ESTIMATING WILLINGNESS TO PAY FOR IMPROVED WATER SERVICE IN BONGA TOWN, SOUTHWEST ETHIOPIA: *A Contingent Valuation Approach*

A Thesis Submitted to the School of Graduate Studies of Jimma University in Partial Fulfillment of the Award of the Degree of Masters of Development Economics

By

MATHIWOS KIFLE WONIT

JIMMA UNIVERSITY

COLLEGE OF BUSINESS AND ECONOMICS

DEPARTMENT OF ECONOMICS

AUGUST, 2020

JIMMA, ETHIOPIA

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By: MATHIWOS KIFLE WONIT

Under the guidance of:

Main Advisor: Mr. Tesfaye Melaku (Ass. Prof)

and

Co-Advisor: Mr. Gadisa Abera (MSc)

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CERTIFICATION

This is to certify that the thesis entities "Estimating Willingness to Pay for Improved Water Service in Bonga town, Southwest Ethiopia: A Contingent Valuation Approach", Submitted to Jimma University for the award of the Degree of Master of Development Economics is an authentic work of Mr. Mathiwos Kifle, who carried out the research under our guidance, certified further that to the best of our knowledge the work reported here does not form part of any project report or thesis on the basis of which a degree or award was conferred on an earlier occasion by this or any other candidate.

Therefore we hereby declare that no part of this thesis has been submitted to any other university or institutions for the award of any degree of diploma.

Main Advisor's Name	*Date*	*Signature*
_____	_____	_____
Co-Advisor's Name	*Date*	*Signature*
_____	_____	_____

DECLARATION

I, Mathiwos Kifle, hereby declare that this thesis entitled "Estimating Willingness to pay for Improved Water Service in Bonga town, Southwest Ethiopia: A Contingent Valuation Approach", is submitted by me in partial fulfillment for the requirements of Msc in Economics (Development Economics) at Jimma university. It is my original work and has been carried out by me under the guidance and supervision of Mr. Tesfaye Melaku (Ass. Prof), and Mr. Gadisa Abera (MSc). All sources and materials in this thesis have been duly acknowledged.

The thesis is original and has not been submitted for the award of degree of diploma to any university or instructions.

Researcher's Name	*Date*	*Signature*
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Board of Examination Thesis

We, the under signed, members of the board of examiners read this thesis "Estimating Willingness to Pay for Improved Water service in Bonga town, Southwest Ethiopia: A Contingent Valuation Approach", and evaluated the final open defense by Mathiwos Kifle Wonit. We examined the candidate and then we certify that it is suitable submission for the reward of Msc Degree in Economics (Development economics).

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ABSTRACT

Improved water is multi-purpose inputs for sustaining life, and facilitating socio-economic growth. However, shortage of this service is the critical issues of the world. The problem is more direct in case of Ethiopia. Further, its value can't be determined from market signal as it is non-market resource. However, for provision and effective management of the service, economic valuation becomes vital. This is therefore; this study designed to estimate willingness to pay for improved water service in Bonga town, southwest Ethiopia. The study used primary data obtained from a survey conducted on randomly selected 306 households in the month of February and March, 2020. The study used the CVM approach to estimate WTP using a DBDC elicitation format administered by in-person interview. The Logit model showed that; household with high income, whose marital status was widowed, employed, and stay a long year in the town, showed positive response. Whereas; respondent whose age is older, who attend primary and secondary school, who were using good substitute source, who were satisfied with current service and who was offered a higher initial bid showed negative response. Further, the result is valid and reliable as it is consistent with prior studies. Therefore, the result of the study from the Logit model suggest that; while setting domestic water tariffs and designing the service provision strategies, such significant factors ought to be considered according to their severity. Moreover, results from the descriptive statistics indicated that about 72.88% of households in the study area were willing to pay the random initial bid. But, generally, about 98.7% of the sampled households were willing to pay something for the improved water services. Accordingly, the estimated mean WTP for a 20 litre of water was found to be 0.65ETB from DBDC approach. This further shows households in the town were initiated to pay cost recovery tariff rate. Thus, the implementation of forthcoming project in the study area is recommended, as there is an opportunity to provide the improved service with a high potential of revenue generation.

Key Words: Bid, Contingent Valuation Method, DBDC, Logit, Willingness to Pay

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ABBREVIATIONS AND ACCRONYMS

AME	Average Marginal Effect
CM	Choice Modeling
CS	Consumer Surplus
CSU	Compensated Surplus
CV	Compensated Variation
CVM	Contingent Valuation Method
DBDC	Double Bounded Dichotomous Choice
ESU	Equivalent Surplus
ETB	Ethiopian Birr
WSSA	Water Supply and Sewage Authority
EV	Equivalent Variation
FDRE	Federal Democratic Republic of Ethiopia
GoE	Government of Ethiopia
HPM	Hedonic Price Method
LPM	Linear Probability Model
MDGs	Millennium Development Goal
MEM	Marginal Effect at Mean
MoWE	Ministry of Water and Energy
MWTP	Mean Willingness to Pay
NBE	National Bank of Ethiopia
NOAA	National Oceanic and Atmospheric Administration
O&M	Operation and Maintenance
OLS	Ordinary Least Square
SDGs	Sustainable Development Goal
TCM	Travel Cost Method
TWP	Total Willingness to Pay
UNICEF	United Nations International Children's Educational Fund
VIF	Variance Inflation Factor
WHO	World Health Organization
WTA	Willingness to Accept
WTP	Willingness to Pay

CHAPTER ONE

INTRODUCTION

1.1. Background of the Study

Water is a multi-purpose resource. It is known that for the existence of life water is the most important requirement. Without water, it is not imaginable to survive on a planet called earth, like is impossible without oxygen, and lacking it causes death. This is the reason why "Water is life'' is commonly used daily conversation of humans.

The phrase "water is life" is witnessed from different aspects. For instance, from geography it is known that, 70% of our planet earth is covered by water, although the fresh water is less than 3% (Balasubramanian, 2015; Baker and Aldridge, 2016), and from biology our body contains 75% water, even there are more things scientists can't understand about it. Thus, this denotes water is the most important input for the survival of life including human being.

The importance of water is not only sustaining life. Additionally, it is central for the socio-economic development of a given country (Sanctuary and Tropp, 2004). This contribution is more direct for the case of Ethiopia (Anderson and Hagos, 2008); since it is used for households, industries, tourism, power source and for different cultural purposes.

In homes water can be used for drinking, bathing, washing, cooking, and the backyard garden and also for general sanitation. In addition to this, water serves as job creating sector (Ardakanian and Jaeger, 2011). Although the availability of water for the above-mentioned uses has been a subject of concern in world countries, where it is available, its quality and quantity are far from the internationally accepted standard and is under question especially in developing countries (Grey and Sadoff, 2006).

Over availability, accessing the improved water service is critical to improve health, to reduce poverty (UNICEF, 2017), and to facilitate economic growth in developing world. That is why the provision of improved water is currently the main focus of many government and development agencies in the world.

However; according to WHO and UNICEF (2001), more than 1 billion people faces lack of any form of water supply access at the turn of the Millennium, even the limited service. With some progress, in 2017, 90% of global population used basic service, but only 71% used safely managed services. However, at least 2 billion people use a drinking water source contaminated with faeces (UNICEF, 2017). Unimproved water also estimated to cause 485,000 diarrheal deaths each year across the world.

Further, this problem was aggravated from time to time and is considered as the major threats of world population in the future (Tietenberg and Lewis, 2012).

The contributing factors for the scarcity of the water supply were increasing population at an alarming rate as demand for water also increases with population increment, droughts, politics and the declining of water quality by pollution as well as climate change.

To tackle the severe problem of water supply service in the world, different plans and strategies were designed by the world community (Whittington *et al.*, 2008), although they were not totally succeed. From those different strategies, the most influential were; International Water and Sanitation Decade, Millennium Development Goal (MDGs), and Sustainable Development Goal.

International Water and Sanitation Decade were designated in 1980's (1981-1990) with an objective of ensuring that everyone in the world would have access to at least basic water and sanitation services by 1990. But at the end of the decade, over 1.1 billion people lacked improved water supplies; even hundreds of millions did receive access to new services.

Following the unsuccessfulness of the decade's strategy, the global community made a new commitment called Millennium Development Goal (MDGs) in 2002 at the Johannesburg World Summit on Sustainable Development. This plan has a target of environmental sustainability, and it includes cutting by half the proportion of people in the world living without access to water by 2015. But at the end of the program, globally 159 million people were using surface water (WHO and UNICEF, 2017), out of which 58% lives in Sub-Saharan Africa.

Similarly, following the unsuccessfulness of the above two strategies; another strategy called Sustainable Development Goal was designated. This plan is under implementation by now with 17 goals, of which goal 6 stands for supplying quality water for all human by 2030. Sustainable Development Goal 6, particularly 6.1 stands for the provision of drinking water for all human beings and 6.3 improving water quality by 2030 (WHO and UNICEF, 2017). Water quality has contribution for the fulfillment of all (17) goals of SDGs in one or other way.

Ethiopia, the second populous country in Africa was described as the "water tower of East Africa", endowed with many water resources (Zelalem and Beyene, 2012). The estimated total per capita renewable fresh water resources is 1,924 m^3 per year. Even the exact groundwater potential of the

country is unknown, it has been estimated to be approximately 2.6-6.5 billion m^3 and the runoff is about 122 billion cubic meters.

However; having all this available resources, Ethiopia is among a few countries in the world affected by chronic water problem (Dinka, 2018). According to 'water.org' report; 62 million of Ethiopians lack access to improved water service by 2019. Further, diseases called diarrheal, which is related with unimproved water service accounts about 5-13% of total deaths in Ethiopia (Houtven *et al.*, 2017). The problem was severe and the citizens were suffering from lack of access to safe drinking water for centuries, even different local and international organizations were actively involved in the area.

Shortage of improved water is the most constraint to socio-economic development in Ethiopia according to different evidences. According to FDRE (2013) report, the government of Ethiopia has set targets of 100% and 98% coverage of safe water supply in urban and rural areas respectively. However, the target was taken before by Universal Access Plan (2005), and Growth and Transformation Plan of 2010. Government and international donors provide funds for the implementation of the target through One WASH National Program (OWNP).

Further, for the successfulness of the programs, the allocated budget for the water service increases from year to year by Government of Ethiopia (FDRE, 2017). But, after a decades implementation of the strategies, the national coverage or the summation of rural and urban water supply was below the intended estimates (NBE, 2017).

Furthermore, the international standard for drinking water states that, in midtowns, per capita daily consumption should be equal to or greater than 50 litres per person. Further, in extreme cases it should be above 20 litres. But, in ethiopia, the daily per capita water consumption was found to be below 15 litre, which is below the internationally accepted standard (Ali and Terfa, 2012).

All the above stated evidence demonstrates that, still Ethiopia doesn't succeed its target to provide improved water for its population. Hence, this calls for additional water project implementation either by government or private organization in the country. Apart from the above problems, lack of clean and safe water is a significant challenge in rapidly growing urban centers in developing countries, including Ethiopia, where Bonga town is not an exceptional. Thus, this study intends to assess the household's willingness to pay for the improved water service to be a part of the solution for the severe problem in Bonga town.

1.2. Statement of the Problem

Following the climate change, water problem is the current as well as future severe threats of the world (Tietenberg and Lewis, 2012; Baker and Aldridge, 2016), because its demand rises over its finite supply. But this stress is, and will not be uniformly spread around the globe, however, the bearer of high load was and/will be developing countries.

Although urban areas of the world are better accessed the improved water service than the rural areas, still it is very low in developing worlds. According to UNICEF (2017), the urban dwellers of Africa and Asia will be the most affected by the lack of access to sufficient clean water. Also, it is estimated that by 2025, about one third of the world's population will live in areas facing severe water stress.

As water is important for sustaining life and facilitating economic growth of a given country (Sanctuary and Tropp, 2004), provision of water; especially the improved one is the priority agendas of government and development agencies over world. While doing that they doesn't give much consideration to the contribution of the user for the service in a form of money or labor, even it is crucial for the sustainability of the service provision. Hence, it is important to assess the fundamental value the user places on and willing to pay, for sustainable provision.

The major bottlenecks for providing improved water in urban areas of the developing world were the shortage of sufficient finance (Whittington *et al.*, 2008). It is true for the case of Ethiopia (Medhin, 2006; Akkaraboyina and Desta, 2018); because the improved water projects are man-made but not natural infrastructure's. Therefore, it requires a huge amount of budgets for its implementation. Moreover; for providing the required amount of water some essential actions must take.

According to FDRE (2013), water supply service in Ethiopia is operating with high cost, but the tariff collected from the user is very low. Because of this low tariff, which is unable to cover capital cost, and operation and maintenance cost, the service provision remained poor. For the sustainability of the project, at least there must be a cost recovery tariff rate, if not; it is difficult to provide the required quantity and quality of the service for the users because of the budget limitation.

