniques

So far we have discussed the revealed and the stated preference non-market valuations methods that are used for measuring the benefits of water related public goods. All methods we discussed have their own strengthens and weakness and appropriate to special type of water use. The revealed preference methods – travel cost method, hedonic pricing method and defensive behavior- used to estimate peoples' willingness to pay for environmental public good from actual consumer behaviors. The revealed preference methods failed to capture the non-use values of environmental resources. The methods are also in adequate for assessing new policy initiatives (Young, 2005, p.156).

In contrast to the revealed preference methods the stated preference methods such as the CVM used to estimate both use and non-use values. Moreover the method is also used to estimate values of proposed new policies (Young, 2005, P.152). Thus, the CVM can measure the total economic (use and non use) values of improved water projects. That is why in 1979 the U.S.A water resource planning councils recommended the CVM as an acceptable method for estimating the benefits of water resource projects (Young, 2005, p.135). Therefore contingent valuation method (CVM) is the appropriate method for valuing the improved water supply of the Debre Zeit town.

2.2 Empirical Literature Review

In recent years CVM has been extensively applied to variety of water related issues in different frameworks. Some of the CVM studies done on improved water supply service are cited below.

Briscoe et al. (1990) employed CVM to assess households' willingness to pay for the improved water supply in three rural areas of Brazil: one relatively prosperous well watered southern state of panama and two dry areas of north areas. In this study the bidding game was administered, and the Probit, Tobit and Multinomial Logit models were used to analyse the survey responses. The findings of the study indicate that the majority of surveyed households are prepared to pay much higher tariffs than existing

tariffs. The willingness to pay for yard tap is positively affected by income, assets, education and formal sector occupation. The findings of the study also indicated that it is possible to provide free water to the poor at public taps without harming the financial viability of the scheme.

Whittington et al. (1991) carried out a CVM study to estimate households' willingness to pay for drinking water in Onitsha, Nigeria. The authors used a bidding game to elicit households' willingness to pay for improved drinking water. In this study 235 sampled households were interviewed in person to elicit households' willingness pay for improved water services. The findings of this study showed that households have both ability and willingness to pay for improved public water system. The study also indicates that if the improved public water system constructed water services can be provided to the people at lower prices below private vendor's price and social welfare would be increased.

Whittington et al (1992) used CVM to estimate the WTP for public taps and private connections to the improved drinking water system in three Ibgo villages: Edem, Ekwegbe and Umunko- in the Nsukka district of Anambra state of Nigeria. All these three villages were predominantly agricultural communities and at the time of the study none of them had operational water supply system. In this study two different

starting values (high and low) starting values were used and each household in the sample was assigned to one of these two groups.

In this study the households' response was analyzed in three ways: interval estimate, ordering of the alternatives, and as choice to a single decision about the availability of water system. To analyze survey responses the ordinary least square (OLS) and Multivariate models were employed. The findings of the study indicates that the coefficients of attitudes, assets, education, housing type, storage capacity and the qualitative variable for the starting point had expected sign and statistically significant and determines households' willingness to pay for the improved services.

Fujita et al. (2005) used CVM to assess the WTP for the improved water supply and sanitation service in Iquitos city, the Republic of Peru. In this study double bound CVM format was used and to analyze survey responses the survival analysis and Weibell models were employed. The data were analyzed by statistical package called CVM 2002. The research finding indicated that age of the respondent, household income and current water usage practices determine households' willingness to pay for the improved water supply service. The findings of the study in particular indicate that the younger the age of the respondent, the higher the monthly income, and the shorter the availability of time to fetch water from the existing source the higher the households' WTP for the improved water services.

Nam and Son (2004) used CVM and Choice Modeling (CM) to assess household demand for the improved water service in Ho Chi Minch city, Vietnam. The study employed the logarithmic random utility model for the CVM study and the multi nominal Logit for the Choice Modeling to analyze survey responses. The study also used Turnbull estimates for non-piped water households to see the surveyed households' willingness to pay at various connection fee levels.

The findings of the CVM study indicate that the coefficients of household size, number of children in the households, water pressure and composite income (household income and bid price) were found significant for piped water. And the coefficients of fridge, bottle and composite income (household income and bid price) were found statistically significant for non-piped one. The findings of this study also clearly indicate that the probability of yes decreases with the increase in the availability of water, and increases with the increase in composite income and increase in household size. The study result also shows that those households who owns fridge and uses bottled water have no willingness to pay for the improved water services.

The results of the choice modeling indicated that the coefficients of the three attributes namely, monthly water bill, water quality and water pressure had expected sign and statistically significant.

In Ethiopia we found some studies done on improved water supply through CVM method. Fisseha Abera (1997) employed CVM to analyses the households WTP for improved water service supply in Meki town. In this study multinomial ordered Probit model was used to analyze the households' response. Similar to other studies in this study socio economic and demographic factors and water problems and households water consumption practices used as explanatory variables.

To assess the magnitude of strategic bias Abera designed the hypothetical market scenario in two formats. The first scenario designed to capture the strategic behavior while the second scenario discouraged the respondent from incorporating strategic behavior. Under the first scenario 106 households were interviewed and under the second scenario 120 households were interviewed.

The findings of this study showed that the coefficients of household income and the time household takes to fetch water from existing source were found statistically significant and determine the households' willingness to pay for the improved water supply. The coefficients of household size and domestic animal (domestic animal was taken as proxy for wealth) had expected sign but their impact on demand for water service were not so strong and rejected. The coefficients of occupational status (i.e., agriculture and small business) and education were not significant and rejected.

Assefa Chaka (1998) used the CVM to assess the WTP for improved water supply of Addis Ababa by taking four kebeles as a case study. In this study Probit binomial models were estimated with LIMDEP 7.0. Chaka specified two models to analyze the households' responses. In the first model, the probability of the household who wish to connect to the improved water supply was taken as dependent variable while in the second model the respondents WTP for improved service falls with in specified interval was taken as dependent variable.

The findings of the study indicate that all coefficients of the explanatory variables had expected signs, though all are not significant. The coefficients of income, household size, sex of the respondent, level of education, and time required for fetching water, and households' attitude towards the responsibility for supplying improved water were found statistically significant. The coefficients of age of the respondent, house (taken as proxy for wealth) and employment in the formal sector though they had expected sign they were not significant and rejected. According to the finding of this research female respondents had more willingness to pay for the improved water service as compared to male respondents.

Dunfa Lemessa (1998) used CVM to assess the WTP for rural water supply by taking Ada'a-Liben district as a case study. The ordered Probit model was estimated to analyze

the variation of WTP for improved rural water supply. Dunfa Lemessa in his study to analyze the household's WTP for improved supply used socio economic and demographic characteristics and status of water used by households as explanatory variables in the model.

The findings of the study indicate that the coefficients of income, time, and status of water quality, education and credit availability had positive sign and statistically significant. Where as the coefficients of alternative water source of the households, corrugated iron sheet roof house (the corrugated iron sheet roof house is taken as proxy for wealth), women, children, domestic animals and sex of the respondent statistically insignificant and rejected. The finding of the study indicates that 54% of the surveyed households were showed their willingness to pay if the improved water service provided to them.

Genanew Bekele (1999) employed CVM to analyze the household's WTP for improved water service in Harrer town. In this study the ordered Probit and ordinary least square (OLS) models were used to estimate the relationships between the household responses with the set of hypothetical determinants. The estimates of the coefficients were obtained by the maximum likelihood method by the econometric soft ware called LIMDEP version 7.0.

Genanew Bekele in his study used the mid point of WTP interval in the bidding game with in which respondents' WTP bid falls as dependent variable. Like others the explanatory variables used in the study were socio economic and demographic factors and the status of water exist at the time of the study. The findings of the study indicates that the coefficients of income, education, gender of the household head, location of the study area, staring point bid game and quality of the water exist during the survey time statistically significant and determines households' willingness to pay for the improved water services. The coefficients of family size and employment in the formal sector were not significant.

The findings of the study show that the entire surveyed households preferred the provision of the improved water service. The surveyed households show their WTP about 15 times more than the existing tariff if they get improved water service.

Alebel Bayrau (2004) analyzed the affordability and willingness to pay for improved water supply of the Nazareth town. The CVM method was employed to examine the determinants of WTP for improved water service. The bidding game was used as elicitation method in the study. The censored least absolute deviation (CLAD) estimator and the Probit models were estimated to analyze the determinants of households' willingness to pay for the improved water services. In this study the probability of a respondent to choose improved water service was used as dependent variable and as

usual the socioeconomic and demographic factors and water related variables were used as explanatory variables.

The findings of this study indicate that male respondents showed more willingness to pay for improved water supply than the female respondents. The coefficients of water expenditure, households perceptions of existing water quality, monthly income, and time taken to fetch water had expected sign and statistically significant. The coefficients of family size, respondents' age, water consumption, reliability of existing water system, households water source, wealth, occupation, and education had expected signs, but they were not statistically significant and rejected.

