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Examining Households' Willingness to Pay for a Reliable and Sustainable Urban Water Supply using Interval Regression Analysis: The case of Addis Ababa[1]

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Abstract

Access to reliable and sustainable water is one of the major problems facing households in Addis Ababa city. Improving the water supply of the city requires a huge capital investment while the current water tariff system operates below cost recovery levels. Developing a better water tariff is critical for the improvement and sustainability of water supply services but much depends upon household Willingness to Pay (WTP), This research has aimed to estimate the interest and ability to pay for a reliable and sustainable water supply in Addis Ababa. It has also tried to examine the challenges to providing a sustainable water supply. To achieve these objectives, a household survey was made using the Contingent Valuation Method (CVM) through Double Bounded Dichotomous Choice format. Key informant interviews with higher officials and selected experts was undertaken with supplementary secondary data collected from the water utility and other relevant institutions. The results were analyzed through descriptive and econometric analysis using an interval regression model. The results showed that the current water supply met only 58% of the city's demand and a majority of households (82%) were dissatisfied with the service. 99% of sampled households indicated they were willing to pay a positive amount for proposed water improvement programs. The calibrated mean willingness of the sampled households to pay was 56.7 cents/jirican, if they could be provided with a reliable and sustainable water supply. In regard to the determinants of household willingness to pay, ten variables, satisfaction, reliability, quality, household perception about the current water tariff, attitude towards responsibility of improving water services, age, family size, income, wealth and education level, were found statistically significant and possible policy variables. The mean

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willingness to pay is much higher than the current tariff and cost of providing the service. The government is, therefore, recommended to launch different water improvement projects to improve the water supply and at the same time design and implement a new water tariff based on the principle of full cost recovery.

Keywords**:** Willingness to Pay, Reliable and Sustainable Urban Water Supply, Contingent Valuation Method, Double Bounded Dichotomous Choice, Interval Regression

JEL Codes: C18 D12 L95 Q21 Q25

1. Introduction

An adequate supply of safe and clean water is the most important precondition for sustaining human life, for maintaining ecosystems that support life and for achieving sustainable development (Topfer, 1998). And providing adequate and safe water to the people at the right location and at an affordable price is one of the main problems for developing countries. Most of the people of these countries depend on unsafe, expensive and inconvenient water services, and all-too-often, even people who do have piped connections do not get enough water. Ethiopia, which is described as "the water tower of Africa" uses only about 3% of its water resources, and of this only about 11% (0.3% of the total) is used for domestic water supplies (IWMI, 2010). Only 57% of the population of Ethiopia had access to safe drinking water at the end of 2015 (UNICEF and WHO, 2015).

The situation of Addis Ababa, the capital city of Ethiopia, is no different from the prevailing conditions of the country. It has been affected by the lack of any reliable water supply like other urban centers in the country. The city administration has been undertaking a number of initiatives to address the challenge and has certainly made changes, but its efforts have been affected by increases of population and both physical and financial resource limitations. Water demand outstrips supply, and the existing potable water supply of the city cannot satisfy the demand.

This affects the life of city dwellers in various ways. When disruptions occur in service provision, poor households are the most affected as alternative sources are too costly, both in terms of money and time. The cost of water from vendors at up to 200 times the tap price (UN-HABITAT, 2003). Currently, both the frequency and the duration of water service interruptions are surprisingly high in different areas of the city. Addis Ababa Water and Sewerage Authority (AAWSA), note that when there is a critical water disruption, households are paying up to 20 Birr/jirican[3] to buy water from vendors. Although UN-HABITAT (2003) and the 2007 national census state that more than 98% residents of Addis Ababa have access to safe drinking water, this changes when cost, availability and time are looked at together.

These basic facts underline that access to reliable water remains one of the major problems facing households in the city. Among the most important strategies proposed to improve the water supply of Addis Ababa are increasing water production by developing ground water sources in the short-term; developing surface water sources in the medium and long term; decreasing Non-Revenue for Water (NRW); and upgrading water supply distribution networks. These are major tasks requiring huge capital, and AAWSA emphasizes, that the current tariff system doesn't even allow it to collect sufficient revenue to cover its operation and maintenance (O and M) costs. So far, the government has shouldered most water delivery costs incurred, an approach which it is claimed leads to inefficient water resources management.

Failure to design a proper pricing policy for water services has resulted in under-investment, poor maintenance, slow progress in extending coverage, and wastage of water. The provision of an improved water supply is neither cost free nor sustainable unless costs are recoverable. Sustainability can only be ensured if tariffs generate enough resources to operate the system, finance expansion of the service to new customers and ultimately replace the infrastructure when necessary (IRC, 2001). Indeed, this is underlined by the Ethiopian Government Water Resources Management policy' of 1999. In other words, producing a policy to develop a better water tariff, enabling the city water utility to become financially strong by examining willingness and ability to pay, is critical for the improvement and sustainability of water supply services. The evaluation of Willingness to Pay (WTP) is useful for policy makers in making efficient investment decisions as well as for designing acceptable and reasonable pricing policies for sustainable management and provision of water services that will improve the welfare of society.

[3] Jirican is the local name for the plastic containers which are commonly used to collect water. They have a capacity of about 20 litres of water. For simplicity, the WTP questions of this study were also asked per jirican.

This study has tried to assess the level of households' WTP for reliable and sustainable water supply, as well as the major factors that influence WTP through a CV survey and an interval regression model. Different studies, including those assessed in the empirical literature review, were conducted in line with WTP for improved water supplies services in other countries and in different rural and urban areas of Ethiopia. I am not aware of any previous study applying an interval regression analysis to estimate factors affecting WTP for reliable and sustainable water service and the amount of money that households of Addis Ababa city are willing to pay. In addition to this WTP elicitation format, the use of Double Bounded Dichotomous Choice (DBDC) and of a hypothetical bias calibration strategy also make this study unique. The specific objectives are to examine the current situation of demand for and supply of water in the city; identify the major challenges and causes that affect a reliable and sustainable water supply service; and estimate the mean value and major determinants of households' WTP for reliable and sustainable water supply services in the study area.

Generally, the low tariff together with inadequate investment from government makes it difficult for the authority to supply potable water as per demand. The basic aim of this paper is to show how the government can fix the issues of policy failure and inefficiency that have led to the current deficit in water supplies. The fact that households suffer socioeconomic losses from unreliable water supplies leads to the point where many city residents may be willing to pay higher tariffs if that ensures improved water supplies. So, examining households' Willingness to Pay for water will provide useful information for policy makers. The issues addressed here are therefore of significance for policy makers, providing insight about the gap between existing water charges and the maximum value consumers are willing to pay, with implications for improvement and sustainability of water supply services.

2. Literature Review

2.1 Sustainable and Reliable Water Supply: Concepts, Challenges and Approaches

Sustainable water management (SWM) is defined as meeting current water demand for all water users without impairing future supply (Mays, 2006). More specifically, SWM is expected to contribute to the objectives of society and maintain ecological, environmental, and hydrologic integrity (Loucks, 1999).

Sustainable development and SWM are inherently related due to the requirement of water for development and UN-Water explains the integration of SWM and sustainable development as: "Water is at the foundation of sustainable development as it is the common denominator of all global challenges: energy, food, health, peace and security, and poverty eradication" (UN-Water, 2016).
A reliable water supply is a regular, steady or uninterrupted safe water supply. An uninterrupted stream of drinkable water flowing from an urban consumer's faucet is, perhaps, how most people perceive and understand water supply reliability. Consumers experience the failure of this supply as unreliability. In either case, water supply reliability has become an expected part of modern urban living. Perceptions of reliability are common to other types of demand and supply, and engineers have formalized this perception by defining reliability as the probability that system does not fail, or conversely, that it is the probability of system failure subtracted from one (Hawk, 2003).

Sustainable development in urban areas requires reliable, equitable, and easily accessible, water, but providing this for rapidly growing urban populations in developing nations creates complex logistic and economic problems. Urban water system sustainability faces challenges linked to physical resources, infrastructure, and socioeconomic conditions. Some of the critical factors involved in urban water supply shortages are population growth, rapid urbanization, lack of capacity, technological capacity, institutional capacity, inadequate financing, increasing global water scarcity, high level of water loss/leakage, climate change, and poor water infrastructure and distribution systems (Khatri (2007), Yimer (1992), Wallace S, Grover (2008), WSP (2009), Montgomery and Elimelech (2007), UN-HABITAT (2006), and Oyebande (2001)).

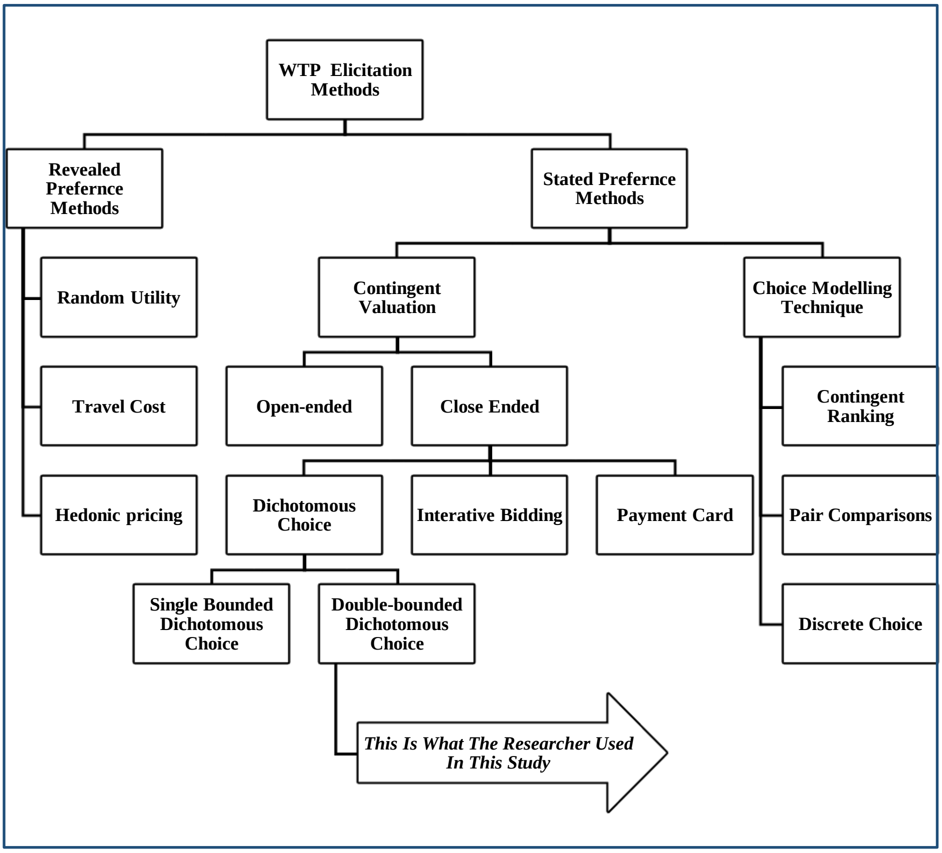
Improving water efficiency requires a multi-faceted approach that considers wider social issues and values as well as physical and technical concerns. Water efficiency can be improved by investing in physical improvement in infrastructure and technology, fostering changes in user behavior, and developing integrated improvements in water management (WSSD, 2002). Alternatively, Mani (2000), underlined the supply and demand aspects for reliable and sustainable water supply, focusing on technical elements and monopolistic public service delivery. While supply orientation is found to be economically inefficient and socially inequitable, a demand-oriented approach focuses on service consumers' needs and a WTP full costs of services, competitive markets, and allows broader participation of the private sector, nongovernmental organizations and community-based organizations. This approach is potentially more economically efficient as it increases social responsibility. According to the World Bank, governments need to adopt a "demand-driven approach" in which utilities "deliver services that people want and for which they are willing to pay" (WB (1993). There are two key ideas underlying the demand-driven approach (Gulyani, 2001). First, utilities can and should charge the full costs for water and use the revenues to improve service and expand coverage. Secondly, to do this, utilities and planners need to understand and respond to demand. In other words, by pricing water effectively and responding to demand, governments and planners would be well on the way to solving the problem.

2.2 Economic Valuations of Environmental Resources: Concepts and Methods

Economic Valuation is about "measuring the preferences" of people for an environmental good or against an environmental failure. The economic value of any environmental goods or services is measured by a summation of individuals' willingness to pay (WTP). In economics, WTP is the maximum amount an individual is willing to sacrifice to procure a good or avoid something undesirable. The most common definition of WTP is the one which states that: "WTP is the maximum amount that an individual state they are willing to pay for a good or service" (DFID, 1998).

