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SCHOOL OF GRADUATE STUDIES**

**Determinants of Household Demand for Improved
Water Services : A Case Study of the Contingent
Valuation Survey in Addis Ababa, Ethiopia**

**By
Assefa Chaka**

May, 1998

Addis Ababa

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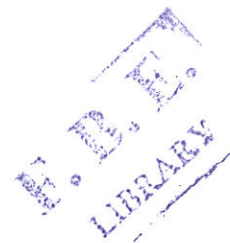
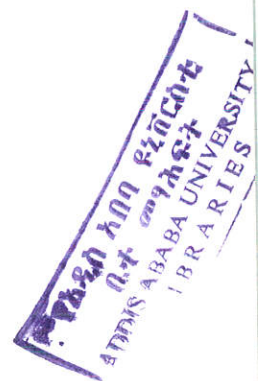
**A Thesis Presented to the School of Graduate Studies
Addis Ababa University**

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

**By
Assefa Chaka**

May, 1998

Addis Ababa



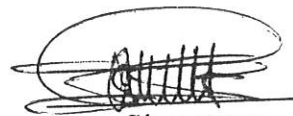
ADDIS ABABA UNIVERSITY
School of Graduate Studies

*Determinants of Household Demand for Improved Water Services:
A Case Study of the Contingent Valuation Survey in Addis Ababa, Ethiopia*

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Abstract

The demand for improved water services is determined by a number of socio-economic and demographic factors and water attributes. Information on the demand side are relevant for policy purposes such as tariff structure and the choices of appropriate water supply schemes. Various methods of determining households' preference and willingness to pay for improved water services are used in developing countries.

In this study both the contingent valuation survey (direct method) and the indirect (revealed preference) methods are used to estimate households' willingness to pay for improved water services in the city of Addis Ababa, Ethiopia. The research was based on primary cross-sectional data from sampled households of different locations in the city.

In the indirect method the binomial probit model was used to determine factors influencing households' decisions to connect to the piped water scheme. The CV approaches were utilised to investigate the determinants of households' willingness- to-pay for private connection and public taps.

The mean WTP bids for private connections and public taps are well above the current subsidised tariff, 8.66 and 4.7 cents per baldi, respectively. The results of the study revealed that the uses of the two approaches can provide policy relevant information on the level and type of improved water services required by households and how they should be paid for. Household income, ownership of house, age and education level are significant determinants of households' decisions to connect to the piped schemes. The significant variables influencing the WTP responses include income, education level and sex of the household head, household size, time for fetching water and household's attitude toward the responsibility of water provision.

The ordered probit model used for estimating of WTP responses of the CVM is found to be a promising approach to predict the number of households who will use an improved system if various prices were charged and to derive demand schedules. And raising tariff with unconstrained supply increases consumer surplus, number of connecting households and revenue for water utility.

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List of Acronyms

AAWSA	Addis Ababa Water and Sewerage Authority
CSA	Central Statistics Authority
CVM/CV	The Contingent Valuation Methodology
OLS	Ordinary Least Squares
WTA	Willingness To Accept
WTP	Willingness To Pay

CHAPTER ONE

INTRODUCTION

1.1. STATEMENT OF THE PROBLEM

Economic infrastructure has substantial impact on economic development and human welfare of every nation. It is believed to be essential for modernisation and diversifying production. It also helps countries compete internationally and accommodate rapid urbanisation.

With an attempt to raise productivity and improve living standards, developing countries have been making substantial amount of investments in new infrastructure such as transport, water supply, power, sanitation, telecommunication and irrigation. These are in fact the areas in which government policy and finance have an important role.

However, the focus of policy so far has been in raising the quantity of investments exclusively, with the neglect of quality of infrastructure and the related services. The 1994 World Bank Development Report revealed that low operating efficiency, inadequate maintenance and lack of attention to the needs of users have all played a part in reducing the development impacts of infrastructure investment in the past (World Bank, 1994). Despite the increase in investment, lack of access to clean water, inadequate transport networks, unreliable power supply are common in most developing countries.

As part of economic infrastructure, piped water supply is one element of the public utilities developing countries are striving to expand. In this part of the world millions of people in both urban and rural areas are confronted with the problem of obtaining sufficient clean water for domestic uses. A 1990 estimate suggests that 600 million urban dwellers in developing countries lived in shelters and neighbourhoods where their lives and health were continually threatened because of the inadequate provision of safe and sufficient water supplies (Satherthwaite, *et al*, 1993).

When the provision of water supply by public agencies is absent or unreliable, people are forced to use alternative sources of water such as dug wells, streams, rivers or other surface water (e.g. open sewers in urban areas) or unsanitary vendors. Lack of clean water due to deficient infrastructure implies the risks of contracting infectious diseases. It also means high opportunity cost (in terms of time, energy and money) for the poor urban households in searching alternative sources of water.

Tremendous efforts have been made by governments of developing countries to develop infrastructure in water supplies and improve the poor access to piped water. However, most of the policy decisions on investments and service so far have been found to concentrate on the supply side. Little emphasis has been placed on providing the consumer with suitable options for the kind of services they need and they are willing to pay (World Bank Water Demand Research Team, 1993). Similarly pricing policies such as introducing subsidies (through lower tariff) with the aim of improving the poor access are found to be unsatisfactory. The subsidies are often captured by middle income and high income households. As a result, most of the efforts were not successful to alleviate the problems.

Following those observations, recognition has increased that policy and planning should be established on a better understanding of what improvement in the water service people need and are willing to pay for. In addition, it is also realised that since the benefits of improved water supplies are great in terms of health, social and economic benefits, many people in developing countries can and will pay for improved services (see for example, Whittington, *et al*, 1991).

The demand for improved water services such as better quality and quantity, higher reliability and shorter distances from the consumer are determined by a number of factors. Information on the demand side such as households socio-economic and demographic characteristics as well as characteristics on existing and new supplies of water are believed to be vital to policy decisions like the choices of appropriate technologies and tariff system. Moreover, various studies in developing countries have showed that the use of the Contingent Valuation surveys

(direct method) and actual water-use practices (revealed preferences) could provide such kind of policy-relevant information. The Contingent Valuation Methods (CVM) typically use survey questions to elicit peoples preference for public goods by finding out what they are willing to pay for specified improvements.

The water situation in the city of Addis Ababa is not different from the prevailing conditions of most urban centres of developing countries. With a rapidly increasing population, which is estimated to reach 2.43 million in 1998 (CSA, 1995), the city is currently facing with critical shortage of improved water services. One study estimated that only 55 percent of the population in 1989 were supplied piped water from both private and shared connections to the city's network (AAWSA, 1991). A recent population and housing census report also indicates that out of the total of 374,842 urban housing units in the city only 100,632 housing units (27%) have private taps and 95,825 housing units (25%) have shared in compounds taps (CSA, 1995). The remaining housing units (about 48%) have no direct access to the system. They collect water from private vendors, public tap, wells or rivers which are highly contaminated.

Most of the private connections belonged to the higher quality housing units. And housing units' quality is closely related with income indicating that the majority of households belonging to the lower income groups are not served by yard taps or house connections. Moreover, the current prices for carried water (from vendors) more than 5 cents per 20 litres bucket or 2.50 *Birr* per cubic meter, which is five times higher than the minimum tariff (subsidised) rate of the water authority (AAWSA, 1993). The sole responsible agent for piped water supply, Addis Ababa Water and Sewerage Authority (AAWSA), provides water for both domestic, administrative and industrial purposes.

Lately the authority has initiated huge water supply projects such as Addis Ababa Water Supply Project Stage III (Region 14 Economic Development and Plan Bureau, 1994). However, the primary focus of the program is to supply adequate water for the rapidly increasing private investment projects (commercial activities) in the city. Little attention is

given to the growing needs of the households for improved water services. In fact recently the Regional Council of Addis Ababa pointed out in its report "... one way of alleviating the obstacles of water shortage on investment activities is to supply the existing water primarily to the investors, by suspending water services to domestic purposes..." (Region 14 Administration, February, 1997).

Generally, the existing policy initiatives in the region regarding water supply seem to neglect the effective demands of the majority of households in the city. Therefore, the need to fill the gap of information on the demand side for policy purposes appears to be timely. The study attempted to shed light on the issue by trying to investigate the determinants of households demand for improved water services in the city of Addis Ababa.

So far, very few studies have been made in our country to assess effective demand for improved water services. Similarly, only a few applications of the CVM can be identified (Fisseha, 1997 and Shimelis, 1997). The investigation results could serve the regional policy decision-makers in avoiding potential resource wastes in over-designing of water projects and in meeting the effective demand of households so that improved water schemes are not under-designed. The estimated benefits could contribute towards devising a reasonable tariff structure and conducting a realistic cost-benefit analysis in urban water supply schemes. Moreover, the study also supplements the past few initiatives in application of the methodology and contribute to further empirical investigations in the area.

1.2. OBJECTIVES OF THE STUDY

The ultimate objective of this study is to investigate the determinants of households' demand for improved water services and their willingness to pay using the Contingent Valuation Method (CVM). The focus is in the city of Addis Ababa.

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The specific objectives include:

1. To identify the determinants and measure the level of willingness to pay (WTP) of households for the improved services;
2. To assess the reliability of the CV survey using an indirect method assessment (actual choice behaviour);
3. To estimate demands for improved water services and total benefits that can be expected from the provision of the improved services; and
4. To determine the appropriateness of the existing government policy concerning water supply and how the WTP responses can be used of evaluating policy options.

Among the factors to be examined, the socio-economic and demographic characteristics of the households, the characteristics of existing and improved services and households attitudes toward government policy are expected to influence the demand for improved water services.

1.3. Organisation of the study

The rest of the study is organised as follows. In chapter two a review of the water supply and demand situation in Addis Ababa is provided. Chapter three deals with a survey of both the theoretical and empirical literature on valuing environmental resources and the Contingent Valuation Methodology (CVM). The scope and the methodology of the research is presented in chapter four. Chapter five provides the empirical results and discussions of the study. And finally, chapter six offers the main conclusions and policy implications of the study.

CHAPTER TWO

The Water Supply and Demand in Addis Ababa City

Established in the late 19th century, the city of Addis Ababa has originally been supplied water from springs developed at the base of Mt. Entoto. This first known water system was supplying untreated water mainly to the palace of Emperor Menelik. With the growing population and urban development, however, the need for water has led to the construction of Gafarsa and Legedadi Dams and the establishments of sole responsible agent for water Addis Ababa Water and Sewerage Authority, AAWSA.

Various studies have been conducted concerning the water supply system of the city (AESL, 1984; BCEOM, 1982; Price Water House, 1993). A detailed and comprehensive study was conducted by Suereca consulting Engineers (AAWSA,1991), as a feasibility study and preliminary design of the Addis Ababa water supply project III. This chapter summarises the main features of the supply system and the prevailing water demand situation in the city focusing on recent developments.

2.1. The Existing Water Supply System

Piped water in the city is currently supplied by the sole responsible authority, AAWSA, which is established in 1971 and re-established in 1994 in order to meet the highly growing need for water. Almost all the water supplied by the authority comes from the two systems of the Gafarsa and Legedadi Dams, which are based on surface water resources though there is a potential for ground water resource development.

2.1.1. The Gafarsa and Legedadi Dams

Dug wells and springs have been the main sources of water in the early development of the city. The old Gafarsa dam constructed at the Little Akaki river around 1935 and raised in 1955, used to supply the city with a capacity of 15,000 m³/day (cubic meter per day) of improved water. In 1960, the storage capacity of the dam was doubled with the construction of the Gafarsa 3 dam with a new treatment plant.

With the expansion of the city and increasing population, the growing need for water led to the construction of the Legedadi dam in 1967-1970, on the Akaki river in the eastern part, outside the city. The Legedadi system consisted of a concrete buttress main dam, gated spill way for overflows, and a rock fill dam with a 50,000 m³/day yield capacity. As part of water II project in 1985, a new treatment plant and pipelines are constructed to raise the supply from the dam to 150,000 m³/day.

The current reliable yield of water from the two sources ranges from 151,000 to 160,000 m³/day. Limited supply pipeline capacity and several broken control valves are the reported problems associated with the systems.

2.1.2. Water Treatments

Treatments (water cleaning and prevention from decay) are carried out at both dams. At Gafarsa dam, using the treatment plant commissioned in 1960, treatment is undertaken via clarifiers followed by rapid gravity filtration and chlorinating. The first stage of the Legedadi treatment plant was commissioned in 1970 with a capacity of 50,000 m³/day. The plant extended in 1985 to the capacity of 100,000 m³/day. It consisted of clarifiers followed by rapid sand filtration and chlorinating. Sludge from treatments are discharged to adjacent rivers.

2.1.3. Water Transmission and Distribution

The Gafarsa transmission line consisted of two 400 mm (millimetre) in diameter pipelines which supply to three subsystems directly and using the Ras Hailu Reservoir (Rufael, St. Paul and Core-Kolfie subsystems). This system supplied most of the south western part of the city by gravity and pumping from service reservoirs.

The Legedadi transmission line, with a 1400 mm pipe line transfers water to the Terminal reservoir. The Legedadi system serves water to the larger part of the city, the north eastern and central areas comprising a total of eight subsystems. Water is served by progressive pumping from different reservoirs.

A total of thirty eight service reservoirs are used with associated thirteen pumping stations for distribution from the two systems. Though the reservoirs are located at various sites in the city, some areas are isolated from services of subsystems. Especially the higher elevation areas of the city, which totally depend on small pumping stations, are currently with critical water shortage problems. The southern extremities in the city are also afflicted by system inefficiencies.

2.1. 4. Water Tariff Structure

All water supplied by the authority are metered. The existing water tariff consisted of initial charge (connection charges and deposit fees), a bimonthly meter reading charge and volume charges based on metered water consumed. The volume charge of the system has got a rising block structure.

The new tariff system is implemented starting March 1994, superseding the previous tariff system which was almost totally based on a simple scale of volume charge for all purpose. In fact the new system initiated based on the recommendation of the tariff study conducted by Price Water House (Price Water House, 1993).

Basis for the study was the long run marginal costs of AAWSA's services and its revenue requirement for its entire capital investment program. Comparison of the old and the new tariff system of water supply is presented in Table 2.1.

Table 2.1. Water Tariff Structures in Addis Ababa (New and Old)

Nº	CHARGES	Old	New
1	Initial charges • Connection • Deposit fees	✓ ✓	✓ ✓
2	Recurring charges • metre rent • volume charge* Block 1 (< 15 m ³) Block 2 (16-40m ³) Block 3 (> 40m ³)	- 0.50 - - -	✓ - 0.50 0.75 1.50
3	Public Fountain Operators	0.30	0.50

* Volume Charge is Birr per cubic meter of water.

Source: AAWSA (1993)

2.2. Water Demand

According to the 1994 population and housing census (CSA, 1995), out of the total households in the city, only 27 per cent had a private access to the pipe water system and 25 per cent used shared connection. This implied that the rest households (47%) relied up on outside water resources mainly from private vendors and public taps. In this section the water demand situation in the city is briefly described in terms of type and number of connections, consumption versus production and population growth and water requirements.

2.2.1. Type and number of connections

The water authority in the city (AAWSA) provides improved (piped) water for all purpose using mainly the two water sources (Gefersa and Legedadi) and six consumer service branches. All water supplied by the utility is metered. The type and number of connected customers for the year 1995 is presented in presented Table 2.2.

A total of 132,410 customers in the city were supplied water from the utility in 1995 (AAWSA, 1997). Out of these, 1382 customers are classified as government and high consumers and the rest are classified as domestic and small commercials. Specific data on domestic connection could not be obtained. However, comparing the connection data for the domestic and small business to the total number of households in the city (more than 400 thousand), it is evident that the number of households connected did not exceed thirty per cent of the total.

Table 2.2. Table and number of customers of AAWSA (1995)

Type of consumer	No. of connection
Domestic and small commercials	130,651
Government and High consumers	1,382
Public Fountains	377
Total	132,410

Source : AAWSA (1997)

The growth of connection is limited due to supply constraint, which is also aggravated by technical and administrative problems. Up to the end of 1997, more than twenty thousand applicants were waiting for private access to the pipe system (AAWSA, 1998). The authority has got difficulties covering its recurrent expenses, let alone finance new schemes (Region 14, Plan and Economic Development Bureau, 1994).

The number of public fountain in city are only 377 standpipes and 51 of them are currently out of use due to technical problems. Those households who can not afford to the costs of private connection and who should be provided with public taps are the one who are suffering most. They have no alternative but to buy with higher prices from those households which are already connected. Current price of water from private vendors exceeds five cents per *baldi* which is five times higher than the official tariff. Even those who are not able to pay those

prices may be forced to use other sources of water such as rivers or wells which are highly contaminated in urban areas.