Thus from the above CVM studies and others it can be conclude that households' willingness to pay for the improved water service influenced by: (1) socio economic and demographic characteristics such as education, income, household size, age and gender; (2) characteristics of existing water supply situation like water pressure, water availability time, water charges or prices and satisfaction with existing water service, and household water use practice; and (3) households attitude towards government policy on water (World Bank, 1993). To analyze the determinants of households' willingness to pay for the improved water services the CVM studies will be estimated through either parametric or non-parametric models (Fujta, 2005, p.69)

CHAPTER THREE

METHODOLOGY

3.1 Description of the study area

The town of Debre Zeit is located about 50 km to the south east of Addis Ababa on the road to Nazareth. The town is found in the Great Rift Valley of East Africa and geographically located at 08^0 44' latitude and 38 ^{o} 58' longitudes at the elevation of 1850 meters above the sea level. The mean annual rainfall of the town is 843 mill meters. The mean monthly temperature of the town lies between 16.7^0c and 21.5^0c.

The estimated population of the town as of July 2006 is 131,159 of which 64,642(49.29%) are male and 66,517(50.71%) are female (CSA, statistical abstract, 2005). The average number of persons per households is 5 and a total of 26,232 households exist in the town. The population growth rate of the town is 4.12 % (CSA, 1994). Most of the inhabitants are civil servants, businessmen and pensioners.

The town has hydroelectric power supply and many factories such as steel rolling factory, pharmaceutical factory, flourmills and the like. The town has also primary schools, secondary schools, and colleges such as school of veterinary medicine, defense engineering college, and private colleges and health facilitates such as hospital and health centers.

3.2 Water supply situation of the town

From the beginning ground water is the main source of water for the inhabitants of Debre Zeit town. Supplying potable water for the town from surface water requires

huge investment cost, for surface water is only given from the more distant surroundings such as Awash River (MoWR).

According to the information obtained from the town's water supply office Debre Zeit town uses pipe water starting from 1960s. In the period 1957 – 58 two boreholes were constructed to the town and after 12 years in 1970-71 one additional borehole constructed and connected to the existing system. The present water wells at Debre Zeit town except one borehole have been drilled in 1979 and 1980. These old boreholes are six in numbers and in total produces 65 liters water per second. The other one-borehole was constructed two years ago, thus it is new. The new borehole produces 5.6 liters water per second. The water produced from all boreholes is disinfected before entering the network and the reservoirs.

Currently water produced from all boreholes distributed to the consumers' from the distribution network and only the remaining water enters into the two reservoirs located in the center of the town. Each reservoir has a capacity to hold 1000 cubic meters (1,000,000 liters). As to the quality of water according to the information obtained from the ministry of water resource water produced from these boreholes has acceptable quality.

> ''The results of water analysis, laboratory test, showed that all ion concentration and other values are within permissible limits, according to WHO standards and they are even with in the desirable limits, except for total hardness which is approximately twice as high. It shall be noted that a high fluoride contents as it was found in the lakes near Debre Zeit does not occur in ground water tapped by the well" (Twelve towns water supply project well reports, Debre Zeit 1979).

Regarding water distribution, during the survey time the treated water distributed to the consumers through 9,748 private connections (9456 for residential consumers, 238 for business organizations and 54 for government organizations), 30 yard connections and 36 functional public fountains. The pipeline also connected to 19 functional hydrants for the supply of water in large amounts to extinguish fire in case of accident (Debre Zeit town water supply office).

Due to lack of preventive maintenance of pipes very high leakage is observed in most places. For instance from the year 1994/95 to 2003/04 a total of 14,530,893 cubic meters of water produced, and only 8,916,226.5 cubic meters of water used by customers. The difference 5,614,666.5 cubic meters or 38.64% of the total water produced lost through leakage. The total water produced, consumed and lost through leakage in the year 1994/95 to 2003/04 is shown in the following table.

Table 3:1

Water produced, consumed and lost through leakage in the year 1994/95 – 2003/04

Year	Water produced in M^3	Water consumed in M^3	Leakage M3	Leakage in percentage
1994/95	1,535,014	907,604	627,410	40.87%
1995/96	1,456,758	827,531	629,227	43.19%
1996/97	1,626,179	747,355	878,824	54.04%
1997/98	1,324,879	772,330	552,249	41.71%
1998/99	1,701,837	918,775	783,062	46%
1999/00	1,322,302	992,009.5	330,292.5	24.98%
2001/01	1,562,960	886,478	676,482	43.28%
2001/02	1,505,996	1,124,834	381,162	25.31%
2002/05	1,666,533	1,164,581	473,952	30%
2003/04*	828,435	574,729	253,706	30.02%
Total	14,530,893	8,916,226.5	5,614,666.5	38.64%

***** Only 6-month data.

Source: Debre Zeit town water supply office.

3.3 Water tariffs structure

The tariff structures of the Debre Zeit town water supply office for one cubic meter were Birr 0.5 and Birr 0.67 at public fountain and private connections respectively

before 1994. Starting from the beginning of 1995 to the end of 1998 the price of one cubic meter become Birr one for all classes of customers. However, since the beginning of 1999 the town's water supply office applied progressive tariff structures on private connections. Accordingly, customers are categorized in to four groups as shown in the following table. The tariff structure at public fountain is still Birr one for a cubic meter of water as it was before.

3.2 Table

The water tariff structures of the town during the survey time.

Block	Consumption range	Tariff in Birr
1	From 0 – 5m ^{3}	1.30
2	From 6m ^{3} - 10m ^{3}	1.65
3	From 11m ^{3} - 30m ^{3}	2.00
4	Above 30m ^{3}	2.25
Public fountain	1m ^{3}	1.00

Source: Debre Zeit town water supply office.

3.4 Questionnaire Development

Before designing the contingent valuation survey method we went to the study area and did focus group discussion in the early August 2006**.** This focus group meeting allowed us to identify the water supply problems of the town and to come up with first draft questionnaire. The draft questionnaire was pre-tested on 21 randomly selected households in the first half of September2006. This pre testing helped us to formulate final survey questionnaire and to set starting bid price for the contingent valuation scenario.

The final version of the survey questionnaire designed for this study has three parts (See Annex I). The first section deal with the household water use practices, present status of water supply situation, water supply period, total time required to collect water from existing source volume of water used by households, status of water born disease and households evaluation of existing water supply situation such as quality, and reliability.

The second section consists of contingent valuation question. In this section hypothetical market scenario was designed as one of the most basic component of the survey questionnaire based on the improvement of existing water supply situation. In this section of the questionnaire to elicit households' willingness to pay the single bound dichotomous choice question followed by open ended question, and general questions such as opinions on how the existing water supply situations were stated.

In the third part of the questionnaire questions related with socio- economic and demographic characteristics of the households such as education level and age of the respondent, family size, average monthly income and the like were stated. The final version of the questionnaire was translated into Amharic language.

3.5 Data source and sampling strategy

The town of Debre Zeit is classified in to 15 kebele administrative. In our survey we include all the Kebeles. Note that we obtained estimated number of population exist in the town as of July 2006 from statistical abstract and expected total number of households live in the town and average number of persons per household from the municipality. To get the numbers of households live in each kebele we use the results of

the 1994 housing and population census to calculate the proportion of households in each kebele. And then sampled households were selected from each kebele using simple random sampling procedure and interviewed in person to elicit households' willingness to pay for the improved water services.

3.6 Description of Explanatory variables and their expected effect

Variables used in estimation of households' willingness to pay for improved water provision and their expected effect on households' preference for the improved services are discussed below.

AGER: - age of the respondent in years. It is generally believed that older people prefer to keep tradition and therefore they have less likely to support the improved services. Therefore the expected sign of this variable is negative.

EDUC: - education level of the respondent in years. Dummy variable 1 if the respondent has at least 4 years of schooling, 0 otherwise. For more educated people have more awareness about the health benefit of improved service they are more likely use and to support the improved service. Thus the expected sign of this co-efficient is positive.

GENDER: - sex of the respondent. Dummy variable 1 if the respondent is male, 0 otherwise. This variable is one of the determinants of households' preference for the improved water service. However, the relationship between sex of the respondent and his or her willingness to pay for the improved water services depends on specific cultural context. Thus we cannot determine the sign of the gender coefficient a prior.

HHSIZE: - House hold size. Household or family size is one of the most determinant factors of households' willingness to pay for the improved water services. Household with large family size need more water that is enough for their family from the improved water services. And at the same time to get adequate water from the improved services that is enough to their family they are required to pay more money. Therefore it is difficult to determine the sign of this variable a prior.

HOUSE: - ownership of house. Ownership of house is taken as proxy for wealth. It is a dummy variable 1 if the respondent has house, 0 otherwise. The expected sign of the coefficient of this variable is positive since richer individuals demand for the improved water service is high for they have no resource constraint.

RESPO: - responsible organ for the provision of the improved water services. Dummy variable 1 if the respondent said the responsible organ for the provision of the improved water service is government, 0 otherwise. Households who said government

is responsible organ for the provision of the improved service have less willingness to pay for the improved service. On the other hand those households who said private institution or community is responsible for the supply of improved service have more willingness to pay for the improved service. Therefore the sign of the coefficient of this variable is difficult to determine a prior.

LSAT: - level of satisfaction with existing water system being used. Dummy variable 1 if the household is not satisfied with existing water service, 0 otherwise. The expected sign of this coefficient is positive since household not satisfied with existing system has more willingness to pay for the improved service.

VOLUME: -Volume of water used by household. Household who use more water will spend more to get water from the improved water services thus household whose water usage is high have less likely to support the improved water service. However, high-income households for they have no financial constraints even if the price of the improved source is high they would pay. Therefore it is difficult to determine the sign of this variable a prior.