The stated objective of water utilities around the world is recovering the above stated costs. The reports of African countries are also in line with this objective (Banerjee *et al.*, 2010), and Ethiopia is not an exceptional. In line with this; in Ethiopia, the rural water tariff is set with the objective of covering operation and maintenance cost, while in urban areas to cover the full cost (FDRE, 2013).

In order to implement cost recovery tariff for improved water service in urban areas, researching whether the users are willing to pay for the service is very important; because WTP is the appropriate measure in the situation where an agent wants to acquire a good and benefited from (Carson, 2000). Moreover, the market mechanism cannot be expected to provide signals in the form of prices for the improved water service, because it is non-market service (Kargbo, 2003). This calls for the intervention of public policy in some form in the area. In this regard, one must rely on alternative methods that will elicit the value a typical consumer places on improved water service by stating their willingness to pay (Carson, 2012).

However, unavailability of appropriate data on the user's ability and willingness to pay for the improved water service in developing countries, including Ethiopia imposes limitation on a project development. Further, valuing water is important for its efficient use. Similarly, important for indicating the projects profitability and sustainability, because without settled price, there will be no control system and which leads to distortion in water use. Therefore, this suggests for the importance of research in the area.

Besides, for valuing the improved water service in monetary value, there is a need to examine the household's willingness to pay for the service costs (Breidert *et al*., 2015). Furthermore, this examination is necessary at least for three things. First, it helps us to make distinction between peoples who are willing and non-willing to pay for the improved service, secondly to know the value that the user places on the improved service, and finally to establish a cost recovery tariff rate, which is the building block for the sustainability of the project.

Bonga town is one among the Ethiopian towns facing severe water problem for which the available supply doesn't meet demand in both the quantity and quality (BoTWSSA, 2019). Water supply and sewage bureau of the town state that budget constraints and manpower are the major obstacles to provide the improved water service for the households. The GoE implements a water project in the town, but it is delayed to be functional for above a decade. In addition to households, many institutions also face these difficulties, which has a negative implication for the public health and socio-economic progress since pure water has a spillover effect.

Considering the entire problems stated above, and the importance of environmental resource, plenty of empirical work was conducted in the world and particularly in Ethiopia. Further, as described above, the improved water service is a non- market service. Therefore, its monetary value can't be derived from market signals. Hence, it is appropriate to use non-market valuation technique to derive its monetary

value. Thus, the non-market valuation method called CVM was used in this study, because of its appropriateness.

Accordingly, the available literatures on the valuation of improved water service, especially in Ethiopia focused on analyzing determinants of WTP for improved water service by employing Probit, Ordered Probit, Logit and Ordered Logit econometric models. However, there are some holes to be fill from those studies (Megersa, 2011; Fentahun, 2014; Kidu and Ewnetu, 2015; Hundie and Tariku, 2016).

To the best of the researcher knowledge; studies conducted by Saleamlak (2013) and Fentahun (2014); found that sex, income, education, and satisfaction from the existing sources are the variables strongly affecting households' willingness to pay decision. While from others finding; current water source, marital status, time taken to collect water, a number of people in the family, age of the respondent, and initial bids provided to the respondent were the factors significantly explaining households willingness to pay for improved water service in their respective case areas (Megersa, 2011; Behailu *et al*., 2012; Beyene, 2012; Hundie and Tariku, 2016).

Even the employment status of the respondent (Maloma, 2014), and the type of water source used as a substitute for the existing service during the shortage of the primary sources (Rousu *et al*., 2008), are variables expected to affect WTP decision; they are missing from studies of Megersa (2011); Behailu *et al,* (2012); Beyene (2012); and Hundie and Tariku (2016); thus included in this study as explanatory variables.

In addition to this, brief expression of the 'payment vehicle' or the mechanism through which the payment would be incurred to the respondent is important in a CV survey in order to generate accurate information, and to derive representative WTP (Gunatilake, 2003; Kontoleon *et al*., 2005; Vondolia *et al.*, 2011). Moreover, detailed description of payment vehicle helps to ensure that the respondents perceive the questions as "real"; but it is not clearly stated in studies reviewed (Saleamlak, 2013; Hundie and Tariku, 2016). Therefore, this study used "surcharge" or additional payment over the water bill for specific payment period as a payment vehicle for the improved water service in the study area.

The other holes of previous studies (Megersa, 2011; Fentahun, 2014) were; the technique how they detect the non-response rate were not clearly stated. Hence; in this study, the strategies of asking the socio-economic background; especially the income status of the household later was used during the survey, as it is believed to reduce non-response rate (Johnston *et al.*, 2017; Bain *et al.*, 2018).

Besides, double bounded dichotomous choice model increases efficiency by bounding respondents WTP. Hence, recommended over single closed format (Haab and McConnell, 2002). However, the available studies in the area, particularly in Ethiopia mostly uses open-ended and single bounded format. Therefore, in this study, a double bounded elicitation format was employed to increase efficiency.

Despite the fact; WTP varies from time to time and area to area (Dlamini *et al.*, 2016), and also vary with user's perception about the environmental improvements, water service in our case. In addition, the factors determining the users WTP for the improved water service depend on the situation and severity of the problem in the study area (Thi *et al*, 2019). Even, the water problem is common in Ethiopian towns; the level of severity differs from town to town. Therefore, this study centered on users WTP and the determining factors influencing people's decisions regarding the improved water services in Bonga town.

Finally, the estimated WTP from the study is important for evaluating policy alternatives, setting socially acceptable water tariffs and for cost recovery purposes in the study area.

1.3. Research Questions

In the regard of the above problems, this study intends to answer the following questions

- ✓ Are the households in the study area willing to pay for improved water services?
- ✓ What are the factors affecting the households WTP decision for the service?
- ✓ How much money the households are willing to pay for the improved service?

1.4. Objective of the Study

1.4.1. General Objective of the Study

The main objective of the study is to estimate willingness to pay for improved water services among households in Bonga town.

1.4.2. The Specific Objectives of the Study

The specific objectives of the study are;

- ✓ To assess the willingness of households to pay for improved water service in the study area.
- ✓ To assess the factors affecting the household's willingness to pay for improved water service in the study area.
- ✓ To estimate WTP in monetary value by applying the stated preference method called CVM.

1.5. Significance of the Study

The increasing urbanization with increasing number of population in Bonga town makes the provision of basic infrastructure including improved water service necessary. However, there is high imbalance between supply and demand for improved water service in the town.

As improved water service is non-market service, the cost recovery price cannot be derived from market signal. Thus it is important to value the service by monetary value to set cost recovery price. This study will, therefore, provide important demand side pieces of information for policy makers which can be used to design appropriate provision of improved water services based on the defined service attribute levels and the monthly service charge that the public will be willing to pay for those improved services. The information could also be used to establish future service provision arrangements with private service providers.

Moreover, the study will used as reference for whom wanted to conduct contingent valuation survey for valuation of natural and environmental resources. Similarly, the future researchers in the area will get some necessary information for their further study.

1.6. Scope of the study

It is known that the user of improved water service is not only households, other bodies like government and non-government organizations; public bodies and others are using the service. However, this study deals only with improved water services of households in Bonga town using cross-sectional data at a point in time. The water use by public bodies, organizations, and others in the town was not addressed in this study; it is, therefore, beyond the scope of this study. The data was gathered only from the sample households since it is impossible to collect from the total population or household as it requires more time. Hence, surveying total population is beyond the capacity of this study.

1.7. Limitation of the study

The study was faced many difficulties during data collection and analysis's. Among them, the major limitations of the study were time and budget. Since, the data collection was in dry season, there may be overestimation of WTP. Therefore, if there, it is the limitation of the study. Beyond this, the outbreak of Covid-19 was an international problem, hence poses some difficulties on this study.

1.8. Organization of the Paper

The remaining part of the paper is organized as follows. The second chapter deals with theoretical and empirical literature review followed by the third chapter which is concerned with the data source and research methodologies. Chapter four is about data analysis and presentation, and the fifth chapter discusses the conclusion, and recommendation.

CHAPTER TWO

LITERATURE REVIEWS

2.1. Theoretical Literature Reviews

2.1.1. Economic Valuation of Environmental and Natural Resources

In managing environmental and natural resource, Economics played a great role. The objective of economic valuation is to measure welfare changes associated with environmental quality changes. Thus, economic valuation accepted and recognized by policy makers. Even the role of economics in resource valuation is high in developed countries; it is very low in developing countries.

Further, there is clear difference between economic value and market value of a given good and service. The economic value implies the maximum amount a consumer willing to pay for good and service, while market implies the minimum amount an economic agent willing to pay in the market place. Thus, always economic value is greater than the market value (Nicholson and Snyder, 2008).

Moreover, the economic value is the welfare change of human being, because of resource improvement (Gunatilake, 2003), water service improvement in this case. Also, both can be represented by price; however, the former is maximum and the latter is minimum. Therefore, economic value is more important than market value for economic policy formulation.

Even it is difficult to place an accurate value for the environmental service, attaching a zero prices for those resources is incorrect and leads to inappropriate policy decisions. To attach monetary value to those goods and service, economists have developed different techniques of environmental and natural resource valuation. Those techniques are classified into three (Dixon, 2008), and among them the most prominent one is stated preference technique which is usually referred as contingent valuation method.

Economic valuation of environmental and natural resource has own more importance recently all over the world (Gunatilake, 2003), because of the government's and other concerning bodies effort to increase resource allocation efficiently to bring sustainable development in their country. Economic valuation of environmental and natural resources entails assessing the preferences of society with regards to an environmental resource or the public good. It is a method used for assigning monetary value to the outcomes of choices about policies, projects and programs (Bateman *et al.*, 2002).

Natural resources are important for maintaining sustainable development. Thus, they should be appropriately managed (Parajuli, 2016). But to manage them, their economic values must be identified correctly (Geleto, 2011). Experts in the area classify the total economic value those resources have in three, as: - Use, option and Non-use values. The total economic value is equal with a total willingness to pay.

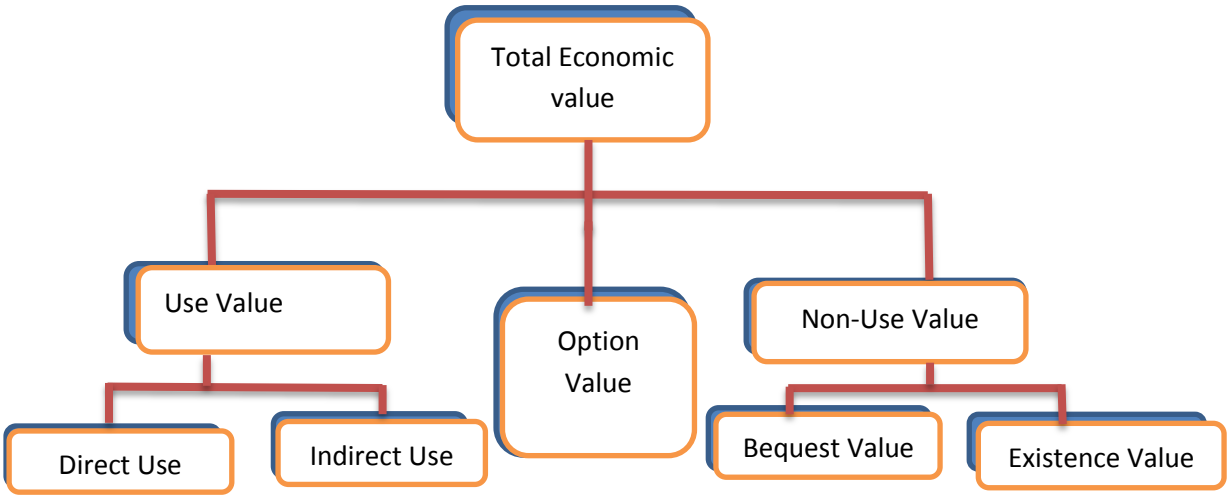

Figure 2. 1: Total economic value of environmental resource

Source: Adopted from (Gunatilake *et al.*, 2007; Tietenberg and Lewis, 2012)

Further, the value which is derived from the actual use of a natural resource and/or the environment is called use value. The value people place on a future ability to use the environment or preferences to use the environment in the future is known as option value. Similarly, the non-use value is defined as the value placed by humans not using directly, but for the other or future individuals. Thus, the total value which is total WTP is the summation of all these values. In general, the only method which includes the non-use value of resources is contingent valuation method (Tietenberg and Lewis, 2012).

2.1.2. Methods of Valuing Environmental and Natural resources

There are a number of methods used for valuing public or environmental goods and services. Those methods categorized generally belong to three categories; benefit transfer method, revealed and stated preference methods (Mavsar *et al.*, 2013). The first is used as alternative to the second and third methods. The second categories are those which depend on observed human behaviors (Tietenberg and Lewis, 2012), and thus derive inferences about preferences and economic values from such behaviors.

The third method uses survey based information to estimate values of the environmental goods and services.