2.2.2. Water consumption versus production

Past and current consumption by type of customers could be used to analyse the current water requirement and assess future water demand. Consumption data based on types of consumer were not accessible. However, a total production and consumption figures could provide a picture on the level of consumption and future trend (Table 2.3).

**Table 2.3 Total production and consumption (Average daily = m³ / day)
(1992/93 - 1996/97)**

Year	1992/93	1993/94	1994/95	1995/96	1996/97
Production	150,850	151,285	156,956	154,397	160,120
Consumption	105,581	105,899	109,868	108,079	112,084
Growth Rate (%)	-	0.3	3.7	-1.6	3.7

Source :AAWSA (1998)

The total daily production, with slight annual variations, averaged for the five consecutive years to 154,032 m³/day while average daily consumption is 108,302 m³/day. Average annual growth rate in both production and consumption is about 1.22 % which is rather low despite the rapid increases in population and economic activities in the city. Pattern of growth of consumption is similar to (dependent on) production indicating water shortage in the city.

'Unaccounted for water' that is the difference between the total metered production (supply) and the metered consumption is about thirty per cent. That is 30 per cent of the total production is lost due to leakage and unrepaired pipe systems.

2.2.3. Future water requirement

Based on the current water requirement and population growth rate, the total water demand up to the year 2020 was projected under a study by SUERCA Consulting Engineers on Addis Ababa Water supply project stage III (AAWSA,1991). The gist of the projection is provided in table 2.4.

Table 2.4 Water Demand Projection

Year	Population Projection '000	Total water Requirement M ³ / day
1994	2164	177,142
1997	2448	205,998
2000	2762	239,004
2005	3353	303,854
2010	4065	388,153

Note: Projection based on SUERCA Consulting Engineers.
The total water requirement (production) was computed considering a 28 % unaccounted for water and 5% losses for treatment process.

The increasing population, rising number of applicants, the stagnant growth of water production and the overall projection indicate that unless immediate measures are taken for the provision of improved water services to all the current water shortage problem worsens in the near future.

Chapter Three

Literature Review

The literature reviewed in this chapter consists of both the theoretical and empirical literature. The survey on the theoretical part comprises of economic valuations of environmental resources, demand for improved water and the contingent valuation methodology. Finally empirical evidenced on the CVM application will be dealt.

3.1. Methods for Valuing Environmental Resources

The development of various methods of estimating benefits of non-marketed goods can be traced to the subject of welfare economics and the recent development of environmental economics. While welfare economics focuses on the aspects of choice that are relevant for social well-being, environmental economics concerns ensuring that the manner in which shared environmental endowment is used consistently with achieving the best for our economic and social well-being (Convery F.J. 1995).

Welfare economics conclude that competitive market will bring an economy to an optimal situation from an economic efficiency point of view. The characteristics that the market need to be competitive include, *inter alia*, the assignment of property rights. However, with the existence of environmental goods which involved externalities and public goods, the free market rarely produces the desired welfare results.

On the other hand, with the desire of having government undertake policy measures, economists have come out with a new welfare criteria i.e. the pareto criteria (Mitchell and Carson, 1989). The pareto criteria states that policy changes which make at least one person better off with out making any one worse off are pareto improving and should be undertaken. With the failure of market, one possibility used for this purpose is the cost-benefit analysis,

which is a procedure for determining the value of a project or program by putting a money value on the gains or losses.

However, the benefits to be expected from the proposed changes in public goods are difficult to measure. In this circumstance, a range of methods of valuing benefits has been developed which can be used when market information is defective or absent. These methods can be classified into the indirect and direct methods, in which how much beneficiaries are willing to pay is determined (Knees and Russell, 1990).

3.1.1. The Indirect Methods

In the absence of market prices for public goods, it is possible to estimate an implicit values for such goods or services by means of the price paid for an other good which is marketed. The best known indirect methods are the Travel Cost and the Hedonic pricing methods. The Travel Cost (TC) method depends on information about the amount of money and time people spent getting into a site to infer a value for that site. Although the Travel Cost can in theory be used to value almost any non-marketed goods and services, in practice, however, it only used for the valuation of specific recreational sites. The method has got several limitations including the substantial data requirement and the problem of valuing the time spent in the site.

Hedonic value methods use market price for related goods or services to estimate an environmental value that is embodied in the observed price of the related good. Mostly property and land prices are used to place implicit value of environmental factors (e.g. air or water quality) that are otherwise difficult to value. The basic assumption of this method is that individuals reveal their preference for environmental quality through their choice and payment for residential housing (Dixon, *et al.*, 1994). The main challenges in these methods are the problem of correctly specifying the functional form, data constraints, and the absence of competitive market for houses in developing countries.

3.1.2. The Direct Approach

These methods are usually classified as Contingent Valuation Methods (CVM) which use surveys to elicit values. Individuals are asked using these techniques, what they would be willing to pay for carefully and hypothetically specified public goods. The CV study incorporates a description of the commodity to be valued, a method by which payment is to be made and a method of eliciting values. Because the elicited WTP values are contingent (dependent) upon the particular hypothetical market described to the respondent, this approach is called the contingent valuation method (Mitchell and Carson, 1989).

The method is developed and first used in developed countries for valuation of public goods such as clean air, water and national parks (see section 3.3). However recently in developing countries the CVM has been most often used for valuation and estimation of demands for publicly provided goods such as improved water supply and sewerage services (Dixon, *et al.*, 1994).

3.2. Demand for Improved Water Services

The supply of improved water may mean the quality of water is improved, the reliability is greater, the quantity of water available may have increased and its distances from the consumer may have reduced. Effective demand for water signify the level of water people demand and are prepared to pay for it at particular price level. It is determined by a complex interrelationship of a number of factors.

Carruthers and Browne (1980) in their study revealed the potential benefits of safe water provision in terms of health benefit, social benefits and economic benefit which are closely related. Unsafe supply of water is certainly a hazard to health. Improving the quality of water can prevent water-born diseases. Whereas increased quantity of water can reduce water-washed diseases such as skin disease, its reliability will reduce the risk of epidemics in the

community. These effects also means lower medical expenditure and an improved sense of well-being and productivity to community (health benefits).

Improved water supply significantly reduces the walking distance to alternative sources which leads to saving of time and energy which may be used for productive purposes (economic benefit). It also implies more time saved to be spent with family, either looking after children or on domestic activities and leisure (social benefits).

Measuring the values of total benefits realised from provision of improved water is a difficult task for cost benefit analysis. The reason being that the value of the non-marketed benefits could not be expressed in financial terms easily (Carruthurs and Browne, 1980). However, since consumers will not be willing to pay more for provision than benefits they derived, economists attempted to estimate the real benefits by asking the beneficiaries how much they are willing to pay for the good using various estimation techniques (Convery F.J. 1995).

In addition, modelling water demand is found to be a more difficult task in developing countries than it is in industrial countries. In developed countries, where it is almost normal for the market mechanism to determine the relative values of goods and services, the economics of water utility management is a relatively simple matter (Briscoe, *et al.*, 1990). Water demand studies are focused on the estimation of income and price elasticities of demand for water. All potential users are expected to connect to the system. And since the quantity of water is relatively inelastic with respect to price, future water requirements and total revenues for a given tariff can easily be estimated (Jones, *et al*, 1984).

In the case of developing countries, however, modelling water demand is a complicated matter. The number of potential users who will prefer to connect to a system is highly dependent on several factors such as household's socio-economic characteristics, the cost and perceived quality of existing water (such as tariffs, cost of connection and the level of service offered).

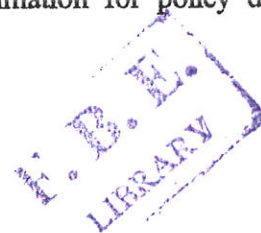
A considerable amount of information is needed on what level of services people require and for what they are willing and able to pay, before decisions are made on water system designs and tariff settings. Otherwise, a hazard of over-designing or under-designing may be encountered. Therefore, water demand studies from developed countries seemed to have limited importance for developing countries.

To fill this gap, quite recently the CVM typically has been used in assessment of water demand in various developing countries, in both urban and rural areas. And the method produced some illuminating insights as the basis of benefit estimation for policy decision purposes (The World Bank, 1993).

3.3. The Contingent Valuation Method (CVM)

The CVM first came into use in the early 1960s by economist Robert K. Davis (1963) when he used questionnaire to estimate the benefits of outdoor recreation in a Maine backwoods area (USA). However, previously the well-known resource economist Ciriacy-Wantrup (1948) had suggested the use of the direct interview method for measuring values associated with natural resources. Unaware of this suggestion, it was Davis who played a key role in developing it. Since then, the CV technique has been utilised by various economists to measure the benefits of a variety of goods including recreation, hunting, water quality and toxic waste dumps (Mitchell and Carson, 1989).

Various researches were undertaken on both the methodological issues (Schultze *et al*, 1981; Cummings *et al*, 1986) and the theoretical works (Freeman, 1979; Brookshire *et al*, 1982; Johanson P.C., 1987). While the theoretical works established that the CV data are generated in forms consistent with the theory of welfare measurements, the methodological works concentrated on refining the CV methods by identifying and testing possible biases. Attempts also were made on establishing its credibility by making comparisons with other benefit measuring techniques. Though the CVM is applied to evaluate both the WTP and WTA



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(willingness to accept) responses, the review here will concentrate only around the WTP studies.

3.3.1. The Theoretical Basis of the CVM

One important advantage of CVM on other benefit estimating methods is its capability of providing the correct measure for benefit estimation and meeting the requirement of economic theory. The theoretical validity of the CV method can be explained as follows with the concepts of the standard consumer surplus (CS) and the Hicksian compensating surplus.

The customary standard measure of consumer benefit is the Consumer Surplus which is defined as the area under the Ordinary (Marshallian) demand curve and above the price line (Mitchell and Carson, 1989). The concept of consumer surplus has got problems as the measure of benefits form changes in prices or quantity. This is due to the fact that the Marshallian demand curve does not hold utility level constant but instead it holds income level constant. On the other hand, the compensating surplus measures benefits from the consumer's current or initial level of utility.

Mitchell and Carson (1989) stated that "for a quantity increase such as raising the level of air visibility, the compensating surplus measure can be interpreted as the consumer's maximum willingness to pay in order to gain the quantity increase and still maintains his initial level of utility ... In the case of quantity decrease as the minimum compensation the consumer is willing to accept in return for receiving the decreased quantity".

In a CV survey respondents are asked to express a value for a change in the provision of a good i.e. the maximum they are willing to pay for. In other words, a respondent is asked to determine what change in his income (coupled with the change in the level of the public good) leaves his utility level unchanged (Johansson P.O, 1994). For this reason the concept of compensating surplus rather than the consumer surplus becomes very important. The compensating surplus (CS) is one of the measures of gain or loss, suggested by Hicks (1941) which hold utility level constant at the initial level.

Now the measures obtainable by the CVM can be represented in terms of the difference between two expenditure functions. In order to derive the income compensated measures the expenditure functions is defined as:

$$e^h (P, Z, U^h) = y^h \text{ for all } h \dots\dots\dots(3.1)$$

Where; P = a vector of prices

Z = a vector of fixed public goods

U = a level of utility and

Y = the minimum amount of income needed to maintain
the specific utility level

The expenditure function of the household gives the minimum expenditure required to reach the specified utility level, given price, p , and the provision of public goods, z (Johansson P.O., 1994; Mitchell and Carson, 1989).

An increase in Z increases utility and the expenditure in private good must fall in order to maintain the individual at the specified utility level. Now letting p_0, z_0, u_0 , and y_0 represent some initial level of those arguments and p_1, z_1, u_1 and y_1 represent some following levels.

The compensating surplus (CS) can be represented by:

$$CS = [e^h (p_0, z_0, u_0) = y_0^h] - [e^h (p_0, z_1, u_0) = y_1^h] \dots\dots\dots (3.2)$$

If CS is positive, then z_1 is preferred to z_0 and the consumer would be willing to pay up to the point where his utility level was the same as it was in the initial situation.

The compensating surplus of the Hicksian measure can be interpreted as the consumer's maximum WTP in order to secure an increased provision of public good and still maintain his initial level of utility.

Once a CV survey is obtained the correct theoretical measure for a sample of individuals that is the aggregate CS associated with a discrete change in public good provision is added together for all individual affected. This will give as the total benefits for the good being valued.

That is,

$$CSz = S^h (e^h (p_0, z_0, u_0^h) - e^h (p_0, z_1, u_0^h)) \dots \dots \dots (3.3)$$

Hence for a discrete change in provision which is desired for a decision making the CVM is capable of obtain the appropriate Hicksian measure (equation 3.2 and 3.3) without having to estimate directly any form of demand curves. Implication of the above explanation is that the CVM enjoys one strong advantages of theoretical validity over the commonly used indirect methods of benefit measurements such as the Travel Cost technique which rely on estimations of some type of demand curves.

3.3.2. Methodological Issues

As mentioned previously, the CVM uses survey questions to elicit people's preference for public goods by finding out what they are willing to pay for a specified improvement. For this purpose in an interview the respondent is presented with a questionnaire which must incorporate the following three parts (Mitchell and Carson, 1989):

i. A detailed description of the commodity to be valued and the hypothetical condition under which the good is provided to the respondent;

A model market scenario constructed by the researcher that is going to be read by the interviewer during the survey;

ii. Questions which elicit the respondent's WTP for the good being valued. The questions are designed with different techniques such as bidding games or card games to facilitate the valuation process; and

iii. Questions about respondents' characteristics, their preferences and their uses of the good in order to get information which is to be used in regression equation to estimate a valuation function for the good. The purpose of the estimation will be to identify whether the respondents' responses are consistent or not with theory in identifying their WTP. It serves as a partial evidence for reliability and validity.

A valid WTP responses resulting from a well designed and carefully tested study are then used to develop a benefit estimate. The results can be generalised to the population from which the respondents are randomly sampled, if a careful random sampling procedure was undertaken and the response rates are high enough.

Various techniques of elicitation are used in CV survey including the open ended questions and the bidding games. Comprehensive reviews of the CVM valuation techniques are obtained in Cummings *et al.*, (1986) and Mitchell and Carson (1989). In the open ended case, respondents are asked to name the maximum price they would be willing to pay for the good. There is a general agreement that open ended (direct question) are difficult to respondent to answer.

In the iterative bidding game which is the most often used technique, respondent is asked whether he would pay a particular amount of money for the good. This amount is then varied until a maximum WTP is reached. The bidding game will enable the respondents to make fully consider the value of the good. One advantage of the iterative bidding game is that the responses often have a lower standard deviation around their mean (Dixon *et al.*, 1994). However it is said to have the potential of a 'starting point bias' that is, the starting bid tends to imply the value of the good, influencing the respondents WTP amount.

The CVM has been used to estimate benefits for various public good in developed countries as well as in developing countries. Despite its advance in its multiple uses and strength over the indirect methods, the methodology is, however, subject to various criticisms because of its hypothetical nature. The hypothetical nature of the method said to produce several biases which may affect its reliability.

One of the objections in the use of CV survey technique is that people may not give responses which reflect their true values. They may not have incentives to answer correctly when confronted with an imaginary situation. More frequently the problem arises in the case of choices between goods which people are not familiar with leading to 'hypothetical bias' (Cummings *et al*, 1986). However, CV elicited for public utilities such as water supply which are familiar to respondents are expected to exhibit greater reliability and predictive validity than those elicited for other public goods (Dixon, *et al*, 1994).

The other major criticism of CVM is the possibility of strategic bias in the method. that is depending on how the respondent perceives the consequences of the hypothetical condition, they may not reveal their true preferences (by acting like "free riders"). They may understate their true WTP if they feel that they have to pay the amount they answer or overstate their true WTP if they feel this brings about the improvement and they do not have to pay. However, recent evidence suggested that the free riding problem is rather low (Cummings, *et al*, 1986), and in most properly designed CV surveys the strategic problem is even lower (Mitchell and Carson, 1989).

To generalise asking people what they are willing to pay to hypothetical good may not be the same as confronting them with a well understood and recognised market and observing what they actually pay. However, based on various reviews on its empirical applications, comparisons with alternative methods, using experiments actually and in laboratory, it is strongly argued that the CVM gives meaningful values. Moreover, it is said to represent the

most promising approach yet developed of determining WTP responses for public goods and utilities (Cummings, *et al*, 1986; Mitchell and Carson, 1989).

3.4. Empirical Evidence relating to the CVM

The literature surveyed on the empirical evidences comprises of two categories. First its applications on various areas in both developed and developing countries and then its particular applications on improved water services will be provided.