QUALITY: - quality of water is being used. Dummy variable 1 if the existing source is not safe to drink before boiling or before doing any other filtration mechanism, 0 otherwise. The expected sign of the coefficient of this variable is positive since if the

existing source is not safe household have more willingness to pay for the improved services.

RELIABL: - reliability of the existing service being used. Dummy variable 1 if the existing source not reliable, 0 otherwise. The expected sign of the coefficient of this variable is positive since if existing source is not reliable household willingness for the improved service will be high.

SOURCE: - source of water being used. Dummy variable 1 if the household has private connection 0, otherwise. The expected sign of the coefficient of this variable is negative since household with private connection is less likely to pay for the improved service than others who use other source such as public tap or venders.

ADCHILD: - Adult children whose age are ≥ 12 years of old. In this study children whose age is above 12 years of old are considered as adult. The expected sign of this variable is negative since a household with abundant labor force has less likely to pay for the improved water services.

TIME: - time taken to fetch water from the existing source. When the supply of water is not adequate people spend a lot of time in search of water to get enough water for their family use. Therefore household who takes more time to get water from the existing source are more likely to demand the improved services and hence has high willingness

to pay for the improved services. Thus, the expected sign of the coefficient of this variable is positive.

PRESURE: - pressure of the existing water source being used. Dummy variable 1 if the respondent said the water has low pressure, 0 otherwise. The expected sign of the coefficient of this variable is positive since when the existing source has low pressure peoples' willingness to pay for the improved water supply will be high.

INCOME: - During the pre-test time we observed that most households not willing to disclose his/her family income. As result we take household monthly expenditure as a proxy for average monthly income. Households with higher income have high willingness to pay for the improved services. Thus the expected sign of this variable is positive.

BID: - bid price offered to the respondents. In this study the bid price is used as one of the explanatory variables in the regression analysis for the bid price influences respondents willingness to pay for the improved water services.

3.7 Hypothetical scenario

Hypothetical market scenario was designed based on the improvement of existing water supply situation of the town. In the hypothetical scenario households that are

currently connected to the existing water supply scheme and households that are not currently connected to the existing water supply scheme but have interest to have private connection from the improved service were proposed that they would get pure potable water from improved service 24 hour a day with constant flow, and households that do not have access to private connection was proposed that it would get pure potable water service from public tap with out having to queue.

3.8 Empirical Models

In this study the respondents were asked single bound close ended 'yes' or 'no' questions followed by open-ended questions to elicit households' willingness to pay for the improved water services. The analysis of survey responses obtained from single bound and open-ended questions formats requires different models (FAO Corporate Document Repository, 2007, pp. 9-10). Thus, to analyze survey responses two different econometrics models will be specified: one for the single bound and the other for open-ended survey responses.

3.8.1 Specification of econometric model for the single bounded Survey responses

Econometric Model for the single bounded close ended survey response can be modeled either as dichotomous variable as in random utility framework used in the utility differential model (RUM) constructed by Hanemann 1984 or as censored

econometric mode proposed by Cameron 1988. When we use the Hanemann approach we start by specifying the indirect utility function. Where as in the Cameron approach we directly specify the cumulative distribution function for individuals' random willingness to pay responses (W.M. Hanemann and B.Kanninen, 1998 p.6). In this study we apply Hanemann's framework to analyze survey responses.

As we discussed in the literature review section earlier households preference for the improved water services affected by income, socio economic and demographic characteristics, characteristics of existing water supply and attitudes towards the improved water policy. Let us denote household income by Y_i, and all other factors that influence households' WTP for the improved services by vector Zi and, the water services at the status quo level by W^O and after the improvement level by W^1. So that household utility function for water services at status quo level is given by:

$U^0 = U(W^O, Yi, Zi)$ _____ (1)

And household utility function for water service after the improvement level is given by:

$U^1 = U(W^1, Yi, Zi)$ _____ (2)

In RUM it is assumed that each individual know his/her utility function or preferences with certainty, and there are some components that cannot be observed by the researcher and treated as random variable (W.M. Hanemann and B.Kanninen, 1998 P.5).

Let us denote this stochastic disturbance term by $\in_I$, and the household indirect utility function for water service at the status quo and after the improvement level by V (W^O, Yi, Zi) and V (W^1, Yi, Zi) respectively. Thus, household utility function for water services at the status quo level can be written as follows,

$$U(W^0, Yi, Zi) = V(W^0, Yi, Zi) + \in_0 \quad (3)$$

And the household utility function for water services after the improvement can be written as follows:

$$U(W^1, Yi, Zi) = V(W^1, Yi, Zi) + \in_1 \quad (4)$$

Where the random terms $\in_0$ and $\in_1$ are assumed to be independently and identically distributed with zero means. Households are faced with two choices: either to maintain at status quo level, W^0, or at after the improvement level, W^1. To get water from the improved services respondents will be asked to pay some amount of money. Let us denote the amount of money household would pay for the improved water services by 'Mi'. Thus, the household will choose the improved water services if the utility with CV program, net of the required payment, exceeds utility of the status quo:

$$V(W^1, Yi\text{-}Mi, Zi) + \in_1 > V(W^0, Yi, Zi) + \in_0 \quad (5)$$

The households know which choice maximizes their utility. However, the researcher observes 'yes' or 'no' responses. The household responses treated as random variable with probability distribution given by:

Pr. (yes) =Pr. {V (W^1, Yi-M, Zi) +$\in_1$ > V (W^0, Yi, Zi) + $\in_0$}..... ..... (6)

= Pr. {V (W^1, Yi-M, Zi) - V (U^0, Yi, Zi)} > $\in_0 - \in_1$.....…..... (7)

And,

Pr (No) =1–Pr (yes).....……..... (8)

Let us define $\eta = \in_0 - \in_1$ and $F\eta$ (.) be cumulative distribution function. In the Probit model, $F\eta$ (.) follows the normal cumulative distribution functions, while in Logit model $F\eta$ (.) follows the logistic cumulative distribution function. Both the Probit and the Logit models give similar parameter estimates (Timothy C. Haab and Kenneth E. McConnell, 2002,p.28). The choice between the Probit and the Logit model is only for mathematical convenience. Assuming the normal cumulative distribution following (Oni, O.A. and et al 2005) the Probit model can be expressed as follows:

$Y^* = F(X\beta + U_i)$……..... (9)

Where Y* is unobservable latent variable = 1 if the response is yes, = 0 if the response is no, X is the explanatory variables, β is unknown regression parameters and U is the random error term.

In single bound dichotomous choice respondents indicate their willingness to pay by answering ‘ yes’ or ‘ no ‘ to a set of offered prices. The respondents respond ‘ yes’ if he/she accept the proposed bid price and respond' no' if he / she refuse to pay the proposed bid price. In both cases the respondents’ actual willingness to pay for the

improved water services is not observable. The 'yes' or 'no 'responses obtained from the single bound survey responses estimated by the maximum likelihood procedure. Following the convection in statistics we can denote the response probabilities using the notation P (Yi/Xi, Θ). Where Yi denotes the response of the individual- we can think of Yi=1 if yes and Yi=0 if no, Xi explanatory variables, and Θ unknown regression parameters. With single bound approach, the likelihood function can be expressed as a series of Bernoulli trials:

$$L= \sum_{I=1}^{n} Y_i \ln Pi + (1-Y_i) \ln (1-Pi) \quad \text{.....(10)}$$

Where Pi = P (Yi/Xi, θ) i^{th} individual's response probability, and Yi is dummy variable indicating an individual choice 1 for yes and 0 for no (Hanemann, W. M and Kanninen B., 1998, pp.23).

Based on the above justification, we specify the Probit model for households' preferences for the improved water service as follows:

$$WTP_i = \beta_0 + \beta_1 AGER + \beta_2 EDUC + \beta_3 GENDUR + \beta_4 HHSIZE + \beta_5 HOUSE + + \beta_6 RESPO + \beta_7 LSAT + \beta_8 VOLUME + \beta_9 QUALITY + \beta_{10} RELIABL + \beta_{11} ADCHILD + \beta_{12} TIME + \beta_{13} BID + \beta_{14} PRESUR + \beta_{15} SOURCE + \beta_{16} INCOME + U_i \quad \text{.....(11)}$$

Where WTP is response to the bid price =1 if the respond is yes, = 0 if the respond is no, βi is regression parameters, Ui is the error term and the explanatory variables are as defined under the variable description sections. The regression parameters are estimated by Maximum likelihood technique by using the standard soft wares.

3.8.2 Specification of econometric Model for open ended Question survey responses:

When dichotomous choice format is followed by open-ended question format finally produces open value of the respondent. In this case the use of binary response models such as the Probit or the Logit is not appropriate. The respondents' willingness to pay survey response from the open ended are estimated as censored model such as the Tobit model if the dependent variable takes non negative values with some zeros or by using linear regression model if the dependent variable takes none zero positive numbers (Siglman, L. and L. Zeng, 1999 p.5).