The term 'value' has many meanings which may be used in different senses. Depending on circumstances, economists place total economic value (TEV) on either stocks or the flow of natural resources. TEV is divided into use value and non-use value. So, total WTP for environmental resources is the sum of use value and non-use value (Tietenberg, 2003). Hence, TEV of water is made up of use and non-use values. Environmental goods are not traded, so their value cannot be determined in the market. Economists have made considerable efforts over the past few decades to value environmental goods and services, and today various methods are available to value non-marketed resources such as water. According to Thomas and Callan (1996), these can be broadly grouped under indirect (revealed preference) and direct (stated preference) methods. The indirect method involves inferring the unobservable demand, and hence the value of environmental goods and services, based on observable demand for related marketable goods and services. The direct method refers to the direct expression of individuals' willingness to pay or accept in compensation for any change. It involves direct estimation of an environmental value based on the responses of individuals to hypothetical valuation questions, and so does not depend on market information (Freeman, 1993). WTP estimation methods used to measure the economic value of non-marketed resources can be summarized as presented in Figure 1.

Figure 1: Environmental Resource Economic Valuation Methods



Adopted from Stephens, 2010

The Contingent Valuation Method (CVM) is the earliest technique of the stated preference of non-market valuation approaches. It involves asking people directly what they would be willing to pay or willing to accept in compensation for change in preferences. This method is called CV as it is contingent on the hypothetical market. It is the most preferred as it deals with both use and non-use values and the survey responses to WTP or WTA hypothetical questions relate directly to the monetary measures of utility change (Perman, 2003). Ciriacy-Wans S.V (1947) first proposed the CV survey method as a method of valuation for non-marketed environmental public good, though the first empirical research, in valuing outdoor recreation, was done in 1963 by Robert K. Davis. Since then the CV method become one of the most widely used valuation approaches in water services, air pollution, soil erosion, deforestation, biodiversity, watershed management and ecosystem valuation (Whittington, 2002).

CVM is superior to other valuation methods as it is able to capture use and non-use values. Other methods like the Hedonic Pricing and Travel Cost method tend to underestimate the satisfaction derived from services rendered since they measure use values only. As Freeman (1993) noted, since non-use values could be larger in certain cases, using measurement techniques that capture only use values underestimates the total derived values. The other reason for using CVM is its ease of data collection and requirement compared to other valuation methods. These points make it clear CVM is the appropriate method to measure the TEV of reliable water supply. That is why in 1979 the U.S.A. Water Resource Planning Council recommended CVM as an acceptable method for estimating the benefits of water projects (Young, 2005). Taking the advantages and disadvantages of different measurement tools into consideration, the researcher identified CVM as the most appropriate method for valuing a reliable and sustainable water supply for Addis Ababa city.

The application of the method, however, requires extreme care to obtain reliable results. Despite its wide application, CVM suffers from a number of biases, including hypothetical, information, strategic, sampling, circumstantial, present generational, and instrumental biases, as well as those arising from respondents' efforts to please interviewers or bias due to partials (Tisdell, 1993). These potential biases make the reliability of the method questionable. Nevertheless, well-designed and soundly executed CVM studies can provide high quality and policy relevant information, and to minimize potential biases and ensure reliable information from CVM studies it is necessary to design with care survey instruments including the use of focus group discussions and pre-testing and use well-trained and experienced interviewers (Whittington, 2002).

2.3 Empirical Literature Review

The CVM, has been successfully employed in many studies of valuing public goods like water resources in developing countries. It was utilized by Ibrahim A. and Robert H. (2010) to obtain estimates of WTP for improved domestic water supply services from 525 urban, rural and camp refugees sample respondents for current and future generation in the Ramallah Governorate, Palestine. With a dichotomous choice as well as open-ended follow-up questions to model individual WTPs the result from Tobit and OLS econometric models showed that the mean annual WTP of total economic value of improved domestic water supply services was about NIS 627 per annum. Similarly, Farolfi (2007) did a study on the determinants of Swaziland households' WTP for an improvement in water quality and quantity using CVM. A sample of 374 (127 rural and 247 urban) was surveyed. A Tobit model was applied to explain household preferences for quality and quantity of domestic water supply. The result confirmed that household income had a positive and statistically significant impact on WTP. Distance to the water source was positively associated with WTP regardless of location (urban or rural) or of the household head's age, education, and gender. Current water consumption was also statistically significant for WTP for improved quantity, but with a negative sign, implying that the more a household consumed water, the less that household was WTP to have improved water quantity.

Samuel et al. (2005) used the CVM questions where 106 households were asked using an open-ended elicitation method to determine the economic value of basin protection to improve the quality and reliability of potable water supply in Ecuador. The empirical result from a Tobit model indicated that households were WTP an average of $5.8 per month, a 25 percent increase in the monthly water bill, to preserve the basin. The main variables found to affect the WTP were the existing monthly water cost, perception of the fairness of the existing water tariff, the number of hours the service was available and the gender of the individual interviewed. Likewise, Montes de Oca G.S (2003) did a study on assessing the WTP for maintained and improved water supplies in Mexico City, using CVM. This revealed that poorer households were primarily concerned with securing reliable services, while wealthier households, which were already enjoying better services, were WTP higher amounts to avoid service deterioration than improvements. The study demonstrated that WTP results could be used to create an equity-based policy of water tariffs reflecting income distribution. The aggregate WTP amounts showed the authorities could collect sufficient resources for both service modernization and a reduction of the existing subsidies by about 70%.

In Ethiopia, there have been different studies undertaken in different towns and years in relation to households WTP for the urban water supply improvements. Fisseha (1997) used a CV survey to estimate the WTP for better water quality, using 266 respondents, in Maki town. A multinomial ordered probit model was used to analyze the households' WTP response. Half of the respondents were dissatisfied by current water quality; and need better water quality provision with higher charges Income, time spent on fetching water, education, occupation and number of domestic animals owned had a significant impact on WTP. Genanaw (1999) employed CVM to assess the determinants of households WTP for improved water services in Harare. The study showed that WTP varied significantly according to the household level of income, educational level, and sex of the household head, the starting point of the bidding game, the main source of water for the household and the perceived quality of the existing water supply. The study also revealed that the mean WTP for private piped improved water connection was more than 15 times the existing authority's tariff rate.

Alebel (2002) did a study on determinants of WTP for improved water service in the urban of Nazareth (Adama) and to find out whether it was possible to introduce a full cost recovery program. He used CVM to examine the determinants of WTP and a bidding game as value elicitation method. He also used a Censored LAD (Least Absolute Deviation) estimation for the empirical analysis. He used the Probit model to see the effect of the explanatory variables on the choice of the household for the improved water service. The Censored LAD estimation result showed gender, income, monthly expenditure for water consumption, quality and time taken to fetch water from existing sources, significantly affected respondents WTP. The Probit estimate result showed that wealth, income, education level, and the quality and time taken to fetch water from the existing household source also affected the choice of the respondents to an improved water service. The descriptive analyses result revealed that the mean WTP for improved water service was higher than the existing tariff.

Similarly, Gossaye (2007) employed the CVM to investigate the WTP for improved water supply services in Debre Zeit town. Data from 234 randomly selected households were used. From the survey, 99.57% of respondents used piped water. However, only 10.26% of respondents were satisfied with the status quo. The result showed that all respondents were willing to pay above the existing tariff level, though the amount varied from individual to individual. The survey results also showed that the mean WTP for one bucket, or 20 litres, of improved water service was 10.2367 and 4.786 cents, according to the dichotomous choice and open-ended survey responses respectively. The result of both Probit and OLS econometric models revealed that age, household size, reliability and income variables influenced households' WTP for improved water service. A similar WTP study was undertaken in Mekele town by Kinfe, (2011). He used a Heckman Two-Step Estimator to identify socioeconomic characteristics and water use practices that affected the amount of money households were willing to pay for the proposed improvement in water supply service. After analyzing the Tobit model, he found the monthly income of the household, price per bucket of water, household water purification practices, and wealth of the respondent, had positive and significant effects on the WTP for improved water service. He also found that the respondent's marital status had a negative and significant effect on the WTP for an improved water supply service.

Yibeltal (2011) also conducted a study using a CV survey on households' demand for improved water supply service in urban areas of Ethiopia, using Motta town as the case study. He used a Double Bounded Dichotomous Choice (DBDC) value elicitation format. The study used cross sectional data collected from 220 randomly selected sampled households. The CV survey responses were analyzed through descriptive and econometric analysis using Probit, bivariate Probit and Tobit as empirical models. The results showed that the existing water source, initial bid offered to the households, age, sex and responsible organ for provision of improved water services had a negative effect on the probability of households' WTP for improved water services in the Probit model; at the same time, they also had a negative influence on the maximum amount they were willing to pay in the Tobit model. On the other hand, education, income, wealth, quality of water being used, reliability of existing services, years of residence, time taken to fetch water from existing sources and levels of satisfaction with existing services, positively affected the probability of accepting the initial bid offered for improved water services and the maximum amount that they were willing to pay.

Fekadu (2011) assessed households' WTP for improved water supply services in Holeta town using CVM. A total of 141 sampled households were interviewed during the survey, along with together with group discussions and key informant interviews. The survey results showed that if the town's water supply office provided an improved water supply more than 80% of the households were willing and able to pay for the service at a price higher than a cost recovery tariff rate. Correlation results showed that income and household size significantly affected households' WTP. Similarly, Dessalegn (2012) conducted a study on factors determining residential water demand in north-western Ethiopia, in Merawi town. The data was collected from 200 households. Descriptive statistics were used for descriptive results. Logistic regression and standard multiple regression analyses were also used to determine the factors explaining households' water source choice decision and the determinants of residential water demand of the surveyed households. The analysis pointed out that monthly expenditure, housing ownership, and educational status of the household head were statistically significant predictors of the households' decision to have a private piped connection.

Belaynesh (2013) did a study on households' demand for improved water service in Sodo town using CVM and a bidding game elicitation format with a single bound close-ended question followed by open-ended follow-up questions. Data was collected from 160 household heads using face-to-face interview. Both descriptive and econometric data analysis techniques were used to analyze the data. Results of the descriptive analysis revealed that of the total sample households, 47.5% had private connections. However, only 18.49% households were satisfied with the status quo. About 99.37% of sample households wanted improved services and almost 94% of households expressed their WTP for the proposed scheme of improved service in the town. The empirical result of the Probit model suggested that whether the household was willing to pay for the improved water supply service or not was affected by house ownership, years of residence, the source and quantity of water used each day, the time loss to fetch water and the initial bid price. In the Tobit model, gender of the household head, level of education, level of satisfaction and initial bid price were found to determine the amount of money an individual would spend on WTP.