3.4.1. Various applications

The method have been applied in industrial countries mainly in the domains of outdoor recreation, improvement of national water quality and air pollution. Earlier Robert K. Davis (1963, 1964) used questionnaire with the bidding game technique to estimate the benefits of outdoor recreation in a Maine backwood areas (USA). The study indicated an economic consistency in the WTP responses. Estimating an equation of WTP bids as a function of income, length of stay in the area, and acquaintance with the local in years, Davis has got a large percentage of total variation of WTP explained by those variables ($R^2= 0.59$).

Brookshire, D. *et al*, (1976) used the CVM to value the aesthetic impact of a proposed power plant on the northshore of the Lake Powell recreation area in Utah (USA). Respondents are asked about their WTP to preserve their view of the lake from the degradation caused by the presence of the power plant and its smoke. A total of 104 respondents were interviewed using the iterative bidding game. The study showed that the CV method as the best alternative for areas where other methods such as the hedonic pricing approach could not be applied. Moreover, the results were consistent with demand theory and incentives for strategic behaviour are also found to be minimal.

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nation's lakes, rivers and streams (Mitchell and Carson, 1989) A total of three improvements in minimum national water quality were valued: from 'below boatable' to the 'boatable' level, from boatable to 'fishable' and from fishable to 'swimmable' water quality. Both verbal description and visual aids were used in the scenario. After a trial on the bidding game techniques, to avoid the possibility of 'starting point bias' a payment card technique were used which showed a number of dollar amounts ranging from zero to high amount. A split-sample technique was also used to examine the influence of scenario components on the WTP amounts and to test different biases. The result of the study showed that there is a strong evidence for the theoretical validity of their findings.

Brookshire, *et al*, (1982) attempted to validate the CV by its direct comparison to the hedonic approaches. In Los Angeles metropolitan area where the air pollution problem is well defined, a total of 390 households were interviewed using the CV survey. The people were asked to provide their WTP for an improvement in air quality. For comparison purpose data was obtained on 634 single family house sales in the same area (for the Hedonic approach). The experiment showed that air quality degradation had a substantial negative effects on housing prices and these negative price effects on housing are comparable to what respondents of the survey have said they are willing to pay for an improvement in air quality. The study evidenced the validity of CVM as a means of determining the value of public goods.

Some applications of the method in developing countries illustrated the insight CVM can bring to the analysis of choice. Though they are started recently most of the studies are concentrated in the contest of publicly provided goods and services such as improved water supply and sewerage services (see section 3.4.2.). In another dimension, for instance, Brown and Henry (1989) estimated the WTP for elephant safari experiences in Kenya by using a questionnaire of visitors. The findings were of great policy interest in that they showed a WTP additional sums to conserve the elephants. Moreover, it indicated that tourism in the area would be seriously affected if elephant numbers declined substantially.

In another study Kramer, *et al*, (1994) used both the CVM and the Travel cost techniques for estimating costs and benefits of Tropical forest, from the creation of Mantida National park, Madagascar. The CVM was used to estimate opportunity costs to local users of the forests as a result of the park establishment, by asking households whether or not they would be willing-to- accept (WTA) a certain amount of offer. The Travel Cost method is used to estimate recreation benefits to the international tourists to the park area. The CV responses were then analysed with a regression model. Using a discrete choice model, it was revealed that a number of socio-economic variables were systematically related to the probability of accepting offered bids.

3.4.2. CVM Applications in improved water services

Focusing on fundamental importance of demand analysis in the selection of appropriate policies, various studies were conducted in developing countries to investigate the determinants of households demand for improved water services. A world Bank Research Team between 1987 and 1990 set out to investigate the determinants of households' water demand in selected regions of Africa (Nigeria and Zimbabwe), Latin America (Brazil and Haiti) and South Asia (India and Pakistan) (Briscoe, J. *et al*,. 1990; Singh, B. *et al*, . 1990; Whittington, *et al*,. 1990; Alfat. A, *et al*, .1993 and The World Bank, 1993).

Both the direct method (CVM) and indirect methods (revealed preference) methods were used to study how households made their choices about water sources and to estimate households WTP for different levels of improvement. The direct approach used the CV survey asking people who did not have an improved water source whether they would prefer the new source if it were provided under specified conditions and how much they will be willing to pay for access.

An indirect method is used together with the CVM for inference based on actual behaviour rather than the actions that survey respondents say they would take. The method used discrete

choice econometric technique to model household decisions and to derive estimates of welfare changes from actual choices that households made.

The studies showed that a set of relevant socio-economic and demographic characteristics of the household as well as characteristics of existing and new water supplies jointly influencing a household's willingness to use or, to pay for, an improved supply.

The team has summarised the joint determinants as follows:

- a. the economic and demographic characteristics of the household including education of family members, occupation, size and composition of family, and measures of income, expenditure, and asset;
- b. the characteristics of existing or traditional source of water versus those of the improved water supply including the cost (both financial and time), the quality and the reliability of the supply; and
- c. households attitude toward government policy in the water supply sector and their sense of entitlement to government services.

Results from the empirical studies have shown that WTP does not depend solely on household income, but equally on the above characteristics. Percentage of income that a house hold is willing to pay varies from study to study. For instance, households are found to pay 2 percent of their income for yard taps but nothing for public taps in Brazil, while in Nigeria many households pay vendors 10 percent of their income. Income elasticities of demand for access to improved water services were found to be uniformly low in most studies (e.g. 0.15 in Brazil and 0.14 in India) suggesting that household income is not major a determinant of demand for improved water.

As expected better educated households were found generally willing to pay more than their counterpart. The CV survey Punjab, Pakistan (Altaf, *et al*, 1992) showed that households with most educated members were on the average willing to pay 25 percent more for private connection. In Brazil, a household head with one to four years of education was 7 percent more likely to connect to a piped system than a family with a head of no education. In Nigeria five more years of education increased a household's WTP for both public taps and private connections by about 50 percent.

Gender and occupation are also found to have significant influences on WTP, though the results are mixed. The direction of gender influence depends on the specific cultural conditions. In Haiti, female respondents are willing to pay more for public taps than male respondents (Whittington, *et al*, 1990). While in Nigeria women are willing to pay only 50 percent as much as men. In India civil servants are more likely to connect to improved system than households with no one worked for the government. In Brazil, respondents employed in the formal sector were willing to pay about 15 percent more than those employed in the informal sector.

Family size and composition such as household size, proportion of adult women and children in the family, age of respondents rarely show any significant effect on willingness to use or pay for improved services (The World Bank, 1993). The findings also show that costs, quality, reliability and level of services of the water source (both the improved or alternative sources) influenced households WTP for improved water services. The higher the cost of existing services, households will pay more for the improved one.

The empirical results also support the expectations that households are more willing to pay for an improved source when the perceived quality of the existing water source is poor, water from the improved source is reliable or for a private connection rather than for access to a public tap. In Haiti, for instance, households that rated the quality of their existing water source "poor" were willing to pay 10 percent more for a private connection than those who rated "satisfactory" or "good" (Whittington, D. *et al*, 1990a).

Differences in WTP amounts can also be attributed due to respondents' attitude toward their entitlement to free or subsidised water provision. In Nigeria, respondents who responded that it is government's responsibility to supply a new water system were found to pay 30 percent less than similar respondents who are less optimistic about government's abilities.

Several elicitation and econometric techniques were used in those studies. Briscoe, *et al.*, (1990) in their studies in Prana state, Brazil used the surveys of both actual and hypothetical water-uses practices. They conducted a total survey of 1232 households in different villages. Both the probit and tobit models were used for regressions. A test was also conducted for strategic bias. They concluded that a well-designed and carefully administered surveys of actual and CVM can provide consistent and reliable information on WTP for improved water supply.

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

Whittington and others (1992) used the CVM to assess the willingness in Kumasi, Ghana, to pay for alternative modes of water supply and sanitary services i.e. for the provision of a water closet and piped sewerage system or for a ventilated pit latrine which does not require piped sewerage.

The result indicated that existing expenditure per household amounted to an average of \$0.50 and the WTP for an improvement amounted \$1.50. On this basis, a subsidy of \$60 million

would be required for provision of water closet but only \$4 million if the ventilated pit latrine were provided. Therefore a strong balance of advantage for ventilated pit latrine was found even without estimating the health benefits of accruing to the whole community.

In a recent study of the preference of rural people in different level of water services, Singh and others (1993) used the CVM to assess WTP for the yard taps or home connection in several rural villages in Kerala, India. An iterative bidding game was used to elicit WTP. Results indicate that there is a potential for the water system to rise out of its low-level equilibrium (poor services produces little revenue thereby leading to continuing poor services).

Only few applications of the CVM can be identified in Ethiopia's situation. An investigation was undertaken using CVM in Meki town to assess consumers WTP for piped water supply (Fisseha, 1997). The results showed that more than half of the sampled households are unsatisfied with the existing services. And almost double the current average price was found to be affordable for improve water services. Shimelis G.(1997) also used the CV survey in valuing economic loss of deforestation in Ethiopia.

3.5. Synopsis

The literature reviewed in this study has dwelt largely on the theoretical and methodological issues of the CV survey, problems encountered and its various applications and its particular application on improved water services. The literature suggests that the WTP approach of the CVM is more viable than the other indirect methods on estimating values for environmental goods. Especially in estimating demand for improved water services in developing countries, the studies illustrated the insight the methodology can bring to the analyses of choices.

Therefore, based on the overall literature survey and with few local applications of the CVM, it is believed that this study can supplement an Ethiopian literature on determinants of demand for improved water and on the application of the CV methodology.

Chapter 4

Methodology and Scope of the Study

The Contingent Valuation Method (CVM) and the indirect approach (revealed preference) were used to investigate the determinants of household's demand for improved water services and determine their willingness to pay under different socio-economic and demographic backgrounds in Addis Ababa City, Ethiopia. These were accomplished by designing and administering a CV survey to estimate households' WTP and collect information on different categories of variables from a cross-section of sampled households in the city.

The information obtained from the survey were then used to analyse the WTP responses, estimate a direct and indirect valuation functions, compare the estimates from the two approaches and derive demand schedules for improved water services of both private connection and public taps.

This chapter describes consequently the limitation of the study, the sample and questionnaire designs, the data types and sources, the field procedure, the model specifications and finally the hypotheses tested in the study.

4.1. Scope of the Study

Due to a very limited time and financial constraints for the study, the investigation was limited to the city of Addis Ababa, covering only four different *kebeles* of two administrative zones. The city of Addis Ababa is selected because it is one of the urban centres in the country with high shortage of water. There is also a great concern of households' water need with the rising competition as the industrial and commercial sectors expanding rapidly.

Attempts were made to have a sample of households with different socio-economic and demographic characteristics, ensuring representativeness using a random sampling procedure. The study was restricted to estimate only the domestic use value of improved water services for domestic purposes for a cross section of households at a given time.

4.2. Data Source and Type

The data type used in the study were mainly primary and cross-sectional for the time period of 1998. Data sources were (1) mainly the CV survey conducted for this purpose and (2) relevant documents from AAWSA and Addis Ababa's Plan and Economic Development Bureau.

Based on the sample design, the first sites selected for the study are found in the northern part of the city with higher elevation (*Wereda 11 kebeles 08 and 11*). Currently there is a critical problem of water shortage in those areas. Water distribution to those areas are totally dependent on small pumping stations of inefficient subsystems. The other areas are found in the central part of the city with dense population it is considered as a partly water problem area (*Wereda 03 kebeles 30 and 41*). Piped water is supplied to these areas using both gravity and pumping method from reservoirs.

The primary data are collected by making a household survey in the selected areas by means of questionnaires developed for the CVM. The mode of data collection used is a face-to-face interview with household respondents.

Though it was desirable to have a sample size that is representative of the population as much as possible, survey methods, however, do not stipulate *a priori* percentage or figure that is adequate in any study (Fowler, F.J., 1993). Therefore, considering limitations in time and costs, a total of 220 households sample were intended to be surveyed and finally 217 households were sampled with a response rate of 98.6 percent.

4.3. The Sample Design

The sample for the study was drawn from two administrative zones in the city, covering a total of four *kebeles*. To each site lists of households were obtained as a sample frame from two sources i.e. lists of customer households connected to the existing piped water system from AAWSA, and total lists of households in the study site from each *kebele* administrative offices.

A multistage sampling technique were used for the study. Out of the total of six total administrative zones of the city two zones were selected. One with a critical water shortage area and the other a partly problem zone. Then *weredas* within the zone as a second stage, *kebeles* within the selected *weredas* as the third stage, and finally household respondents within the *kebeles* at the fourth stage were randomly selected for the sample survey.

At the *kebele* level, a post-stratification was further carried out based on the probability proportional method to have a representative sample of households which are connected and not-connected to the water system. Summary of the description of the sample set is given in Table 4.1.

Table 4.1. Summary Description of the Community Data Set

District		Level of services (sampled)		Total sample size	Water Problem
<i>Wereda</i>	<i>Kebele</i>	connected	not-connected		
11	08	13	24	37	serious
11	14	17	38	55	serious
03	30	17	61	78	Partly
03	41	10	37	47	Partly
Total		57	160	217	

Source: survey data

4.4. The Questionnaire Design

The CV survey questionnaire was developed primarily adopting the Mitchell and Carson techniques (Mitchell & Carson, 1989), with some modifications to make it relevant to the specific study (see Appendix A).

The questionnaire typically consisted of three main parts:

- i. Hypothetical description of the circumstances under which the improved water is made available, for both private and public taps. The mode of payment proposed is based on volume charge of water consumed and folding the initial costs of connection in the volume charges,
- ii. One or more questions that determine how much the respondent is willing to pay the provision using the iterative bidding game elicitation method. The iterative bidding game is an elicitation technique of WTP in which respondents raises or lowers bids from an arbitrarily chosen starting point until a maximum WTP is revealed by the respondent, and
- iii. A series of questions about the relevant socio-economic and demographic characteristics of the households, the characteristics of the existing water sources, household attitudes and housing characteristics were included. For the purpose of the two potential biases i.e. strategic and starting point biases the elicitation part of the questionnaire was prepared in different scenarios for subgroups.

4.5. The Field Procedure

After designing the draft questionnaire, the field procedure consisted of pre-testing the questionnaire, administering and implementing of the actual survey in the selected sites. The pre-testing of the questionnaire was made on each study site to a total of twelve respondents, three from each area (*kebele*). Two experienced interviewers and the researcher himself took part in the pre-testing process. The purpose of the pre-tests were to make some possible modifications in the design of the questionnaire so as to make it easier and understandable for both the respondents and interviewers to meet the survey objectives.

The pre-test actually has helped in restructuring question orders, in adding some important questions and in polishing the willingness to pay section of the questionnaire. Especially, it has indicated that people were reluctant to answer questions which begins with economic characteristics such as income and expenditure before the actual problems of water supply were discussed. Moreover, respondents were less willing to answer exactly earning questions such as "how much is your monthly income?".

Therefore, the questionnaire was restructured making the income related questions categorical and to be asked after the willingness to pay question section. Slight adjustment was also made on the starting point values of the elicitation method making it distinct for valuing private tap and that of public tap. The pre-test results were not included as an input in the final analyses.

After a final questionnaire was developed, a two-day training of enumerators was conducted. A total of six enumerators and two supervisors including the researcher participated in the actual survey. The enumerators were selected based on their previous experiences in rural and urban household surveys. The survey started on the 26th of February 1998 and continued for twenty successive days. All enumerators and supervisors took part together in each specific site survey. Finally, the data collected was coded and prepared for analyses using the SPSS statistical software.

4.6. Model Specification

As mentioned in the literature review section, water demand studies of industrial countries have limited relevance for the peculiar situations of developing countries. As a result various models for investigating demand for improved water services are developed for practical application in developing countries. The models for the CVM and the indirect approach used in this study are discussed below.

4.6.1. The Indirect Approach

For the indirect approach (revealed preferences), which is applied to assess the actual choice behaviour, it is assumed that households will have a number of choices in deciding the type of water source to use. Moreover, the main interest of policy makers for water supply decision will be to know the proportion of households that will be connected for given level of services and specified prices.

The probability that a household will connect to an improved water system is a function of different variables including household attributes. The dependent variable in this case will be binary in nature indicating the choice of a particular service level i.e. either connect to the piped water system or not. The linear regression model is not appropriate for binary choice dependent variable for two reasons. First, the linear probability model is subject to Heteroscedasticity of the error term. Secondly and more serious, the probability estimates could lie outside the zero-one interval (Greene, 1993).

Therefore, the respondents' choices were modelled within a discrete choice random utility model (probit), a variant of qualitative response models, in which a respondent's response is equal to the indirect utility that the household receives from choosing to connect the piped system rather than continuing to use other alternative sources (Greene, W.H., 1993; Singh *et al.*, 1993; Briscoe, J. *et al.*, 1990). The outcome of this discrete choice is viewed as a reflection of an underlying latent regression model.