Our survey result shows that all the survey respondents expressed their willingness to pay some amount of money that exceeds zero for the water they will get from the improved source. Therefore the ordinary least square (OLS) model is the appropriate model for analyzing the determinants of households' willingness to pay for the improved water services for our open-ended survey responses. Based on this theoretical

background we specify the linear regression model for the improved water services empirically as follows:

$$MWTP=\theta_0+\theta_1AGER+\theta_2EDUC+\theta_3GENDUR+\theta_4HHSIZE+\theta_5HOUSE+\theta_6RESPO+\theta_7LSAT+\theta_8VOLUM+\theta_9QUALITY+\theta_{10}RELIABL+\theta_{11}ADCHILD+\theta_{12}TIME+\theta_{13}BID+\theta_{14}PRESUR+\theta_{15}SOURCE+_{16}INCOME+U_i \quad \ldots\ldots(1)$$

Where MWTP is reported maximum willingness to pay by the surveyed households in cents per bucket of improved water services, θ is regression parameters, U_i is the error term and the explanatory variables are as defined under the variable description sections. This model is estimated by using the standard econometric soft wares such as STATA.

3.8.3 Welfare Measure

In the preceding section we have specified econometric models used in analyzing the dichotomous choice and open-ended contingent valuation survey responses. We turn now to welfare evaluation. The mean and the median measures are the most widely used measures of welfare change. The critical issue is the choice between the mean and median measures. Statistically the median measure has a smaller sampling error than the mean estimate. The mean estimate is more sensitive to skew ness or kurtosis (Hannemann, W.M and Kanninen, B., 1998, PP.18-19)

However, in the cost benefit analysis the median measure is not the appropriate measure. The median measure is appropriate when the decisions are based on voting. The mean measure is the appropriate method of welfare measures in cost benefit analysis and it reflects the Kaldor-Hicks compensation criterion (Hannemann, W.M and Kanninen, B., 1998, P. 23). Because of this fact to calculate the total benefit of the improved water services in this study the mean measure is employed.

For the Probit model specified above once the Probit regression model of the dependent variable of the yes/no indicator on constant and an independent variables including bid regressed the mean willingness to pay will be obtained by dividing the intercept by the negative of the bid coefficient. That is,

$$\text{Mean WTP} = \frac{\beta_0}{\text{-Bid coefficient}}$$

Where WTP is willingness to pay and β_0 is the intercept (FAO Corporate Document Repository, 2007, p.12).

For the open ended contingent valuation survey responses the maximum willingness to pay figures reported by the respondents can be simply be averaged to produce an estimate of mean willingness to pay:

$$\text{Mean WTP} = \sum yi / n$$

Where n is the sample size and each y is a reported willingness to pay amount by surveyed households (FAO Corporate Document Repository, 2007, p.9). By this we conclude our model specifications.

CHAPTER FOUR

ANALYSIS OF SURVEY RESULTS AND DISCUSION

In this section we discus survey results. Both descriptive and results of econometric models will be discussed. In particular the amount of money surveyed households' are willing to pay for the improved water services and socio-economic and demographic factors and water attributes that influences households' willingness to pay for the improved water services, and total potential revenue of the improved water system will be discussed.

4.1 Descriptive Statistics

4.1.1 Socio - economic profiles of the respondents

For this study a total of 237 sampled households were interviewed in person. However, for three questioners were incomplete only 234 questioners used in the analysis. The basic information on sampled households is shown in table 4.1. Of the surveyed households 155 /66.24%/ were male respondents while 79/33.76%/ were female respondents. The average household size of the surveyed households is 5.14 persons, ranging from 1 person to 20 persons. The survey respondents on the average 41.77 years old, ranging from 22 to 71 years old. The survey results also show that 121 /51.71%/ respondents are employed in the formal sector for salary. One hundred forty five

/61.97%/ have at least four years of schooling. The surveyed households on the average earn Birr 339.12 monthly income ranging from a minimum of Birr 50 to Birr1169. The survey results also show that 162/69.23%/ households live in their own house while 72 /30.77%/ households live in rented houses.

4.1.2 Existing water supply situation of sampled households

Most of the surveyed households 233 /99.57%/ use pipe water. Of the total surveyed households 179/76.5%/ households have private connections, 5/2.14%/ use yard connections, 49/20.93%/ use public fountain and private venders. Only one person or /0.43%/ of the total respondents use none pipe water mainly dug well. The survey results also show that sampled households, on the average consume 3.598291 bucket or 71.9658 liters of water per day.

As to the characteristics of the existing services delivery only 24/10.26%/ respondents satisfied with the status quo level. Two hundred ten respondents /89.74%/ revealed their dissatisfaction with existing systems. Of the total surveyed households 204 /87.18%/ respondent said the existing source is not reliable and not available as wanted. One hundred ninety three /82.48%/ respondents said that the existing pipe water they use have no adequate pressure. Two hundred twenty respondents /94.02%/ of the total respondent said the existing pipe water has good quality and have no harmful effect on

health. All the respondents did not use any kind of purification method to treat the water they use.

Table 4.1

Social and water use profiles of surveyed households

Description	Variable	Mean	Stan. Dev.	Minimum	Maximum
Socio-economic characteristics					
Gender dummy variable1 if male, 0 otherwise	GENDUR	0.6624	0.03098	-	-
Household size	HHSIZE	5.14	0.16775	1	20
Number of adult children in the house	ADCHILD	1.93	0.0794	0	7
Education dummy variable 1 if the respondent has at least 4years schooling, 0 otherwise	EDUC	0.6197	0.0318	-	-
Age of the respondents	AGER	41.77	0.66378	22	71
House dummy variable 1 own, 0 otherwise	HOUSE	0.6923	0.03024	-	-
Household average monthly income in Birr	INCOME	339.12	12.7799	50	1169
Occupation dummy variable 1 if the respondents work in formal sector for salary, 0 otherwise	OCCUP	0.5171	0.03274	-	-
Water use profile and perceptions					
Water used volume	VOLUME	3.598291	0.10819	1	10
Responsibility Dummy variable1if government, 0 otherwise	RESPO	0.88034	0.02126	-	-
Satisfaction dummy variable1 if not satisfied, 0 otherwise	LSAT	0.8974	0.1988	-	-
Quality dummy variable1 if not safe to drink, 0 otherwise	QUALITY	0.0598	0.01553	-	-

Reliability dummy variable 1 if notreliable, 0 otherwise	RELIABLIT	0.8718	0.0219	-	-
Pressure dummy variable 1if the existing pipe water has low pressure, 0 otherwise	PRESSUR	0.8248	0.02683	-	-
Source dummy variable 1if private connection, 0 otherwise	SOURCE	0.76496	0.02778	-	-

Source: computed from survey data

- Note that the mean estimates of dummy variables should be interpreted as percentage. For example, the mean of the respondent's level of education is 0.6197. This means that 61.97% of the respondents have at least 4 years of schooling.

Regarding the responsibility in the provision of improved water supply for the town 206 /88.03%/ respondent said government should provide the improved services. Twenty-four /10.26%/ respondents government and community should provide the improved services. Four households /1.7%/ said private sectors should provide the improved water services for the town.

4.2) Analysis of willingness to Pay

In the open ended question we asked the sampled households to state the maximum amount they would like to pay for a bucket or 20 liter of water they get from the improved services. All interviewed persons stated the amount of money they are willing to pay for a bucket or 20 liter of water in cents. Summary of maximum

willingness to pay for the improved water services reported by the surveyed households is shown in table 4.2.

Table 4.2.

Summary of maximum willingness to pay reported by the surveyed households

Maximum WTP reported	Number of surveyed HHs	Percentage	Cumulative percentage
5	49	20.94	20.94
10	69	29.49	50.43
15	72	30.77	81.20

20	39	16.66	97.86
25	5	2.14	100
Total	234	100	

Source: Surveyed households

As we can see from the table if the improved system is implemented for a bucket or 20 liters of water 49 respondents or 20.94% of the respondents expressed their willingness to pay 5 cents, 69 respondents or 29.49% of the respondents expressed their willingness to pay 10 cents, 72 respondents or 30.77% of the respondents expressed their willingness to pay 15 cents, 39 respondents or 16.67% of the respondents expressed their willingness to pay 20 cents and 5 respondents or 2.14% of the respondents expressed their willingness to pay 25 cents. If we multiply the reported maximum willingness to pay (coloumn1) by corresponding number of households (column2) and divide the sum by total surveyed households of 234 we get of 12.4786 cents, which is the surveyed households are willing to pay, on average, for a bucket or 20 liters of improved water services they can get from the improved scheme. If we multiply the average willingness to pay of surveyed households of 12.4786 cents for a bucket or for 20 liters of water they will get from the improved services by households average daily consumption of 3.598291bucket or 71.97 liters of water and then if we multiply the

results by 30 days we get average monthly willingness to pay of sampled households of Birr 13.47. This average monthly willingness to pay of the sampled households accounts for 3.97% of average monthly income of the surveyed households of Birr 339.12, which is below 5% generally believed ceiling for the ratio of water and sanitation tariffs to total household expenditures (Fujita et al, 2004, p.81)

When we see the tariff structures of the town water supply office, at the time of survey the price of one bucket or 20 liter of water was 2.6 cents for consumption from 0 to 5 m^3, 3.3 cents for consumption from 6 m^3 to 10 m^3, 4 cents for consumption from 11 m^3 to 30 m^3 and 4.5 cents for consumption above 30 m^3 at private connections and 2 cents at public tap. This shows that the current tariff structure is much more below the customers are willing to pay. Thus if the improved system is introduced in addition to addressing the water need of the town the authorities can also collect more fund from water sale which can be used for water expansion projects.