Each category includes direct and indirect techniques, and both require surveys. These surveys can be postal, telephone, self-administered or face-to-face interviews, with each having advantages and disadvantages. However, in developing countries face-to-face surveys were considered to be the most appropriate, because of the low literacy rates, and the poor postal and telephone infrastructure generally found in these countries (Alberini and Cooper, 2000).

2.1.2.1. Revealed Preference Methods

Revealed preference methods are "observable" because they involve actual behavior (Wittink, 2011). The method requires exploration of people's preference as revealed by their actions in markets, which are significantly related to the non-marketed value of an environmental good under consideration. In this method, one observes a real choice in some market and cleverly infers information on the trade-off between money and the environmental good (Deacon and Kolstad, 2000).

The revealed preference method includes travel cost method (TCM) for estimating the use value of recreational sites and hedonic pricing method (HPM), which has been used to estimate pollution costs. Most of the time, TCM and HPM are unlikely to estimate non-use values because of their dependence on the actual market situation (Lyons, 2004). That is why; this study used stated preference method considering the importance of non-use values of improved water service.

2.1.2.2. Stated Preference Methods

The method which uses survey techniques to elicit willingness to pay for a marginal improvement or for avoiding marginal loss of natural resources is called stated preference method. The main valuation techniques in these categories are choice modeling and contingent valuation methods (Haab and McConnell, 2002; Honu, 2007). This method infers monetary value of a non-market good from intended behavior, through a questionnaire survey.

Stated preference methods attempt to elicit environmental values directly from respondents by asking them about their preferences for a given environmental good or service. This method considers environmental gains-an improved scenic view, better levels of air quality, or water quality etc. and seeks to measure the monetary value of those gains directly (Tietenberg and Lewis, 2012).

The rationale behind stated preference technique is estimating a consumer's WTP in monetary value for the non-market environmental good in order to generate financial potential from the user to achieve the goal of environmental improvement or reducing harms (Carson, 2012). Interest in stated preference methods has been kindled by their capacity to yield estimates of the full array of use and non-use environmental benefits and costs.

2.1.2.2.1. Choice Modeling

Choice modeling is a stated preference method in which respondents are asked to indicate their preference among two or more multi-attribute alternatives (Johnston *et al.*, 2017). Choice modeling refers to a variety of procedures for inferring WTP from sets of rankings or ratings of alternative options presented to respondents (Pearce and Ece, 2002).

The method was initially developed out of the limitations encountered in using conjoint analysis techniques to model telecommunication choices in Australia. The contingent ranking and rating are variants of techniques widely used in marketing known as conjoint analysis. A common feature of this type of approach is the requirement that survey respondents consider alternatives which are described in terms of their component characteristics or 'attributes' with different levels.

CM method has its own strengths and drawbacks. Its strength is that enabling the analyst to provide an array of information to policy makers, since its application contains a wealth of detail regarding respondents' preferences. On other hand, its limitation is that its ability to yield a rich data set is enabled by a more complex questioning process that places greater strain on respondents' cognitive capacities (Lyons, 2004). Moreover, in a CM application, the common CM practice of including more than two alternatives in a choice set provides respondents with an additional degree of freedom in strategic behavior biases.

2.1.2.2.2. Contingent Valuation Method

Contingent valuation method is a technique of calculating the willingness to pay for improved service from the demand curve for the service. It depends on the neoclassical concept of economic value under the framework of individual utility maximization. It implies asking to a sample of the population about their willingness to pay (WTP) for the provision of a given good or service (Wattage, 2011).

Although the method is proposed by Ciriacy-Wantrup (1947), the first economist to implement a CV survey was Davis (1963) in his study on the economic value of recreation in the Maine woods. But historically; the method was in use for about two decades before 1963 or starting from 1943 as an

alternative to revealed preference methods such as the travel cost method (TCM), especially in the field of outdoor recreation in a period between 1943-1989. This period covers a period from the origin of a method up to the Exxon Valdez accident.

Beginning from 1989, there is extensive debate over the validity of the method following the Exxon Valdez oil spill and this stimulated further research on the theory and empirics of stated preferences for non-market valuation techniques. Finally, from 1992 to now, the CVM has been accepted as a strong non-market valuation method, being accepted at both an academic and a political level (Hoyos and Mariel, 2010).

Contingent valuation is the only feasible method for non-market valuation of environmental resources as it estimates the passive use values of resources (Krutila, 1967), which cannot be estimated by other methods of valuation (Carson *et al.*, 2000). Since it directly asks people to state their preference toward the commodity and given that the value estimates obtained are contingent on the information previously provided to the respondent in the survey, it is referred to as a "stated preference" method. The word 'contingent' is used here to reflect that the preferences are stated for a described hypothetical situation.

CVM directly estimates the economic values for all kinds of ecosystem and environmental services that has both use and passive values. Although it is the most controversial method; it is recently the widely used method to estimate the value for non-marketable goods, because it has two advantages over indirect methods. First, it can deal with both use and non-use values, whereas the indirect methods cover only the former, and involves weak complementarity assumptions. Second, in principle and unlike the indirect methods, CVM answers to WTP or WTA questions go directly to the theoretically correct monetary measures of utility changes (Hoyos and Mariel, 2010).

The goal of CVM is to quantify compensating and equivalent variation of a resource or environmental quality. Compensating variation is more appropriate when the respondent is required to pay for the good, like paying for an enhancement in water quality/quantity. On the other hand, equivalent variation is mainly used when the respondent might potentially lose the good, thus it is the minimum compensation that the individual will accept instead of the loss (Perman *et al.*, 2003). Both techniques can be elicited by asking the WTP or WTA from the respondents.

Like any other methods used for the economic valuation of natural and environmental resources; CVM has its own strengths, and also not free from some limitations. Among others, the major advantage of the method over other method is that; it is enormously flexible, includes all types of "non-use" values, and

its result is not difficult to analyses and describe. On other hand, the drawback of the method is inability to include the preference of future generations. Also the method is open for different biases to be happened; however, with careful administration, the survey result can be reliable and valid (Honu, 2007).

Despite the weakness of the method, which exists even today, CVM method has been used extensively and there is now a large amount of documented evidence on the use of contingent valuation to derive the welfare assessment of environmental quality changes (Bateman *et al.*, 2002; Gunatilake *et al.*, 2007). Further, it appeals to be appropriate for valuation of non-market goods and services in developing countries (Alberini and Cooper, 2000).

2.1.2.2.3. The Link between Welfare Economics and Contingent Valuation Method

The impact of non-marketable goods and service on welfare of the consumer was ignored for a long period of time. But in reality, in addition to marketable goods and services, non-marketable goods and service has also impact on consumer's welfare. The Economic values of natural and environmental resources measured using their effect on human welfare (Gunatilake, 2003). Further, human welfare includes concern of future generation, which is called bequest value in this case. Therefore, estimating economic values of environmental or public goods is an attempt to measure the impact and/benefits these goods bring to individual utilities.

According to Freeman *et al.*, (2014), the changes in non-marketable goods and service affect human welfare or utility by different ways. For instance; through price change of the goods and service under consideration, change the price for the factors of production and it may change the quality and quantity of other public goods.

Further, for the case of this study, it is assumed that the improvement in quality of water service can lower costs incurred for aversion, it can lower the cost of water used as factor of production and can induce sanitary in the community thus improving clean scenery and improved clean air which concurrently can lower the risks of infections and child mortality. Similarly an increase in quantity improves the amount of water daily consumed across the households in the study area.

The central concern of policy makers is to measure efficiency among alternative public resource allocation decisions to improve social welfare. A more appropriate welfare measure for policy in the provision of public goods or resource allocation is the use of Pareto improvement, a gain to one person without making any other one worse-off. The idea of a Pareto improvement lies on the basis that overall

benefits of a public intervention should exceed the costs of that intervention (Dixon, 2008). In this context, resource allocation can achieve greater efficiency.

Allocation of resource is efficient when it is not possible to make one or more persons better off without making at least other person worse-off (Perman *et al.*, 2003), and the reverse is true. Thus, Pareto improvement is not a sufficient but a necessary condition for achieving allocative efficiency in environmental or public provisions of goods, a state where no further improvements are possible without worsening ones welfare.

Conventionally, welfare changes from changes in environmental or public goods have been estimated using Consumer Surplus (CS), the area under the Marshallian demand curve and above the price level. These demand functions are derived through utility maximization. Consumers are presented with a problem of maximizing utility subject to an income constraint. Solving the utility maximization problem leads to a set of ordinary demand functions as functions of prices and income (Gunatilake *et al.*, 2007).

There have, however, been concerns about the use of CS as a welfare measure due its inefficiency in keeping utility constant. In addition, environmental or public goods have a particular characteristic that makes the concept of the Marshallian demand function and consumer surplus difficult to be applied, i.e. absence of price.

The absence of a price for environmental or public goods makes them untradeable as they do not have private property characteristics. Therefore, one cannot directly observe the price and other information required to estimate the Marshallian demand curve. Accordingly, the welfare's change measurement using CS may be misleading. Therefore, it is important to use a more accurate welfare measure that is free from ambiguity.

To solve this ambiguity, Hicks (1943) developed four alternative welfare measures as a correction of the ordinary demand functions. The use of Hicksian compensating welfare measure assumes that consumer's utility level remains the same as before the change in the supply of environmental services (Nicholson and Snyder, 2008). Given the ordinary demand function, formulating the duality of the maximization problem derives the expenditure function. An individual is, therefore, assumed to minimize expenditure subject to a given level of utility, because expenditure function allows us to held utility function constant.

Solving the minimization problem leads to the Hicksian demand functions, which shows the quantities consumed at various prices assuming that income is adjusted, so that utility is held constant (Freeman *et al*., 2014), unlike Marshalian demand function which held income as constant.

The four alternative welfare measures which are a refinement of the ordinary CS are compensating variation, equivalent variation, compensating surplus and equivalent surplus. The compensating and equivalent variations are the measures for the change in price, and represented as the area under Hicksian demand curve, while compensating surplus and equivalent surplus are the measures for the change in quality or quantity. Further, compensating surplus and compensating variation holds utility constant at initial level, while equivalent surplus and equivalent variation hold utility constant at alternative level (Gunatilake, 2003).

Compensating Variation (CV): CV is the money income adjustment necessary to keep an individual at his original level of utility (U_0), since it is the change in income that will just compensate the consumer for the price change. If there's a price decrease, CV is the adjustment of an individual's income needed so to keep him/her at the initial utility level as without the price decrease, maximum WTP. Similarly, given a price increase, CV is defined as the amount of money that is required by the consumer to keep him/her at the same utility level as without the price increase, minimum Willingness to Accept (WTA) (Gunatilake *et al.*, 2007).

Compensating Surplus (CSU): CSU is defined as money income adjustment necessary to keep the consumer at original utility level with changes in quality or quantity. For an improvement, CSU is the amount of money that needs to be deducted from the income of the consumer to keep him at the same utility level as without the environmental improvement, maximum WTP. Similarly, with degradation, CSU is the amount of money to be given to the consumer to keep him/her at the same level of utility prior to the environmental damage, minimum WTA (Haab and McConnell, 2002).

Equivalent Variation (EV): is the money income adjustment necessary to maintain an individual at his final level of utility ($U1$) throughout the provision change (Gunatilake *et al.*, 2007).

With a price decrease, EV is defined as the additional income to be given to the consumer to bring him/her to the same level of utility she/he would attain with the current income, minimum WTA in place of the price decrease. Similarly, with a price increase, EV is defined as the amount of money to be taken away from the consumer to bring him/her to the same level of utility s/he would attain with the current

expenditure, maximum WTP to avoid the price increase. The EV measures the maximum amount of income that the consumer would be willing to pay to avoid the price change.

Equivalent Surplus (ESU): ESU is defined money income adjustment necessary to keep the consumer at the final level of utility with changes in quality or quantity. For an improvement, ESU is the additional income to be given to the consumer to bring him/her to the same level of utility that she/he would attain with the current income given the environmental improvement, minimum WTA. Likewise, with deterioration, ESU is the amount of money to be taken away from the consumer to bring him/her to the same level of utility she/he would attain with the current income if the environmental damage occurred, maximum WTP to avoid the deterioration (Gunatilake *et al.*, 2007).

2.1.2.2.4. Approaches of Contingent Valuation Method

CVM mainly relies on stated preferences from respondents; there are a number of formats for eliciting WTP or WTA. The approaches (elicitation formats) are discussed below as follow;

Open-ended format: The traditional method which entails asking respondents the maximum amount of money they are willing to pay or accept without any referendum. With advantages like being quick to administer and avoiding the "anchoring effect", this method has proved not to be in line with economic theory. According to Arrow *et al.*, (1993), asking respondents about WTP using an open-ended format presents them with a difficult task. Respondents often find it difficult to ascribe an economic value of a non-market good instinctively and therefore needs some form of reference point to bound value judgment (Wattage, 2011).