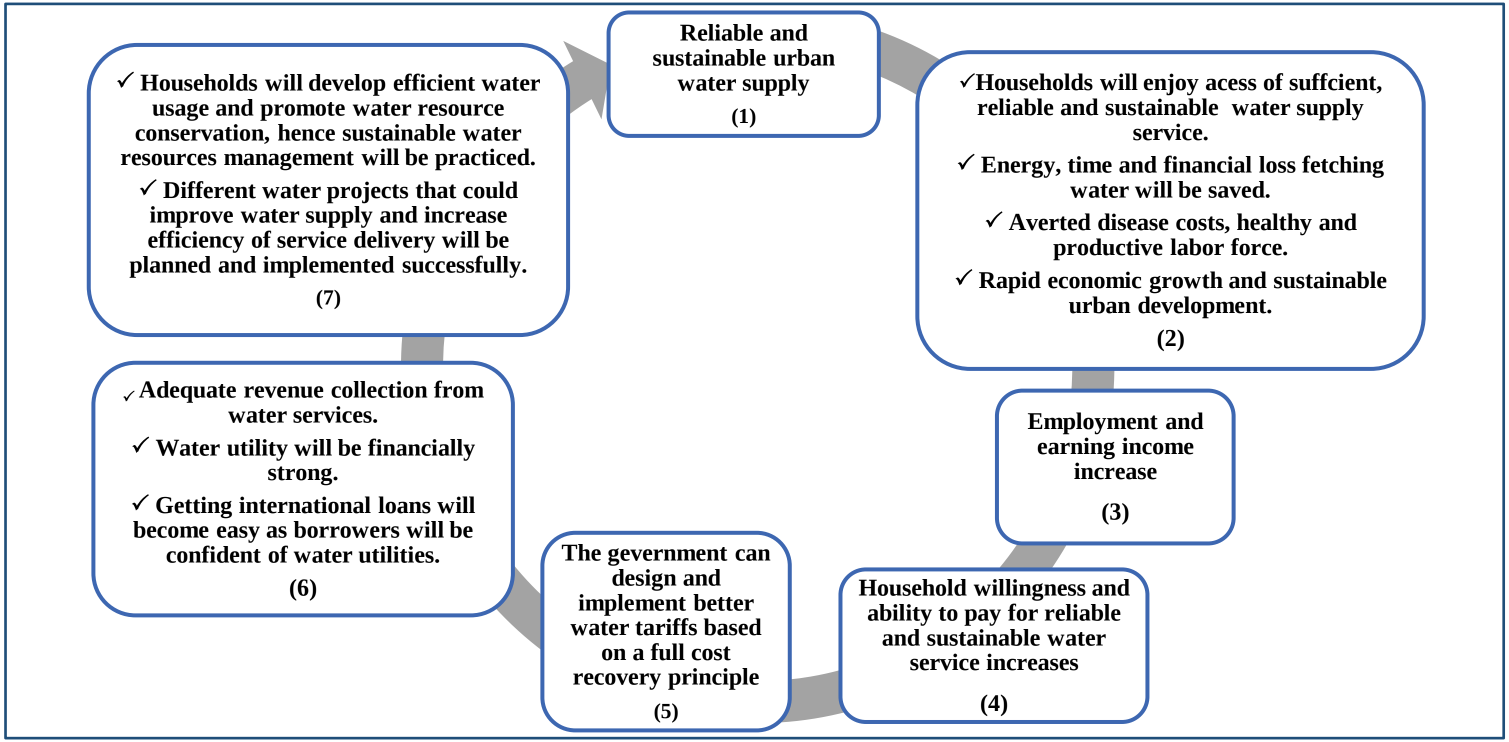
Recently Tamirat (2014) used CVM to estimate households' WTP for improved water services and identify the potential factors affecting this in Dilla. The CV survey was made using 132 randomly selected households. The data were collected through a single-bound dichotomous choice format followed by open-ended questions. He employed two econometric models, Probit and Tobit models, to analyze the data together with descriptive analysis. The result revealed that from the total sampled households 93.94% were willing to pay a positive amount for the water improvement program. The mean WTP for a jirican (20 litres) of improved water from both close-ended and open-ended questions was found to be 18.96 and 21.29 cents respectively. Both values were much higher than the current water tariff of the town. The findings of his study also revealed that households' monthly income, sources of water, occupation, and the wealth of respondents positively affected households' WTP, while households' family size, quality of water and bid value offered to the respondents, negatively affected their WTP.

In general, from these researches it seems households were commonly willing to pay more for improved water supply services. Most of the respondents were dissatisfied with their current water services. If the utility suppliers were prepared to provide improved water supplies, households showed their WTP above the existing tariff. However, the existing water supply situation and socioeconomic characteristics of the respondents affected their WTP. This empirical literature also shows that CVM was the widely used method of valuation proving it is a useful tool for valuing non-marketable goods like water services. The reviewed studies also show the various researchers used CVM with Logit, Probit and Tobit econometric models; none tried to use other methods which might be appropriate to estimate household WTP for improved water services. This researcher has employed a different method of estimating WTP for a reliable and sustainable urban water service, an interval regression model. He has also employed the Double Bounded Dichotomous Choice (DBDC) WTP elicitation format and a hypothetical bias calibration strategy in this study.

2.4 Conceptual Framework of the Study

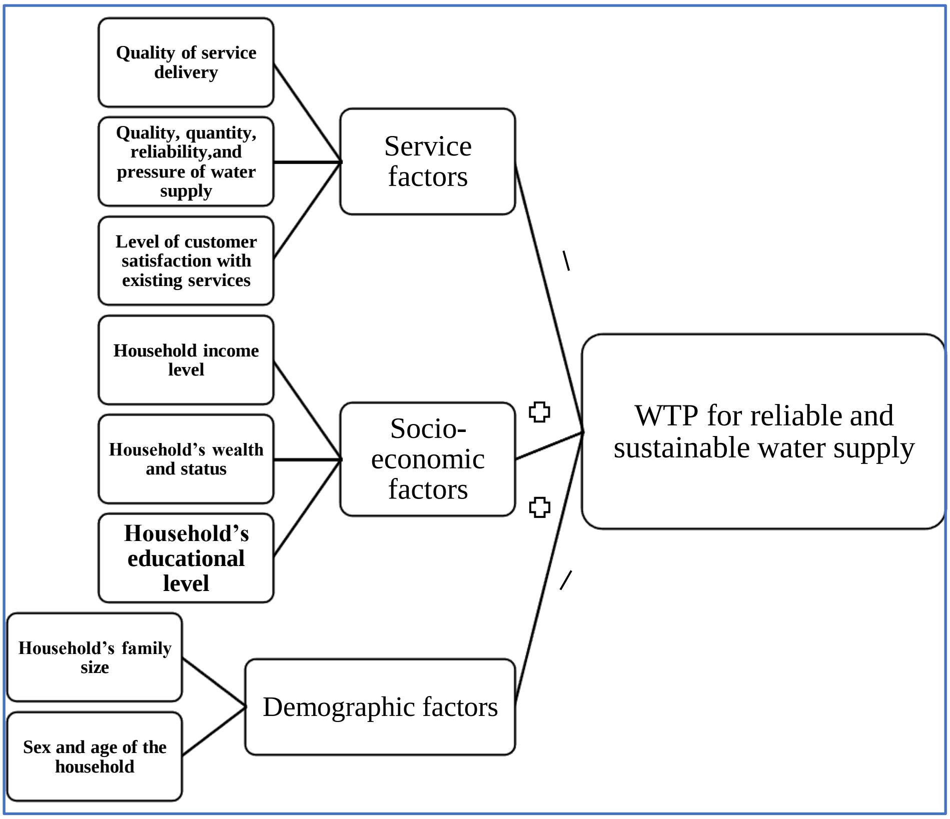
In this study, the hypothetical reliable and sustainable water service to be valued can conceptually be defined as the provision of potable water for 24 hours every day with sufficient amount and pressure. Simply, availability when needed is considered as a proxy for a reliable water service, while a long-lasting reliable water supply system or receiving continuing benefits from the proposed schemes is considered as sustainability. To show the general framework of the study, the following conceptual framework chart was designed on the basis of the theoretical and empirical literature reviews.

Figure 2: The linkage among reliable and sustainable urban water supply, WTP, better water tariffs and rapid and sustainable urban development (Source: Author, 2016).



One way to express demand for water is through WTP. Studies around the WTP explore what levels of service and quality people want and what price they are willing to pay. Different factors influence the customers' WTP. Based on the related reviewed empirical studies, the basic factors that affect households' WTP for improved water supply can be summarized as follows.

Figure 3. Selected factors having an influence on the households' WTP for reliable and sustainable water supply



Source: Author, 2016)

The relationship, between the service factors that include quality, quantity, reliability and pressure of water supply, and level of customer satisfaction with existing services can be expected to have an inverse relationship with households' WTP. If they are already satisfied with the current service, they have no reason to pay more. Concerning the socioeconomic and demographic factors, a household's income level, wealth status (which could be proxy through the owning of a fixed asset like a house) and education levels, have a positive relationship with the WTP for water supply. The effects of family size, sex and age composition of the household, however, remain controversial as their effects differ from place to place according to the physical, cultural or social context of the area under consideration. Here all these independent variables are tested against data collected from sampled households.

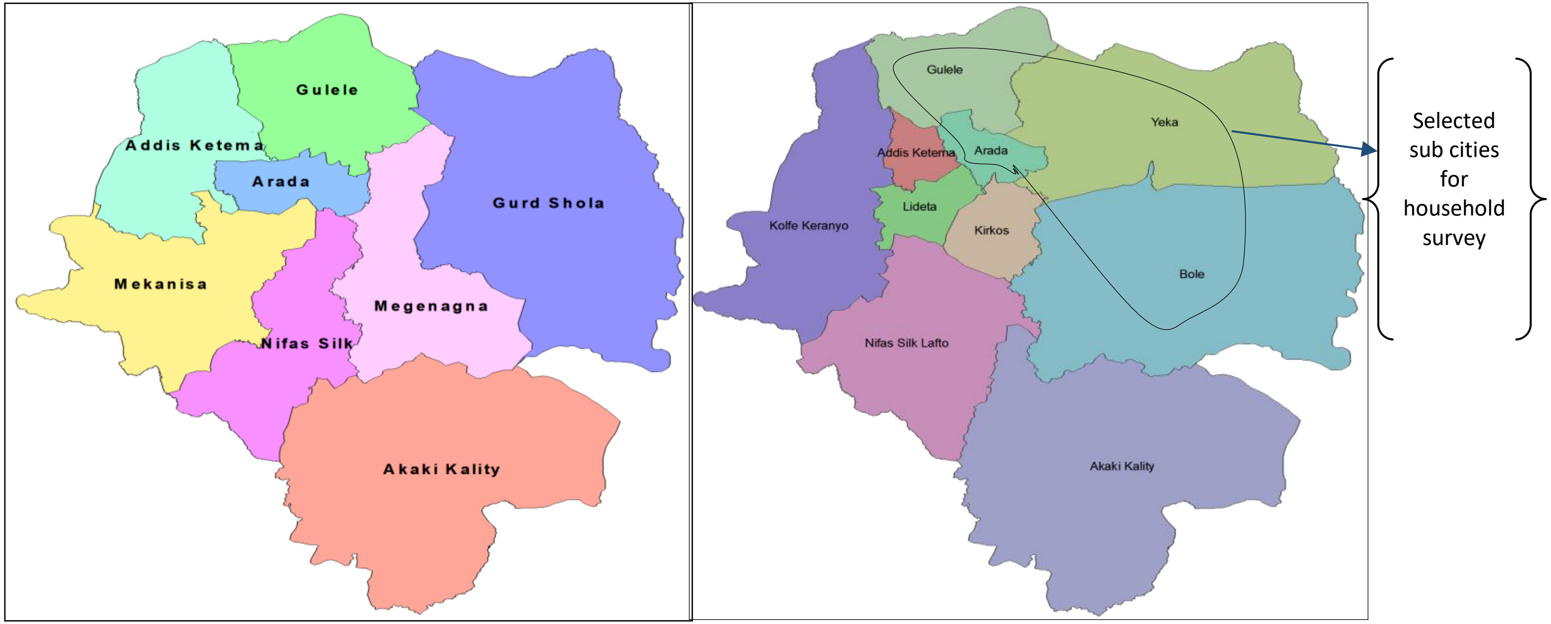
3. Methods of the Study

3.1 Description of the Study Area

This study was conducted in Addis Ababa. The city was established in 1887 by Emperor Menilek II and gets its name from Queen Taytu, meaning "new flower" in the national language. It is the largest city of the country with a population of around 4 million and an area of 540 km2. It is the capital city of Ethiopia and hosts the headquarters of the African Union, the United Nations Economic Commission for Africa (UNECA) and other continental and international organizations. It is a self-governing, chartered city with three layers of government, the city itself, and 10 sub cities and 116 woredas (districts). Geographically, the city lies between 9º 1' 48" N latitude and 38º 44' 24" E longitude. It is located in the center of the country at an altitude ranging from 2,100 meters at Akaki in the south to 3,000 meters at Entoto Hill in the north. Its temperature is mild and warm, ranging between 20oc and 25oc, with an average annual rainfall of 1250mm. It was the first city in Ethiopia to get the opportunity of a modern pure water supply system, nine years after the establishment of the city, when a tap water line installation was provided to Menilek II's palace with the help of European foreigners. Eight years later some areas of the city were also given a water supply system using the Kebana river which runs down from the Entoto Mountains. At the time, this was considered miraculous, but today almost all city residents have access to a potable water supply.