4.3 Determinants of household's willingness to pay responses

4.3.1 Analysis of the results of the Probit Model

As we have discussed in the methodology sections Probit model is employed to analyze factors that determine households' willingness to pay for the improved water services for single bound dichotomous choice questions survey responses. Note that where the

explanatory variables are highly inter- correlated it is difficult to disentangle the effects of explanatory variables on the dependent variables (Maddala, G.S, 1992, PP. 269-270). And hence to minimize the problem we did multicollinarity test. The result indicated that the correlation matrix among the explanatory variables is below 0.8(see annex II). According to the rule of thumb multicollinarity is a serious problem if the correlation matrix is in excess of 0.8(Gujirati, D., 1988, p.299). Thus multicollinarity problem is not a serious problem in our data.

4.3.1.1 Likelihood ratio test for Probit model

The likelihood ratio test is a test against the null hypotheses that all the slopes coefficients are equal to zero (Johnson, J. & Dinardo, 1997, P. 422; Loomis, J.B, 1988 P. 53). This test is given by:

$$LRT= 2 [L (\beta_0,\beta i) – L (\beta_0, 0)]$$

Where L (β_0,βi) is the maximized value of the log likelihood of the model being estimated, L (β_0, 0) is the value of the likelihood estimated only with constant term, β_0 is regression constant and βi the slope coefficients. The null hypothesis of all slopes are equal to zero will be rejected if LRT ≥ critical χ^2 value. In our model the maximized log likelihood value is -63.951516 and the value of log likelihood with only constant term is – 121.39581. Therefore the likelihood ratio test is:

$$LRT = 2 (-63.951516– (– 121.39581))$$

= 114.888588

At 5 % level of significance the critical value X^2 (16) 26.296. Thus the null hypotheses that all the slope coefficients are equal to zero are rejected. Thus the model has some explanatory power.

4.3.1.2 Measures of Goodness of fit

The use of conventional R^2 for goodness of fit when the dependent variable takes either 1 or 0 is not appropriate. A summary measure used similar to the conventional R^2 that have been suggested for models with qualitative dependent variable is calculated based on likelihood ratio as follows:

$$1- \frac{L(\beta_0,\beta i)}{L(\beta_0, 0)}$$

Where L (β_0,βi) is the maximized value of the log likelihood of the model being estimated, L (β_0, 0) is the value of the likelihood estimated only with constant term. This measure has value 0, when the entire slope coefficients are zero, and value 1 when the model is perfect predictor. In our Probit model this summary measure is:

$$1- \frac{(-63.951516)}{(-121.39581)}$$

= 0. 4732

This result indicates that our Probit model explains about 47.32% of the variation.

4.3.1.2 Results of Probit model

In survey and cross sectional data heteroscedascity is a serious problem. The robustness to heteroscedasticity is a compelling virtue (Greene, 2005, p.226). The method was proposed first for linear regression models but has subsequently been extended to non-linear regression models (Hanemann, W. M and Kanninen B., 1988, p.32). Thus to correct for hetroscedascity problem we estimated the robust standard errors. The coefficients of Probit model only give the significance and the direction of the effect and the marginal effects give the size of the response probabilities. Thus we estimate both regression coefficients and the marginal effects. The STATA out put for the Probit model is shown in table 4.3.

Table 4.3

Estimated parameters and marginal effects from the Probit model

Variables	Coefficients	Marginal effects	Standard err. of marginal effect	P- Value
AGER	-0.0347961	-0.004702	0.0027825	0.032**
EDUC	0.3913065	0.056955	0.0487159	0.228
GENDUR	0.0119803	-0.0016143	0.0368351	0.965

HHSIZE	0.2487351	0.0336116	0.0181863	0.052*
HOUSE	0.2367735	0.0342591	0.0452056	0.406
RESPO	-0.4260717	-0.0453291	0.0386361	0.354
LSAT	0.4313493	0.0743082	0.1034471	0.371
VOLUME	-0.2029832	-0.0274292	0.014883	0.081*
QUALITY	0.0015285	0.0002063	0.0824667	0.998
RELIABL	1.068661	0.240802	0.1170639	0.003***
ADCHILD	0.0052057	0.0007034	0.0253868	0.978
TIME	-0.0101849	-0.0013763	0.001044	0.198
BID	-0.2592989	-0.0350391	0.0074026	0.000***
PRESUR	-0.0884992	-0.0114636	0.040966	0.788
SOURCE	-0.0021648	0.0002923	0.0456845	0.995
INCOME	0.0032881	0.0004443	0.0001306	0.001***
CONSTANT	2.654367	-	-	0.018

***Significant at 1%level of significance

** Significant at 5%level of significance

* Significant at 10%level of significance

The age dummy has negative sign and statistically significant at 5% level of significance. The result shows that remaining other thing constant if the age of the family head increases says by 1 year, the probability of households' willingness to pay for the improved water service decreases by 0.4702 percentage. That is, as the age of the household head increases their willingness to pay for the improved water services decrease. Thus, age of the house head is one of the major determinants of households' willingness to pay for the improved services in Debre Zeit town.

Household size has positive sign and significant at 10 % level of significance. The result shows that remaining other thing constant if the number of family size increases says by 1 person, the probability of households' willingness to pay for the improved water service increase by 4.87159 percentage. Thus family size is one of the determinants of households' willingness to pay for the improved water services in the Debre Zeit town.

The volume of water used has negative sign and statistically significant at 10% level of significance. The result shows that remaining other thing constant if the volume of water usage by the household increases say by one bucket or 20 liters, the probability of households' willingness to pay for the improved water services reduces by 2.74292 percentages. That is households whose water usage is high have no willingness to pay for the improved scheme. Thus volume of water used by the household is one of the determinants of households' willingness to pay for the improved services in the town.

The reliability of existing water source has positive sign and statistically significant at 1 % level of significance. The study result shows that remaining other thing constant if the reliability of the water source increases says by 1 % the probability of households' willingness to pay for the improved water services increases by 24.0802 percentages.

Thus the unreliability of the existing water source is one of the factors that influence households of Debre Zeit town to pay for the improved water services.

The coefficient of starting bid price has negative sign and significant at 1% level of significance. The negative sign and the significance of this coefficient indicated that as the starting bid price increases say by 1 cent, the probability of household's willingness to pay for the improved services reduces by 3.50391 percentages.

Household average monthly income has positive sign and statistically significant at 1% level of significance. The significance and positive sign of the income variable is consistent with economic theory. The result shows that remaining other thing constant if average monthly income of the household increases says by 1% the probability of households' willingness to pay for the improved water services increases by 0.04443 percentages. Thus, household average monthly income is one of the major determinants of willingness to pay for the improved water services in Debre Zeit town.

The education dummy variable as expected has positive sign indicating that educated people has more willingness to pay for the improved services. But this variable is not significant and rejected.

The gender dummy variable has negative sign indicating that female respondents have more willingness to pay for the improved water services than males. However, this variable is not significant and rejected.

The house dummy variable has positive sign as expected indicating that wealthy people has more willingness to pay for the improved water services. However, this variable is not significant and rejected

The responsibility dummy variable has negative sign indicating that if government has responsibility to provide the improved water service households have no willing to pay for the improved water services. However, this variable is not significant and rejected.

The satisfaction dummy variable has positive sign indicating that households have not satisfied with the existing water source and they have more willingness to pay for the improved water services. However, this variable is not significant and rejected.

The quality dummy variable has positive sign indicating that the existing source is not safe to drink and households have more willingness to pay if the improved water service is implemented. However, this variable is not significant and rejected.

The number of adult children has unexpected positive sign and not significant and rejected.

The time taken to fetch water from the existing source has unexpected negative sign and not significant and rejected.

The pressure dummy variable has negative sign indicating that the existing source has the required pressure and households have no willingness to pay for the improved services. However, this variable is not significant and rejected.

The water source dummy variable has negative sign indicating that households with private connections have less willingness to pay for the improved services. However, this variable is not significant and rejected.

The mean willingness to pay for single bound dichotomous choice Contingent Valuation survey response for Probit model can be calculated by dividing the regression constant (intercept) by the negative of the bid coefficient as we discussed in the methodology section. Thus, the mean willingness to pay is calculated as follows: -

$$\text{Mean WTP} = \frac{Bo}{\text{-Bid coefficient}}$$

$$= \frac{2.654367}{-(-0.2592989)}$$

$$=10.2367$$

That is according to the results of the Probit model the mean willingness to pay for one bucket or for 20 liters of improved water service is 10.2367 cents.

4.3.2 Analysis of the results of Regression model

4.3.2.1 The F-test for Regression model

The F- test is a test against the null hypotheses that all the slopes coefficients are equal to zero in linear regression model (Hill R. C. et al 1997, p.158). Consider the following regression model:

$$Y= \beta_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots \beta_k X_k + Ui$$

Where Y is the dependent variable, X_2, X_3, ...X_k are explanatory variables, $\beta_2, \beta_3 \ldots \beta_k$ are regression parameters, β_1 intercept and Ui is the error term. To test the relevance of the explanatory variables we set the null hypothesis,

$$H_0: \quad \beta_2 = \beta_3 = \ldots = \beta_k = 0$$

And the alternative hypothesis

H_1: at least one of the regression parameters is non-zero.