Moreover, this elicitation technique has proved to result in high non-response rates and large numbers of questionably high or low values. In an attempt to improve the CVM elicitation format, researchers have introduced the following elicitation formats.

Checklist (Payment card) format: In this format respondents face a card with a list of bids by either point estimates or interval ranges and choose their maximum WTP (Hoyos and Mariel, 2010). Card indicates range of possible values, one of which is pointed out by interviewee. Even solving some problems of open ended format, this format has problems of starting point bias, and it leads to final result of WTP to be biased. So these drawback calls for another appropriate format.

Bidding game format: By recognizing the starting point bias in payment card format, Mitchell and Carson (1981) developed bidding game format. In this format the respondents were asked a sequence of

questions until maximum is found or respondents are iteratively asked to state their maximum WTP: like *"*would you be willing to pay X Birr for this item*?*" If the answer is positive, a new question with a higher value for X is asked, and if the answer is negative, a new question with a lower value for X is asked.

The bidding game ends when the respondent switches from "yes" to "no" or from "no" to "yes" (Hoyos and Mariel, 2010). But this format also suffer from different problems, for instance, lack of incentive compatibility and starting point bias, and fatigue effects are another problem because the question is very long.

Dichotomous discrete choice: Single-bounded referendum (take-it or leave-it) – This format was included in CV survey by Bishop and Heberlein (1979) for the first time. In this format individuals are asked whether they would pay a certain amount of money for the improvement of the environmental and natural resources or simply the respondents were asked as whether they are willing to pay or accept a certain amount given a scenario.

The main improvement of this method compared to the other methods is that it shortens the respondent's task in a fashion similar to the bidding game without going through the iterative process. Moreover, the respondent, just like any other consumer, has only to make a judgment about a given price (Wattage, 2011). The method still suffers from the starting point bias while it also needs large sample sizes and proper model specifications for statistical precision on WTP estimate.

Dichotomous discrete with follow up question: Is same as Dichotomous discrete choice, but with an additional follow-up question of maximum WTP. The above (Dichotomous discrete choice -single-bounded referendum) methods have been shown to suffer from compatibility problems in which survey respondents can influence potential outcome by revealing values other than their true willingness to pay. Therefore, the discrete "dichotomous double bound" method was introduced in an attempt to increase precision on estimates.

This method was originally developed by Hanemann (1985), and mainly involves questioning respondent's two yes or no WTP questions where the bid price in the second or follow-up question is higher or lower if the answer to first question is positive or negative. This method has shown to produce more efficient estimates than those from a single question (Song *et al*., 2019).

According to Calia and Strazzera (2000), although there is potential bias the double bound CVM comes with, it has been noted that the method is justified as it produces lesser mean square error which in-turn leads to more conventional WTP estimates by lessening the confidence interval of the WTP measures.

According to Haab and McConnell (2002), Double-bounded model increases efficiency over single dichotomous choice models in three ways. First, the answer sequences yes-no or no-yes yield clear bounds on WTP. For the no-no pairs and the yes-yes pairs, there are also efficiency gains, since it is near to true WTP than the open one. These come because additional questions, even when they do not bound WTP completely, further constrain the part of the distribution where the respondent's WTP can lie.

Finally, the number of responses is increased, so that a given function is fitted with more observations. It is therefore, for the same reasons this study used the dichotomous double bound with a follow up question to estimate WTP for improved water services in the study area.

2.1.2.2.5. The Basics of the Contingent Valuation Method

Using DBDC formats, the value estimation of the natural and environmental resource is proceeds through different steps. Generally One may distinguish between 5 steps in establishing the method as presented in Tietenberg and Lewis (2012).

The first step is constructing hypothetical market; the main idea here is to construct a scenario which corresponds as closely as possible to a real-world situation. Under this step the researcher sets the reasons for the payment. In this study improvement in the service is the reason for the payment. The payment vehicle or method of payment should be clear in addition to the construction of the provision rule. After constructing hypothetical market, the next step is collecting data from the sampled households. After data collection, mean WTP will be estimated and is the third step. The fourth step is deriving bid curve and finally, the fifth step is aggregating the data.

2.1.2.2.6. Biases in Contingent Valuation Method

Different literatures witness that CVM has been vastly used in the economic valuation of environmental and public goods for the last three decades. However, regardless of the substantial use and improvements conducted along the years, the CVM is still subject of great controversy and suffers major criticisms with regards to the biases the method comes with. The CVM suffers from a range of biases in terms of theoretical and practical situations given its nature of technique and the survey instrument.

According to Tietenberg and Lewis (2012), the expected biases which may happen in the valuation of environmental and public goods are discussed as follows.

Free-Riding and Strategic Behavior Bias: This type of bias arises when the respondent provides an incorrect answer to influence an intended outcome (Gall-ely, 2010). The respondent may understate his/her answers on the assumption that others will pay for its provision or assuming that the payments of others will be sufficient to ensure provision of a good, which s/he will then enjoy i.e. free-riding, thus incorrect WTP/WTA.

Strategic behavior bias happens when the respondent particularly keen upon a good and calculates that the decision regarding provision depends upon the mean valuation of the sample, then s/he may behave strategically and overstate her/his true WTP in an effort to raise that mean and thereby ensure provision. This bias emanates from selfish behavior of human beings.

Hypothetical Bias: Since CVM depends on hypothetical answers from respondent, it may face hypothetical biases especially when the respondent is not familiar with the good which is going to be valued. Thus, this bias is not influential when the resource is familiar (Murphy and Stevens, 2004).

Starting Point Bias and Anchoring effect: In dichotomous choice format this form of bias occurs when the initial bid presented to a respondent influence the value of WTP. The main methods presenting this bias are payment card, the bidding game and dichotomous choice with single referendum as they present starting bids. This type of bias leads to understated WTP, but can be controlled by good surveys (Chien *et al*., 2005).

Payment Vehicle Bias: This form of bias emanates from the fact that the method of payment presented to respondents may influence the amount of WTP by the respondent. A payment vehicle like increasing taxes may not affect unemployed respondent and, therefore, the respondent may overstate WTP. Similarly, a working respondent may understate WTP due to the payment vehicle of increased taxes, since it affects him/her. The bias can be solved by providing appropriate payment vehicle, which considers all users of the service (Vondolia *et al.*, 2011).

Non-response bias: This is another influential bias expected in CV survey. This type of bias occurs when either the respondents refused to answer or unavailable to answer. However, it can be solved by using different techniques, like increasing sample size, if it is random (Gunatilake, 2003).

Interviewer Bias: This bias occurs when the character of the interviewer influences the respondent's to accept or to pay a given amount. The respondent may attempt to please the interviewer by overstating WTP or the interviewer might lead the respondent towards the amount he/she is expecting. This effect can be solved by employing well-trained, neutral interviewers.

Information Bias: Due to the nature of a CVM as a stated preference method, information provided to a respondent is a key factor in revealing unobserved but true WTP. Although information bias is passive bias in CVM studies, better to give good information to the respondent to gather a true response (WTP/WTA).

2.2. Empirical Literature Reviews

This section discusses different empirical findings and reports about the willingness to pay for improved water service in different countries of the world, as well as in Ethiopia specifically. Further, the method used to estimate the monetary values for non-marketable goods and services was discussed.

2.2.1. Empirical Literatures about Economic Valuation of Non-Marketable Goods

Recently, Economic valuation of non-marketable natural and environmental resource gets a great importance, because of its impact on human's welfare. This impact was ignored for a long period of time, but now a day, it is the international concern of academicians and politicians. For valuing those resources for which the market signal failed to provide the monetary value, economists use different approaches as discussed in the above sections. Among those different approaches CVM is the prominent one. Thus, this study used CVM, because of its ability to include non-use values of resources in its estimations.

Contingent valuation method was used for valuation of different natural resources. By applying CVM; benefits from air quality, water quality, conservation of forest, reducing soil erosion, protecting wetland, protecting endangered species and the like resources were valued in different areas (Carson *et al*, 2000; Kontoleon *et al*., 2005). For instance; in Poland, Ligus (2018) estimate willingness to pay for air quality by applying contingent valuation method. In Ethiopia, WTP for forest conservation was estimated by Mezgebo (2012) and Endalew *et al*., (2019), WTP for the conservation of national parks by Sherif (2019), and also for irrigation purposes (Gebreegziabher *et al.*, 2018).

In general; there are a number of researches conducted in the world, and in Ethiopia specifically to value natural and environmental resources by applying contingent valuation method.

2.2.2. CVM Application in Valuation of Improved Water Supply Services; from World Countries Experience

There exist a number of studies conducted using CVM in eliciting the value of water resources for both household and commercial use. Below, few among many are discussed by revising different evidences from different countries of the world.

A contingent valuation study in Central Tanzania estimated the willingness to pay to improve water service, by using Multinomial Logit functions (Kaliba *et al*., 2003). The survey was conducted in 30 villages of two regions (Dodoma and Singida). Their survey result showed that; 14% and 31% of residents responds as they are satisfied with the available supply, 64% and 59% responds for increasing water discharge and the rest 22% and 10% of residents indicates for other improvement in water quality in Dodoma and Singida respectively.

Generally, residents in the area were willing to pay greater amount of money to improve the water utility of their community as indicated in the finding of the paper, especially from the response of those needs for the improvement. Further, the mean WTP above current payment becomes 32Tsh per 20 litre and 91Tsh per household in Dodoma and Singida Region respectively. Recently, similar study was also conducted by Nzilano (2017) in the area.

Kargbo (2003) used CVM to estimate households' Willingness to pay for improved water services in Sierra Leon, Makeni. The study was conducted with an objective to determine the appropriateness of the existing government policy in relation to water supply and draw up appropriate policy implications and recommendations based on the findings. However, the residents of Makeni are willing to pay less than the previously existing tariff, but the aggregate WTP value per month is greater than the previously realized monthly figure as depicted from descriptive analysis of the survey.

Furthermore, the regression result of the study indicate that responsibility for water management, water quality and income produce the largest marginal effects in Makeni and that willingness to pay is positively related to income, education and water quality while it is negatively related to the age of the respondent and responsibility as revealed from the OLS results.

Another evidence from Uganda; Wright (2012) conducts study by applying CVM with an iterative bidding process to estimate the populations' WTP for the operation and maintenance of an improved water source in two villages called Kigisu and Rubona. For the study, data were collected from 122 households from the total of 400 households resides in the community and analyzing the result with

Probit model. Besides, the number of children in the home, and the distance from the existing source were the primary variables influencing households' WTP for the improved water service in the study area as shown in the finding.

By applying CVM with double bounded dichotomous choice elicitation format, Dlamini *et al.,* (2016) conduct a study to assess household water demand and willingness to pay (WTP) for improved water services in Swaziland. The study was conducted in two regions of Swaziland called Lowveld and Lubombo by using purposive and cluster sampling methods. The subjects of the study were 314 households. Out of total respondents, about 67% were willing to pay the initial bid offered for an improvement in their water services.

Further, about 93% of the sampled households were willing to pay something for the improvement in water services. Moreover, the results of the study showed that household income, education, gender, distance and owning a backyard garden positively and significantly affect WTP; whereas, age, water quality and the initial bid offered negatively and significantly affected WTP for improved water service.

There is another evidence from South Africa by Rananga and Gumbo (2015). They conducted study in the two communities in Mutale Local municipality collecting information through open-ended questionnaire interviews with selected respondents. They find that 89.9% of the total respondents were not satisfied with the existing services. However, about 95.5% of total respondent were willing to pay for the improved water service. The result also indicates that the level of education, family size, age of the consumer and monthly income matters for the willingness to pay for the improved water service in the study area.

In Kazakhstan, more than 90% of the consumers were willing to pay for better water quality and regular water supply according to Tussupova *et al.,* (2015). They used CVM with different starting point bids to investigate WTP for piped water supply for the Pavlodar Region, Kazakhstan. In the study area, around 90% of surveyed households were willing to pay for better water quality and regular water supply. Further, the mean WTP becomes about 1120 in bids and about 1590 KZT per household per month.

The results of their study showed that households with access to groundwater perceived this as of good quality and not willing to pay, whereas consumers without access to groundwater those who used open-source, standpipe or delivered water for which they had to travel and spend time or to pay are willing to pay more.

Another study was conducted in Nepal with the aim of analyzing the factors associated with willingness to pay for improved water supply system by Dhungana and Baral (2016). They collected data from 127 households in rural Tanahu, Nepal, through structured questionnaire and the study uses Chi-square test to find the factors associated with willingness to pay for improved water supply system. The result of their study showed that there are no any significant association between willingness to pay for improved water supply system and social, demographic and economic variables; however, water source, dental pain, water quantity, want for change and water fetching time have significant association with willingness to pay for improved water supply system.

Akeju *et al.*, (2018) examined the WTP for improved water supply by applying CVM. The study was conducted in Owo Local Government Area of Ondo State, Nigeria. They collected data from 256 households through multi-stage sampling from eleven political wards in Owo. Their data were analyzed using descriptive statistics and Logit regression. According to their finding; about 43% of the residents obtained water from public utility while 20.3% and 18.8% obtained water from well and borehole respectively.