In order to understand this model it was assumed that a particular household, i , chooses between two choices ($j = 1, 2$) of water sources based on maximising two conditional utility functions. The first utility, U_1 , is gained from the improved source ($j = 1$) and the second utility, U_2 is derived from using alternative ($j = 2$) sources. The choices are influenced by both the water sources characteristics and household attributes.

The utility function for each household can be specified as follows:

$$U_{ij} = a_0 + a_1C_j + a_2T_j + a_3Q_j + a_4Y_i + a_5Z_i + e_{ij} \dots \dots \dots (4.1)$$

Where U_{ij} = utility index

C_j = Cost of obtaining water

T_j = Time required for fetching water

Q_j = perceived quality of water

Y_i = household income

Z_i = a proxy for a set of socio-economic variables

e_{ij} = error terms

In other words, the utility, U_{ij} , for each household, i , of a particular source, j , depends on costs of obtaining water from that source C_j , the time required to fetch water, T_j , the perceived quality, Q_j , income, Y_i , a set of socio-economic variables, Z_i , and other unobservable factors included in the error terms, e_{ij} .

Based on the above specification, a particular household chooses the improved system if the utility gained, $U_{i1} - U_{i2}$, is greater than zero. Obviously the utilities are not observable.

The random utility model then will be based on an underlying latent regression model the difference between the two utilities ($U_{i1} - U_{i2}$) as an unobserved variable, Y^* , such that

$$Y^*_h = \beta' X_h + e_h \dots\dots\dots(4.2)$$

$$e_h \sim N[0,1]$$

Where Y^*_h = Unobservable Utility Index

β = Vector of Parameters

X_h = Vector of explanatory

We assume the error term, e_h has a standard normal distribution, with mean zero and variance one (Greene, 1995). The variable Y^* is hypothesised to be a function of households socio-economic characteristics as well as water attributes, represented by vector X .

Since the variable Y^* is not observable, we cannot estimate equation (4.2) directly. However, we observe the decision made by the household i.e. whether a connection is made or not.

Using the observed indicator Y , as counter part of Y^* , our observation will be

$$Y = 1 \text{ if } Y^* > 0$$

$$Y = 0 \text{ if } Y^* \leq 0 \dots\dots\dots(4.3)$$

That is, the household either connects ($Y = 1$) to the improved system or not ($Y = 0$). The probability that $Y = 1$ (the probability that a household chooses the improved system rather than the alternative source) is:

$$\text{Prob}(Y^* > 0) = \text{Prob}(\beta' X + e_h > 0) \dots\dots\dots(4.4a)$$

$$= \text{Prob}(e_h > -\beta' X) \dots\dots\dots(4.4b)$$

If the distribution is symmetric,

$$\text{Prob}(Y^* > 0) = \text{Prob}(e_h < \beta' X) \dots\dots\dots(4.5)$$

$$= F(\beta' X) \dots\dots\dots(4.6)$$

Where $F(\cdot)$ is Cumulative Distribution Function (CDF) of the Standard Normal.

Equation (4.5) provides the binomial probit model estimated in this study for the indirect approach. Based on the assumptions of the discrete choice model stated above, estimates were obtained using the maximum likelihood function with the help of Limdep econometric software (version 7.0).

The log-likelihood function for the observed data is given by

$$\ln L = \sum_{y=1} \ln F(\beta' X_h) + \sum_{y=0} \ln (1 - F(\beta' X_h)) \dots \dots \dots (4.7)$$

where the first sum is over the observations for which $y=1$ and the second sum is over the observations for which $y=0$.

4.6.2. The Contingent Valuation Model

For the contingent valuation approach to estimate a valuation function that relates the hypothesised determinants with the WTP responses, we used the ordered probit model. This model is an extension of the binomial model discussed above (section 4.6.1). To begin with, the WTP responses derived from a bidding game elicitation technique are considered as an ordered discrete data (not-continuous). They merely express respondents preferences to the proposed improved water services with a sort of ordinal ranking (Altaf, *et al*, 1992). Therefore, the Ordinary Least Square (OLS) regression model will not be appropriate for this purpose.

The ordered probit model, like the binomial probit model, is also based on an underlying latent regression model of the following specification:

$$W_h = a + \beta'X_h + e_h \dots\dots\dots (4.8)$$

$$e \sim N[0,1]$$

where W_h is the unobserved variable, representing the household's maximum willingness to pay for the proposed improved water service.

It is hypothesised that W_h is a function of the household's socio-economic characteristics and the attributes of the new and the existing water sources (vector X). And a and β are parameters of the model and the error term is assumed to have a random normal distribution.

W_h (which is the true willingness to pay) is not observable from the bidding game. Therefore, we can not estimate equation (4.8) directly. What we do observe is the WTP responses and we know within which range W_h falls.

Letting R_1, R_2, \dots, R_m be the m prices which divide the range of WTP space into $M+1$ categories, we can have a categorical, Y_h , variable such that,

$$Y_h = 1 \text{ if } W_h < R_1$$

$$= 2 \text{ if } R_1 < W_h < R_2$$

$$\dots\dots\dots (4.9)$$

$$= M+1 \text{ if } W_h > R_m$$

Letting $i=1,2,\dots,M+1$ and substituting from equation (4.8) into equation (4.9) we have

$Y_h = i$ if

$$R_{t-1} < a + \beta'X_h + e_h < R_t \dots\dots\dots(4.10)$$

$$\text{or } R_{t-1} - a < \beta'X_h + e_h < R_t - a \dots\dots\dots(4.11)$$

$$\text{or } R_{t-1} - a - \beta'X_h < e_h < R_t - a - \beta'X_h \dots\dots\dots(4.12)$$

Assuming e_h follows a standard normal distribution we have the following probabilities

$$P(Y_h = i) = P(R_{t-1} < W_h < R_t)$$

$$= P(R_{t-1} - a - \beta'X_h < e_h < R_t - a - \beta'X_h) \dots\dots\dots(4.13)$$

Letting $U_t = R_t - a$ and $u_{t-1} = R_{t-1} - a$ then ,

$$P(Y=i) = P(u_{t-1} - B'X_h < e_h < u_t - B'X_h) \dots\dots\dots(4.14)$$

$$= F(u_t - B'X_h) - F(u_{t-1} - B'X_h) \dots\dots\dots(4.15)$$

Where $F(\cdot)$ is the Cumulative Standard Normal Distribution Function.

Estimates are obtained based on the method of maximum likelihood. The probabilities which enter the log-likelihood function are

$$\text{Prob } [y_1 = j] = \text{Prob } [Z_1 \text{ is in the } j^{\text{th}} \text{ range}] \dots\dots\dots(4.16)$$

Entering the above probabilities in to the log-likelihood unction, we have

$$\ln L = \sum_h \ln L_h = \sum_h \ln \text{prob } (y_h = i) \dots\dots\dots(4.17)$$

$$= \sum_h \ln [F(u_t - \beta'X_h) - F(u_{t-1} - \beta'X_h)] \dots\dots\dots(4.18)$$



where h represent each observation (household) and i is the appropriate WTP category into which a particular household falls.

4.6.3. Estimated Equations

The two models are used to estimate the following two equations for the indirect method and the CVM approach, respectively:

$$\begin{aligned} \text{a. } P(i=1) &= a_0 + a_1 \text{ HSEX} + a_2 \text{ HEDU} + a_3 \text{ HAGE} + a_4 \text{ HOCC} + a_5 \text{ AVINCM} \\ &\quad (+) \quad (+) \quad (-) \quad (+) \quad (+) \\ &+ a_6 \text{ HHSZ} + a_7 \text{ HTNRE} + a_8 \text{ RESP} + e \dots \dots \dots (4.19) \\ &\quad (+) \quad (+) \quad (-) \end{aligned}$$

$$\begin{aligned} \text{b. } P(\text{WTP} = i) &= B_0 + B_1 \text{ HSEX} + B_2 \text{ HEDU} + B_3 \text{ HAGE} + B_4 \text{ HOCC} \\ &\quad (+) \quad (+) \quad (-) \quad (+) \\ &+ B_5 \text{ AVINCM} + B_6 \text{ HHSZ} + B_7 \text{ TIM} + B_8 \text{ RESP} + e \dots \dots \dots (4.20) \\ &\quad (+) \quad (+) \quad (+) \quad (-) \end{aligned}$$

Where, P_i = the probability that a household will connect to the improved system.

$P(\text{WTP} = i)$ = the probability that respondent's WTP for the improved service falls within specified interval

HSEX = Sex of the head of the household

HEDU = The educational level in the household, measured as number of years of schooling

HAGE = Age of the household head

HOCC = Occupational status of the household head

AVINCM = The total household income per month

HHSZ = The family size measured as number of people in the household

TIM = The time required in minutes to collect water from other sources, if respondent does not have a connection

RESP = A dummy variable measuring household's attitude about the responsibility of water supply management.

4.7. Description and Specification of Explanatory Variables

The independent variables used in the models are expected to influence the likelihood a household making a particular choice of source of water and its WTP response. The rationale for the influences of those explanatory variables is based on factors such as the need for water, availability of labour for collecting water, ability to pay, existing water arrangement, personal characteristics of household members and attitudes of respondents towards the management of the water provision.

The total household need for water hence the preference for improved services may be related to the family size and to the level of consumption in the household. For a family fetching water from outside source, the available labour in the family will have an important role. Households with scarce labour may prefer more of improved services.

Ability to pay also directly relates to a greater preference for improved services. Factors such as household income, household assets and housing characteristics (as a proxy for status of wealth) could be used for estimation purposes. The existing water arrangement for water, whether privately owned or not (e.g. from vendors), its quality level, costs of water, will have different impacts on preference for improved water service. Household members characteristics such as age, occupation, education and sex will have different expected influence on preferences. Moreover, attitudes such as the level of satisfaction with existing management such as responsibility of provision, whether water service should be charged or not (free or subsidised), will influence the respondents preference for the improved service. Table 4.2 provides names and description of variables used in the analyses.

Some variables are selected for the models in the study and others are omitted due to multicollinearity problem and irrelevance. There are nine variables chosen for the model based on the above rationale. The expected coefficient signs and specification of the independent variables are presented below.

HSEX: The sex of the household head. It is generally assumed that women would express more preference for improved water services and may be more willing to pay for than men. The reason being that women are primarily responsible for the difficult task of collecting water and using it for domestic purposes. The dummy variable for sex is specified as 1 for female and 0 for male. The coefficient of this variable is expected to be positive.

HEDU : The educational level of the respondent. The number of years in schooling is used as measurement. The literature suggests that as the level of education increases among household members, there would be more awareness to health benefits of improved water services. Educated households are expected to put higher opportunity costs for time spent collecting water from outside sources (Briscoe, *et al*, 1990). Therefore, educated households are expected to have more preference for improved services than uneducated households. A positive relationship is expected between educational level and WTP and preference for improved water service.

HAGE: Age of the household head. Older household members who used to live with more free water supply and less prices, may be reluctant to prefer new improved services and less willing to pay for it. A negative relationship is expected between age and willingness to pay for new improved sources.

HOCC: Occupational status of the household head. Its effect on willingness to pay varies from study to study. In India civil servants were more likely to be connected to the water system (Singh, B, *et al*, 1993). The study in Brazil indicated that formal sector employees to pay more WTP than the informal sector (Briscoe, J, *et al*,. 1990). A dummy of 1 is specified for civil servants and 0 otherwise. Another education variable with a dummy of one for formal

sector employment is also specified. The coefficients are expected to be positive if civil servants and formal sector employed heads are more likely to connect to improved water system.

AVINCM : The total household income per month. Economic theory suggests that income and quantity demanded are positively related, except in the case of inferior goods. A positive sign is expected on the variables of income and proxies of wealth. A dummy one is used for properties owned by household, and 0 otherwise. Private ownership of house (HTNRE) is used as a proxy for wealth. A negative sign is expected for improved water from public tap which may be considered as an inferior good when income level rises (Briscoe, *et al*, 1990)

HHSZ: Family size: Number of members of household may be positively related with preference for improved water as the need for water is higher with large families or as the proportion of female and children rises, the more available labour, hence, the more preference for public tap. One study observed a positive relationship between family size and WTP for public taps and a negative relationship for a private tap (Bondu, 1992). In our study both influences are tested for WTP for private and public taps.

TIM: Time required for collecting water from outside sources. A positive coefficient is expected for this variable, as more time is required for obtaining water, the more an improved water service is preferred and more willingness to pay for it. Here time is considered as real cost of water from the existing sources which is a close substitute for the improved one. Therefore, as the price (cost) of the close substitute rises, WTP is expected to rise for the improved one.

HTNRE: Ownership of housing unit as a proxy for status of wealth. It will have the same expected effects as the measure of household income on the probability of connection and WTP.

RESP: A dummy for household attitude about the responsibility of water supply management. A dummy 1 is given for those who said it is totally government's responsibility and 0 otherwise. Therefore, a negative relationship is expected between RESP and WTP.

Table 4.1. Names and Descriptions of Variables

Variable	Description
WTP1	Household's maximum willingness to pay for improved water services, privately connected (cents per <i>Baldi</i>)
WTP2	Household's maximum willingness to pay for public tap (cents per <i>Baldi</i>)
COSTW	Price of water per <i>Baldi</i> in cents for households collecting water from outside sources.
DSTRCT	Location of study site 0 = <i>Wereda</i> 11 <i>Kebele</i> 08 1 = W/11 K/14 2 = W/03 k/30 3 = W/03 k/41
DSWQD	Occurrence of Diseases in the past one year in the household in relation to deficiency of water quality 1 = yes, 0 = no
HAGE	Age of the household head in years
HEDU	Education level of Household head 0 = illiterate 1 = 1-8 years of schooling 2 = 9-12 years schooling 3 = > 12 years of schooling
HUDU1	1 = 1-8 years , 0 = otherwise
HEDU2	1 = >8 years , 0 = otherwise
HHSZ	Family size in number of household members
HOCC	Household head occupation 0 = civil servant 1 = private business 2 = house wife/domestic work 3 = pensioned 4 = private employee 5 = others
HOCC1	1 = civil servants , 0 = otherwise
HOCC2	1= formal sector, 0 = otherwise
HSEX	Sex of household head 1 = female 0 = male
HITNRE	Type of tenure of the housing unit 0 = owner occupied (private) 1 = Rented from <i>kebele</i> 2 = Rented from others

Variable	Description
HTNRE1	1 = Private ownership, 0 = otherwise
AVINCM	The total monthly household income in <i>Birr</i>
MSPRBLM	The most serious problem with the existing water services 0 = poor quality 1 = less quantity 2 = Unreliability 3 = higher volume charge 4 = others
PCNCN	Households status to the existing piped system 1 = connected 0 = not connected
RESP	Respondent's perception on the responsibility of improved water provision 1 = government 0 = otherwise
STSFCTN	Level of satisfaction with the existing water services 0 = No 1 = Yes
TIM	Time spent in minutes per day on fetching water from outside sources.
WCAP	Per capita monthly water consumption in <i>Baldi</i> (a 20-litre bucket)
WEXP	Total monthly water expenditure in <i>Birr</i> .

Chapter five

Empirical Results and Discussion

This chapter presents the results of the survey using both the indirect and CV (Direct) methods. The indirect method deals with the probability of connection to the piped water system whereas the CV survey illustrate the WTP responses on both private connection and public tap. Demands for improved water services are estimated. The chapter also includes on descriptive statistics of selected variables and various tests.

5.1. Descriptive Analyses

Before getting into the analysis of the econometric results, first a brief review on the characteristics of the sample with the help of descriptive statistics. A summary statistic of WTP responses and selected variables used in the analyses is provided in Table 5.1 . Moreover, a comparison of survey results and averages in the city for some variables is presented in Table 5.2.

5.1.1. Socio-economic and Demographic Characteristics

In the CV survey conducted in four different *kebeles* in the city, a total of 217 questionnaires were completed out of expected sample of 220 households, with a 98.6 per cent of response rate.