This is provided by the Addis Ababa Water and Sewerage Authority (AAWSA), the sole supplier. AAWSA was established as an autonomous body by order No. 68/1971 issued on 26 February 1971 and re-established by Proclamation No 10/1995 with a wider mandate and greater power as an independent public authority under the city administration. AAWSA now has two main responsibilities. These are: to provide a safe and adequate water supply; and to provide sewerage and sanitation services to the people within the limits of Addis Ababa. The Authority has its headquarters' offices, eight branches and a project office. While the city is divided into 10 sub-city areas for administrative purposes, there are 8 utility branch areas responsible for the operation and service provision of water supply and wastewater disposal. The 8 utility branch boundaries and the 10 sub-city boundaries are shown in Figure 4.

Figure 4: A map showing boundary of the 10 Sub-cities of Addis Ababa /right/ and the 8 Utility Branch areas /left/



Source: AAWSA, 2016

3.2 Type and Source of Data

Both primary and secondary data sources were used to get the necessary information for this study. Primary data was collected using questionnaires and key informant interviews. To gather information from sampled households, face-to-face personal interviews were administered using well-structured contingent valuation/CV/ questionnaires. To expand the information and produce reliable data, the study also used structured interviews with the concerned professionals and officials from AAWSA. Information from the survey and interviews was also supplemented with secondary data gathered from both published and unpublished material including office records and reports, journals, research papers, and books.

3.3 Samples and Sampling Techniques

The data was gathered from a random sample survey of households which had their own tap water connection used only for domestic purposes. Based on the June 2016 bill data of AAWSA, in Addis Ababa there are 380,989 (84%) domestic water customers, the population of the study. As it is difficult to incorporate and analyze the WTP of all these domestic customers, an appropriate sample was taken. There are several approaches to determine an appropriate sample size. For the case of large populations, the commonly used Cochran's equation can yield a proportional representative sample, and the sample size determination of this study, 384, was based on this formula (Cochran, 1963). This took into account the resemblance of the sampled households, as well as resource and time limitations. Regarding the sampling technique, a multistage sampling technique was used: four sub-cities were selected as a first stage, then one woreda from each sub-city, and finally households within the selected woredas. The selection was mainly carried out on the basis of the current water supply situation. To test impact, the socioeconomic diversity of households was taken into consideration in selection of sample areas.

Table 1. Distribution of representative sample of domestic customers in the study area

No (1)	Name of sub city (2)	Name of selected woreda (3)	Current water supply condition -		No. of active domestic customers in the woreda (4)	No. of questionnaires distributed to each woreda (5) = (4) * (384/13,099)	Method of selection
			average no. of days of piped water in a week	Degree of current water supply problems			
1	Bole	Wereda 04	7 days	Not serious	2118	62	Simple random sampling.
2	Arada	Wereda 06	5-6 days	Less serious	2922	86	
3	Yeka	Wereda 02	2-4 days/	Serious problem	3979	116	
4	Gulele	Wereda 08	≤1 day	Critical problem	4080	120	
Total	4	4	-	-	13,099	384	

Source: Author, 2016

The four representative sub-cities selected were Gulele, Arada, Yeka and Bole, with four woredas (one from each sub-city), selected on the basis of the specified criteria. There were 13,099 active domestic customers connected to the existing piped water system living in these four woredas. So, the sample frame of the study is 13,099 and based on this sample frame, households were sampled from each selected woredas proportionally.

3.4 Questionnaire Design and Development

In this study, the researcher has tried to measure the value of the hypothetical reliable and sustainable water supply service. As water is one of the environmental goods and services, its value cannot be determined in the market but a proper non- market valuation technique needs to be applied to value any proposed improvement in the water supply service. As shown in the literature review, different methods can be used to measure the economic value of non-marketed resources, but as indicated above, the CVM technique is superior to other methods. It is used here as an appropriate method to measure the value of water services, to estimate households' WTP for improved water supply in Addis Ababa.

The most widely used elicitation formats in CV surveys are broadly classified into two basic techniques: open-ended or close-ended questions. In an open-ended question, the respondent is asked to state the maximum amount that he/she is willing to pay for the good that is being valued. In a close-ended CV question (also referred to as a "dichotomous choice" or "referendum" question), the respondent is asked whether he/she is willing to pay a specified amount presented as the value of the improved service, and the respondent is expected to answer "yes" or "no". Close-ended questions have become the preferred form of elicitation question, since they were introduced by Bishop and Heberlein (1979) and the National Oceanic and Atmospheric Administration /NOAA/ panel recommended their use (Haab and McConnell, 2002). It was therefore used here to elicit WTP for water supply services. CV surveys used three major close-ended elicitation methods: bidding game, payment card, and dichotomous choice. Dichotomous choice is subdivided into Single Bounded Dichotomous Choice /SBDC/, (take-it-or-leave it approach) and Double Bounded Dichotomous Choice /DBDC/, (take it- or-leave- it with follow-up questions) (Hanley, 1997).

To arrive at the most rational WTP estimates, CVM studies favor the DBDC approach under which respondents are presented with a "follow-up" question in addition to the "yes-no" options of the SBDC. This, of course, is contingent upon their response to the initial bid: a lower bid is offered if the respondents say no to the offered price and, similarly, a yes response is followed by a higher bid. Thus, DBDC questions expand the information base of the WTP estimates and may provide a more accurate assessment than SBDC (Haab and McConnell, 2002). The number of responses is increased so a given function is fitted with more data points; the sequential bid offers for yes-no and no-yes responses yields clear bounds to the WTP, and finally, for the no-no and yes-yes combinations, there is a gain in efficiency as they shorten the distributions where the respondent's WTP are likely to reside. Moreover, the DBDC CVM is asymptotically more efficient than the SBDC model, as proved by Hanemann, (Hanemann 1991). Given these advantages, the DBDC question format was used here.

The questionnaire was designed following the NOAA panel guidelines for every CV study (Haab and McConnell, 2002), and divided into three basic parts: household's socioeconomic characteristics, existing water supply situation in the city, and the household's willingness to pay for improved water supply questions. After designing the draft questionnaire, pre-testing (pilot survey) was conducted by the researcher himself with 50 randomly selected household heads from the previously selected four woredas. The pilot survey result was used as an input in designing the final survey questionnaire. It was also used to set the starting bid for the CV elicitation element of the questionnaire, though during the pilot survey the WTP part was open-ended.

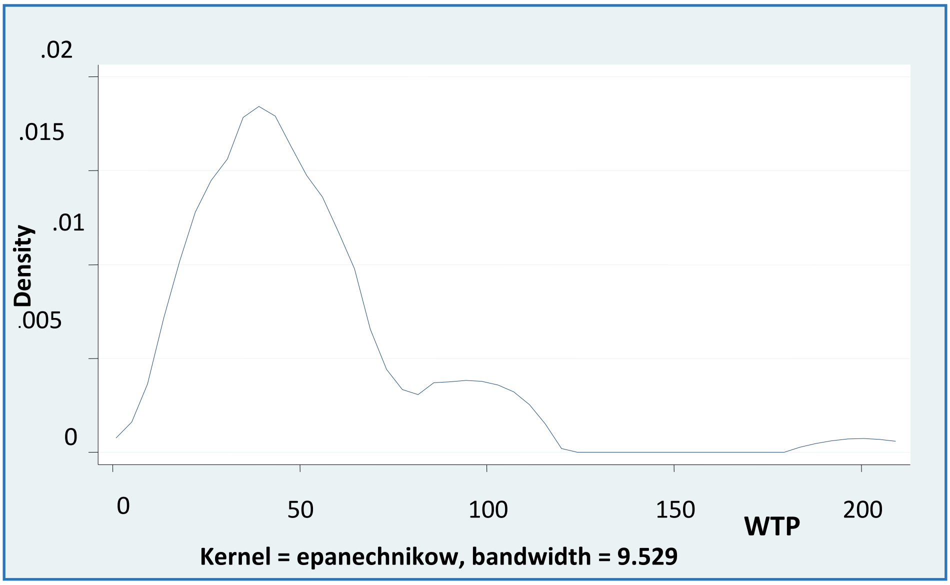
To make clear the good or service going to be valued for respondents, the hypothetical reliable and sustainable water service was defined ion the questionnaire. Before answering the WTP questions, households were told to suppose the authority would improve the piped water service and be able to provide a 24 hour-water supply every day; that the amount of water would be sufficient for their domestic use; the system would be reliable, and they wouldn't need to store water in containers or use water from private wells; their families would not need to spend their money, time and effort in fetching water from a distance; and the pressure of the line would be good with no electric motor or water storage tanks being necessary. Residents were requested to share the costs of the necessary proposed water projects if the community agreed and sufficient revenue to recover costs could be generated. On this basis, household ability and attitude towards paying for water supply improvement program was calculated.

3.5 Bid Design

The initial bid values were determined on the basis of the results of the pilot survey. The researcher used kernel density distribution8 to determine the starting bid values. As explained above, to obtain a preliminary guess about the WTP distribution, we conducted a pilot study with open-ended questions that directly asked the individuals the maximum amount they were willing to pay for improved water supply. The range of response varied between 10 cents and 2 ETB. To fit the observed data points to an underlying probability distribution the researcher used non-parametric kernel density estimation and with result indicated in Figure 5.

[8] In statistics, kernel density estimation (KDE) is a non-parametric way to estimate the probability density function f(x) of a random variable X, is a fundamental data smoothing problem where inferences about the population are made, based on a finite data sample. This technique is widely used in various inference procedures such as signal processing, data mining and econometrics (Silverman, 1986).

Figure 5: Kernel Density Estimates of stated WTP from the Pilot Study



Source: Own computation, 2017

Here we get a bandwidth of about 10 and the arithmetic mean of the sample WTP is 50. So, taking the arithmetic mean as a reference, it is possible to determine the initial bid values by adding and subtracting 10 successively to the right and left side of the mean respectively. Based on this method, five starting bids of 30, 40, 50, 60 and 70 cents were selected and randomly allotted to 384 sampled households in the final survey. The follow-up bids were the double of initial bids if the respondent answered “Yes” and half of the initial bids if he/she answered “No”. Table 2 presents the initial bid values and the bid values in the follow-up question. The level of initial bid was randomly assigned to each household as recommended by Mitchell (Mitchell, 1989). For simplicity, the WTP questions were asked per jirican; jiricans commonly have a capacity of about 20 litres of water.

Table 2: Alternative bid values used in the study (cents/jirican)

bid1 (Initial)	30	40	50	60	70
bid2 (Higher)	60	80	100	120	140
bid2 (Lower)	15	20	25	30	35

Source: Own computation, 2017

3.6 Model Specification

For estimating WTP function using cross sectional household level data, we need to specify a proper econometric model. We assume that all households face the same prices and improved status of tap water services, and WTP varies across households depending on the household socio-demographic characteristics, income and the existing status of water services. This allows the econometric model for WTP to be specified as: WTPi= $\beta_i X_i + \varepsilon_i$, where: WTPi is dependent variable, representing the ith household maximum WTP for the proposed water service; Xi is a vector of explanatory variables; βi is the coefficient of variables that affect household maximum WTP, and$\varepsilon_i$is the error term.

Though there are many factors that could affect the maximum WTP of households, only some of the most important explanatory variables were selected for the model in the study; others were omitted to avoid multicollinearity and irrelevance. On this basis, 15 variables were chosen.

Table 3. Variables included in the estimation, their description and expected sign

No	Variable	Denotation	Description	Expected sign
X1	The respondent's perception about quality of the existing water supply	QLTY	A dummy variable 1 was specified for households which perceive poor quality and 0 otherwise.	Positive
X2	Reliability of existing water source	REWS	A dummy variable taking 1 if the existing source is not reliable; 0 otherwise.	Positive
X3	Pressure of existing water source	PRSUR	Dummy variable 1 if the respondent said water had low pressure, 0 otherwise.	Positive
X4	Respondents' level of satisfaction with existing service	SAT	Dummy variable 1 if the household is not satisfied with existing water service, 0 otherwise.	Positive
X5	Average monthly expenditure for fetching water from own and alternative sources during absence of water, that is bill plus cost of water from vendors.	WEXP	Continuous variable (Birr)	Positive
X6	Households monthly water consumption	WC	Continuous variable (in M3)	Positive or Negative
X7	Household's perception on the current cost/tariff of water service.	TARIF	Dummy variable 1 if the respondent said the current water tariff is cheap, 0 otherwise.	Positive
X8	Households perception of responsible body for provision of improved water services	RESP	Dummy variable 1 if the respondent said the responsible organ is government and 0 otherwise.	Negative

No	Variable	Denotation	Description	Expected sign
X9	Age of respondent	AGE	Continuous variable (in year)	Negative
X10	Sex of respondent	SEX	A dummy variable for sex will be specified as 1 for female and 0 for male	Positive
X11	Household family size	FSZ	Continuous variable (in number)	Positive or Negative
X12	Educational status of the respondent	EDU	Continuous variable (in schooling years)	Positive
X13	Occupational status of the respondent	OCC	This is a dummy variable taking the value 1 if the respondent is employed in government, private organization, NGOs, and other related areas; 0 otherwise.	Positive
X14	Household average monthly income	MINC	Continuous variable (in Birr) which is a sum of income of the head and other members of the family.	Positive
X15	Household wealth status.	WLTH	Ownership of the house is used as a proxy for wealth. It is a dummy variable, 1 if the household owns a house and 0 otherwise.	Positive

Source: Author, 2016.