If the null hypothesis is true none of the explanatory variable influence the dependent variable and the model has no relevance. On the other hand if the alternative hypothesis is true the null hypotheses of all slopes are equal to zero will be rejected and it is concluded that the model has some explanatory power. The F- test can be given by,

$$F = \frac{R^2/(K-1)}{(1-R^2)/(n-K)}$$

Where $R^2$is the value of the coefficient of determination, K is number of parameters, n is sample number (Intriligator, M.D, 1997, p.128). In our regression model the value of $R^2$is 0.3441, the number of regression parameters (K-1) is 16, and sample number is 234. In the F- test the null hypothesis of all slope coefficients will be rejected if the calculated F value exceeds the critical value. Therefore the F- test for regression model is:

$$F = \frac{0.3441/(16)}{(1-0.3441)/(234-17)}$$

$$= 7.115195$$

At 5% level of significance the critical value F (K-1, n-K) is 1.99. That is, the calculated F test exceeds the critical value. Thus the null hypotheses that all the slope coefficients are zero are rejected and it can be concluded that the model has some explanatory power.

Measure of Goodness of fit

The R^2 value of 0.3441 indicates that the linear regression model explains about 34.41% of the variation.

4.3.2.2 Results of Linear Regression Model

As we have tried to explain in the methodology section to see the effects of household characteristics and existing water use practices and problems on households' willingness to pay for the improved water services in addition to the Probit model we estimated the linear regression model. The Robust regression model was estimated to correct for the heteroscedasticity problem. The STATA out put of the linear regression model coefficients are shown in table 4.4.

Table 4.4

Results of Linear Regression model

Variables	Coefficients	Robust standard error	t- ratio	P- Value
AGER	-0.0998694	0.0355726	-2.81	0.005***
EDUC	0.8383263	0.7600415	1.10	0.271
GENDUR	-0.1707336	0.66942	-0.26	0.799
HHSIZE	0.4136283	0.2204489	1.88	0.062*
HOUSE	0.7803634	0.6988438	1.12	0.265
RESPO	0.0966114	1.044945	0.09	0.926
LSAT	1.209392	1.68886	0.72	0.475
VOLUME	-0.2848657	0.2621332	-1.09	0.278
QUALITY	-1.194453	1.063615	-1.12	0.263
RELIABLITY	2.257039	1.344152	1.68	0.095*
ADCHILD	-0.599027	0.3963834	-1.51	0.132
TIME	-0.0328952	0.0200252	-1.64	0.102
BID	0.3221788	0.0740899	4.35	0.000***
PRESSUR	0.4685477	0.7986657	0.59	0.558
SOURCE	0.2018433	0.8796225	0.23	0.819

INCOME	0.0084816	0.0018716	4.53	0.000***
CONSTANT	6.304812	2.392164	2.64	0.009
R squared 0.3510				

***Significant at 1% level of significance

** Significant at 5% level of significance

* Significant at 10% level of significance

The age of the respondent has negative sign and statistically significant at 1% level of significance. The negative sign and significance of the age variable shows that as the age of the household head increases their willingness to pay for the improved water services decrease. Thus, age of the house head is one of the major determinants of households' willingness to pay for the improved services in Debre Zeit town.

Household size has positive sign and significant at 10% level of significance. The positive sign and the significance of household size indicate the feelings of urgency of meeting water need increases with the number of people in the household. Thus household size is one of the major determinants of households' willingness to pay for the improved water services.

The reliability dummy variable has positive sign and statistically significant at 1 0% level of significance. The positive sign and the significance of this variable indicate that if the households get reliable water service they would pay. Thus the unreliability of the

existing water source is one of the factors that influence households of Debre Zeit town to pay for the improved water services.

The household average monthly income approximated by household expenditure has positive sign and highly significant at 1% level of significance. The positive sign and the significance of this variable show that remaining other things constant household's willingness to pay for the improved water services increases if their income increases.

The bid coefficient has positive sign and statistically significant at 1% level of significance. The significance and the positive sign of the bid coefficient in this model indicate the existence of upward biases. This result is related to the findings of similar studies done on Harer town by Genanew Bekele and on A'da Liben district by Dunfa Lemessa.

The education dummy variable as expected has positive sign indicating that educated people has more willingness to pay for the improved services. However, this variable is not significant and rejected.

The gender dummy variable has negative sign indicating that women have more willingness to pay than male. However, this variable is not significant and rejected.

The house dummy variable has positive sign as expected indicating that wealthy people has more willingness to pay for the improved services for they have no financial constraints. However, this variable is not significant and rejected.

The responsibility dummy variable has positive sign. However, this variable is not significant and rejected.

The time taken to fetch water from the existing source has unexpected negative sign and insignificant and thus it is rejected.

The pressure dummy variable has positive sign indicating that the existing source has no the required pressure. However, this variable is not significant and rejected.

The water source dummy variable has positive sign indicating that households with private connections have more willingness to pay for the improved services. However, this variable is not significant and rejected.

The volume of water used has negative sign indicating that household whose water usage volume is high has no willingness to pay for the improved services. However, this variable is not significant and rejected.

The satisfaction dummy variable has positive sign indicating that households have not satisfied with the existing system and they have more willingness to pay for the improved services. However, this variable is not significant and rejected.

The quality dummy variable has negative sign. However, this variable is not significant and rejected.

The number of adult children has negative sign indicating that households with abundant labor force have no willingness to pay for the improved water services for they have labor constraints. However, this variable is not statistically significant and thus rejected.

4.4 Estimating aggregate WTP and aggregate potential Revenue

4.4.1 Estimated aggregate willingness to pay:

The main purpose of this study was to estimate households' willingness to pay for the improved water services. The total willingness to pay for the improved water services as shown in table 4.5 can be obtained by multiplying the mid points of willingness to pay interval (column 2) by total number of households (column 4). As shown in the table total willingness to pay for one bucket or 20 liters of improved water services is 262,781.45 cents or Birr 2,627.82 per day or Birr 959,154.30 per year.

4.3.2 Estimated aggregate Potential Revenue:

As we have introduced in the previous sections the implementation of the improved scheme not only reduces the water problem of the town but also increases the revenue collected from water sale. If the improved scheme is introduced by increasing water tariff the authorities can collect more funds that can be used for the expansion of water development projects. The potential revenue of the improved scheme can be estimated through using the reported maximum willingness to pay by the respondents and the reported average daily consumption. To make aggregation over the whole households class intervals for maximum willingness to pay are employed.

Thus, the aggregate revenue that can be expected from the provision of improved services as shown in table 4.5 is calculated by multiplying the mid points of the willingness to pay interval (coloumn2) by total number of households' willingness to pay for the improved services at least minimum amount (coloumn6). The aggregate revenue expected from the provision of the improved water services if each household consumes only one bucket or 20 liters of water from the improved source is shown in the table (column 6).

As we can see from the table if the price of one bucket or 20 liters of water is 2.5 cents 26,232 households will pay for the improved water services and the expected aggregate

revenue is 65,580 cents or Birr 655.80 Birr per day or Birr239, 367 per year. When the price of one bucket or 20 liters of water is 7.55 cents 20,739households will pay for the improved water services and the expected aggregate revenue is 156,579.45 cents or Birr 1,565.7945 Birr per day or Birr 571, 514.993 per year. When the price of one bucket or 20 liters of water is 12.55 cents 13,003 households will pay for the improved water services and the expected aggregate revenue is 163,187.65 cents or Birr 1,631.8765 per day or Birr 595,634.923 per year. When the price of one bucket or 20 liters of water is 17.55cents 4,932 households will pay for the improved water services and the expected aggregate revenue is 86,556.60 cents or Birr 865.566per day or Birr 315,931.59 per year. When the price of one bucket or 20 liters of water is 22.55cents 559 households will pay for the improved water services and the expected aggregate revenue is 12,605 cents or Birr 126.05 per day or Birr 46,008.25 per year.

Table 4.5

Total WTP and aggregate revenue would be expected from the improved system.

WTP interval in cents per 20 liters	**Class mark for WTP**	**No .of Sampled HHs**	Total No. of HHs	**Total WTP in cents for 20 liters**	**Minimum amount HHs are Willing to pay**	Total Revenue
0 – 5	2.5	49	5493	13,732	26,232	65,580
5.1 – 10	7.55	69	7,736	58,406.80	20,739	156,579.45

10.1 – 15	12.55	72	8,071	101,291.05	13,003	163,187.65
15.1 – 20	17.55	39	4,373	76,746.15	4,932	86,556.60
20.1- 25	22.55	5	559	12,605.45	559	12,605
Total		234	26,232	262,781.45		

Source: Results from contingent valuation survey.

The demand for the improved water services at different price level is shown diagrammatically in figure1 below.