Moreover, 70.3% of the residents were dissatisfied with unreliable water services but 74.9% of the respondents were show they are willing to pay for the improved service. Finally the result of regression analysis revealed that gender, a frequency of water, education, household size, income, quality of water and connection charges were the factors influencing residents' WTP for improved water supply services in the study area.

A recent study by Thi *et al*., (2019) used CVM to investigate and understand the users' preferences and WTP improved waste water service in Ho Chi Minh City, Vietnam. They collected data from 431 households and CVM with Double-bounded questions were used for the analysis.

Applying Logit model, from Double-bounded questions the study found that bid level, a respondent opinion of 10% of environmental protection fee for wastewater that is applied in the area at the time of survey, respondent knowledge on operated wastewater treatment plants in city, prior information on the plans of wastewater treatment plants, marital status, and first and second choice variables were associated with respondents' WTP for the improved sewerage services, whereas from the result of the single-bounded model, water payment, gender, household income, and house ownership played a role in households' WTP.

2.2.3. CVM Application in Valuation of Improved Water Supply Services; Ethiopian Experience

There are plenty of empirical works done by employing CVM for eliciting WTP for improved water service in Ethiopia by different researcher. Among them, some are discussed below.

Megersa (2011) conducted study in Holeta town to examine and analyze the households' willingness to pay for improved water supply services and also to examine the determinants of willingness to pay in urban areas by using Contingent valuation method. Data from 141 sampled households was selected by using simple random sampling technique. Bidding game elicitation format was employed by the researcher to capture the data about households WTP.

The study found that 80% of residents were able and willing to pay for the service above the cost recovery tariff rate. Further, households in the area were willing to pay 10.46 cents on average for 20 litre of water. According to his finding, the only variables significantly affecting households' willingness to pay were the level of household income and family size in Holeta town. Finally the study concluded as; households in urban areas of Ethiopia are highly encouraged to pay the cost recovery tariff, if the proposed projects are implemented.

Behailu *et al*., (2012) used CVM to estimate Willingness to pay for basic water services in Shebedino District, Southern Ethiopia. For collecting participant households from kebeles of the district two stage sampling were employed by the researchers. By employing simple and systematic random sampling techniques, they collected data from 635 participants. Further, bidding game elicitation format was used to gather information about how much households are willing to pay for the service. From the data collected; they find that, Willingness to pay for basic water services is often high if the services are appropriate and affordable.

From their finding, the majority of respondents (83.62%) were willing to pay 10 cents for 25 L of water. The household's average monthly expense of water was about 2.36% of their average monthly income. Despite the fact, the regression result revealed, there is association between socio-economic and economic variables with WTP in the study area. Finally, households show that they are willing to pay more than what they are paying at the time of survey if the proposed project implemented in the district.

The other study appears to have been conducted in Goro-Gutu district by Zelalem and Beyene (2012). The study was employed CVM to estimate willingness to pay for improved rural water supply. They used purposive sampling supported by random sampling to select 132 households from three rural

kebeles of the district. Further, double bounded elicitation format was employed to capture willingness to pay information. To examine the determinants of WTP, binary and ordered Probit models was used by the researchers. The estimated mean WTP was found to be Birr 6.83 per household per month.

Moreover, the results of the study indicate that households who earn better annual income, participated during the early phase of project implementation, and who spent too much time in collecting water from the existing source shows high WTP. Whereas; households with large family member, who are using improved water sources during the survey, and who got higher starting bid values are less likely to pay.

Another study was conducted by Saleamlak (2013), in Mekele city, Ethiopia. The study employed single bounded dichotomous choice value elicitation format to analyze the determinants of households' WTP for improved water services. The study used 215 randomly selected households as a source of information. The survey responses were analyzed through descriptive and econometric analysis using Probit and Tobit model as empirical models.

Besides, the survey result reveals that there is high willingness to pay in the city. Furthermore, the estimated mean WTP is between 29.60 cents and 51.51 cents per 20L depending on the model used or from close and open ended questions. Finally, the finding of the study showed that; sex, education, monthly income, and satisfaction from the existing service were the significant variables affecting the households WTP for the service in the city.

Evidence from rural areas of Amhara region, shows households in the Ankasha Woreda was willing to pay for improved water service. The study was conducted by Fentahun (2014) with an objective of assessing the demand for improved water supply services. By employing simple random followed by stratified sampling technique, 200 households were selected as sample from three kebeles of the Woreda. The study used CVM with a single bounded elicitation format followed by open ended questions, and for analysis purpose both Tobit and Probit models were used. Mean willingness to pay for the improved water service in the area as indicated in that paper was 1.52 Birr per 20L.

From the regression result, the variables significantly and positively affecting households' willingness to pay in the study area was; households' monthly income, time taken to collect water from the existing source for single trip, educational level, marital status, age and sex of the household head. While the initial bid price and availability and quality of existing water source have negative and significant effects on the probability of willingness to pay for improved water provision in the study area.

Empirical work by Kidu and Ewnetu (2015) in Nebelet town, uses CVM to estimate the willingness of household for the improved water service. 181 households were randomly and proportionally selected as a subject of the study from the two kebeles of the town. According to their finding, there is high willingness to pay for the improved service in the area. Further, double bounded dichotomous choice model was employed to estimate mean willingness to pay. Moreover; in the study area, out of total samples around 96% were willing to pay to access the private water connection, while 4% were not.

Besides, Tobit model was used in the study to identify the socioeconomic factors affecting the household's willingness to pay for improved services. The result from Tobit model shows that household income, distance, water expense, initial bid, education, level of satisfaction from existing service, marital status and sex was associated with households willingness to pay for the provision of improved water service. As a conclusion the study puts; if the government implements the proposed project in the study area, the residents showed that they are willing to pay the cost recovery tariff within five years.

Hundie and Tariku (2016), conducted a CVM study in Jigjiga city to estimates WTP for better quality of water supply service. Their study used 210 sample households randomly drawn from the study area through systematic sampling technique. The residents of the city show high willingness to pay for improved water supply service, since highest percentage of respondents were not satisfied with the existing services. Further, their perception about not satisfied with current service arises from low quality and quantity.

Moreover, the econometric model employed for estimation of mean WTP were simple linear WTP function supported by random utility model. Further, single bound elicitation format information was employed to estimate mean WTP. Response to the hypothetical scenario shown that sampled households stated that their mean WTP of 94 cents per 20L. Furthermore, the result of the study showed that; household income, family size, water source, age of the respondent and bid value were the variable significantly affecting WTP for improved water service provision in Jigjiga city.

2.2.4. Concluding Summary of the Reviewed Literature

The importance of reviewing different literatures within or across different case areas was to get some necessary notes, as well as to find holes from and to fill the holes. From reviewed literatures, it is witnessed that, improved water service was a non-market resource. Further improved water service has passive use values in addition to use values (Gunawardena *et al.*, 2017). Therefore, it makes using non-

market valuation technique more important for estimating economic values of improved water services, especially CVM. Further the economic valuation of the service is necessary for setting socially acceptable tariff which covers the cost of service provision.

From the literature reviewed, the study found some missing variable, problem of elicitation format, payment vehicle format, technique to reduce non-response rate, and the like issues. Therefore, this study will fill this knowledge as well as methodology holes.

Besides, the reviewed literature on water quality improvement and other nonmarketable environmental goods and services in developing economies in general, and Ethiopia in particular imply that the CVM can be successfully applied to low income countries (Alberini and Cooper, 2000).

In general, such evidence witnessed that, CVM is the only appropriate method to estimate the economic value of improved water service since improved water has non-use value in addition to its use values according different literatures (Wang *et al.*, 2011). Therefore, this study employed CVM to estimate the household's willingness to pay for improved water service because of the methods appropriateness.

2.3. CVM Framework

CV is a survey based method for eliciting the economic value of non-market goods and services. To do this, the method has its framework as discussed below.

2.3.1. Conceptual Framework

The value consumer places on service can inferred from the observed choice made by the consumer over the services, but also from the stated choices a consumer declares when confronted with a hypothetical scenario of change in supply. Contingent valuation method is widely implemented in many environmental valuation studies. CVM- is a best and appropriate method of eliciting willingness to pay of consumers or households when the good or service is non-market or public goods or services.

The rationale behind the appropriateness of CVM over other method is its ability to consider the non-use value of improved water service. According to Wang *et al.*, (2011), the value of improved water service includes not only use values, but also non- use values. Therefore, if appropriate questions are requested in a hypothetical market questionnaire survey, CVM reveals people's preference-related value of non-marketed environmental goods; improved water service for the case of this study (Gunatilake *et al.*, 2007).

For eliciting the economic value of natural and environmental resources, WTP and WTA can be used (Perman *et al.*, 2003). However, the application of WTP and WTA depends on property right (Gunatilake *et al.*, 2007). This study employed WTP is because household have no property right on the improved water service, and they are the users from the proposed improvements. So they are asked their maximum willingness to pay for accessing the improved service either in quality, quantity or both. Their maximum willingness to pay can be raised from their expectation of welfare change. If there is welfare change, it calls for water policy for improved water supply. Generally, the welfare change due to change in water service will leads to higher willingness to pay among the beneficiaries.

2.3.2. Theoretical Framework

The theoretical framework of CVM, which is used in this study, is discussed as follows depending on Freeman *et al*, (2014) and Haab and McConnell (2002) specification, and specifies econometric model in the following way.

Because of its flexibility, simplicity and ability of estimating non-use (existence, and passive) values of non-market goods and service, CVM is chosen over other methods. It is survey based method to attach monetary value for goods and service for which the market system can't (Banda *et al*, 2006).

Theoretically, the framework of CVM is based on microeconomics concept of utility maximization or welfare change from consumption of goods and services; it may be market or non-market goods and service, change in water service in this case.

Assuming a household who maximizes his/her utility function subject to a budget constraint, his/her indirect utility function which forms the underlying basis of welfare change estimation is derived as follows

$$V = v(p, q, m) \quad \text{.....1}$$

Where p is the vector price of market commodity, q is the status of water service acquired by households and m is the household's budget.

The Contingent Valuation Methodology (CVM) was built on the above framework adopting indirect utility functions. The indirect utility function (equation 1) represents that the desire of the consumer to maximize utility is under the constraint of budget, and the optimal level of utility obtainable depends indirectly on the price of good being bought and the individual income (Varian, 2005).

Denoting q_0 as existing water service received by the households in the town or status quo and q_1 as an improved service, the value of change to household in monetary term is represented by Hicksian measure called Compensating Surplus (CSU) which satisfies;

$$V(p, q_1, m - CSU) = V(p, q_0, m) \quad \text{.....2}$$

For the case of improvement, Compensating Surplus (CSU) would be positive because q_1 is preferred over q_0 for improvement or household's welfare is increased because of the change in q from q_0 to q_1. Hence, CSU measures the household's willingness to pay for the improved water service. So equation (2) can be rewritten as;

$$V(p, q_1, m - WTP) = V(p, q_0, m) \quad \text{.....3}$$

Where; WTP- is the maximum amount of money households willing to pay in exchange of improved water service. Finally by solving equation (3) for WTP, it becomes;

$$WTP = WTP(p, q_0, q_1, m) \quad \text{.....4}$$

The final equation (4) represents that household's willingness to pay for improved water service functionally depend on price of market goods and services (p), households income (m) and the status of water services both currently existing (q_0) and the improved one (q_1).

In this study, the improved water service represents the potable water used by households without any prior treatment like boiling, and its supply will be sustainable in the long-run.