The full estimable econometric model then is:

$$\text{WTPi} = \beta_0 + \beta_1 QLTY + \beta_2 REWS + \beta_3 PRSUR + \beta_4 SAT + \beta_5 WEXP \pm \beta_6 WC + \beta_7 TARIF - \beta_8 RESP - \beta_9 AGE + \beta_{10} SEX \pm \beta_{11} FSZ + \beta_{12} EDU + \beta_{13} OCC + \beta_{14} MINC + \beta_{15} WLTH + \varepsilon_i$$

3.7 Estimation Method

The purpose of CVM is to estimate individual WTP for changes in the quality or quantity of goods or services. The estimation method depends on how the information on WTP is elicited. In the case of open-ended questions a Tobit model, or in case of close-ended questions, the Probit or Logit model are the appropriate methodologies. But Probit and Logit can be used only for the SBDC and since the DBDC method was applied in this study it was not possible to apply those estimation methods.

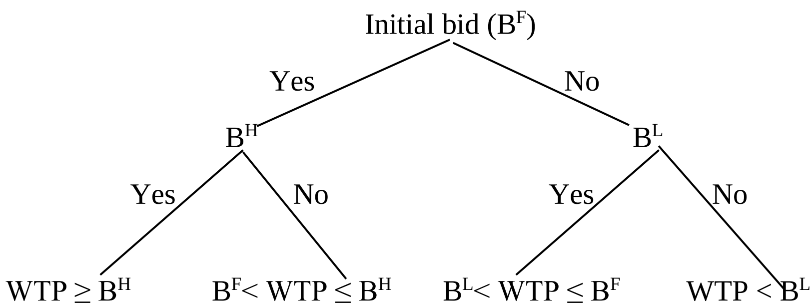
In the SBDC question format, the respondent is offered a single bid value and is expected to answer yes or no only once. But in the DBDC, there are follow-up questions about the WTP contingent upon the response to the first question. The respondent is expected to answer yes or no to the close-ended questions. In this study, WTP questions were set up in a DBDC format to elicit a household's WTP through a sequence of dichotomous-choice questions arising from the answer to a question such as: "Would you be willing to pay B cents for one jirican of improved water?" The opening bid, B, is chosen randomly from a set of predetermined values.

As indicated earlier, the values of initial bids were determined by the researcher based on the pilot survey results. That is B$\in$ $[30, 40,50,60,70]$. On the basis of the response to the opening bid, the respondent is asked a similar follow-up question, but with a larger bid value, 2B, if he/she answered "yes", or a smaller bid, 0.5B, if he/she answered "no" to the first question. Designate the initial bid (bid1), the amount in the first question, B in the above case, as BF; the second question (bid2) that would be asked with a higher bid amount as BH (2BF in this case); and a lower bid amount (0.5BF in this case) as BL. Given the responses of the two questions, the maximum and minimum bid questions, the bounds on the WTP depend on the answers to the two questions. DBDC could then have four possible interval outcomes:

i. Yes and Yes, then WTP ≥ BH, that is BH will be used as the lower bound;
ii. Yes and No, then BF< WTP ≤ BH, that is BF will be used as the lower bound and BH becomes the upper bound;
iii. No and Yes, then BL< WTP ≤ BF, that is BL will be used as the lower bound and BF becomes the upper bound;
iv. No and No, then WTP < BL, that is BL will be used as the upper bound. Where BF stands for first bid, BH stands for higher bid, and BL stands for lower bids.

On the basis of responses to the opening bid and follow-up questions, the respondent's latent WTP would be placed in one of four regions: (-∞, BL), (BL, BF), (BF, BH) or (BH, ∞). See Figure 5 below:

Figure 5. The Sequence of DBDC Questioning and formation of WTP bounds



Source: Author, 2016

The two-sequence bid offer, therefore, provides a censor or bound of the respondent's WTP. If the respondent's answer to the initial and the higher bid levels are both affirmative, then their WTP is right censored. If the answer to the initial and the lower bid levels are negative, then their WTP is left censored. But, if both answers alternate in sign, then their WTP is in an interval, with the second bid acting as an upper or lower bound to the respondent's unobserved WTP. In such cases the interval data model can be used to estimate the mean WTP and to explore the determinants of WTP, (Cameron, 1988). Thus, in this study, an interval regression model was applied to estimate determinants and mean WTP for improved water supply. The regression analysis was done by using STATA version 13.

3.8 Calibration Strategy of Hypothetical Bias

CVM is a good method for non-market valuation of environmental goods but it suffers from potential biases. To minimize these various methods were applied to acquire reliable information: the survey instrument was designed with the use of focus group discussions and pre-testing (the pilot survey); face-to-face personal interviews were administered with interviewers experienced and well trained; respondents were given a careful description of the good under consideration and issues they should take into consideration. In addition, the use of a dichotomous choice version of the CVM, especially the DBDC, rather than asking directly for a respondent's WTP, also increased the efficiency of the research results. Equally, given that the hypothetical bias9, noted in the literature survey, could be a key problem affecting the quality of the study, the researcher has applied an additional strategy to minimize this bias systematically.

The discrepancy between WTP and an ability to pay is a hypothetical bias that could be explained by uncertainty in responses to a CV survey. Li and Mattson (1995) assumed respondents with incomplete knowledge about the true valuation of a commodity might give wrong answers to valuation questions that did not match their true WTP. In the context of CV surveys, respondents can be uncertain about their WTP because they are uncertain about the provision of a public good or because they are uncertain about their future income (Wang, 1997). Therefore, it's necessary to implement tools that can mitigate hypothetical bias in CV surveys. Different studies have used CV to estimate the WTP for improved water and these studies show that most household heads are willing to pay for this. However, these studies do not address the hypothetical bias that often leads to an overestimation of WTP. This renders the results unreliable for policy purposes. Since the provision of potable water for the society is a critical policy issue for local government, it is important to mitigate the threat of hypothetical bias, something that hasn't been done in previous DBDC studies on water.

A number of calibration approaches are advocated in the literature and have been used to mitigate hypothetical bias in CV surveys. They can broadly be

[9] In stated preference valuation surveys, hypothetical bias can be defined as the difference between what a person indicates they would pay in the survey or interview and what a person would actually pay. Simply put, hypothetical bias in surveys reflects the old saying that "there is a difference between saying and doing" (Loomis, 2014).

grouped into ex-ante and ex-post approaches. An ex-ante approach is used prior to the valuation question. It consists of: (a) reminding the respondents to take into consideration their budget before stating their WTP, (b) warning the respondents about the existence of the hypothetical bias in CV studies, and explicitly asking them to respond to the valuation question as if the payment was real, (c) giving respondents time to think over their response to the valuation question, or (d) explicitly informing the respondents that they should consider that the results of the study will be consequential. The ex-post approach of adjusting WTP responses already obtained in a survey addresses hypothetical bias with Follow-up Certainty Questions (FCQ) after the valuation question. Respondents are asked on a pre-defined scale to state how certain they are regarding their answer to the WTP question. "Yes" respondents who are unsure about their answers are treated as "no" respondents. This recoding approach has proved to be effective at mitigating hypothetical bias and has produced promising results in recent years (Blumenschein K., 2008).

In this study, both ex-ante and ex-post approaches were used to mitigate hypothetical bias. Using the ex-ante approach, before answering the WTP questions, people were asked to consider the advantages associated with the proposed scheme and their monthly income, as well as consider on what else they might spend money. They were also told that the results of the study would be made available to policy makers, and could serve as a guide for future decisions. In the ex-post approach, the researcher tried to calibrate the result following the approach proposed by Champ, (Champ, 1997). This uses Follow-up Certainty Questions (FCQ) to reduce the mean WTP. So "Yes" respondents were asked to affirm how certain they were regarding their answers to the WTP question. Using a 7-point scale of certainty ranging from 1 ("Very Uncertain") to 7 ("Very certain"), respondents were asked how certain they would be to pay the given amount if the program was actually implemented. The WTP responses were then calibrated based on the respondent's feedback for certainty. The calibration strategy is indicated Table 4.

Table 4: The Calibration Strategy and WTP Bounds in DBDC Elicitation with Calibration

Response to First bid (BF)	Response to second bid (BL, BH)	Certainty level to first bid	Certainty level to the second bid	Outcome	WTP bound (WTPlowerbound, WTPupper bound)
	Yes	-	>= 5	Yes-Yes	(BH, +∞)
	Yes	-	< 5	Yes-No	(BF, BH)
	Yes	>=5	-	Yes-No	(BF, BH)
Yes	No	< 5	-	No-No	(-∞, BL)
No	Yes	-	>=5	No-Yes	(BL, BF)
No	Yes	-	< 5	No-No	(-∞, BL)
No	No	-	-	No-No	(-∞, BL)

Note: for yes-yes responses, only the second higher bid response was calibrated because it seems logical that these respondents could certainly pay the first bid at least.

4. Empirical Results and Discussion

4.1 Descriptive Analysis

As previously stated, in the survey a total of 384 randomly sampled households from different areas of the city were interviewed. Five responses were dropped because of a lack of basic required information such as income. There were four protest answers with WTP zero and they were also eliminated from the data set. As a result, a total of 375 (97.7%) questionnaires were founded usable for the analysis.

4.1.1 Demographic and socioeconomic characteristics of households

Social and demographic variables and economic issues that could influence household WTP were asked and their responses are summarized and presented here. From the total surveyed households, 194 (51.73%) were female respondents, while 181 (48.27%) were males. The data on respondents' age shows that the average age was 40.6 years, and the range from 19 to 80. The average family size of households who used the water tap was about 4.78 individuals with a minimum of 1 person and a maximum of 12 household members. The education figures reveal that 356 (95%) had some formal education and some 19 respondents were illiterate. The average educational level of household heads was 13th grade, and the range was from zero years of schooling to a maximum of 24 years.

On employment, 218 (58%) of the total 375 sampled households were engaged in salaried work, of which 147 (39%) were in government organizations, 18 (5%) in Non- Government Organizations and 53 (14%) in private organizations. The rest 157 (42%) were engaged in non-salary activities, with 112 (30%) respondents running their own businesses, 16 (4%) housewives, 5 (1%) retired, one student, one daily laborer and 22 (6%) unemployed.

From this result we can infer that about 88% of the surveyed households were engaged in different income-generating occupations. The average monthly income of sampled respondents was Birr 7,720.62 with a minimum monthly income of Birr 300.00 and a maximum of Birr 80,000.00. Data for the wealth of the households, proxied by whether the household owned the house, showed 163 (43.5%) of the respondents owned the house they lived in. Of the remaining 212(56.5%), 98(26.1%) were living in houses rented from the government or the kebele, 87 (23.2%) were privately rented and the remaining 27 (7.2%) lived in their family house. To expand the data about house ownership, respondents were also asked whether they had a house of their own in another place; 38 (10.13%) said yes, raising the number of respondents owning their own house to 201 (53.6%).