The average household size in the sample is 5.92 ranging from one to sixteen members in a family. Out of the total households, 112 (51.6%) are male headed while 105 (48.4%) households

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Table 5.1. Summary Statistics of Selected Variables used in the Analyses

Variable	mean *	Standard Deviation	Range	Valid Cases
WTP1	8.664	5.965	0-26	217
WTP2	4.669	1.673	0-12	133
COSTW	8.93	2.94	2-20	142
DSTRCT	1.62	1.01	0-3	217
DSWQD	0.3	0.46	0-1	217
HAGE	49.14	14.20	20-90	217
HEDU	1.13	1.37	0-3	217
HEDU1	0.34	0.47	0-1	217
HEDU2	0.21	0.41	0-1	217
HHSZ	5.92	2.58	1-16	217
HOCC	1.89	1.63	0-5	217
HOCC1	0.23	0.42	0-1	217
HOCC2	0.54	0.50	0-1	217
HSEX	0.48	0.50	0-1	217
HTNRE	1.79	0.92	0-3	217
HTNRE1	0.25	0.43	0-1	217
AVINCM	384.8	273.01	50-1599.50	216
PCNCN	0.26	0.44	0-1	217
RESP	0.58	0.49	0-1	217
STSFCTN	0.17	0.38	0-1	217
TIM	30.79	30.51	1-180	142
WEXP	8.93	7.08	0.3-60	217
WCSN	107.92	58.01	4-420	217
WCAP	20.11	11.26	2-75	217
MSPRBLM	2.14	1.216	0-7	217

* The mean value indicated for dummy variables is proportion

are female headed. Age of the Family head ranges from twenty years to ninety years old with a mean value of 49 years old.

Data on educational status indicates that 54.4 percent of the household heads have at least primary education equivalent to eight years of formal education. The employment statistics reveal that 23 percent of household heads are government employed. Fifty-four percent of the heads are engaged in the formal sector employment.

The other major economic variable is household income. The mean monthly household income is *Birr* 364.52. It is computed based on the mid-values for the categorical income groups.

5.1.2. Housing Characteristics.

The housing attributes such as its construction materials, number of rooms, types of tenure, monthly rent and lighting determine the quality of the house and reflected the wealth status of the family. More than ninety per cent of the sampled house are found to be made up of wood and mud walls and only six percent are built with bricks and blockets. Out of these housing units about 91 percent are used for residential purposes while nine percent are for both residential and small business purposes.

Most of the houses (75%) are rented and only 25 percent are owner occupied. The average monthly rent for residential houses is about *Birr* 11.9 ranging from *Birr* one up to *Birr* 240. The number of rooms in a house ranges from one to twelve rooms with a mean value of 2.24. Fifty-seven percent use electricity with private meter and 41 per cent with shared meter electricity. Only 1.4 percent reported to use kerosene as a source of light.

Table 5.2. Comparison of selected Variables statistics to population parameters in the city

Variable	Survey Results	CSA / AAWSA
Household Head (%)		
Male Headed	52	67
Female Headed	48	33
Household size	5.9	5.1
No. of Rooms	2.24	2.1
Owner Occupied houses (%)	25.0	34.0
Average Monthly House Rent (<i>Birr</i>)	27.75	40.18
Privately pipe Connected houses(%)	25.8	26.8
Per capita water Consumption Litre/p/day	13.4	26.9
Applicants Waiting for Access to the system (% of total)	5.0	5.3

5.1.3. Current Water Use Patterns and Problems

Almost all the households surveyed (99%) used piped water as the main source of water for domestic purposes. Only two households (1%) used dug well as a source of water. Sources of piped water in the survey area consisted of house connected, private tap in compound, pipe shared in compound, from private renders and public taps. Table 5.3. presents distribution of households by type of major source of water.

The table indicates that more than half (55.3%) of the total households obtain piped water purchasing from private vendors who have connection to the existing piped water system. Those who have direct access to the system (private or shared connection) account only about 34 percent. And nineteen per cent said they get water from public taps. Moreover, eleven households (5%) using private vendors said they have applied for connection to the pipe system and still waiting for connection.

Table 5.3. Major Sources of Water to Households

Source of Water	No. of Households	Percentage
Pipe in the house	9	4.1
Pipe in compound (Private)	47	21.7
Pipe in Compound (Shared)	20	9.2
Private vendors	120	55.3
Public taps	19	8.8
Dug wells	2	0.9
Total	217	100.0

Households average monthly water consumption is about 107.9 *Baldi* (a 20 litre bucket) with mean per capita consumption of 20.1 or 13.4 litre per capita per day. A study undertaken by Seureca states a higher figure(26.9 litre)(AWWSA,1991). Price per *Baldi* of water ranges from one cent (official tariff) to those connected up to twenty cents to those buying from private vendors. The mean price of water per *baldi* for those households who use outside sources is about 8.9 cents. On the average households are spending 2.3 % of their income on water which is comparable to study in Brazil (2%) (Briscoe, *et al.* 1990).

The subsidised tariff, and the recurring shortages of water would have encouraged those connected households to sell water with higher priced to those who have no access to the system.

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

Unreliability of supply, higher costs of water, poor quality and quantity of water and higher connection charges are mentioned by different respondent as the most serious problems with the current water services in the city. More than half of the respondents (53.5%) mentioned

unreliability of water supplies as the most serious problem. In addition, 65 households (30%) reported to have encountered diseases of family members in relation to deficiency of water quality in the past one year.

Another important variable concerns household's attitude towards the responsibility of improved water provisions. More than half (58%) of the respondents expressed that the government should provide free or subsidised improved water services to the citizens, while the rest (42%) said otherwise (either the community, private or all responsible), with 15%, 4% and 23% identifying community, private and all responsible, respectively.

Other important opinion variables are the intensity of current water problems and the efforts made by government in solving them. More than fifty percent have opined the current water problem as a very serious one. And sixty seven percent said that the government paid not too much attention in solving water problems to households.

5.1.4. WTP for Improved Water Services

The WTP questions of the contingent valuation survey consisted of two parts using the bidding-game question format, one for private connection and the other for public stand tap. The WTP questions for private connection is presented for all respondents (for both who have a private access to the existing pipe system and those who have not). The WTP question for public tap, on the other hand, is presented to 133 households who are interested in its provision.

The overall results of the valuation indicated that respondents took the interviews seriously and well understood the bidding game elicitation technique. The enumerators evaluation revealed that more than 95 per cent of the respondents have well understood the valuation process and have given careful considerations in their responses. Moreover, tests on different biases on the WTP bids also indicated that respondent have genuinely expressed their feelings towards the proposed schemes (see next section).

Histograms on the frequency distribution of the WTP bids for the two proposed schemes are presented in Figure 5.1 and 5.2. For convenience of further analyses the table of frequency distribution is presented in section 5.2. The table reveals that about 44 percent of the total households surveyed are willing to pay between five and nine cents per *Baldi* of water for private connection. On the other hand, more than half (51.9%) of the households who are also interested in public taps claimed to offer between four and five cents per *baldi* of improved water from the proposed public stand pipe.

The mean WTP bids for private connection and public tap are about 8.7 cents and 4.7 cents per *Baldi*, respectively (Table 5.1). The result showed the expectation that on the average people are more willing-to-pay for improved private connection than for public taps. Moreover, the existing average cost of water for those using private vendors is about 8.9 cents. Hence, the WTP responses seemed realistic.

WTP bids in relation selected characteristics also analysed using correlation matrices and cross-tabulations. Pearson's coefficients of correlation indicated that the WTP bids for private connection are positively correlated to the continuous variables such as household income (+0.57), price of alternative water sources (+0.17), water expenditure (+0.13) and time for fetching water (+0.17). And they are negatively correlated to age of household (-0.20) and monthly rent of houses (-0.44)(see Appendix B for correlation matrices).

Attempt was made to examine whether the WTP responses depended on the location of the study. Cross-tabulating WTP bid ranges with location of households (DSTRCT), a Pearson's chi-square value of 13.11 is obtained. The critical value of chi-squared distribution with nine degrees of freedom is 16.9 at 5% level of significance which is larger than the computed value.

Therefore, we can not reject the hypotheses of independence between the WTP bids and the study site. It implies that WTP does not depend on the study area.

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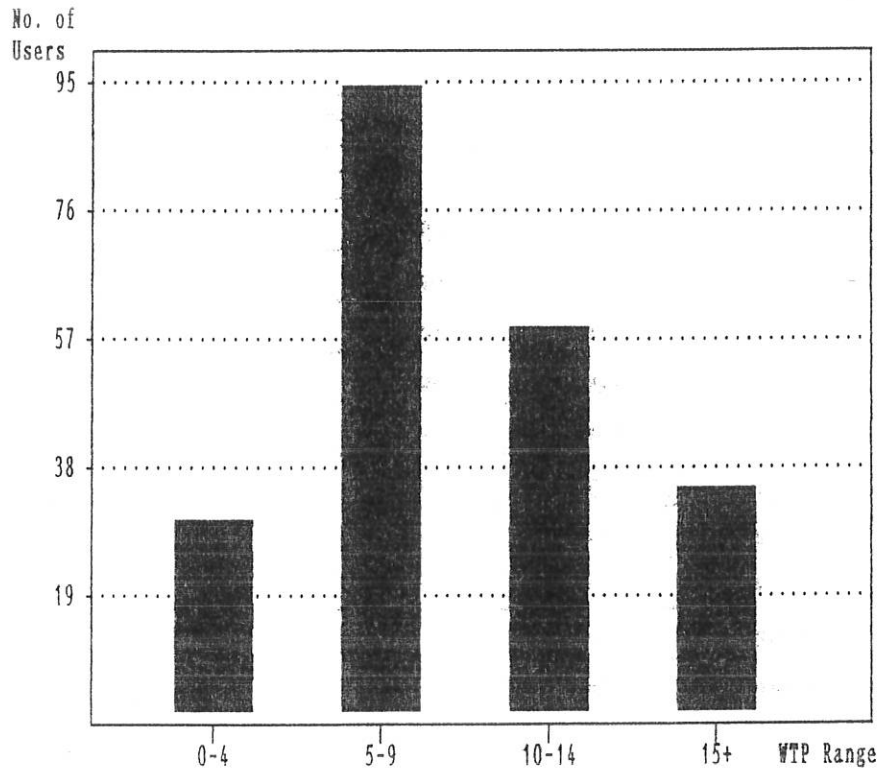


Figure 5.1: Histogram of WTP for Private Connection

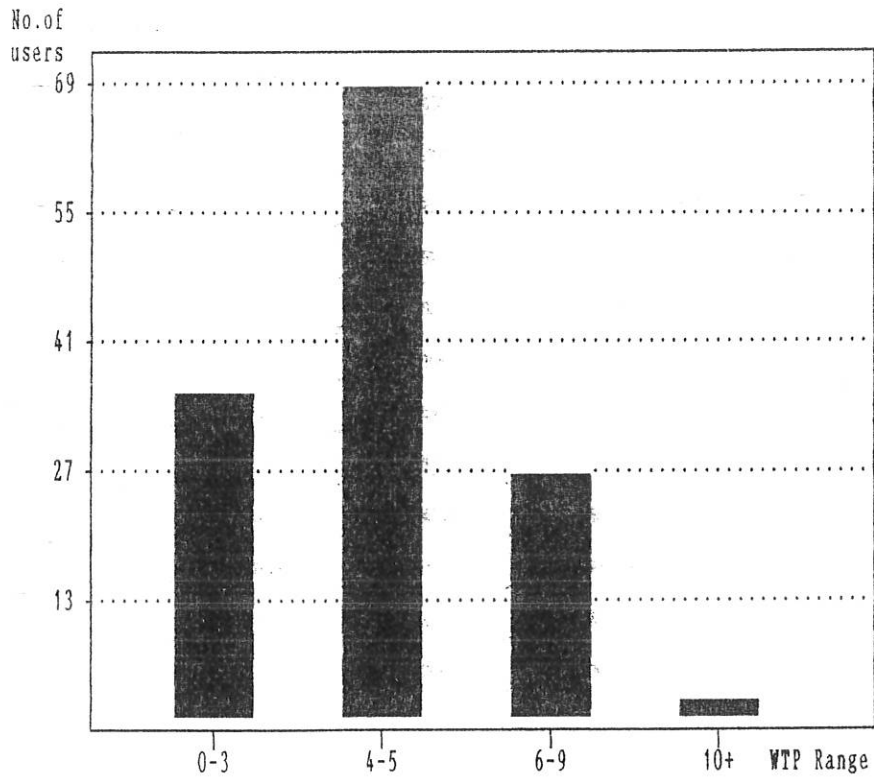


Figure 5.2: Histogram of WTP for Public Tap

On the other hand, exercises on cross-tabulating WTP bids with sex of household ($\chi^2=20.3$), occupation ($\chi^2=7.3$), ownership of house ($\chi^2=22.6$) and attitude ($\chi^2=28.9$) indicated that WTP for improved water services is dependent on those discrete variables. For the sake of brevity the table results of the cross-tabulations are not shown in the paper.

The next sections discuss the results of tests of biases, results of the estimates of the models and demand estimations, subsequently.

5.2. Tests for Biases

Attempts were made to test for the existence of two types of biases in the contingent valuation survey which are thought to be the most serious problems in the methodology: Strategic bias and starting point bias. The other major bias in the CVM, hypothetical is not considered to be a problem for goods as improved water which is well known by urban households.

5.2.1. Strategic Bias

Strategic bias may arise when a respondent gives a WTP amount that differs from his or her true WTP amount in an attempt to influence the provision of the good and/or the respondent's level of payment for the good.

Such strategies may influence an individual's answer in two ways. Suppose an individual is asked his WTP amount for the provision of privately connected improved water services. If he thinks the government or water agency will provide the service if the responses are positive and he does not have to pay for it, he will have an incentive to overpledge in order to increase the likelihood of the provision.

On the other hand, if he believes the purpose of the survey is to assess people's WTP for the service to determine water charges, the respondent will have an incentive to understate his true WTP amount so that tariffs are set at a lower level.

In our case, an experiment was conducted to test for its existence on WTP bids for private connection by using two subsamples. Two different elicitation formats were used one for each subsample (see appendix A for different formats). One group was told that the tariff for the provision of water services will be set based on the amount of WTP responses that households will say they are willing to pay for private connection. The other subsample were told with another format which clearly indicate that the costs for its provision will be covered by the administrative body with no or little change on the tariff rate. They were told that the purpose of the survey is to evaluate the importance of improved water services.

The former group are expected to understate their true WTP if they act strategically while the latter group are expected to overpledge so that their revealed WTP amount can influence the provision of the services. The results of the test for strategic bias is presented in Table 5.4. Out of a total of 217 observations, the first subsample of 101 respondents received Format A with a scenario for an incentive to overstate. And the second subsample of 116 household were treated with Format B with a potential of strategic behaviour of understating their true WTP amount. The formats were distributed randomly among respondents.

Table 5.4. Test for Strategic Bias

	Format A	Format B
Total Observation	101	116
Mean WTP bid*	9.21	8.27
Standard Deviation	6.27	5.27
Overall mean WTP	8.664	
Standard Deviation	5.96	
t-statistic	1.13	

* Mean WTP bid in cents per *Baldi*

A two tailed t-test comparing the null hypothesis that the two subsamples are from the same population against the alternative hypotheses that they are from different population is conducted (see Appendix B for Thayer's two-tailed test details). Though the mean WTP bids from the overpledging format is larger than that of the underpledging format, the difference

between the two means is not found to be statistically significant at 95 % significant level. Therefore, the t-test suggests that there were no strategic behaviour when the respondents answered the WTP questions.

5.2.2. Starting point Bias

The other major concern is the possibility of bias in WTP responses caused by the arbitrary starting point of the bidding game elicitation method. A respondent who is not certain of the appropriate answer may interpret this initial value to imply a value for the good to be provided. Studies also showed that even the initial (starting) bid is rejected by the respondent, starting points below the respondent's true WTP amount tend to decrease the revealed WTP amount while starting points above it may tend to increase it (Mitchell and Carson, 1989).

To test for the occurrence of a starting point bias similar test was conducted by distributing two different questionnaire randomly for two groups of respondents on WTP bids for private connection. A low starting point of five cents and a high starting point of ten cents were used for the test. If the bias prevails, we would expect the low starting point to result in a lower bid while the high starting point to raise the WTP bids.

Table 5.5. Test for Starting Point Bias

	High starting	Low starting
Total Observation	114	105
Mean WTP bid*	9.27	7.97
Standard Deviation	6.42	5.72
Overall mean WTP	8.664	
Standard Deviation	5.96	
T-statistic	0.83	

* Mean WTP bid in cents per Baldi

Results of the test are shown in Table 5.5. The null hypotheses of the test was that the two samples are from the same population that there is no difference in the responses from respondents who received different starting points.

A two tailed t-test were used for comparing the mean WTP bids of the two subgroups. The t-statistic showed that the null hypotheses that the two subsamples are from the same population cannot be rejected at 95 percent confidence level. The result suggest that there is no starting point bias in the WTP responses indicating that the difference in the means of the two subsamples can not be attributed to starting point differences.

In general, results of the two tests showed that there are no evidences for the existence of strategic or starting point bias in the willingness to pay responses of our survey.