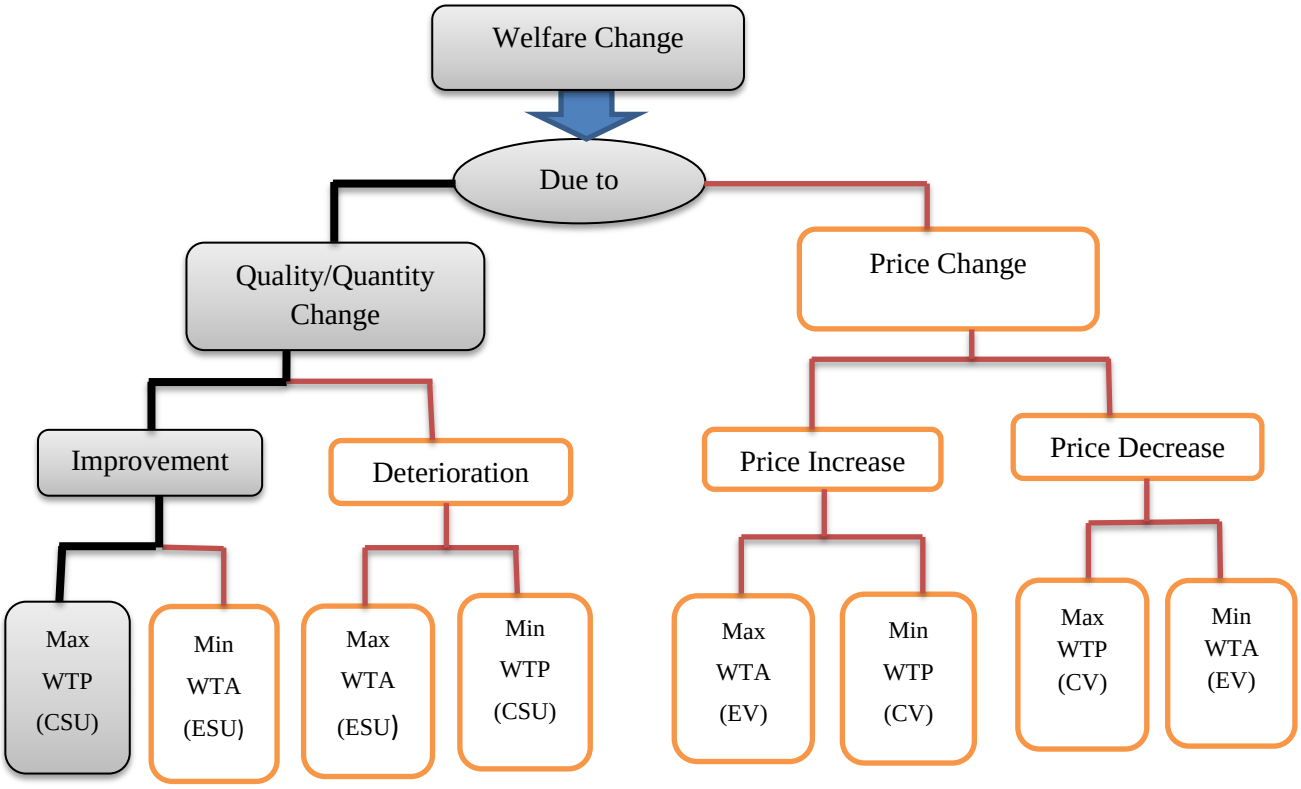

Figure 2. 2: Frame work showing the linkage between welfare change and maximum WTP

Source: Adopted from (Gunatilake, 2003; Gunatilake *et al.*, 2007)

Where: CV = Compensating Variation, EV = Equivalent Variation

CSU = Compensating Surplus and ESU = Equivalent Surplus

N**ote**: The linkage between welfare change and maximum WTP adopted in this study is shown by shaded area and black arrows.

CHAPTER THREE

METHODOLOGY OF THE STUDY

3.1. Description of the Study Area

The study was conducted in Bonga town, which lies between latitude and longitude of $7^0 16' N$ and $36^0 14' E$ with an elevation of 1714masl. Bonga town is situated in SNNPR, southwest Ethiopia. The town is 460KM far from the capital city of Ethiopia, and 118 KM from Jimma (Jeffrey, 2019). The town is the administrative city of Kaffa zone.

According to KaZFDD (2019), the number of population in the town increases at an alarming rate and estimated to reach 36,961 people by 2020; of which 19,024 are male and 17,937 are females. This rapid population growth is attributable to a combination of factors including, continued migrations from the rural areas and natural growth. For such increasing population, availing the necessary infrastructure, including improved water service is necessary as well as compulsory for the concerning bodies.

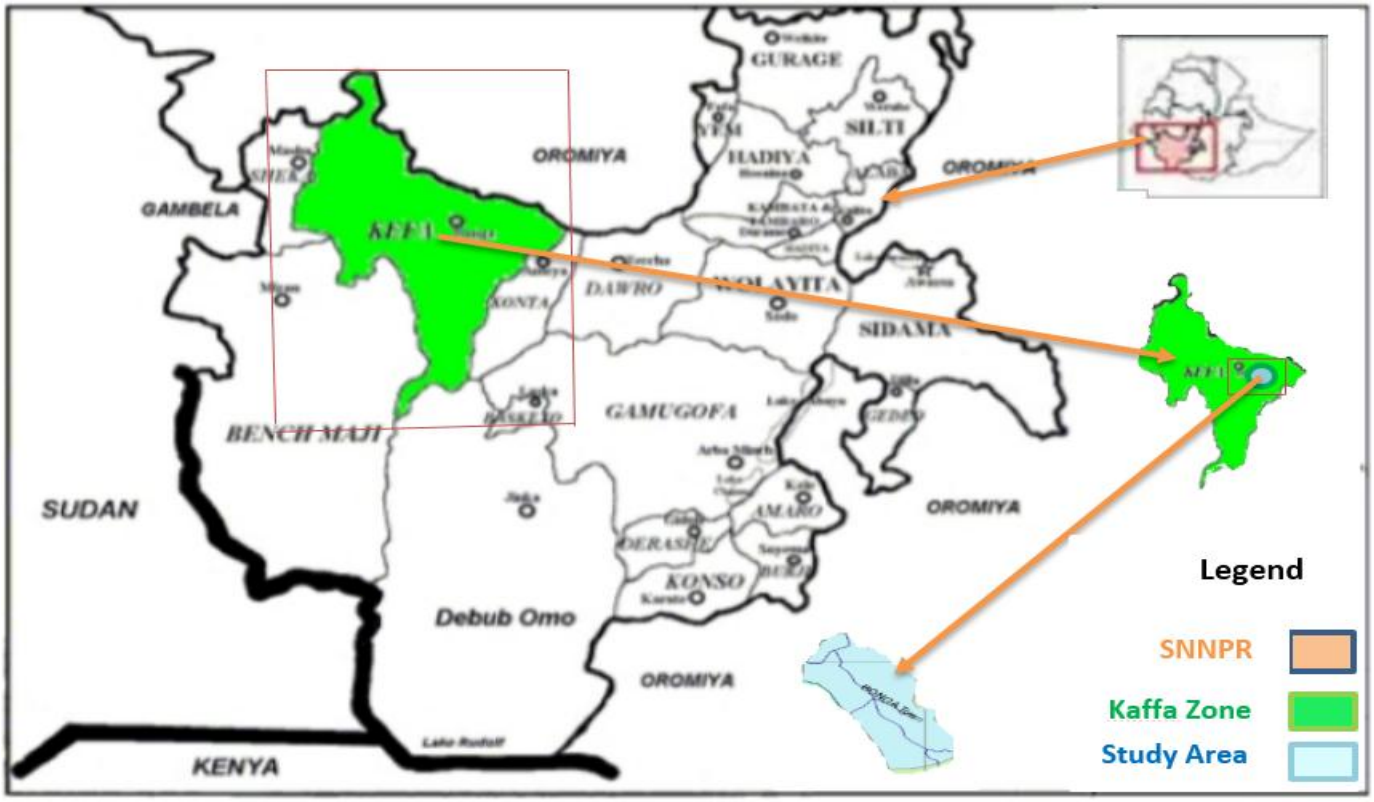

Figure 3. 1: Map of the study area

Source: Kaffa Zone, Finance and Economic development, population and statistics team, 2008

3.2. Data Sources and Types

The study mainly employed primary data, which is supplemented with some secondary information. The primary data were gathered through a questionnaire which includes demographic and socio-economic characteristics of the respondents, perception of resident about currently existing water service, and the CVM responses to estimate the mean WTP. Accordingly, the study relied on primary cross-sectional data for the time period of 2020 that is obtained from a CV survey.

To tackle the problem of interviewer bias the researcher himself conducted the face to face interviews. Moreover, the study was also supplemented with secondary data, including published and unpublished sources such as reports from Ministry of Water and Energy (MoWE), Bonga town Water and Sewage service bureau, Journal articles and other relevant sources.

3.3. Study Population

The study population for this study consists of households in three kebeles of Bonga town. Thus, households in Bonga town were a subject of information for this study whether they own house or not (rented houses). Therefore, any household who was selected as sample randomly was asked the prepared questions and their answers were used as primary information for this study.

3.4. Sampling Technique and Sample Size

The study used primary data collected through a survey questionnaire using personal interviews. For this study, respondents were classified as households regardless of whether the house was owned or rented. As the household in the town were homogeneous and finite, a simple random probability sampling was adopted to select the sample household from the total households in the town.

The simple random sampling technique gives equal chance for the households in the town to be selected as a sample. Moreover; for homogeneous population, simple random probability sampling technique provides unbiased and better estimates (Ajay and Micah, 2014). Further, simple random sampling is recommended for CV survey (Gunatilake, 2003).

However, there is no sampling frame, which lists the individuals from which one can select sample in the study area. But, this doesn't preclude the application of simple random sampling technique to determine sample size in the town. According to West (2016), as long as the map of population area was known and preliminary or pilot survey was conducted, it is possible to select sample respondent by using simple mapping technique.

Further, to calculate the sample size "n", given the population or household size N in the study area, the study employed the sample size determination formula developed by Kothari (2009) for finite populations as follow;

$$n = \frac{Z^2 p.q.N}{e^2(N-1)+Z^2 p.q} \quad \text{.....5}$$

Where: n = sample size, z = the z-value of the desired degree of confidence, p= the population proportion of households of interest, q = 1- p, and e = the absolute size of error and N is the household size. But, P value is not given; therefore, it was set to be 0.7 depending on pilot survey result. Thus, q=1-p=0.3. The absolute size of error was set at 5% and the confidence interval was 95% (z =1.96)

Given the estimated total household of 6,937 in the town as of KaZFDD (2019):-

$$n = \frac{1.96^2(0.7)(0.3)6937}{0.05^2(6937-1)+1.96^2(0.7)(0.3)} = 5{,}596.323/18.145 = 308$$

Where N = 6,937, p = 0.7, q = 0.3, z = 1.96 at α = 0.05 and e = 0.05.

Despite the fact, non-response rate is highly expected in cross sectional survey. Thus, it is appropriate to add some unit sample on the calculated sample size to compensate the expected non-response rate as well as incomplete information's. For this reason, even there is no agreed percent of sample to be added, this study adds 10% of calculated sample. Therefore, the total sample for this study is 338 households.

Furthermore, the town has three kebeles called 01, 02, and 03 with unequal number of households. Therefore, the calculated sample was classified for three kebeles proportionally by making stratification. The stratification is important, as the households reside in different kebeles. The stratification was done by identifying N_1, N_2 and N_3 respectively. Then after identification; n_1, n_2 and n_3 was determined as follows;

Assuming *Pi* the proportion of population or household included in stratum *i*, and *n* represents the total sample size, the number of elements selected from stratum *i* is *n* x *Pi*.

Where $pi = Ni/N$

Given N_1=2,172, N_2=2,606 and N_3=2,159, the proportion of samples selected from the 3 kebeles was as described below.

Table 3. 1: Sample size determination

Kebele	Total No. of HH	Sample determination	Sample size
01	2,172	$\boldsymbol{n_1 = n(N_1/N)}$=$\mathbf{338}(\frac{\mathbf{2,172}}{\mathbf{6,937}})$	106
02	2,606	$\boldsymbol{n_2 = n(N_2/N) = 338}(\frac{\mathbf{2,606}}{\mathbf{6,937}})$	127
03	2,159	$\boldsymbol{n_3 = n(N_3/N) = 338}(\frac{\mathbf{2,159}}{\mathbf{6,937}})$	105
Total	6,937		338

Source: Own computation, 2020

3.5. Questionnaire Design and Survey Administration

The questionnaire design is important and fundamental part of a CV survey for assuring credibility. Traditionally for eliciting users WTP for improved water service, an open ended questionnaire was in use until the 1980's (Hanemann, 1994). But as the method has some difficulties for the respondent; another format called discrete or close ended format was developed, and since then it is applied in many researches from the earliest till today.

Using closed ended elicitation format, there are different ways of gathering information from the sampled population as discussed in above sections of this paper, but among them, NOAA (Arrow *et al.*, 1993) recommends the use of in person interview for reliability. Furthermore, the method was witnessed to produce a high response rate (Pearce and Ece, 2002; Zainudin *et al*., 2016).

To collect accurate information, providing clear information for the respondent is vital. Among others, specification of the commodity going to be valued, and the payment mechanism are essential. If this point is missing, the final finding will be biased. Further, other important point is, notifying that, the improved service can be provided when the user agrees to pay the cost recovery price. And also for accessing the improved service paying the service cost is must.

The survey questionnaire of this study contains four sections, which is recommended by Carson (2000); Gunatilake *et al.*, (2007); and Zainudin *et al.*, (2016), as contents of good CV surveys. Section I, an introductory section in which the contexts of the decisions were briefly expressed, and the description of the service was provided. The introductory section is believed to reduce the strategic biases. Section II,

bundle of questions containing the household demand for and perception about the current water service of the town.

Section III; contain questions regarding the household's willingness to pay for the improved water service, this is presenting the valuation scenario in question. Additionally, the payment mechanism and the reasons for payment were provided to the respondent. A set of questions regarding the background and socio-economic profiles of the respondent was the fourth section (section IV). The socio-economic questions were presented in the last of all questions to reduce non-response rate during the survey (Johnston *et al.*, 2017). Finally, the questionnaire prepared containing the above four sections are attached at the back of the paper (see appendix I).