4.1.2 Existing water supply and demand situation of the city

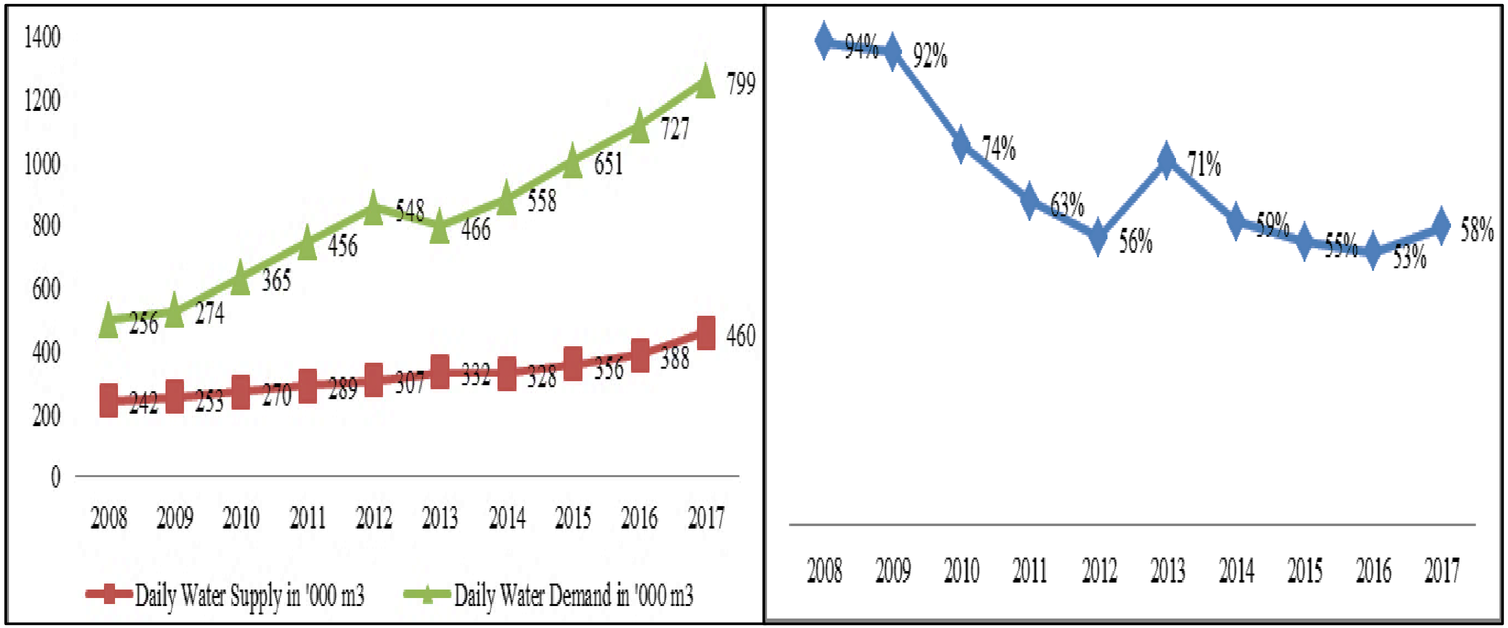
Water access and adequacy is one of the basic preconditions making an urban center an acceptable place to live in, and the AAWSA works hard to meet the ever-growing needs of residents. However, for various internal and external technical problems the average actual daily water production of the city is below capacity and far below needs. AAWSA reports show the theoretical capacity of water production should be 608,000 m3/day, but the average actual water production is only about 460, 262 m3/day. This covers only 58% of the city's daily water demand. As shown in Figure 6, though the volume of water is increasing, the population coverage is declining from year to year. The growth rate of water demands is greater than the growth in supply. According to the 2007 national census, 98.64% of the housing units of Addis Ababa had access to safe drinking water, but despite this high access rate, there has been a shortage of water supplied to households. Nearly half of the produced volume of water is consumed by non-domestic customers. As a result, the domestic mean daily per capita consumption is about 30 litres, far below the AAWSA's stated standard of 110 litres. This also falls below the global minimum standard of 50 litres/day/person, described as the threshold for meeting basic needs, independent of climate, technology, and culture (Gleick, 1996). This underlines the gap between water demand and supply in the city.

The survey results show that about 80% of households see the quality of water they get as relatively acceptable, but only 25.1% of respondents saw the quantity as sufficient. In terms of reliability, the bulk of households, 83.5%, said that the existing water supply was unreliable. Water availability at all times is crucial and offers a good indicator of efficient and effective service delivery and customer satisfaction. The study results show that on average, the surveyed households got water supply only four days in a week and both the timing and the days were uneven. Comparisons across the different areas of the city underlined the unfair pattern of water distribution. Table 5 confirms the lack of equal and fair distribution of water supplies in the city, with some sub-cities getting water every day while others, like Gulele sub city, were suffering from a critical shortage. This unreliable and inadequate water supply made a majority of the consumers, 306 (81.6%), dissatisfied with existing water supply services.

The average monthly consumption of water for a household was found to be 4.38 m3, with the average monthly household expenditure for water Birr 40.51, 0.52% of the average monthly income (Birr 7,720.62). The survey results revealed that households from high water supply problem areas spent more but consumed less compared to relatively good water supply areas. When water was not available at the required time and amount, households usually bought water from venders (at a higher price than the official tariff). Some also incurred additional labor and transportation cost to fetch water.

Figure 6: Trends of Addis Ababa daily water demand and supply.

Volume of water demand/supply in '000 m^3 **Water coverage based on total demand**



Source: AAWSA, 2008-2017

Table 5. Water Availability and household average monthly water consumption and expenditure in the study areas

No	Name of surveyed sub-cities	Average no of days piped water available in a week	Average monthly water consumption in m^3	Average monthly water expenditure in Birr
1	Bole	7.0	7.23	14.1
2	Arada	5.5	4.43	27.66
3	Yeka	3.0	3.58	35.86
4	Gulele	≤ 1.0	3.12	68.05
Average as of survey result		**4.1**	**4.38**	**40.51**

Source: Own computation, 2017

The current water tariff structure of the city was set in 2011 covering three types of customer category (public fountain, domestic and non-domestic) and seven blocks. In the survey, when asked about the current water tariff the bulk of households (68%) responded that the tariff was cheap. According to bill data, when the block increases the number of domestic customers and consumption levels fall, so when prices increase households are forced to manage their demand. Households were asked whether they would change their water consumption if the water tariff changed but about 78% said they would manage their water demands following any change in price. In other words, increasing the water tariff would not only help the authority to get additional finance, it would also offer a means of demand management strategy. Setting an appropriate water price would be one way to achieve water supply sustainability.

The sampled households agreed that there was a major water supply problem, but they differed on the responsibility for solving it. 146 (38.9%) of the respondents claimed that the government should take the responsibility to provide improved water services. About 137 (36%) respondents said it should be the joint responsibility of government and community, while the remaining 25.1% said suggested the community, private contractors or NGOs, or all together should be responsible. The econometric results of this study indicate that the attitude of households regarding responsibility is one of the key determinants of their WTP for such services.

4.1.3 Challenges of sustainable and reliable water supply in Addis Ababa

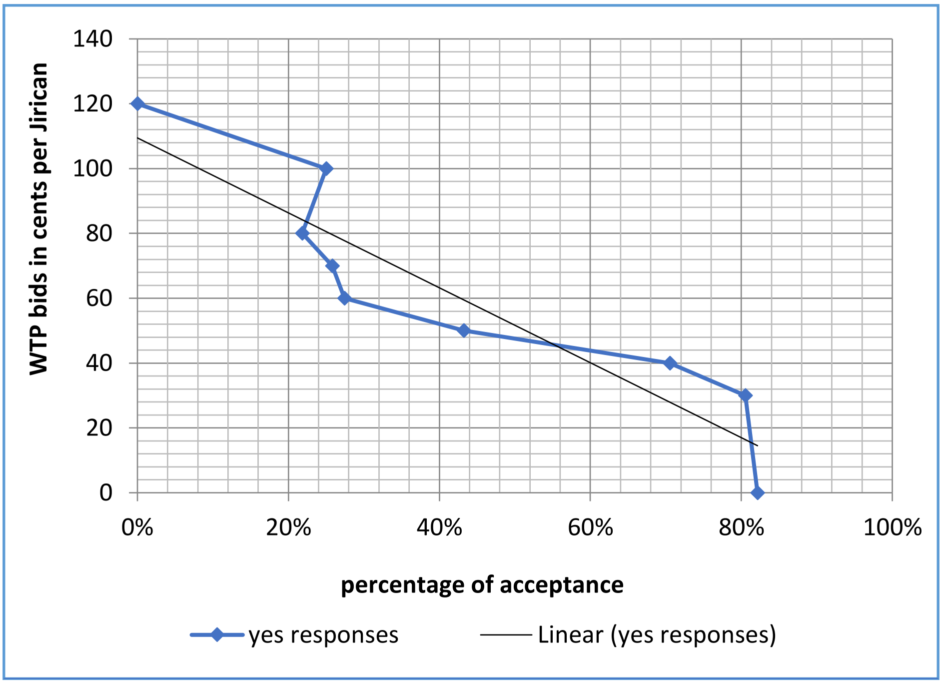
Sustainable urban development requires sustainable, reliable, equitable, and easily accessible water supplies. AAWSA has carried out a number of different water supply projects to improve its service. However, both categories of respondents (households and key informant interviewees) agreed that there were problems associated with the water supply service in Addis Ababa. They also agreed on the major problems affecting the efficiency of water supply service delivery: high population growth, poor infrastructure, rapid urbanization, the huge amount of water loss/leakage (estimated to be 45%), high levels of water consumption by non-domestic users (about 48% of supplied volume of water), inadequate technical capacity, and inadequate human and financial resources. Additional challenges were also identified: shortages and outages of electric power, a backward water distribution system, poor governance, lack of stakeholders' coordination and climate change.

With reference to the primary concern of this study, interviewees stated the presence of poor cost recovery and budget constraints significantly hindered any smooth performance of water supply. The development of water supply projects requires huge investment and Operation and Maintenance costs (O and M) are increasing while the water tariff of the city remains too low to cover these. In addition, the authority faces a low level of payment culture among the community and of meter reading, making it difficult to collect payments. Currently, the authority covers only 20% of its expenditure, not enough to cover even O and M costs, though it should be able to cover both O and M and capital investment. This tariff structure, unable to recover the full cost of water supply, is in fact contrary to the country's tariff setting guidelines which demand that urban water authorities cover their own expenditure including investment costs.

4.1.4 Demand and WTP for a reliable and sustainable water supply

Since most households were not satisfied with the existing source, more than ninety percent of the respondents said they needed an improved water supply and they would be happy if different water supply improvement projects were implemented successfully. Consequently, 99% of randomly sampled households were willing to pay for a reliable and sustainable water supply and willing to participate in improvement of water supplies. Appendix 1 shows a summary of the household responses to the DBDC questions, and. Appendix 2 gives the structure of 375 answers to the DBDC questions, excluding identified protest bidders. As expected, the frequency of "Yes" and "Yes/Yes" respondents decrease with the starting bid. On average, 4.27% of the total responses were "No/No", meaning that their WTP is below the lower bids, that is (-∞, BL). Among the remainder, the WTP given by 77.34% of respondents was somewhere in the interval between the lower bid and the starting bid (33.07%), that is BL< WTP ≤ BF or (BL, BF) and between the starting bid and the upper bid (44.27%), BF< WTP ≤ BH or (BF, BH). About 18.40% were willing to pay more than the higher bid, WTP ≥ BH or (BH, +∞). Figure 7 gives the relationship between the probabilities of accepting different alternative bids of WTP. The negatively sloped demand curve shows that, like most economic goods, the demand for reliable and sustainable water services will decrease with increasing water use charges, all other things being constant.

Figure 7: Household acceptance rate of different WTP bids.



Source: Own computation from Survey Results

4.2 Econometric results and discussion

The estimation results show that without calibration the mean WTP of the sampled households was 62.15 cents for a jirican (20 litres) of water if provided with a safe water supply service in a regular and sustainable manner. The calibrated mean WTP was 56.66 cents/jirican. The mean WTP decreased when applying the calibration approach, which suggested the presence of a hypothetical bias. The policy being valued in this study was the provision of reliable and sustainable water supply to the households in Addis Ababa which could be considered and adopted by policymakers. Therefore, the calibrated mean is used for analysis and interpretation. The calibrated mean value was larger by a small amount than the value found by the study undertaken in the case of Mekele town with a mean WTP of 51.51 cents/jirican (Saleamlak, 2013) In Addis Ababa, the mean value of household WTP (56.66 cents/jirican) was surprisingly higher than the water tariff structure of the city, more than four times the mean of the existing tariff of 13 cents/jirican . This showed that households were willing to pay much more for reliable and sustainable water services than they were paying for the existing water supply service. By taking households' average monthly water consumption (7.23 m3/month when water was available for seven days a week) and average monthly income (7,720.6 Birr) from the descriptive analysis of this study and the mean WTP, the average monthly expenditure for improved water would be 204.83 Birr/month, 2.7% of their average monthly income.