5.3. Tests for Heteroscedasticity

Before passing into the analyses of the results of the estimation of the models, tests on the possible existence of heteroscedasticity are undertaken. The violation of the homoscedasticity assumption that is the disturbance term not remaining constant has two important implications for our analyses. First, though it does not affect the unbiasedness of our estimates, the coefficients of the estimates will be inefficient. Secondly, we cannot make reliable inferences using t-tests and other tests on the over all significance of the model in case of heteroscedasticity since the error terms will not remain unbiased.

Since we are likely to encounter this problem often in economic data particularly with cross-section data, we tested possible existence using the likelihood Ratio (LR) test.

A general formulation for heteroscedasticity has the form

$$\text{Var } [e] = [\exp (\alpha'Z)]^2$$

where Z stands for a vector of weighting variables (Greene, 1993).

The LR statistic for testing the null hypotheses of homoscedasticity assumption is obtained by

$$\text{LR} = -2[\log L - \log L_0]$$

where $\log L$ is the log likelihood for the model with Heteroscedasticity and $\log L_0$ the log likelihood for the model with homoscedasticity assumption.

The LR statistic has a χ^2 distribution with degrees of freedom equal to the number of variables in Z. Both models are estimated. The results of the tests for the three models are shown as follows:

For the connection probability model the age variable (HAGE) was used as a weight for the Heteroscedasticity after a trial and for both ordered probit models the time variable (TIM) were used as a weight.

The LR statistics are computed as

a. for the connection probability model

$$\begin{aligned} LR &= 2(-94.86042 + 96.5864) \\ &= 3.45196 \end{aligned}$$

b. for the ordered probit model (private)

$$\begin{aligned} LR &= 2(-226.3476 + 227.2786) \\ &= 1.862 \end{aligned}$$

c. for the ordered probit model (public tap)

$$\begin{aligned} LR &= 2(-125.8771 + 126.4852) \\ &= 1.2162 \end{aligned}$$

The critical value of chi-square at one degree of freedom is 3.84 at 95% level. Comparing the results, none of the computed statistics are found to be larger than the critical value. Therefore, the null hypotheses of homoscedasticity cannot be rejected in all the three models and Heteroscedasticity is not found to be a problem on the models.

5.4. Determinants of connection probabilities

Results of the estimates of the binomial probit model for the probability of connecting to the piped system is presented in Table 5.6. The log likelihood Ratio statistic is 74.67 for the model (chi-squared statistic). With 7 degrees of freedom, the critical value from the chi-squared table is 14.1 at 95% level¹ which is less than the tabulated value. Therefore, the joint null hypothesis that the coefficients on the explanatory variables are all zero is rejected, indicating the overall significance of the model. Count R^2 indicates that the model predicts 155 of the total 206 cases or 75.2% per cent of the observation correctly.

As described in the descriptive part, eleven households which are currently not connected but who have already decided to connect and applied to the water utility and waiting for access. Due to the impediment of supply constraints, the preference to connect to the piped schemes is currently unfulfilled for them. The decision to connect and the actual connection to improved water may be influenced by different factors. The appropriate model in this case was the Double Hurdle model² which permit the participation (decision to connect) and the actual connection as two separate situations (Cragg, A, 1971; Burton, M. *et al.*, 1994). However, considering the very few number of those actually decided to connect but could not get access (only 5% of the total) and the inaccessibility of econometric software on Double Hurdle models, we omitted those eleven cases and used the probit model for regression.

In assessing the parameter estimates, the signs of all the explanatory variables but one are as expected. And all but three estimates are statistically significant. Household income and private ownership of house have positive signs and statistically significant and these suggest

¹ $Lr = 2(\ln L_r - \ln L)$, where L_r and L are the log-likelihood function evaluated at the restricted and unrestricted estimates respectively.

² The Double Hurdle models assumes that each consumer makes two choices with respect to goods such as water to maximize his or her utility; whether to consume (participation on decision) and how much to consume (consumption decision). This specification allows the participation and consumption decision to be determined by deferent sets of parameters.

that households with higher income and residing in their own house are more likely to connect to the piped system.

Family size is positive, albeit insignificant. The larger the family size, implying higher requirement of water to the family and the more likely to connect to the improved system. As expected, sex and formal sector occupation of the head are positively related to the probability of connection, though both are insignificant.

Education level of the household head with more than eight years of schooling has significant positive relation with the probability of connection. Age of the family head has unexpected

Table 5.6 Maximum Likelihood Estimates of determinants of the probability of connecting to the pipe system

	coefficient	t-ratio	slope	Mean of X
Dependent Variable:				
Probability that a Household will connect to the piped system				
Independent Variables:				
Household income(AVINCM)	0.00209	4.169***	0.00076	387.2
Household size (HHSZ)	0.04057	0.932	0.01468	5.854
Sex of Household Head (HSEX=1 if female)	0.04125	0.192	0.0146	0.4757
Age of Household Head (HAGE)	0.02397	2.586***	0.00867	49.19
Occupation(HOCC2=1 if formal)	0.26946	1.040	0.1015	0.5340
Education level (HEDU2=1 if > 8 yr.)	0.69554	2.550**	0.25164	0.2087
Ownership of House (HTNRE1=1 if private)	0.64765	2.572**	0.23481	0.2524
Intercept	-3.1035	-4.748***	-1.1228	
Log likelihood		-96.58640		
Restricted Log likelihood		-133.9225		
Chi-squared (freedom=7)		74.67224		
Pseudo R ² (LRI)		0.28		
Count R ² =		0.75		
No. Of Observation		206		

* significant at 10%; ** significant at 5% level; *** significant at 1% level

Note: An analogue to R₂ in this model is the likelihood ratio index (LRI)

$LRI = 1 - \ln L / \ln L_0$

Count R² = (no. of correct prediction) / (No. of total observation)

positive sign and it is significant. This must be due to the fact that with the existing lower tariff which was constant for a very long time, those who are connected long ago are still maintaining their connection status. In other words, though the tariff remained constant, they were not affected by the growing costs of connection. To see the magnitude of the effects of the right hand side variables on the probability of connecting, the partial derivatives or the marginal probabilities are examined. The marginal change in an explanatory variable, X_i , on the probability of connection is given by

$$\partial p_1 / \partial x_i = \beta \phi(\beta' x_i),$$

where $\phi(\cdot)$ is the standard normal density (Greene, 1993).

Slopes in Table 5.6 give the predicted effects of the changes in the independent variables on the probability of connection. For the continuous variables the elasticities are computed. Both effects are calculated at the mean values of the explanatory variables.

Table 5.7 Probability of connecting to the piped system (effects of discrete variables)

<i>Variable</i>	<i>Probability</i>
OVERALL	0.34
SEX	
female = 1	0.35
male = 0	0.33
HEDU2	
> 8 years = 1	0.55
otherwise = 0	0.30
HOCC2	
formal = 1	0.40
non-formal = 0	0.29
HTNRE1	
private = 1	0.53
rented = 0	0.29

Note: Over all probability is computed at all explanatory variables at their mean value.

Probability for selected discrete variables is computed at their dummy value while the rest variables are at their mean value.

For instance, the effects of income is minimal that if household income were doubled, the probability of connection increases by around 0.1 per cent. Similarly if family size doubles it increases the probability of connection by about 1.5 per cent.

For the discrete variables, the effects of each variable were computed as the changes in the probability of connecting when the values of the explanatory variables change from zero to one, *ceteris paribus*. Both the elasticities and marginal effects are calculated at the mean values of the regressors. Table 5.7 summarises the overall probability of connecting to the system and that of the discrete variables. The mean value of the dependent variable that is the probability of connecting with all the independent variables at their mean value is 0.3446 (34%).

When we look at the discrete variables at different values, female household heads have a probability of 0.35 while male headed households have lower probability, 0.33. The level of education with more than 8 years of schooling increases the over all probability to 0.55 while otherwise it is only 0.30.

Households who live in their own houses have a 0.53 probability of connection whereas those living in rented houses have a 0.29 probability indicating that the preference to connect more relates to a secured residential condition and private ownership of houses.

The results suggest that higher education and ownership of house (a proxy for wealth) have large effects and household income with minimal effect. Relative to others, households with a head of more than eight years of education are 25 per cent more likely to connect to the piped system. Private ownership of house, other variables being at their mean value, increases the probability of connecting by about 24 percent.

We can see from the results that households' preference to connect to the improved piped water system depends on their socio-economic and demographic characteristics.

The data is then further used to investigate the effects of those household characteristics and water use attributes on the maximum willingness to pay for improved water services. Both the level of services of private connection and public stand pipes are examined. Consequently, a comparison of the results of the above indirect method to the results of the Contingent Valuation (Direct) method is undertaken to look at the validity of the CV survey on WTP for improved water services.

5.5. Determinants of WTP for private connection

For the estimates of the WTP bids for private connection in the ordered probit model, the chi-squared statistic of the Likelihood Ratio ($\chi = 101.2$) illustrates the overall models as a good fit (Table 5.8). In assessing the parameter estimates, all the coefficients of the independent variables have the expected signs. The t-statistics also indicate that six out of the nine variables, to be statistically significant at 10 per cent level and below..

The coefficient for household income (AVINCM) is positive and highly significant at 0.01 level. The result suggests that households with high level of income tend to have a higher WTP bids and more likely to connect to the proposed improved water services, supporting the hypotheses of the consumer demand theory.

The sign of the coefficient of HAGE is negative but not significant in our sample. The sign suggests the expectation that as age of the household's head increases, they would be less likely to prefer for improved water services which require more costs than the existing one.

Female headed households are more willing to pay than their male counter parts. The sign on the dummy variable HSEX is positive as expected and its coefficient is highly significant at 0.01 level.

The sign on the coefficient of the educational level HEDU1 both positive as expected and statistically significant at 0.1% level. The result indicates that relative to illiterate households,

educated households are more aware of the health benefits of safe improved water and hence they tend to have higher WTP bids for it.

Table 5.8. Maximum Likelihood Estimates of determinants WTP bid for private connection

	Coefficient	t-ratio	Mean of X
Dependent Variable			
Probability that a household's WTP bid for a private connection falls within a specified interval			
Independent Variable:			
Household Income(AVINCM)	0.00145	4.402***	384.8
Age of household Head(HAGE)	-0.00966	-1.466	49.14
Sex of household Head (HSEX =1 if female)	0.61285	3.431***	0.4839
Education(HEDU=1 if 1-8 yr.)	0.32192	1.788*	0.3364
Occupation(HOCC2=1 if formal)	0.05655	0.297	0.5392
Household size(HHSZ)	0.07430	2.298**	5.908
Time required(TIM)	0.01138	4.691***	20.15
Ownership of house (HTNRE1= 1 if private)	0.09585	0.462	0.2488
Responsibility (RESP=1 if government)	-0.55103	-3.393***	0.5806
Intercept	0.52879	1.106	
Log likelihood	-227.2786		
Restricted Log likelihood	-277.8924		
Chi-squared (freedom =9)	101.2276		
Pseudo R2 (LRI)	0.20		
Count R2 =	0.53		
No of observation	217		

* significant at 10%; ** significant at 5% level;*** significant at 1% level

The variable of formal sector employment (HOCC2) is positive as expected, though the estimates is statistically insignificant in our data. The sign, however, support the theoretical expectation that household with formal sector employment having more awareness for the benefits of improved water services and to have higher WTP bids than otherwise. Family size (HHSZ) has the expected positive sign and it is significant at 0.05 % level implying households with large family size requiring higher amount of water and more likely to prefer to private connection and prepared to pay more for it.

The coefficient of the variable of time for fetching water (TIM) is positive as expected and the estimate of the coefficient is highly significant at 0.01 % level. The amount of time required to fetch water from outside sources is generally considered as a measure of cost of obtaining water from the existing alternative sources i.e. as the 'price' of the close substitute of the improved water services (Whittington, *et al*, 1990). Therefore, the positive sign on the coefficient is consistent with the general demand theory. The higher the time needed to collect water which means the higher the price of the close substitute, the households will have higher preference and WTP bids for improved water services.

The coefficient on HTNRE has the expected positive sign and supports the expectation that households with higher income and wealth status (proxied by house ownership) to have higher WTP bids than the poor households and those living in rented houses. However, the estimate is not statistically significant in our sample.

The effect of household's attitude toward the responsibility of improved water provision (RESP) has the expected negative sign and highly significant at 0.01 level. People with the opinion that it is government's responsibility to provide free or subsidised water services to citizens tend to have lower WTP bids than the other group with similar other attributes.

The overall econometric results of the CV models clearly indicate that the independent variables on socio-economic and demographic characteristics, water services attributes as well as household's attitude all affect the WTP bids they put on an improved water services. Comparing the two methods, the results of the connection probability model (section 5.4) are more or less similar to the WTP results. Except the variable for age of household head, all other variables in the two models have identical signs. The results indicate that the WTP bids are not a random variable but they are related to the explanatory variables systematically.

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5.6. Determinants of WTP for Public Tap

Concerning the results obtained for the WTP bids for the provision of public stand pipes, the maximum likelihood estimates are presented in Table 5.9. The chi-squared statistic here also indicate the overall significance of the model as a good fit for our data. Out of the seven independent variables all but one have the expected signs for this model and three of them are found to be statistically significant.

The sign of the coefficient of household income (AVINCM) has the negative sign for the WTP bids for public taps. The possible explanation is that households with higher income and wealth prefer and are more willing to pay for private connection than for access to a public tap. As income and wealth increases, households will be less likely to prefer for access to public taps, which may be considered as an inferior good relative to private connection.

Education level with eight years of schooling (HEDU1) has the expected sign and it is significant at 0.05 % level. However, more than eight years of schooling has a negative sign though it is not significant. This perhaps explain that as education level increases to highest level, households are less willing to pay to public tap and may prefer private connection.

As expected the family size variable (HHSZ) coefficient is positive and it is highly significant at 0.01 level. The result implies that as the number of household members increases, the more available labour force for water supply from outside sources, and the higher the preference for improved water services from public taps.

Table 5.9 Maximum Likelihood Estimates of Determinants of WTP for Public Tap

	Coefficient	t-ratio	Mean of X
Dependent Variable: Probability that a household's WTP bid for a public tap falls within a specified interval			
Independent variables:			
Household Income (AVINCM)	-0.00056	-0.724	315.4
Sex of Household Head (HSEX)	0.36620	1.368	0.5038
Education level (HEDU1 = 1 if 1-8 yr. HEDU2 = 1 if > 8 yr.	0.75726 -0.10265	2.188** -0.291	0.3383 0.1579
Household size (HHSZ)	0.23232	3.303***	5.526
Time required (TIM)	0.00147	0.199	27.41
Responsibility (RESP = 1 if government)	-0.58039	-1.801*	0.6015
Intercept	-0.24468	-0.476	
	Log likelihood	-126.4852	
	Restricted Log likelihood	-143.4520	
	Chi-squared (freedom = 7)	33.93372	
	Pseudo R2	0.118	
	Count R2	0.52	
	No. Of observation	133	

* significant at 10%; ** significant at 5% level; *** significant at 1% level

The signs on HSEX and TIM are both positive and as expected. Relative to others, female headed households and those who require more time to fetch water from the existing sources have higher WTP bids for the proposed improved water from public taps. But their coefficients are found to be statistically insignificant. The household attitude variable RESP is negative as expected and it is highly significant. The possible explanation is similar to that of the WTP model for private connection.

The overall findings of the three models suggest that the use of the Contingent Valuation survey in estimating the value consumers (households) place on an improved water services is consistent with the theoretical expectations. The results have implications for policy proposes in that we can predict the level of improved water services people demand and what they are

willing to pay using the CV survey and the ordered probit models. The following section deals with the later.

5.7. Estimating Demand for Improved Water Services

The WTP bids are used to determine the proportion of households that would accept a particular service option at any given tariff. Using the survey results, we can estimate the demand for improved water services in terms of tariff versus number of connections. The demand schedules obtained from the survey are the major kind of information needed for policy purposes to make sound investment and water tariff decisions by planners.

The basic approach is to determine the number of households who would connect to the system at different prices using the frequency distribution of the WTP responses. Frequency distribution of WTP bids for private connection and public taps are shown in Table 5.10.

The information on the frequency distribution can be used in various ways. If we have a representative sample, for instance, we can predict the distribution of WTP responses in the total population. We can also predict the WTP in the community at a specified price. Table 5.10, for instance, reveals that about 44 percent of the total households surveyed are willing-to-pay between 5 and 9 cents per *baldi* of water for private connection. On the other hand, 3.7 percent of the respondents are unwilling-to-pay for the proposed private connection. Those who bid zero have said either they cannot afford to pay or they are satisfied with the existing source.