As discussed earlier, this study used double bounded elicitation formant with follow up questions, because, it increases statistical efficiency over single bounded (Calia and Strazzera, 2000; Haab and McConnell, 2002). In double bounded elicitation format initial bid or proposed cost can be provided to the respondent and the second question will be followed depending on the answer for the first bid. The initial bid was set by conducting pilot survey prior to the main data collection.

Haab and McConnell (2002), describe three reasons for efficiency gains from a follow-up question. First, the answer sequences of yes-no or no-yes put tighter bounds on willingness to pay decision. Second, the yes-yes pairs and the no-no pairs, even though they do not completely bound willingness to pay, constrain the part of the distribution where the respondent's willingness to pay can lie. Finally the number of response becomes two per person, so that a given function is fitted with more observations. This method asks a household whether s/he is willing to pay a pre-specified randomly assigned amount or bid.

3.6. Description of Payment Vehicle

The decision of choosing which payment vehicle to use depends on the resource to be valued, the socio-economic characteristics of the sample and the institutional structure governing the area (Alberini and Cooper, 2000; Wang *et al.*, 2011). Careful selection as well as description of payment vehicle have a notable impact on WTP (Gunatilake, 2003).

Thus, for the effectiveness of CV survey; describing payment vehicle or the mechanism through which the user pays for the improved service is essential, especially to make the hypothetical scenario seem real. Similarly, it is important to notify that the payment will be in the future, but not at the time of interview. Regarding the payment, what is needed during the interview is only expression of their

willing to pay for improved service not current payment. In this study, surcharge per month or additional payment over monthly water bill was used as the payment vehicle for improved water service in Bonga town.

3.7. Method of Data Analysis

Empirically the study uses both descriptive and statistical analyses to address the study objectives and to answer the research questions. The empirical analysis framework in this study was carried out by two levels, one was the analysis of variables affecting household's willingness to pay decision and the estimation of mean willingness to pay for the improved water service, was the other analysis. The first analysis was done by the help of Logit, and the second one by using the double bounded dichotomous choice approach, through STATA software version 14. The goodness of fit of the model and the significance of the model can be measured by using pseudo-*R* square and the chi-square respectively.

3.7.1. Model Specification

3.7.1.1. Logit Model

In the Logit model, the dependent variable; WTP in this study is the log of odds ratio (Gujarati, 2004), and which is the linear function of the regressor or explanatory variable.

The logistic distribution for the binary response variable or household WTP is represented as;

$$pi = E(WTPi = 1/Xi) = \frac{1}{1+e^{-Zi}} = \frac{1}{1+e^{-X\prime\beta}} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots 6$$

And, Households Not Willing to pay $(1 - pi)$ is expressed as;

$$1 - pi = 1 - \frac{e^{Zi}}{1+e^{Zi}} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots 7$$

Where: X is a vector of explanatory variables determining the individual's choice of whether or not to pay,

β is the set of parameters or coefficients of explanatory variables

For simplicity, equation 6 can rewritten as; $pi = \frac{e^{Zi}}{1+e^{Zi}} = \frac{e^{X\prime\beta}}{1+e^{X\prime\beta}} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots 8$

Equation 8 is called cumulative distribution function, and represents the probability of something happening; in this case household willing to pay.

Since pi is non-linear in $\beta's$ and Xi, it is not possible to apply the OLS procedures to estimate the parameters. So what is required is that linearizing equation 8, because the problem is more apparent than the real case. Given the probability that household willing and not willing to pay, we can write the

odds ratio or relative risk, i.e. the ratio of households willing to pay to households not willing to pay can be derived as follows;

$\frac{pi}{1-pi} = \frac{1+e^{Zi}}{1+e^{-Zi}}$, by simplification it becomes $e^{Zi}=e^{X\prime\beta}$ ……..….9

Finally, by taking the natural log of the odds ratio (equation 9) we can derive the logistic distribution. i.e.

$$Li = \ln(\frac{Willing}{Not\ Willing}) = Zi = X'\beta \text{……10}$$

For estimation purpose, equation 10 can be modified as

$$Zi = X'\beta + ui = \alpha + \beta iXi + ui \text{……..……..11}$$

Where $X\ and\ \beta$ are as defined above.

Thus, the log-odds are a linear function of the explanatory variables

Letting an individual's true but completely unobserved willingness to pay for improved water service by $WTPi^*$ (latent variable),

$$WTPi^* = X'\beta + ui = \alpha + \beta iXi + ui$$

$$WTPi^* = \alpha + \beta_1 AGE + \beta_2 SEX + \beta_3 MS + \beta_4 NHH + \beta_5 EDU + \beta_6 ES + \beta_7 INC + \beta_8 RESID + \beta_9 SATS + \beta_{10} DEX + \beta_{11} SUBS + \beta_{12} BID1 + ui \text{ … … … … … … … … … … … … … … … … … … …..……..12}$$

Where; α-constant intercept and β_1 … ….. β_{12}- coefficients of explanatory variable

$WTPi^*$- is the i^{th} households true but unobservable willingness to pay for improved water service and is binary choice dependent variable.

The description of dependent and explanatory variables, which is expected to affect household's willingness to pay for improved water service are discussed in section 3.9 with their expected sign.

3.7.1.2. Estimation of Mean Willingness to Pay

The third objective of this study was to estimate the WTP in monetary values by applying CVM. As discussed above, the study used a dichotomous choice with follow up questions to elicit the WTP decision of household for improved water service in Bonga town.

For eliciting mean WTP, different approaches were used early. For instance, open ended format is one method to estimate WTP. In this format individuals are asked how much they willing to pay. The other approach is payment card method, in which individuals are asked to choose the amount they willing to pay from a series of amount provided. But, those methods have many drawbacks including little information can be obtained from a given individual.

Having a goal of solving the drawbacks related with open-ended and payment card formats, Hanemann *et al.*, (1991) developed dichotomous choice method or close ended format. In this approach the individuals asked, will you willing to pay X Birr for the service? The answer may be 'Yes' or 'No'.

Further, dichotomous choice method classified as single and double bounded formats. The usual way of estimating mean WTP employed in many empirical studies were single bounded approach, which is similar with Probit model. However, the problem of this approach is that, a given individual provides little information. Hence, to obtain accurate estimate from this approach, we have to investigate too large samples. This requires too much time and budgets.

3.7.1.2.1. Estimation of Mean WTP from Double Bounded Dichotomous Choice Model

It is witnessed that the double bounded elicitation method increases statistical efficiency over single bounded elicitation format (Calia and Strazzera, 2000; Haab and McConnell, 2002). Further, double bounded approach is more efficient method than the single bounded, as it bounds the decision of respondents. Similarly, the method enables as to acquire more information from a single respondent. Hence, this study adopted double bounded dichotomous choice elicitation format.

In DBDC, there are two binary dependent variable $WTP1i$ and $WTP2i$, so there are two latent variables $WTP1i^*$ and $WTP2i^*$ (Haab and McConnell, 2002).

Assuming the error terms are normally distributed with zero Mean and correlation coefficient ρ, the DBDC model representation of the true, but unobserved household WTP is as follows;

$$WTP1i^*=X1i'\beta 1i+u1i$$

$$WTP2i^*=X2i'\beta 2i+u2i \quad \text{.....13}$$

The specification of the above Model is as follows

$$WTP1i^*=\begin{cases}1, if WTP1i^* > 0\\ 0, otherwise\end{cases}$$

$$WTP2i^*=\begin{cases}1, if WTP2i^* > 0\\ 0, otherwise\end{cases} \quad \text{.....14}$$

Through contingent valuation questionnaire; the information gathered directly from individual i, using the dichotomous choice model has a dichotomous answer 'yes' and 'no'. When it is double dichotomous, the follow up bid will be provided to the individual i depending on the first choice either by lowering when the answer is 'no' or increasing when the answer is 'yes'. Further, the procedures for estimating mean WTP in this study was adopted from Haab and McConnell (2002) and Lopez-Feldman (2012), with little modification that suits it to the water service valuation.

Given these scenario, and assuming p^1 the initial bid and p^2 the second bid; the bound on WTP of a given individuals decision are described as follows;

p^1 ≤WTP<p^2, when the individual answers yes for first and no for second bid

p^1>WTP≥ p^2, when the individual answers no for first and yes for second bid

WTP≥ p^2, when the individual answers yes for first and second bid respectively

WTP<p^1, when the individual answers no for first and second bid respectively

The most general econometric model for the double-bounded data come from of Haab and McConnell (2002) formulation. The linear function to estimate the mean willingness to pay can be modeled as;

$$WTPi(xi, ui) = xi\beta + ui \quad \text{……15}$$

Where; xi is a vector of explanatory variables, β is a vector of parameters and ui is an error term. Generally, it is expected that the individual will answer 'yes' to initial question when his/her WTP is greater than the suggested amount, or when WTPi > p^1 and the same is true for follow up.

Letting $WTP1i = 1$ and $WTP2i = 1$, when the i^{th} individual answers "yes-yes" and WTP1i=0 and WTP2i=0 when answers "no-no", and under the assumption of normality; the probability of observing possible two-bid response sequences (*yes-no*, *yes-yes*, *no-yes*, *and no-no*) given the values of the explanatory variables is given as follows:

First, the probability of observing "yes-no" response can be shown as;

$$pr(yes, no) = pr(WTP1i = 1, WTP2i = 0)$$

$$pr(p^1 \le xi\beta + ui < p^2)$$

$$pr\left(\frac{p^1 - x'i\beta}{\sigma} \le \frac{ui}{\sigma} < \frac{p^2 - x'i\beta}{\sigma}\right) = \Phi\left(\frac{p^2 - x'i\beta}{\sigma}\right) - \Phi\left(\frac{p^1 - x'i\beta}{\sigma}\right)$$

Finally, by rearranging and simplifying the probability of an individual i, answers yes for initial and no for follow up question becomes;

$$pr(yes, no) = \Phi\left(x'\frac{\beta}{\sigma} - \frac{p^1}{\sigma}\right) - \Phi\left(x'\frac{\beta}{\sigma} - \frac{p^2}{\sigma}\right) \quad \text{……16}$$

Second, the probability of observing "yes-yes" response can be shown as below;

$$pr(yes, yes) = pr(WTP1i = 1, WTP2i = 1)$$

$$pr(x'i\beta + ui > p^1, x'i\beta + ui \ge p^2)$$

$$pr(x'i\beta + ui > p^1 / x'i\beta + ui \ge p^2) * \mathrm{pr}(x'i\beta + ui \ge p^2)$$

By definition we know that p^2>p^1, then

$$pr(x'i\beta + ui > p^1 / x'i\beta + ui \ge p^2) = 1$$

Therefore, $pr(yes, yes) = \text{pr}(ui \geq p^2 - x'i\beta)$

$$=1\text{-}\Phi\left(\frac{p^2 - x'i\beta}{\sigma}\right)$$

Finally, by symmetry it becomes;

$$= \Phi\left(x'i\frac{\beta}{\sigma} - \frac{p^2}{\sigma}\right) \quad \text{.....17}$$

Third, the probability of "no-yes" is

$$pr(no, yes) = pr(p^2 \leq WTP < p^1)$$

$$pr(no, yes) = pr(p^2 \leq x'i\beta + ui < p^1)$$

$$= pr\left(\frac{p^2 - x'i\beta}{\sigma} \leq \frac{ui}{\sigma} < \frac{p^1 - x'i\beta}{\sigma}\right)$$

$$= \Phi\left(\frac{p^1 - x'i\beta}{\sigma}\right) - \Phi\left(\frac{p^2 - x'i\beta}{\sigma}\right)$$

$$= \Phi\left(x'i\frac{\beta}{\sigma} - \frac{p^2}{\sigma}\right) - \Phi\left(x'i\frac{\beta}{\sigma} - \frac{p^1}{\sigma}\right) \quad \text{.....18}$$

The forth or "no-no" response probability can be solved analogously.

Where; $WTP1i$ *and* $WTP2i$, are the dichotomous variables that capture the response to the first and second closed questions.

After solving for the probabilities of two-bid response, the estimation can be done by constructing likelihood function to directly obtain estimates for β and σ using maximum likelihood estimation.

The function that needs to be maximized in order to find the parameters of the model is:

$$\sum_{i=1}^{N}\left[di^{yn}ln\left(\Phi\left(x'\frac{\beta}{\sigma} - \frac{p^1}{\sigma}\right) - \Phi\left(x'\frac{\beta}{\sigma} - \frac{p^2}{\sigma}\right)\right) + di^{yy}ln\left(\Phi\left(x'i\frac{\beta}{\sigma} - \frac{p^2}{\sigma}\right)\right) + di^{ny}ln\left(\Phi\left(x'i\frac{\beta}{\sigma} - \frac{p^2}{\sigma}\right) - \Phi\left(x'i\frac{\beta}{\sigma} - \frac{p^1}{\sigma}\right)\right) + di^{nn}ln\left(1\text{-}\Phi\left(x'i\frac{\beta}{\sigma} - \frac{p^2}{\sigma}\right)\right)\right] \quad \text{.....19}$$

Where; $\Phi(x)$- is standard cumulative normal

$di^{yn}, di^{yy}, di^{ny}$ *and* di^{nn} are indicator variables that take the value of one or zero depending on the relevant case for each individual, that is to say, a given individual contributes to the logarithm of the likelihood function only in one of its four parts.