This indicated that if an average household in the study area consumed the proposed per capita amount of water and paid for one jirican of water a price equal to their mean WTP, it could afford the price based on the recommendation of the World Bank which has stated a household should spend up to 5% of its monthly income on water. It implied that a household living in the study area was willing and able to pay more if provided with reliable and sustainable water supplies. According to information provided by the AAWSA the estimated average cost per cubic meter of water is about 13.91 ETB, equivalent to 28 cents/jirican. So, the surveyed households not only expressed their WTP above the existing tariff, it was also more than twice as high as the cost of providing the service.

A significant difference was observed during the survey between household responses regarding WTP for the proposed provision of improved water service. This variation was due to the existence of differences in socioeconomic and demographic backgrounds and the water supply. The estimation result showed that among the 15 explanatory variables hypothesized to affect WTP decisions and included in the analyses, ten were statistically significant at the 5% level of significance. These independent variables could broadly be classified into three major groups, service, demographic and socio-economic factors. From the eight water service variables considered in this study - satisfaction, reliability, quality, perception about the current price of water service, and household attitudes toward the responsibility of improving water service – were statistically significant; pressure, water consumption, and water expenditure have positive signs but were not statistically significant. Out of the three hypothesized demographic variables, age and family size had a negative impact on the value of household WTP and were statistically significant, whilst Sex (being female) had positive impact but was insignificant for their WTP. As expected, the four socioeconomic variables, monthly income, wealth/proxied by house/, occupation, and education level of the respondent, had a positive effect on the level of their WTP. However, occupation was not statistically significant. The diagnostic statistics reveal that the chi square value for the model was perfectly significant at the 1% level of significance, meaning that the explanatory variables jointly influenced household's WTP. Table 6 presents the estimated coefficients of the explanatory variables (determinants) and their impact on the amount of household WTP for reliable and sustainable water supply. The signs show the direction of change in the dependent variable (WTP) given a unit change in the explanatory variable.

The overall econometric results of the model clearly indicate that the independent variables on socioeconomic and demographic characteristics, and water service attributes as well as household attitudes, all affect the value of WTP they put on the proposed water service. These variables were also mentioned by the World Bank (WB, 1993) as key determinants of household WTP for improved water services. The result of the data analysis also shows that, except the difference in the magnitude and significance level of the effects, the major determinants of WTP for improved water supply service that are incorporated in this study are similar to the findings of other studies mentioned in the empirical review of this paper. In this aspect, this study is consistent with the empirical literatures.

Table 6: Interval regression result for the determinants of WTP for reliable and sustainable water supply

Explanatory Variable	Coef.	Robust Std. Err.	P>z
SEX	1.489436	2.033034	0.4640
AGE*	-0.2130679	0.1019236	0.0370
EDU*	0.6391822	0.2573228	0.0130
OCC	0.493152	2.787901	0.8600
MINC*	0.0015486	0.0003563	0.0000
FSZ*	-0.9098825	0.4406752	0.0390
WLTZ*	10.93778	2.032012	0.0000
WC	-0.2585033	0.2069043	0.2120
WEXP	0.0163425	0.0202647	0.4200
QLTY*	8.48401	2.468525	0.0010
PRSUR	3.307189	2.808972	0.2390
REWS*	8.321632	3.616867	0.0210
SAT*	8.697711	3.347202	0.0090
RESP*	-6.056457	2.162568	0.0050
TARIF*	5.623755	2.036821	0.0060
Constant	33.69833	6.248452	0.0000
Number of observations	375		
Prob > chi2	0.0000		

* Significant at the 5 % level of significance.

Source: Own computation from Survey Result, 2017.

However, there are dissimilarities in some variables particularly regarding demographic variables, sex and family size. This study found an inverse relationship between WTP and family size while a study in Debre-Zeit, (Gossaye (2007)) shows family size positively affecting household WTP for improved water services. In this study, female respondents were more willing to pay than males no doubt because they are more responsible for water collecting and directly influenced by water related problems. Much of the literature agrees with this finding, but studies undertaken in Holeta, Nazareth, and Dilla towns by

Fekadu (2011), Alebel (2002) and Tamirat (2014) respectively revealed that males were more willing to pay for improved water supply services than women. Explaining possible reasons for this finding, Fekadu stated that women do not have equal control over or access to household cash resources so that they might be reluctant to give a positive response to WTP questions even though they might give more value to improved water service.

5. Conclusion and Recommendations

5.1 Conclusion

The existing water supply of Addis Ababa cannot satisfy the increasing demand for water. Nearly half of the water is consumed by non-domestic users, and there is a shortage of water quantity supplied to households. Surveyed households received water supplies only four days a week on average. The timing of water availability and the average of days per week was uneven, underlining the unfair and unequal water distribution in the city. In other words, this paper found the present water supply in Addis Ababa to be grossly inadequate and unreliable, making the majority of the surveyed households (82%) dissatisfied with the present supply. The water utility of the city has been facing drawbacks and challenges that hinder its efforts to create a reliable and sustainable water supply based on demand. The water tariff of the city is too low to recover investment and operational costs showing t the current charges are against tariff-setting guideline, forcing urban water authorities to finance their own expenditure.

However, the value of household WTP was found to be high compared with the current tariff rate as well as the cost required to provide service. The calibrated mean WTP of the sampled households was 56.66 cents for a jirican (20 litres) of water, if provided with a safe, regular and sustainable water supply. This study revealed that the surveyed sample households expressed their WTP both above the existing tariff structure and above the cost of providing the service. Generally, households living in the study area were willing and able to spend more if provided with more reliable and sustainable water supply. Variables concerning service delivery (satisfaction, reliability, quality, households' attitude towards the current water tariff and the responsibility of improving water services) were statistically significant. Regarding demographic variables, age and family size had negative impact on the value of household WTP, while the socio-economic variables of income, wealth, and education levels had a positive effect.

5.2 Policy Implications

Addis Ababa needs substantial investment, both for new infrastructure and for upgrading existing facilities in the short-, medium and long-term, to provide a water supply that will be adequate and sustainable to meet its ever-growing demands. More attention should be given to manage water demands through pricing mechanisms, education, conservation, and reuse programs. It is better to identify potential and develop alternative sources of water for non-domestic purposes. The water utility should strengthen its institutional capacity. Improving its financial situation should be one of the key pillars for transforming the authority into an effective public utility that can deliver the required water services. To achieve this important goal, a reliable method of meter reading and bill collection should be established, and water tariffs should be set at a level that allow the water authority to develop a self-sustaining program. As surveyed households expressed their WTP above the existing tariff structure, the government can launch different water projects that could assure reliable and sustainable water supply to the community while at the same time improving its financial viability by increasing water tariff structures based on the principle of full cost recovery. Household willingness and ability to pay is much higher than the cost of providing services, so, if private companies are involved in this service delivery program, they can benefit both themselves and the community. Based on the econometric results of the study, some socioeconomic and demographic characteristics, water services attributes and household attitudes significantly affected the value of WTP that households put on proposed water services. The water authority and policy makers should therefore give serious attention to these statistically significant variables when designing policies related to water supply services.

References

Alebel, B. (2002). Affordability and WTP for Improved Water Supply in Urban Areas, strategy for full cost Recovery, case of Nazeret town, Ethiopia. Unpublished MSc Thesis, Addis Ababa University.

Belaynesh, T. (2013). Households Demand for Improved Water Supply Service in Ethiopia: Case of Sodo Town. Paper Presented at 11th Annual Conference of EEA.

Bishop R. C. and Heberlein, T. A. (1979). Measuring value of extra market goods: are indirect measures biased?' *American Journal of Agricultural Economics*, 61(5), 926-930

Blumenschein K., B. G. (2008). Eliciting WTP without bias: Evidence from field experiment. *The Economic Journal*, 118(525), 114-137.

Cameron, T. (1988). "A new paradigm for valuing non-market goods using referendum data: Maximum likelihood estimation by censored logistic regression." *Journal of Environmental Economics and Management* 15 (3), 355-379.

Champ, P. B. (1997). "Using donation mechanisms to value nonuse benefits from public goods". *Journal of Environmental Economics and Management* 33(2), 151-162.

Ciriacy-Wantrup, S. V. (1947). "Capital Returns from Soil-Conservation Practices," *Journal of Farm Economics*, 1188-9

Cochran, W. G. (1963). *Sampling Techniques* (2nd ed.). New York: John Wiley and Sons, Inc.

Dessalegn, C. (2012). Factors Determining Residential Water Demand in North Western Ethiopia, Case of Merawi. MSc thesis, Cornell University.

DFID. (1998). Guidance note for demand assessment in water and sanitation sector, London.

Farolfi, S., Mabugu, R. E. and Ntshingila, S. N. (2007). "Domestic Water Use and values in Swaziland: A Contingent Valuation Analysis." Agrekon 46, no. 1.

Fekadu, M. (2011). Assessing Households WTP for Improved Water Supply Services in Holeta Town using CVM. Unpublished MA Thesis, Addis Ababa University.

Fisseha, A. (1997). Estimating WTP for water: A case Study on Meki Town, Unpublished MSc Thesis, Department of Economics, Addis Ababa University.

Freeman, A. (1993). The Measurement of Environmental and Resource Values: Resource for the future. Washington DC.

Genanaw, B. (1999). Determinants of Household's WTP and Demand for Improved Water Services: A CV Study in Harar Town, Ethiopia. Unpublished MSc Thesis, Addis Ababa University.

Gleick, P. (1996). Basic water requirements for human activities: Meeting basic needs. Pacific Institute for Studies for Development, Environment and Security, U.S.A.

Gossaye, F. (2007). Household WTP for improved water services, an assessment of CVM in Debre Zeit Town, Ethiopia. Unpublished MSc Thesis, Addis Ababa University.

Gulyani, S. (2001). The Demand Side Approach to Planning Water Supply; World Bank, Washington, D.C.

Haab and McConnell. (2002). Valuing environmental and natural resources, econometrics of non-market valuation, Edward Elgar, Cheltenham U.K.

Hanemann, M. L. (1991). "Statistical efficiency of double-bounded dichotomous choice contingent valuation", *Journal of Agricultural Economics* 73. 1255-1263.

Hanley, N. J. (1997). *Environmental Economics in Theory and Practice*, Macmillan Press Limited, London

Hawk, D. (2003). Water Supply Reliability. Available at https://anyflip.com/jmbd/nbsp

Ibrahim A. and Robert H. (2010). Applying CVM to measure the total economic value of domestic water services: A case study in Ramallah Governorate, Palestine. European Journal of Economics, Finance and Administrative Sciences ISSN 1450-2275 Issue 20 (2010)

IRC. (2001). Key Factors for Sustainable Cost Recovery, International Water and Sanitation Centre, Delft.

IWMI. (2010). Water Resources and Irrigation Development in Ethiopia, Working Paper 123.

Khatri, K. V. (2007). Challenges for Urban Water Supply and Sanitation in the Developing Countries, Discussion Paper for the session on Urbanization, UNESCO-IHE, Delft, The Netherlands.

Khuc. (2013). Household's WTP estimation for safe drinking water: A Case Study in Vietnam, MSc Thesis, Colorado State University.

Kinfe, G. (2011). Determinants of household demand for improved water supply service in Mekelle City. Water Policy 13(2011) 125-142

Li C. and Mattson, L. (1995). "Discrete choice under preference uncertainty: an improved structural model for contingent valuation". *Journal of Environmental Economics and Management.* 28, 256–269.

Loomis, J. B. (2014). "Strategies for Overcoming Hypothetical Bias in Stated Preference Surveys". *Journal of Agricultural and Resource Economics* 39(1), 34-46.

Loucks, D. G. (1999). *Sustainability Criteria for Water Resource Systems*; Cambridge University Press: Cambridge, UK.

Mani, Devyani ed. (2000). "Investigating a demand orientation in water and sanitation delivery," *Annual journal of the UN Center for Regional Development*, Nagoya, Japan.

Mays, L. (2006). *Water Resources Sustainability*, McGraw-Hill Professional, New York, USA.

Mitchell, R. C. and Carson, R. T. (1989). Using surveys to value public goods: the contingent valuation method. Resource for the Future, Washington DC.