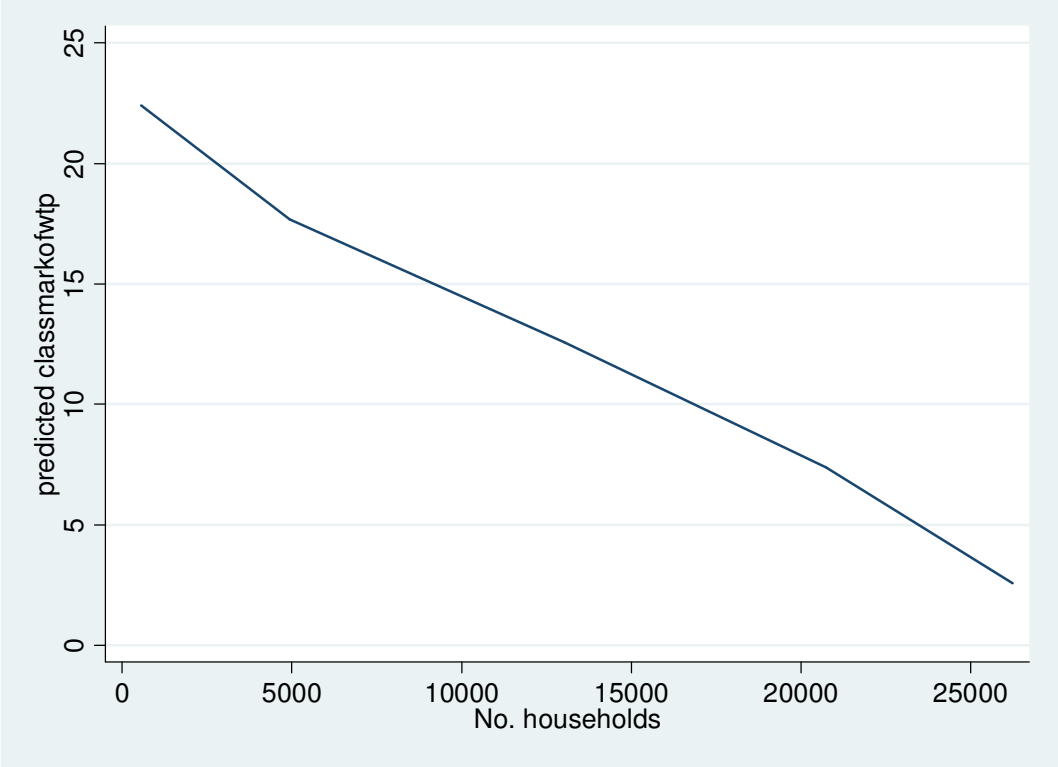

Figure 1 Household demand of the improved water services at different prices.

The survey result shows that each household on the average consumes 3.598291 bucket or 71.96 582 liters per day. Thus taking into consideration this household average water consumption the maximum revenue can be collected from the improved system at the optimum price of 12.55 cents per bucket or per 20 liter is Birr 5,871.97 per day or Birr 2,143,267.78 per year if the improved scheme is implemented.

CHAPTER FIVE

CONCLUSIONS AND POLICY IMPLICATIONS

5.1 Conclusions

In this study the demand side of the improved water supply services was analyzed. The survey responses of 234 randomly selected households from all the 15 kebeles of Debre Zeit town were analyzed in the study. The sampled households were asked questions related to their socio-economic and demographic characteristics, water use practices, and problems with existing water services system and some general questions. The surveyed households also asked single bound close-ended dichotomous questions followed by open-ended questions to elicit households' willingness to pay for the improved water services.

To analyze the survey responses contingent valuation method was employed. The survey responses were analyzed by using STATA 9.0 econometrics soft ware. The survey response analyzed by using both descriptive analysis and econometric models.

The survey results disclosed that pipe water is the main source of water for the town. Of the total survey respondents 99.57% use pipe water. Only 0.47% of the respondents use non-pipe water. However, only 10.26% of the respondents satisfied with the status quo level. 89.74 % of the respondents expressed their dissatisfaction. 87.18% of the respondents revealed that the existing source has poor reliability. The whole surveyed households expressed their willingness to pay for the improved services ranging from 5 cents to 25 cents for a bucket or 20 liters of water they will get from the improved sources. 78.63% of the respondents show their willingness to pay equal and above the bid price offered to them. 21.37% percent of the respondents show their willingness to pay for the improved services but below the bid price offered to them. The total willingness to pay for one bucket or 20 liters of improved water service is Birr 2,627.82 per day or Birr 959,154.30 per year. If the improved system is implemented the authorities can collect a total revenue of Birr 5,871.97 per day or Birr 2,143,267.78 per year.

To identify the determinants of households' willingness to pay for the improved water service Probit and OLS econometrics models were estimated.

The results of the Probit model show that age, household size, water volume, reliability dummy and the income variable determine households' willingness to pay for the improved services. Where as in the OLS model age, household size, reliability dummy and the income variable determine households' willingness to pay for the improved water services in Debre Zeit town. That is, even though the significance level different the results of both the Probit and the OLS models are the some except for VOLUME which is significant in Probit model and insignificant in the OLS model.

The mean willingness to pay for a bucket or for 20 liters of water in Probit model and from the open-ended survey responses is different. The mean willingness to pay for a bucket or for 20 liters of water from the open-ended survey responses is 12.4786 cents. While in Probit model the mean willingness to pay for a bucket or 20 liter of water is 10.2367 cent.

5.2 Policy Implications

Debre Zeit town suffers from increasing problems of water shortage. The inhabitants of the town have high eager to have reliable and improved water services. All the

surveyed households expressed their willingness to pay for the improved water services above the existing tariff structures. Thus, the expected revenue from the provision of the improved water services will be high. The findings of this study also clearly show socio-economic and demographic characteristics and water related variables that affect households' willingness to pay for the improved water services. Based on our research findings we can draw the following policy implications:

1. The strong positive relationships between the income of the respondents' and their willingness to pay for the improved water services in both Probit and OLS models indicate that the water tariff charged should reflect the income characteristics of the households.
2. The surveyed sampled households expressed their interest to pay above existing tariff structure. Thus, if the improved water supply is provided to the town by increasing water tariff structures the financial viability of the authorities will be improved and at the same time the water need of the households will be satisfied.
3. The positive relationship between household size and their willingness to pay for the improved water services in both Probit and OLS models indicate that households with large family size need the provision of the improved water services. Thus in designing the improved system for the town policy makers needs to take the household size into consideration as

one of the factors that influence households' willingness to pay for the improved services.

4. The positive relationship between the reliability and households' willingness to pay for the improved water services in both Probit and OLS models indicate that the existing system is unreliable. This implies that if the inhabitants of the town get the improved reliable water services they would pay for the water services they would get from the improved source. Thus in designing the water system of town policy makers should take the poor reliability of existing system into consideration and emphasis should be given in providing the reliable water services.

5. The negative relationship between the volume of water usage and willingness to pay for the improved water services in Probit model indicate that household whose water usage is high not willing to pay for the improved water services. This implies that in designing the improved water tariff policy water volume used by the households should be taken in to consideration.

6. The negative relationship between the age of the respondent and willingness to pay for the improved water services in both Probit and OLS models implies that older peoples have no interest to pay for the

improved services. Thus in designing the improved system for the town policy makers needs to take the age of family heads into consideration as one of the factors that influence households' willingness to pay for the improved services.

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ANNEX I

CONTINGENT VALUATION SURVEY - HOUSEHOLD QUESTIONNAIRE

This survey is being undertaken by a student of Addis Ababa University, Faculty of Business and Economics in the Department of Economics as a partial fulfillment for the award of M.Sc. in Economics This questionnaire is designed to obtain information on the current situation of water supply in Debre Zeit town and residents' willingness to pay for an improved water supply services. The information collected is for purely academic purpose and will be kept confidential. And your name and personal information will never be linked with your responses. Hence, you are requested to participate in this discussion as truthfully as you can.

Name of the Interviewer: _____

Date of Interview: _____

Interview started _____ Interview ended _____

Kebele NO. _____ HouseNo. _____

A) Questionnaire on water use practices and problems

1) For what purpose do you use water?

a) For drinking and house keeping b) for washing of clothes

c) for sanitation purpose d) for livestock e) for a b c and d

f) for all but_____

2) What is your main source of water?

a) Piped water b) other source

If piped water go to question 3 to 25

If other go to question 27 to 37

3) If piped water what kinds of piped do you use?

a) Shared yard connections- Go to 4 b) public tapes- Go 5 to 9

c) Pipe in side the house d) private pipe out side the house

4) If shared yard connection, how many households use the yard connection? _____households

5) If public tap how much time do you spend to fetch water at a time? _____minutes

6) If public tap how much times, on average, do you go per day for fetching of water? ____times.

7) If public tap how many persons from the household go at a time to fetch water from this source? _____persons

8) If public tap who often go to the public tape to fetch water?

a) Women b) girls c) boys d) men e) a and b f) all

9) If your current source of water is public tape why don't you have your own connection or yard connection?

a) High connection cost

b) the house is not mine, but rented

c) Scarcity of water

d) I do not want to have yard or private connection

e) other reason (specify) _____

10) How much water, on average, do you use daily? _____Bucket (Note that one Bucket assumes contains 20 liters)

11) How much, on average, do you pay for your water consumption per month from this source? _____Birr per month

12) How do you judge the existing water tariffs of the town's water supply office?

a) too expensive b) too cheap c) fair and affordable d)It is difficult to judge

13) Do you get tape water at desired time and quality?

a) yes b) no

14) If no to (13) above from where do you get additional water?

a) from vendors b) from rivers c) from springs d) from wells

e) other source(specify)_____

15) If "from vendors" how do you judge their price as compared to the town's water supply tariffs?

a) the same b) two fold c) three fold d) four fold e) five fold

f) It is not possible to say this much for their price is flexible

16) During what time you often face water shortage?

a) During night time b) During day time c) morning d) at noon

e) It is not possible to tell the exact time for it has no constant time

17) From your experience how often you get piped water with in 24 hours?