The frequency distribution data is further used to derive the expected total connection frequencies for the provision of improved water at a particular price (tariff). In addition to the actual observation in the study, the prediction of the ordered probit model is also

Table 5.10 Frequency Distribution of WTP bids (for private connection and public taps)

Private Connection			Public Taps		
WTP Bids Cents per <i>Baldi</i>	Frequency Distribution		WTP bids Cents per <i>Baldi</i>	Frequency Distribution	
	N°	%		N°	%
0	8	3.7	0	1	0.7
1-4	22	10.1	1-3	34	25.6
5-9	95	43.8	4-5	69	51.9
10-14	57	26.3	6-9	27	20.3
15+	35	16.1	10+	2	1.5
Total	217	100.0		133	100.0

Note: WTP bids are inclusive intervals

used to derive the demand schedule for improved water services (Whittington *et al*, 1990). This helps us to compare the simple expectation (prediction) with the model predictions.

Table 5.11 and 5.12 present the expected connection frequencies using both the actual and predicted frequencies of the ordered probit model for both private connections and public taps at various prices.

Table 5.11 Connection Frequencies: Provision of improved piped system (private connection) Using actual versus predicted outcomes

Bid (tariff) cents per <i>baldi</i>	Households connecting to system			
	actual		predicted	
	%	No	%	No
0	100.0	217	100.0	217
5	86.2	187	96.8	210
10	42.4	92	28.1	61
15	16.1	35	12.0	26

From the tables we can see that at zero price, all households are likely to connect to the improved system. Depending on their maximum willingness to pay for the improved services the number of households who are likely to connect declines as the price (tariff) level rises.

If the price charged for private connection does not exceed 5 cents, from the actual WTP responses we can expect about 86.2 percent respondents to connect while the ordered probit regression predicts about 96.8 percent households likely to connect to the system (Table 5.11). Similarly if the maximum charge for improved water from the public tap is 4 cents, 73.7 per cent of the actual (observed) respondents prefer to use the proposed scheme. The ordered probit model, on the other hand, predicts about 83.5 per cent to use this source rather than the alternative water sources (Table 5.12).

We can now derive the demand schedule for the proposed improved water services in terms of price versus number of users, using the predicted outcomes of the ordered probit model. Table 5.13 shows the demand schedule for both private connection and public taps, summing up the number of household connecting or using the improved scheme if various prices are charged.

**Table 5.12 Connection (use) Frequencies provision of improved water (Public tap)
Using actual versus predicted outcomes**

Bid (tariff) Cents per <i>Baldi</i>	Households expected to use			
	Using actual data		Using prediction	
	%	No	%	No
0	100.0	133	100.0	133
4	73.7	98	83.5	111
6	21.8	29	11.3	15
10	1.5	2	0.0	0

The demand schedules are the most important results of the study using the CV survey. As mentioned this is the type of information which is required by planners and policy-makers to make sound investment decisions and tariff structure.

Table 5.13 Demand schedule: Derived from the ordered probit model (price versus No. of users)

	Price (Cents per <i>Baldi</i>)			
	0	5	10	15
Number of users private connection (N=217)	217	210	61	26
	Price (Cents per <i>Baldi</i>)			
	0	4	6	10
No. of users public taps (N=133)	133	111	15	0

Now from the survey results (Table 5.2) we can see that currently only 57 household or 26 percent of the total households are privately connected to the existing piped system. This is due to various attributes including the supply constraints. The rest of the households (74%) are either using water from private vendors, public taps or shared yard taps. In addition, more than 82 percent of the respondents are saying that they are not satisfied with the existing piped water services.

From the WTP responses we can also see that the average maximum WTP for an improved private connection is 8.7 cents and that of public tap to be 4.8 cents per *baldi* which are higher than the current official tariff. Even those already connected to the system, they revealed a higher willingness to pay if an improvement in quantity, quality and reliability to the existing system is done.

Survey results on current connections, WTP bids and dissatisfactions can lead us to look at the effects of raising tariff on the possible improvement in water provision to households. A comparison of the WTP bids and the current tariff shows that there is a potential for an

improvement in the existing water services if some critical policy changes are made in terms of tariff structure and water investment projects.

To analyse the effects of tariff changes on number of connections, consumer surplus and possible revenue increase for the water authority, estimated demand for the proposed private connections is used (figure 5.3. and 5.4). Figure 5.3 shows the number of current private connection which is supply constrained, current tariff and consumer surplus. The current tariff is on the average one cents per *baldi* for households. The demand curve is estimated based on the prediction of the ordered probit model.

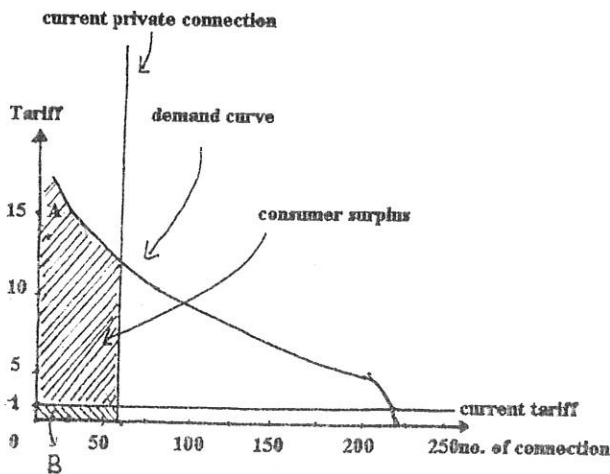


Figure 5.3 Current Available private connection and Consumer Surplus

The above figure shows that the consumer surplus as the shaded area (A), below the demand curve and above the current tariff level. And the possible revenue for the authority is the shaded area (B).

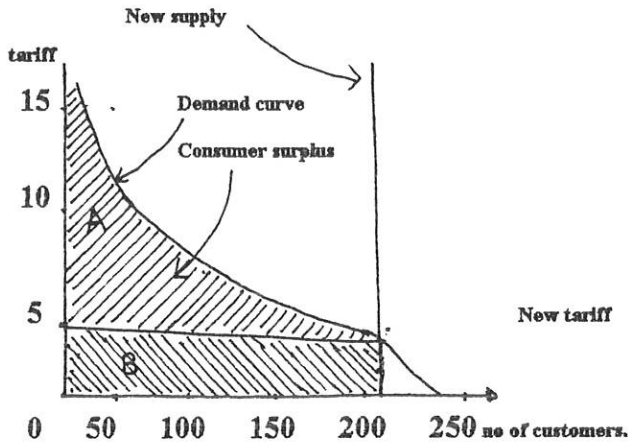


Figure 5.4 Consumer surplus and increased private connection with the proposed scheme

Figure 5.4 provides the effects tariff raise on the consumer surplus, increase in connections and possible revenues. If the tariff rate is raised to five cents which is far below the mean WTP bid, and supply is not restricted, the number of households connecting to the proposed system increases to 211. There will also be a large increase in consumer surplus as the number of households connecting with the new tariff structure rises (shaded area in fig 5.4). Though those who have already connected loses in consumer surplus, it is more than offset by the large increase as the number of connection increases (Around 30% increase). We also expect a rise in revenue to the water authority, a potential for expanding improved water schemes.

The results suggest that it is possible to raise the current tariff, and increase the number of connection with improved water scheme. The increase in revenue by the water authority should be used for investment and maintenance of more reliable and high quality improved water services. This is possible when the initial costs of connection are folded (amortised) into the volume charge.

CHAPTER SIX

CONCLUSION AND POLICY IMPLICATIONS

6.1. Conclusion

This study attempted to provide empirical evidence on the relationship between household preferences and WTP for improved water services, and the factors determining such preferences. For this purpose both the indirect approach (revealed preferences) and the Contingent Valuation (CV) approach were used. The study was based on primary cross-sectional data from sampled households of different locations in the city of Addis Ababa. Response from the survey were used to analyse the effect of socio-economic and demographic characteristics, attributes of the existing (alternative) water sources as well as the improved water services and household's attitudes on WTP bids

Methods used in the analyses were descriptive statistics, the binomial probit model for connection probability, and the ordered probit models for WTP. Tests on the existence of potential biases in the CVM were conducted.

The order probit model was further used to derive demand schedules for the proposed improved water services for private connections and public stand pipes and to analyse possibilities for improvement of the existing piped water service in the city.

The survey data illustrates that the average WTP bids for private connection to be 8.66 cents per *baldi* of improved water from private connection and 4.7 cents for public taps. Both the mean WTP bids are well above the existing official tariff for piped water.

Unreliability of supply, higher connection costs, poor quality and quantity of the existing piped water services are found to be the most serious problems in the sampled areas. The results of

the tests showed that there are no evidences for the existence of either starting point or strategic biases in the willingness-to-pay responses.

The major evidences of the study is that surveys using both actual and hypothetical water-use practices can provide policy relevant information on the level improved waster services and their WTP for.

The empirical results, showed that estimates obtained from the connection probability model are more or less consistent with estimates of the WTP model for private connection. With the exception of age variable all variables in the former model have the expected and similar signs with the latter model.

In the connection probability model the variable household income, ownership of residing house, age and education level of household head are found to be significant determinants of households' decisions to connect to improved water scheme. The hypothetical models showed that the signs of almost all the explanatory variables to be in the directions expected.

The t-statistics of the ordered probit model for private connection indicated that variables on household income, sex, education level, household size, time and household attitude on responsibility of water provision to be statistically significant. In addition, in the model for the public tap, estimates on education level, household size and household attitude are statistically significant.

The possibility of deriving demand schedules for improved water using the ordered prohibit model clearly reveals that raising tariff with unconstrained supply could lead to increased connections, higher consumer surplus and possible rise in revenue for water authority.

The overall results demonstrate that the WTP responses from the CV survey using the iterative bidding game elicitation technique are not ad hoc but they are systematically related to the

independent variables suggested by theory. Hence, it is possible to suggest the CV survey as a feasible method for estimating WTP for public utilities such as improved water services.

However, we cannot certainly claim that people behave as they said they would. For this, a resurvey may be required to test the results of the CV survey and compare the WTP responses to the actual behaviour of households once the proposed water scheme is made.

6.2 Policy Implications

The study attempted to identify the determinants of household's preference and WTP for improved water services in the city of Addis Ababa. In a situation where critical water shortage and dissatisfaction in current water services prevail, the CVM approach is found to be a practicable way to estimate WTP and identify what level and type of services are required

Based on the empirical evidences some remarks on policy implications of the study can be forwarded which need the attention of the water authority and policy markers. Moreover, the similarities of the existing domestic water use conditions in the city (see chapter Two) and the survey results allow us to make generalisations about the city concerning improved water.

The basic issues guiding policy for improved water services are the levels of service to be provided and water supply schemes, the payment conditions, possible trends as socio-economic condition change in the future.

The WTP bids could be used to predict the level and types of improved water demanded by households. This information is vital for relating standard of services (individual connection or public taps) and design criteria. If water schemes are overdesigned scarce resources are misused, while undersigned schemes lead to unsatisfied demand. Therefore, it is suggested that the water authority could use the approaches such as CVM and the ordered probity model to emanate information on the level of demand. The possibility could help to get out of the

current supply driven policy and set out design criteria for improved water projects and programmes.

One of the major problems indicated by respondents is the higher costs of connection to the existing pipe system. From the WTP bids, household are willing to pay higher than the current (subsidised) tariff if the costs of connection are distributed (amortised) in the tariff and if more reliable and high quality water is provided. Initial connection costs and deposit fees are part of the existing tariff structure in the city. On the other hand, the authority could not even cover its recurrent expenses, let alone develop new schemes due to financial constraints. Therefore, folding the connection costs in tariff and dropping deposit fees could lead to a potential for revenues and opportunities for financing new water supplies as the number of connection rises, if the WTP bids and payment conditions are considered.

At present, with few private connections and very few public taps, the majority of the households (the low income group) depend on private vendors or on the good will of their neighbours for water supply. The current rising block water tariff policy under such a situation implies a worsening effect on the lower income water consumers. Hence, the tariff policy should encompass social objectives so that the poor urban consumers are charged a lower rate which must be supplemented with immediate measure on expanding communal stand pipes.

As the structure of employment (in favour of formal sector) and education level rises, preference for improved water and private connections are likely to increase in the future. The effect of private ownership of house (which is also likely to rise) also reinforce this trend. This implies that projection of water demands should not only depend on population growth but encompass changes in those socio-economic conditions. The WTP bids and their determinate could be used to identify such trends in the future.

Finally, attempts to change the attitudes of the citizens on the proper responsibility of the government and the role of the individuals and the community in the provision of improved water services could help, if proper handling and sustained services of the piped water schemes are sought for.

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Appendices

Appendix A: Questionnaire

**A CONTINGENT VALUATION SURVEY
QUESTIONNAIRE
(DEMAND FOR IMPROVED WATER SERVICES)**

Identification Code _____

Interviewer _____

Date Of Interview _____ Time _____

Length Of Interview _____ Minutes

Supervisor _____

ATTENTION : UPPER CASE LETTERS = INSTRUCTIONS FOR INTERVIEWER
lower case letters = questions and statements to be read aloud to the
respondent

INTRODUCTION TO THE RESPONDENT:

Good day, I am _____ from the Addis Ababa University. We are talking to a selected sample of households in Addis Ababa city about demand for improved water services. The research is an attempt to clarify and understand the preference and attitude you place on improved water services. Your views could be used to help policy makers make informed decisions.

First, let me begin by saying that most of the questions have to do with your attitudes and opinions, and there are no correct or wrong answers.

This interview is completely confidential and strictly for academic purposes. And your name will never be linked with your answers. Therefore, honest discussion is the best way ahead.

SECTION A:**PERSONAL CHARACTERISTICS OF HOUSEHOLD MEMBERS**

First, I am going to ask a few questions about you and your household members' personal characteristics.

- A1. What is your name? _____
- A2. Your address? Zone _____ *Wereda* _____ *Kebele* _____ House No. _____
- A3. Gender (OBSERVATION) 1 =female _____ 2 = male _____
- A4. Who is the head of the family ? Ato/w/o _____
- A5. How many people, both adults and children, live in this household including yourself?
_____ Number

IF "RESPONDENT ONLY" TO Q.A5, ASK Q.A6:
IF MORE THAN ONE HOUSEHOLD MEMBER, SKIP TO Q.A7

RECORD THE ANSWERS FOR Q.A6, Q.A7 IN THE HOUSEHOLD TABLE
BELOW.

- A6. Please, tell me your age, education level and occupation.
- A7. Starting with the eldest member of this household, please tell me the sex, age, education level, occupation and their relationship to you.

INTERVIEWER: CHECK THE TOTAL NUMBER LISTED IN THE TABLE IS THE SAME AS THE NUMBER OF HOUSEHOLD MEMBERS IN Q.A5.

- A8. For what purpose is this household used?
1. _____ Residential only
 2. _____ Residential and business
 3. _____ Others (specify) _____

SECTION B: EXISTING WATER USE CONDITIONS AND PROBLEMS

In this section, I am going to ask you about your water use practices, including the cost of collection, the quality, and the reliability of the water supply.

B1. Have any of your household members suffered from diseases caused by deficient water quality such as diarrhea, or typhoid, in the past one year?

1. yes
2. no

B2. What is the main source of water for the members of this household ?

1. Piped water _____ > GO TO QB3
2. Others (specify) _____ -----> SKIP TO Q.B34

IF "PIPED WATER" TO Q.B2, ASK:

B3. What kind of piped water services do you use currently?

1. Tap inside the house -----> SKIP TO Q.B5
2. Tap in the compound, private --> SKIP TO Q.B5
3. Tap in the compound, shared ---> GO TO Q.B4
4. Tap outside compound ----->SKIP TO Q.B11

IF "TAP IN COMPOUND, SHARED" TO Q.B3 ASK:

B4. How many households use the shared tap in the compound?

_____ Households

B5. How much water do you consume per day on the average?

_____ *Baldi/Insra* (or a 20-litter bucket)

B6. How much are you charged per month, on the average, for using this sources?

_____ *Birr/month*

B7. For what purpose(s) is the water from this source used? IDENTIFY AND RANK STARTING WITH THE MAIN PURPOSE

- ___ 1. Drinking
- ___ 2. House keeping
- ___ 3. Washing clothes
- ___ 4. Others (specify) _____

B8. In relation to its quality, amount and reliability, how do you rank the current status of water services from this source?

15.1 Quality :1. Good 2. Satisfactory 3. Poor

15.2 Quantity: 1. Good 2. Satisfactory 3. Poor

15.3 Reliability 1. Reliable 2. Unreliable.

B9. Are you satisfied with the arrangement of the existing water services?