Montes de Oca G.S, B. J. (2003). Assessing the WTP for Maintained and Improved Water Supplies in Mexico City. Article in Working Paper - Centre for Social and Economic Research on the Global Environment, University of East Anglia

Montgomery and Elimelech. (2007). Water and sanitation in developing countries including health in the equation, Environ. Sci. Technol. 41, 1, 17–24.

Oyebande, L. (2001). "Water problems in Africa—how can the sciences help?", *Hydrological Sciences Journal* 46, 6

Perman, R. Y. (2003). *Natural Resource and Environmental Economics*, Bell and Bain Ltd. 3rd edition.

Robert K. Davis. (1963). *Recreation Planning as an Economic Problem, Natural Resources Journal*, 239.

Saleamlak, F. G. (2013). Households' Willingness to Pay for Improved Water Supply Services in Mekelle City, Northern Ethiopia. Unpublished MSc Thesis, Addis Ababa University.

Samuel D. Zapata, Holger M. Benavides, Carlos E. Carpio and David B. Willis. (2005). Economic value of basin protection to improve quality and reliability of potable water supply: evidence from Ecuador, Clemson University, Clemson.

Schuster-Wallace, Grover, V. I., Zafar Adeel, Confalonier, C., Elliott, S. (2008). Safe Water as the Key to Global Health. United Nations University International Network on Water, Environment and Health.

Silverman, B. W. (1986). *Density Estimation for Statistics and Data Analysis*, published in Monographs on Statistics and Applied Probability, London: Chapman and Hall.

Stephens, M. (2010). Review of Stated Preference and Willingness to Pay Methods. Accent report on WTP final document. Competition commission in association with RAND Europe.

Tamirat, M. (2014). Determinant of Households' WTP for improved water supply services in Dilla Town, Southern Ethiopia, MSc Thesis, Addis Ababa University.

Thomas and Callan. (1996). *Environmental Economics and Management: Theory, Policy, and Applications*. Chicago, IL: Irwin McGraw-Hill.

Tietenberg, T. (2003). *Environmental and Natural Resource Economics*, 6th International edition, Pearson Education, Inc.

Tisdell, C. (1993). *Environmental Economics: policies for environmental management and sustainable development*. Cambridge University Press.

Topfer, K. (1998). Editorial Comments on Freshwater, Our Planet 9 (4), 3 UNEP, Nairobi, Kenya.

UN-HABITAT. (2006). "Water and shared responsibility", Water and Human Settlements in an Urbanizing World. The United Nations World Water Development Report 2: 89-113. Published jointly by UNESCO, Paris, France, and Berghahn Books, New York, USA.

_______. (2003). Urban Inequities Report: Addis Ababa.

UNICEF and WHO (2015). "Progress on sanitation and drinking water – 2015 update and MDG assessment". Printed in United States of America, ISBN: 978-92-4-150329-7.

UN-Water (2016). Rio+20 UN Conference on Sustainable Development: WATER and RIO+20. Available on http://www.emwis.org/thematicdirs/news/2012/06/rio-20-un-conference-sustainable-development-water-and-rio-20 (accessed on 09 July, 2016).

Wang, H. (1997). Treatment of don't-know responses in contingent valuation surveys: A random valuation model. *Journal of Environmental Economics and Management*. 32, 219-232.

WB—the World Bank Water Demand Research Team. (1993). "The Demand for Water in Rural Areas: Determinants and Policy Implications." The World Bank Research Observer, 8:1. The World Bank Washington, D.C. pp. 47-70.

Whittington, D. (2002). "Improving performance of CV studies in developing countries". *Environmental and Resource Economics* 22:323-367, Kluwer Academic Publishers, Netherlands.

WSP. (2009). "Water and Sanitation program, Guidance notes on services for the urban poor."

WSSD. (2002). "World Summit on Sustainable Development, taking an integrated approach to improving water efficiency", Global Water Partnership.

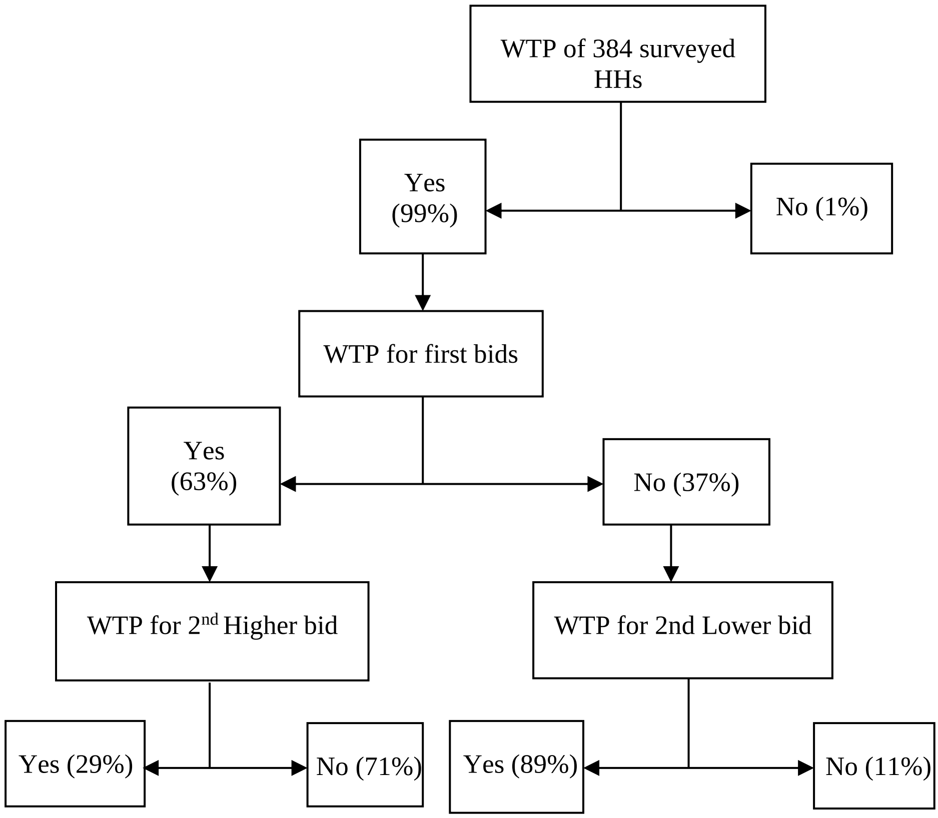
Yibeltal, B. (2011). The value of improved water supply services in Motta Town, East Gojam, Ethiopia: Application of CVM, Unpublished MSc Thesis, Addis Ababa University

Yimer, M. (1992). Factors affecting household water supply and consumption in Nazareth, Unpublished MA Thesis, Addis Ababa University.

Young, R. A. (2005). Determining the Economic Value of Water: Concepts and Methods, Resource for the Future, Washington.

Appendices

Appendix 1. Summary of Household's Responses to DBDC Questions of WTP for Reliable and Sustainable Water Supply



Appendix 2: Details of Households Answers to the Alternative Bids

Bid cards	Bid cards Statistics		Answers to initial bids /BF/		Answers to all bids			
					Frequency		%	
			Yes	No	YY	NY	YY	NY
BF/BH /BL	Frequency	%			YN	NN	YN	NN
30/60/15	84	22%	82%	18%	33	13	8.80%	3.47%
					36	2	9.60%	0.53%
40/80/20	77	21%	80%	20%	16	13	4.27%	3.47%
					46	2	12.27%	0.53%
50/100/25	78	21%	70%	30%	12	19	3.20%	5.07%
					43	4	11.47%	1.07%
60/120/30	74	20%	43%	57%	8	39	2.13%	10.40%
					24	3	6.40%	0.80%
70/140/35	62	17%	27%	73%	0	40	0.00%	10.67%
					17	5	4.53%	1.33%
Total	375	100%			69	124	18.40%	33.07%
					166	16	44.27%	4.27%

Appendix 3: The Interval Regression Result

```
Interval regression                             Number of obs   =        375
                                                Wald chi2(15)   =     421.85
Log pseudolikelihood = -257.17221               Prob > chi2     =     0.0000
```

	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
SEX	1.489436	2.033034	0.73	0.464	-2.495237	5.47411
Age	-.2130679	.1019236	-2.09	0.037	-.4128346	-.0133013
FSZ	-.9098825	.4406752	-2.06	0.039	-1.77359	-.0461749
EDU	.6391822	.2573228	2.48	0.013	.1348388	1.143526
OCC	.493152	2.787901	0.18	0.860	-4.971033	5.957337
MINC	.0015486	.0003563	4.35	0.000	.0008502	.002247
WLTZ	10.93778	2.032012	5.38	0.000	6.955112	14.92045
WC	-.2585033	.2069043	-1.25	0.212	-.6640282	.1470216
WEXP	.0163425	.0202647	0.81	0.420	-.0233757	.0560607
QLTY	8.48401	2.468525	3.44	0.001	3.64579	13.32223
PRSUR	3.307189	2.808972	1.18	0.239	-2.198295	8.812673
REWS	8.321632	3.616867	2.30	0.021	1.232703	15.41056
SAT	8.697711	3.347202	2.60	0.009	2.137316	15.25811
RESP	-6.056457	2.162568	-2.80	0.005	-10.29501	-1.817903
TARIF	5.623755	2.036821	2.76	0.006	1.63166	9.61585
_cons	33.69833	6.248452	5.39	0.000	21.45159	45.94507
/lnsigma	2.696495	.062061	43.45	0.000	2.574858	2.818132
sigma	14.82767	.9202198			13.12945	16.74555

```
  Observation summary:         15  left-censored observations
                                0     uncensored observations
                               69 right-censored observations
                              291       interval observations
```

Appendix 4: Correlation Matrix for Explanatory Variables: Test for Multicollinearity

```
. corr SEX Age EDU OCC MINC FSZ WLTZ WC WEXP QLTY PRSUR REWS SAT RESP TARIF
(obs=375)
```

	SEX	Age	EDU	OCC	MINC	FSZ	WLTZ	WC	WEXP	QLTY	PRSUR	REWS	SAT
SEX	1.0000												
Age	0.1011	1.0000											
EDU	-0.1094	-0.3701	1.0000										
OCC	-0.2310	-0.1481	0.3339	1.0000									
MINC	0.0241	-0.1306	0.3112	0.1631	1.0000								
FSZ	0.0979	0.1700	-0.0817	-0.1366	-0.0633	1.0000							
WLTZ	0.0537	0.1530	0.0915	0.0107	0.1935	0.1363	1.0000						
WC	-0.0425	0.1766	-0.1366	-0.0414	0.1321	0.2257	0.0936	1.0000					
WEXP	-0.0003	0.1558	-0.0634	-0.0888	-0.0414	0.2566	0.0960	0.1465	1.0000				
QLTY	-0.0141	0.0014	0.0728	0.0332	0.1654	0.0607	0.1384	-0.0227	0.1219	1.0000			
PRSUR	-0.0229	-0.0419	0.0767	0.0174	0.1679	0.0498	0.1848	-0.1303	0.0609	0.4566	1.0000		
REWS	-0.0121	-0.1704	0.2169	0.1250	0.2493	-0.0583	0.1720	-0.1510	0.0490	0.1641	0.2622	1.0000	
SAT	0.0036	-0.1356	0.2369	0.0944	0.2660	-0.0491	0.2212	-0.1744	-0.0218	0.2275	0.3355	0.7583	1.0000
RESP	-0.0217	0.1967	-0.2646	-0.0411	-0.2115	0.0969	-0.1723	0.1381	0.0006	-0.0758	-0.1847	-0.4499	-0.4571
TARIF	-0.0334	-0.1918	0.2702	0.0397	0.2451	-0.0837	0.1871	-0.0762	-0.0735	0.1514	0.2048	0.4820	0.5025

	RESP	TARIF
RESP	1.0000	
TARIF	-0.4030	1.0000

Appendix 5: Test for Goodness to Fit

```
. fitstat

Measures of Fit for intreg of RWTPLB RWTPUB

Log-Lik Intercept Only:      -420.673     Log-Lik Full Model:           -257.172
D(358):                       514.344     LR(15):                        327.002
                                          Prob > LR:                       0.000
McFadden's R2:                  0.389     McFadden's Adj R2:               0.348
Maximum Likelihood R2:          0.582     Cragg & Uhler's R2:              0.651
McKelvey and Zavoina's R2:      0.606
Variance of y*:               557.454     Variance of error:             219.860
AIC:                            1.462     AIC*n:                         548.344
BIC:                        -1607.495     BIC':                         -238.098
```