_____ hours.

18) Is there any time where piped water is completely absent?

a) yes b) no

19) If your response to 18 above is 'yes' specify the time during which water is completely absent_____

20) How do you rate the status of the service of piped water your household use?

a) Quality

i) good ii) average iii) not good

b) Quantity

i) Good ii) average iii) not good

c) Reliability

i) Good ii) average iii) not good

21) Does your household use any purification method to clean piped water before drinking?

a) yes b) no

22) If “no” what are your main reasons for you for not using purification?

a) the water is clean for drinking

b) the water is not clean, but purification is time consuming and costly

c) the water is not clean, but has no side effect on health

23) Has any one of your household members suffered in connection to the piped water your household use?

a) yes b) no

24) If yes what was the disease?

d) diarrhea b) typhoid c) cholera d) other water born disease

25) Generally are you satisfied with the existing piped water service?

a) yes b) no

26) If “no” what are the main causes of your dissatisfaction?

a) poor quality b) un reliability c)other reason (specify)_____

27) If your response for (2) above is 'other source' what other source do you use

a) river b) spring c) well d) other (specify)_____

28) How many times on average do you go to fetch water from this other source? per day? _____times

29) How much time do you spend to fetch water from this other source at a time? ___hours ___minutes

30) How many persons go at a time to fetch water from this other source?_____persons.

31) Who often goes to fetch water from this source?

a) Girls b) boys c) women d) men

32) How much do you pay for one bucket of water you get from this other source _____cents?

33) Why do you prefer this source (none piped)?

a) Access to pipe water is difficult

b) The pipe water is too cost and not affordable

c) This source is more reliable

d) Collecting water from public tap takes more time

e) This source has better quality

34) Does your household use any purification method to clean the water they get from this other source?

a) yes b) no

35) If "no" what are your main reasons for you are not using purification?

a) the water is clean for drinking

b) the water is not clean, but purification is time consuming and costly

c) the water is not clean, but has no side effect on health

36) Has any one of your household members sick in connection to the water you use from this other source?

a) yes b) no

37) If your response for 36 above is 'yes' what was the disease?

d) diarrhea b) typhoid c) cholera d) other (specify)_____

B) Opening statement on willingness to pay questions for improved water service

Currently there is a big gap between the supply and the demand for clean potable water in Debre Zeit town. There is excess demand over its supply. The main reasons for the shortage of the town's water supply are: (1) high population growth; (2) the existing boreholes and water pumps have in operation since 1981 and lose their efficiency; and (3) there are high water leakage problems.

To improve the water supply of the town existing boreholes need rehabilitation and the water pumps and the pipelines need replacement. For the existing boreholes are not enough, additional boreholes also should be constructed. For the new boreholes to be operational additional water pumps and new water tanker would still have to be provided. To have public taps at different places in the town pipelines will have to be constructed from the boreholes to the public taps. In addition to the investment cost it is also necessary to pay for operational and maintenance costs.

I) If the town's water development investment done accordingly, the water would run all the day and every household that has currently private connections and have interest to have private connections from the improved source would benefited from the improved scheme 24 hours a day during 365 day a year. They could obtain quality water, which can be used for drinking with out boiling with constant flow as much as they want from the improved source. However, all households of the town, including yours, who want to have private connection from the improved services would have to pay initial investment costs and running costs, which will be added to their water bill.

Willingness to pay questions

1) Are willing to participate in this program?

a)Yes b) no

2) If "yes "if the price of water from the improved source is 5/ 10 /15 cents per Bucket or for 20 liters are you willing to pay?

a) yes b) No

. If you say either "yes" or "no" go (3)

3) What is the maximum amount of cents do you want to pay for one bucket of water you get from the improved source? _____cents.

NOTE if "0" is recorded in "3" above go to "4"

4) If the maximum amount of money you would like to pay for the improved water service you will get from the improved service is ' zero' what is your reason for you do not want to pay?

a) Water should be provided free of charge

b) I satisfied with the existing source

c) I do not have enough money

d) Other reason (specify) _____

II) If this improved scheme is implemented household that does not have access to individual piping also benefited from the improved services for they do get quality water that does not require boiling to drink through out the year with out having to queue from public taps.

5) Have an interest to participate in this program?

a Yes b) no

6) If "yes "if the price of water from the improved source is 5 cents per

Bucket or for 20 liters are you willing to pay?

a) yes b) No

. If you say either "yes" or "no" go (3)

7) What is the maximum amount of cents do you want to pay for one bucket

of water you get from the improved source? _____Cents.

8) If the maximum amount of money you would like to pay for the improved water service you will get from the improved service is ' zero' what is your reason for you do not want to pay?

a) Water should be provided free of charge

b) I satisfied with the existing source

c) I do not have enough money

d)Other reason (specify)_____

General questions to be filled by all respondents

9) Generally, whom do you think responsible for the supply of improved water service for the town?

a) Government b) community c) private sector d) other (specify)_____

10) What do you recommend regarding the improved water supply for the town?

_____

_____

C) Questionnaires on demographic and socio economic characteristics

1) What is your name? Mr. /MS_____

2) Are you the head of this household?

a) yes b) no

3) If " no" who is the head of the household or spouse? Mr. / Ms_____

4) How many people live in this household, including your self? _____

5) Would you tell me the age, sex, education and occupation of your family members?

(Note that if the space provided below is not enough use back of the paper)

No	Relationship	Sex		Age	Education					Occupation (if any)
		M	F		Elementary	Junior	Secondary	College /university/	Other	
1										
2										
3										
4										
5										
6										
7										
8										

6) The house you live in is yours or rented?

a) Mine b) rented

7) If rented from whom do you rent?

a) Kebele b) private c) government

8) Please tell your average, monthly expenditure for the following items:

a) For food _____Birr b) For house rent (if any) _____Birr

c) For electricity consumption _____Birr d) for education fee and educational material _____Birr e) for transportation cost _____ Birr

f) For miscellaneous expense _____Birr

Thank you

ANNEX II

Correlation matrix of the explanatory variables

	AGER	EDUC	GENDUR	HHSIZE	HOUSE	OCCUP	RESPO
AGER	1.0000						
EDUC	-0.3902	1.0000					
GEND	0.2507	-0.0567	1.000				
HHSIZ	0.5074	-0.2250	0.1911	1.000			
HOUSE	0.3324	-0.2362	0.1310	0.2284	1.0000		
OCCUP	-0.4267	0.3527	-0.2016	-0.2574	-0.1810	1.0000	
RESPO	0.1516	-0.1804	-0.0405	0.1694	-0.0746	-0.0401	1.0000
LSAT	***-0.2508***	***0.2864***	***-0.0924***	***-0.1079***	***-0.0423***	***0.0398***	***-0.0378***
VOLU	***0.4290***	***-0.1479***	***0.0999***	***0.7905***	***0..2247***	***-0.1833***	***-0.0378***
QUAL	***-0.0922***	***-0.0251***	***-0.0104***	***-0.0772***	***0..2247***	***-0.1833***	***0.1336***
RELIA	***-0.1082***	***0.2525***	***-0.0305***	***-0.0538***	***-0.0064***	***0.0387***	***-0.0232***
ADCH	***0.4632***	***-0.2352***	***0.1585***	***0.7895***	***0.2503***	***-0.2061***	***0.1626***
TIME	***-0.0165***	***0.0715***	***-0.1292***	***-0.0260***	***-0.0860***	***0.0903***	***0.0103***
BID	***0.0179***	***-0.0041***	***-0.0479***	***-0.0527***	***-0.0713***	***-0.1408***	***0.0302***

PRESU	*-0.1235*	*0.1020*	*0.0275*	*-0.0492*	*-0.0637*	*0.1170*	*-0.1007*
SOURC	*- 0.0064*	*0.0224*	*0.1584*	*-0.0049*	*0.1327*	*-0.0718*	*-0.0491*
INCOM	*-0.0697*	*0.0557*	*-0.0422*	*-0.0167*	*0.0354*	*0.0836*	*-0.0572*

LSAT	**VOLUM**	**QUAL**	**RELIA**	**ADCHIL**	**TIME**	**BID**	**PRESSURE**
LSAT	**1.0000**						
VOLUM	**-0.0396**	**1.0000**					
QUALITY	**-0.0335**	**-0.0805**	**1.0000**				
RELIABL	**0.7130**	**-0.0933**	**-0.0111**	**1.0000**			
ADCILD	**-0.1365**	**0.6302**	**0.0003**	**-0.0441**	**1.0000**		
TIME	**0.0301**	**-0.0671**	**0.0066**	**0.0727**	**-0.0089**	**1.0000**	
BID	**-0.0362**	**-0.0518**	**-0.0867**	**-0.0488**	**-0.0089**	**0.0340**	**1.0000**
PRESUR	**0.2518**	**-0.0508**	**-0.1207**	**0.2604**	**-0.0555**	**-0.0449**	**-0.0436**
SOURCE	**0.0784**	**0.0360**	**-0.0726**	**0.0889**	**-0.0083**	**-0.6916**	**-0.0644**
INCOME	**0.2898**	**-0.0221**	**-0.0044**	**0.2692**	**0.0426**	**-0.0691**	**0.0256**

	PRESUR	SOURCE	INCOME
PRESUR	**1.0000**		
SOURCE	**0.1422**	**1.0000**	
INCOME	**0.0996**	**0.0935**	**1.0000**