1. Yes
2. No

IF "NO" TO Q.B9, ASK:

B10. What is(are) the cause(s) your dissatisfaction? IDENTIFY AND RANK STARTING WITH THE MOST SERIOUS CAUSE

- ___ 1. ___ Poor quality
- ___ 2. ___ Less quantity
- ___ 3. ___ Unreliability
- ___ 4. ___ Higher connection charges
- ___ 5. ___ Higher volume charges
- ___ 6. ___ Others (specify) _____

IF "TAP OUTSIDE COMPOUND" TO Q.B3 ASK:

B11. From which source do you get water currently?

- 1. ___ Public tap -----> GO TO Q.B12
- 2. ___ Private vendors -----> SKIP TO Q.B23
- 3. ___ Other organizations
(specify) _____ -----> SKIP TO Q.23

IF "PUBLIC TAP" TO Q.B11, ASK:

B12. For what major purpose(s) do you use water collected from public tap? IDENTIFY AND RANK

- ___ 1. ___ Drinking
- ___ 2. ___ House keeping
- ___ 3. ___ Washing clothes
- ___ 4. ___ Other (specify) _____

B13. Why do you prefer this source?

- 1. ___ No access to the existing system
- 2. ___ I can not afford the costs to the existing system
- 3. ___ Its reliability
- 4. ___ Lower volume charge
- 5. ___ Shorter distance than other sources
- 6. ___ Other (specify) _____

B14. How much time do you spend to collect water from this source at a time?

_____ minutes

B15. How often do you go to the public tap per day?

_____ times

B16. How many persons from your household go to fetch water at a time ?

_____ persons



B17. Who goes to the public tap?

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

B18. How much water do you collect on the average on a day?

_____ *Baldi / Insira*

B19. How much do you pay per *Baldi / Insira*?

_____ Cents

B20. How much money do you spend per month to collect water from this source?

_____ *Birr* per month

B21. Are you satisfied with this source of water?

1. ___ yes
2. ___ no

B22. If no, why are you dissatisfied ? IDENTIFY AND RANK

- ___ 1. ___ Poor quality
- ___ 2. ___ Low quantity
- ___ 3. ___ Unreliability
- ___ 4. ___ Higher volume charge
- ___ 5. ___ Far away from home
- ___ 6. ___ Others (specify) _____

IF " PRIVATE VENDORS OR OTHER ORGANIZATIONS" TO Q.B11 ASK:

B23. Whom do you buy water from?

1. ___ Private vendors
2. ___ Other organization (specify) _____

B24. Why do you prefer this source? IDENTIFY AND RANK

- ___ 1. ___ No access to the existing pipe system
- ___ 2. ___ I can not afford to existing system
- ___ 3. ___ Its reliability
- ___ 4. ___ Lower volume charge
- ___ 5. ___ Shorter distance than other sources
- ___ 6. ___ Other (specify) _____

B25. How much time do you spend for collecting water at a time?

_____ minutes

B26. How many persons go to collect at a time?

_____ persons

B27. Who goes to collect water from this source?

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

B28. How often do they go per day?

_____ times

B29. How much do you pay per *Baldi* /*Insira* ?

_____ Cents

B30. How much water do you collect on the average on a day?

_____ *Baldi* / *Insira*

B31. How much do you spend per month on the average for buying water from this source?

_____ *Birr* per month

B32. Are you satisfied with the services from this source?

1. ___ yes

2. ___ no

B33. If "No", why are you dissatisfied? IDENTIFY AND RANK

___ 1. ___ Poor quality

___ 2. ___ Low quantity

___ 3. ___ Unreliability

___ 4. ___ High volume charge

___ 5. ___ Far away from home

___ 6. ___ Others (specify) _____

IF "OTHERS" TO Q.B2 ASK:

B34. What other sources do you often use for water collection?

1. ___ River

2. ___ Well

3. ___ Spring

4. ___ Other (specify) _____

B35. Do you collect freely or are you charged?

1. ___ Charged -----> GO TO Q36

2. ___ Free -----> SKIP TO Q.37

IF "CHARGED" TO Q.35, ASK:

B36. How much do you pay per *Baldi*/*Insira*?

_____ cents

B37. How much water do you collect, on the average, on a day?

_____ *Baldi* / *Insira*

B38. How much time do you spend fetching water at a time?

_____ minutes

B39. How many members of the household go to fetch water at a time?

_____ person(s)

B40. Who goes to this source ?

1. ___ Girls

2. ___ Boys

3. ___ Both

4. ___ Others (specify) _____

B41. How often do they go per day?

_____ times

B42. Are you satisfied with this source of water?

1. Yes
2. No

B43. If "No", why are you dissatisfied? IDENTIFY AND RANK

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

ASK THE FOLLOWING QUESTIONS TO ALL RESPONDENTS

B44. To what extent do you perceive the current provision of piped water is an issue worth discussion?

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

B45. Who do you think is responsible for water supply ?

1. Governmmt
2. Commmunity
3. Private
4. Others (specify) _____

B46. So far, has the administrative body done enough in solving the problems in the provision of piped water to household ?

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

Format A

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

In this next section of the questionnaire, I am going to ask you how much it is worth to you in money terms, the provision of improved water.

INTRODUCTORY STATEMENT AND PAYMENT CONDITIONS

It is widely accepted that the provision of improved water means a good quality of water which is safe for health and an increased amount of water available for use. It also means a highly reliable source at any time. Moreover, the family need not have to spend its time and effort in fetching water from distant sources.

Now, first, let us assume that you have an option for a private connection to such an improved piped water supply scheme. The improved system will provide you with as much water as you wish at any time of the day, through out the year.

You may not be required to pay initially the costs of connection to the new scheme. Whatever you say the amount the administrative body will cover the costs of provision of the new scheme, with little or insignificant increase in the tariff rate. The purpose of this valuation is to examine the importance of this good for policy decision.

THE WILLINGNESS TO PAY (WTP) QUESTIONS

C1. Would you be willing to pay five cents per *Baldi* /*Insra* to obtain improved water from the new scheme?

IF THE RESPONDENT SAY "YES", THEN REPEAT THE QUESTION BY INCREASING THE BID BY FIVE CENTS (TEN CENTS? FIFTEEN CENTS?) UNTIL A NEGATIVE RESPONSES IS OBTAINED.

WHEN THE RESPONDENT SAY "NO", THEN REPEAT THE QUESTION BY DECREASING THE BID BY ONE CENTS UNTIL A POSITIVE RESPONSE IS OBTAINED, AND RECORD THIS AMOUNT.

_____ Cents per *Baldi*

Format B

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

In this next section of the questionnaire, I am going to ask you how much it is worth to you in money terms, the provision of improved water.

INTRODUCTORY STATEMENT AND PAYMENT CONDITIONS

It is widely accepted that the provision of improved water means a good quality of water which is safe for health and an increased amount of water available for use. It also means a highly reliable source at any time. Moreover, the family need not have to spend its time and effort in fetching water from distant sources.

Now, first, let us assume that you have an option for a private connection to such an improved piped water supply scheme. The improved system will provide you with as much water as you wish at any time of the day, through out the year.

Let us also assume that you will be charged a monthly water fee based on the volume of water your household consume in the month. The tariff per volume will be the same for all consumers. The more you consume the higher will be your monthly bill. You may not be required to pay initially the costs of connection to the new scheme. In stead, it will be distributed over several years in your monthly bill depending on your affordability.

THE WILLINGNESS TO PAY (WTP) QUESTIONS

C1. If the price (tariff) your household pay for obtaining water from this system is five cents per *Baldi/Insra*, would your household choose to connect or prefer using other sources of water?

IF THE RESPONDENT SAY "YES", THEN REPEAT THE QUESTION BY INCREASING THE BID BY FIVE CENTS (TEN CENTS? FIFTEEN CENTS?) UNTIL A NEGATIVE RESPONSES IS OBTAINED.

WHEN THE RESPONDENT SAY "NO", THEN REPEAT THE QUESTION BY DECREASING THE BID BY ONE CENTS UNTIL A POSITIVE RESPONSE IS OBTAINED, AND RECORD THIS AMOUNT.

_____ Cents per *Baldi*

ASK Q.C2 ONLY IF A ZERO BID WAS RECORDED FOR Q.C1.

C2. Did you bid zero because you believe that:

1. ___ Water should be provided free of charge
 2. ___ You are satisfied with existing source(s)
 3. ___ I would not have enough money to pay for the new system
 4. ___ Others (specify) _____
-

WILLINGNESS TO PAY QUESTION FOR PUBLIC TAPS

ASK QC3 AND QC4 ONLY IF A ZERO BID WAS RECORDED

C3. Are you interested in public tap provision?

1. ___ Yes
2. ___ No

C4. If yes, let us assume that a new scheme of improved water system using a public tap will be provided to you. The public tap will be in your *Kebele* as near as possible to your house. You will be provided a good quality water as much as you wish at any time of the day throughout the year.

You will be charged per volume charge based on the volume of water you consume at a time. If the price you pay for use of water from this source is 3 cents per *Baldi* will you be willing to use this source?

IF THE RESPONDENT SAY "YES", THEN REPEAT THE QUESTION BY INCREASING THE BID TO 5 CENTS (THEN 10 CENTS ? 15 CENTS ?) UNTIL A NEGATIVE RESPONSE IS OBTAINED. WHEN THE RESPONDENT SAY "NO" THEN REPEAT THE QUESTION BY DECREASING THE BID BY 1 CENT UNTIL A POSITIVE RESPONSE IS OBTAINED, AND RECORD THIS AMOUNT.

_____ Cents per *Baldi*

SECTION D: HOUSING CHARACTERISTICS AND HOUSEHOLD INCOME

This last section asks a few question about you and your house conditions.

D1. What is the type of tenure of this housing unit?

1. Owner occupied -----> SKIP TO Q.D3
2. Rented from *kebele* -----> GO TO Q.D2
3. Rented from others (specify) -----> GO TO Q.D2

D2. If rented, what is the monthly amount of rent ?

_____ *Birr*/month

D3. How money rooms are there in this housing units?

_____ Rooms

D4. What are the main construction materials of this house?

(INTERVIEWER: SUPPLEMENT WITH OWN OBSERVATION)

1. Wood and mud
2. Blockets
3. Bricks
4. Others (specify) _____

D5. What type of lighting has the house?

1. Electricity (meter private)
2. Electricity (meter shared)
3. Lantern
4. Kerosene
5. Others (specify) _____

D6. Do you have the following in your house?

- | | | |
|---------------|---------------------------------|--------------------------------|
| 1. Radio | 1. <input type="checkbox"/> Yes | 2. <input type="checkbox"/> No |
| 2. Telephone | 1. <input type="checkbox"/> Yes | 2. <input type="checkbox"/> No |
| 3. Television | 1. <input type="checkbox"/> Yes | 2. <input type="checkbox"/> No |

D7. Please tell me which category of the following best describes the total average income that you (and all other members of this household) earn per month. Once again, I would like to remind you that this interview is completely confidential and your name will never be associated with your answers.

1. Under *Birr* 100
2. *Birr* 100 to *Birr* 199
3. *Birr* 200 to *Birr* 299

- 4. ____ *Birr* 300 to *Birr* 399
- 5. ____ *Birr* 400 to *Birr* 499
- 6. ____ *Birr* 500 to *Birr* 599
- 7. ____ *Birr* 600 to *Birr* 699
- 8. ____ *Birr* 700 to *Birr* 799
- 9. ____ *Birr* 800 to *Birr* 899
- 10. ____ *Birr* 900 to *Birr* 999
- 11. ____ *Birr* 1000 to *Birr* 1299
- 12. ____ *Birr* 1300 to *Birr* 1499
- 13. ____ *Birr* 1500 and over

D8. How much do you spend on the average on the following items ?

- 1. Electricity _____ *Birr* per Month
- 2. Education _____ *Birr* per Month
- 3. Food _____ *Birr* per Month
- 4. Transportation _____ *Birr* per Month
- 5. Others (specify) _____ *Birr* per Month

D9. Would you like to suggest how to ensure safe improved water for all households?

CLOSING : Thank you for your time and cooperation.

SECTION E: INTERVIEWER'S EVALUATION

INTERVIEWER: COMPLETE THESE QUESTIONS IMMEDIATELY AFTER THE INTERVIEW

E1. In your judgement, how well did the respondent understand what he/she was asked in Q.C1 or/and Q.C4?

1. Understood completely
2. Understood somewhat
3. Understood a little
4. Did not understand very much
5. Did not understand at all
6. Other (specify) _____

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

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

I hereby certify that this is an honest interview taken in accordance with my instruction.

Interviewer's signature Date

Supervisor's signature Date

Appendix B: CVM hypotheses Tests

1. Testing for Strategic Biases

Type :Using two equivalent sub samples, each of which is but with a scenario that involves the same good but different incentives for engaging in strategic behaviour.

Method: By Random assignment of the two different formats (Scenarios) to respondents

Null hypotheses, H_0 = The mean WTP bid of the two subsamples are similar.

Alternate hypotheses, H_1 = The mean WTP bid of the two subsamples are different.

The formula for calculating the two-tailed t-test comparing the null hypotheses $H_0 : X_1 = X_2$, with the alternative $H_1 : X_1 \neq X_2$

$$T = (X_1 - X_2) / (S_p \cdot \sqrt{\frac{1}{N_1} + \frac{1}{N_2}})$$

$$\text{Where } S_p^2 = [(N_1 - 1)S_1^2 + (N_2 - 1)S_2^2] / [N_1 + N_2 - 2]$$

T= Calculated value of t

X_1 = the mean WTP bid of Scenario One

X_2 = the man WTP bid of scenario Two

S_p = the standard deviation of the difference between the two subsamples

S_1 = Standard Deviation of Scenario One

S_2 = Standard Deviation of Scenario Two

N_1 = No. of observation of scenario One

N_2 = No. of observation of scenario Two.

Performing the calculation using the above formula yields a value of $T=1.13$. If the WTP bids in each of the two subsamples are considered to be independent variables, T has students t -distribution with $N_1 + N_2 - 2$ degrees of freedom.

For 215 degree of freedom at five percent level of significance the tabulated value of $t = 1.96$

The calculated value of T is less than the critical value. Hence one accept the null hypotheses that there is no significant difference between the two mean WTPs; suggesting that there is no strategic behaviour in this CV survey.

Variable	Descriptive Statistics					
	Mean	Std. Dev.	Skew.	Kurt.	Minimum	Maximum
WTP1	8.6636	5.9653	1.3	4.4	0.0000	26.0000
AVINCM	384.8108	273.0069	1.2	5.5	0.0000	1599.5000
COSTW	8.9331	2.9398	0.3	4.9	2.0000	20.0000
HAGE	49.1429	14.2020	0.4	2.7	20.0000	90.0000
WEXP	8.9300	7.0762	3.0	17.8	0.3000	60.0000

Covariance matrix

	WTP1	AVINCM	COSTW	HAGE	WEXP
WTP1	38.66				
AVINCM	829.0	0.5328E+05			
COSTW	0.9372	105.4	8.643		
HAGE	-18.87	-654.3	-5.392	211.1	
WEXP	4.990	527.2	7.676	-14.02	33.99

Correlation matrix (a)

	WTP1	AVINCM	COSTW	HAGE	WEXP
WTP1	1.000				
AVINCM	0.5776	1.000			
COSTW	0.5127E-01	0.1553	1.000		
HAGE	-0.2089	-0.1951	-0.1262	1.000	
WEXP	0.1377	0.3918	0.4478	-0.1655	1.000

Variable	Descriptive Statistics					
	Mean	Std. Dev.	Skew.	Kurt.	Minimum	Maximum
WTP1	8.6636	5.9653	1.3	4.4	0.0000	26.0000
AVINCM	384.8108	273.0069	1.2	5.5	0.0000	1599.5000
HHSZ	5.9171	2.5842	0.7	3.6	1.0000	16.0000
RENT	27.7519	117.2930	8.3	80.2	1.0000	1257.0000
TIM	29.0493	30.3458	2.4	9.6	1.0000	180.0000

Covariance matrix

	WTP1	AVINCM	HHSZ	RENT	TIM
WTP1	30.46				
AVINCM	590.0	0.3563E+05			
HHSZ	0.7265	95.93	4.996		
RENT	-5.520	-281.3	-4.287	515.4	
TIM	27.30	-15.32	0.2171	107.4	837.7


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Correlation matrix (b)

	WTP1	AVINCM	HHSZ	RENT	TIM
WTP1	1.000				
AVINCM	0.5663	1.000			
HHSZ	0.5889E-01	0.2274	1.000		
RENT	-0.4405E-01	-0.6564E-01	-0.8448E-01	1.000	
TIM	0.1709	-0.2804E-02	0.3357E-02	0.1635	1.000

DECLARATION

I, the undersigned, declare that this thesis is my own original work and has not been presented in any University. All sources of materials for this thesis have been fully acknowledged.

Name: Assefa Chaka
Signature: 
Date: June, 1998
Place: Addis Ababa University