Finally, the mean WTP can be computed by a formula

$$Mean\ WTP = \bar{x}i'\hat{\beta} \quad \text{.....20}$$

Where; $\bar{x}i'$- is a vector of sample average of explanatory variables, $\hat{\beta}$ is a vector of parameters.

3.8. Model Diagnostic Test

Before applying the model for statistical inferences, it is necessary to test or check whether the model fits well (Greene, 2002; Gujarati, 2004). In binary response model; for the analysis to be valid, the model has to satisfy the assumptions of the binary response model. The critical assumptions to be fulfilled in binary response models are; specification test, goodness of fit test, multicollinearity test and heteroscedasticity test. If one of these assumptions is not met, the model may have a problem of biased coefficient estimates or very large standard errors for the regression coefficients, and these problems may lead to invalid statistical inferences.

3.8.1. Specification Test

Under this test, we test whether the model is correctly specified or not. This test is conducted to confirm that the probability function is correctly specified. The test involves two steps; the first step is estimating the probability function and the second step is model building for the test and estimation using the information from the first step. When the model is not specified correctly while doing the above steps, the model will become correctly specified by including relevant and excluding irrelevant variables from the model (Gujarati, 2004). The command "ovtest" can be used to test for specification error.

3.8.2. Goodness of Fit Test

Under this test, we test whether the overall model is statistically significant or not (Gujarati, 2004). The goodness of fit test of the model will be done by using either Likelihood ratio or Hosmer and Lemeshow's goodness of-fit test. The estimated model fits the data well if the LR test statistic is statistically significant and HL test statistic is not statistically significant.

3.8.3. Multicollinearity Test

Under this test, we test whether the explanatory variables are correlated or not. This test is conducted to verify if there is the presence of severe correlations among regressors in the model under consideration. To detect the problem of multicollinearity the test can be performed by command "corr" in software. While doing this test, all independent variables may be orthogonal or uncorrelated with each other.

In the case of orthogonal regressors both the tolerance and variance inflation factor (VIF) are 1, if not orthogonal, the tolerance becomes closer to 0 and VIF very large. Hence, the closer the tolerance and VIF to 1, the less severe the problem of multicollinearity, and the reverse is true. The rule of thumb recommends it is necessary to consider the severity of the multicollinearity problem when the VIF is 10

or greater and tolerance is 0.1 and less. Therefore, to deal with the severe correlation among regresses, we use the VIF result and identify the source of multicollinearity from the test (Greene, 2002).

3.8.4. Heteroscedasticity Test

Under this test, we test whether the variance remains constant for all observations or not. But, there are many situations in which the variance may not be constant over entire observations. Under such circumstances we face a heteroscedasticity problem (Gujarati, 2004). To see the problem we run the "*hottest"* command in software Stata and in response we see the p-value of white test to decide the issue.

3.9. Description of Variables and Expected Outcomes

3.9.1. Dependent Variables (Willingness to pay)

Willingness to pay is an economic concept which aims to determine the amount of money a consumer will pay for accessing the improved water service (Gall-ely, 2010). Conceptually, WTP is applied to many research studies worldwide and developing countries for improved water services. Hence, the dependent variable in this study is willingness to pay for improved town's water services using two binary dependent variables, each taking a value of 1, if the household is willing and 0, otherwise. The first binary relies on the answer to the first bid offered and second one relies on the answer to the follow up question or second bid. This is the key dependent variable in answering the objective on mean WTP for improved water services.

3.9.2. Independent Variables

There are so many variables expected to affect the household's willingness to pay decision for improved water service in the study area; but as discussed in the scope of the study, analyzing the effect of all variable is beyond the capacity of this study. By referring different literatures, the study identified the following variables as explanatory variables expected to affect the response variable severely.

Age of the respondent (AGE): Age is a continuous variable which is expected to affect the respondent's willingness to pay for the improved water service negatively (Dlamini *et al.*, 2016). Because, it is assumed that as the age of respondent gets older, s/he may consider that, s/he will not be served from the improvement for a long time. Thus, higher age leads to lower WTP, hence, negative effect expected.

Sex of the respondent (SEX): The sex dummy (0= male and 1=Female) is another explanatory variable expected to affect the respondent's willingness to pay decision (Kidu and Ewnetu, 2015). This study expects female respondents to be more willing to pay than men, since traditionally it is the role of women to collect water for household consumption in our country, Ethiopia.

Marital status of the respondent (MS): This is categorical variable taking a value of (0=married, 1=unmarried, 2=divorced, and 3=widowed). The marriage status is expected to be related directly to the dependent variable. It is because people who are married use more water for household consumption and need the improved service than who are not married (Saleamlak, 2013). Hence, marital status of the respondent is expected to affect the respondent's willingness to pay positively.

Numbers of people in the family (NHH): The family or household size is expected to affect the household's willingness to pay decision negatively (Moffat *et al*, 2011; Zelalem and Beyene, 2012) Because, it is assumed that as family size increases the households faces high consumption burdens for other goods and service, so less of their income will be allocated for water. Thus, allocated budget for water may be lower, hence, minimum WTP expected.

Level of education attained by the respondent (head) (EDU): This categorical variable is taken to capture the year respondent spent on the formal school system (0=never attend, which is a reference category, 1=primary (1-8), 2=secondary (9-12), and 3=college and above). The level of education attained by the respondent is believed to be directly related with willingness to pay (Fentahun, 2014). An educated person has knowledge of the impact of unclean water on health of human being. Therefore, as the year or level of education increases the awareness of a person for health also increases, so maximum willingness to pay for improved water services is expected.

Employment status of the respondent (of head) (ES): The respondent's employment status is a dummy (1= employed and 0 otherwise) indicating employed or not. Since employment creates opportunities to generate income, it is expected to affect the response variable positively. From economic view of point, employment is believed to be strengthening the income generating capacity, hence consumption of goods and services. Thus, maximum WTP decision is expected.

Average Monthly income of the Family (INC): There is general agreement on the positive effect income on willingness to pay decision for improved water service in different literatures (Akeju *et al*., 2018). It is justified as; when the household has a sufficient income s/he will pay more over who have a shortage of income. Sufficient income enables possible, sufficient consumptions including improved

water. Economic theory postulates that the demand for improved goods increases with increases in income, thus, willing to pay more for the improvement over their counterparts. This variable is represented by Ethiopian birr.

Respondent's year of residency in the town (RESID): This variable is continuous, and refers to the number of years the respondent stay in the area. This variable is expected to affect household's willingness to pay positively (Saleamlak, 2013), because it is assumed that a person resides for a long year in the area understands the problem of water service in the area than their counterparts.

Satisfaction from the existing service (SATS): The level of satisfaction from existing water service emerges from the quality, quantity and frequency of water per week in the study area. This variable is expected to affect the dependent variable negatively. Because, when the user is satisfied with existing service, s/he may not will to participate in the proposed project to be implemented; and the reverse is true (Rananga and Gumbo, 2015).

Household's exposition for water borne diseases (DEX): This variable implies the health history of the family member. It is a dummy variable taking 1, if exposed and 0 if not. Water borne diseases are caused by ingesting contaminated or unimproved water services, and when it occurs, it incurs cost to the household for buying medicines and visiting doctors. Therefore, it is expected that, exposition to water borne disease is directly related with maximum willingness to pay for improved water service (Dhungana and Baral, 2016).

Type of substitute service or source (SUBS): This study classifies the type of substitute water used in to two as (0=good, and1= poor) substitute sources. Thus, the type of substitute service used by the resident during shortages of their primary service is expected to affect their willingness to pay decision for improved water service. That is; when the existing substitute service during the shortage of their primary source is improved one (good), they may not be interested to participate in proposed projects. Therefore, it is expected as; improved substitute service (good) leads to lower willingness to pay and the reverse is true. Hence, negative effect is expected.

Initial bid (BID1): Initial bid provided to the household randomly is the other variable expected to explain household's willingness to pay for improved water service. It is expected to affect WTP negatively, i.e. as random bid increases households WTP will decrease.

Table 3. 2: Summary of explanatory variables description

Explanatory Variables	**Definition of Variables**	**Description**	**Expected signs**
AGE	Age of the respondent	Continuous	-
SEX	Sex of the respondent	Dummy	+
MS	Marital status of the respondent	Categorical	+
NHH	Number of people in the family	Continuous	-
EDU	Level of education attained	Categorical	+
ES	Employment status	Dummy	+
INC	Average Monthly income	Continuous	+
RESID	Year of residency	Continuous	+
SATS	Satisfaction from the existing service	Dummy	-
DEX	Household's diseases exposition	Dummy	+
SUBS	Type of substitute service	Dummy	-
BID1	Initial bid		-

Source: Own computation, 2020

CHAPTER FOUR

DATA ANALYSIS AND PRESENTATION

This chapter deals with the empirical findings and discusses the results obtained. Accordingly, to address the study objective and to answer the research questions, the data from the contingent valuation survey was analyzed by two parts.

The first part used descriptive analysis with the help of summary statistics. Under this analysis, the significance and relationship of discrete independent variables was described by t-test and chi-square test respectively (see appendix IX). Afterward, an overview of the households' attitude towards the existing water supply in the town was also discussed. In the second part, DBDC approach developed by Lopez-Feldman (2012) were used to estimate WTP from the surveyed data econometrically. In the Logit model, the study examined and discussed factors that affect household's probability of accepting the initial bid randomly posed to them.

4.1. Descriptive Analysis

4.1.1. Demographic and Socio-economic Character of Household

This study intends to use data collected from 338 households in the month of February and March, 2020, which was randomly selected from three Kebeles of Bonga town. However, only responses from 306 households were found to be usable for analysis. Hence, the information from 306 households was used for the analysis of this study.

From the complete information, about 212 were male and 94 were female respondents. Further, out of 212 male respondents, 170 were willing to pay the initial bid while 42 were not. Similarly, from 94 female respondents, 53 were willing and 41 were not willing to pay the pre- specified bid.

Out of total respondents, 245 respondents were employed in different economic activities, while 61 were not employed either temporarily or permanently. Of the 245 employed respondents, 209 were willing to pay the initial bid while 36 were not. Similarly, of the 61 unemployed respondents, 14 were willing to pay while 47 respondents were not willing to pay the pre specified bids. The result of employment status also in line with economic theory, i.e. employed person demands and able to pay for acquiring goods and services.

Additionally, the respondents were reported their perception about satisfaction they derived from currently existing water service in the town. Out of total sample respondents, about 49 were satisfied

and 257 respondents were not satisfied with currently existing service. Further, from 49 satisfied, only 1 respondent were willing, while 48 were not willing to pay the pre-specified bid. Similarly, from 257 unsatisfied respondents, 222 were willing and 35 were not willing to pay the initial bid.

Moreover, the type of water used as a substitute source was also one of the key variables used in the study. From the total households, about 60 respondents report as they are using good substitute source during the shortage of their primary source, while 246 report as they are using poor substitute source. Out of 60 users of good substitute, 25 were willing and 35 were not willing to pay the pre-specified bid. Similarly, from 246 users of poor substitute source, 198 were willing and the rest 48 were not willing to pay the randomly posed initial bid. Further, the result shows that a respondent who are using unimproved substitute service are more willing to pay the pre specified bid than their counterparts.

Table 4. 1: Summary statistics of Dummy explanatory variables

Variable		**Total**	**Willing**	**Non-Willing**	χ^2
Sex	Female	94	53	41	18.6709*
	Male	212	170	42	
Employment Status	Employed	245	209	36	96.0685*
	Unemployed	61	14	47	
Satisfaction from existing service	Satisfied	49	1	48	148.095*
	Not satisfied	257	222	35	
Level of substitute service	Good	60	25	35	36.7757*
	Poor	246	198	48	
Diseases Exposition	Exposed	206	170	36	29.6868*
	Unexposed	100	53	47	

Source: Own survey, 2020.

* Significant at 1% probability level

Additionally, out of 306 respondents, 206 (67.32%) respondent reports that one or more of their family members were exposed to water borne diseases in the last months or years, while 100 (32.68%) respondents report that none of their family member were exposed to the water related diseases. Of the 206 respondent exposed for diseases, around 170 respondents' show positive willingness to pay, while 36 were not. And of the 100 unexposed respondents; about 53 respondents were willing to pay the pre-specified bid and 47 were not.

The marital status of the respondent was also reported. From a total of 306 respondents; two hundred thirty one (75.49%) were married, nineteen (6.21%) were unmarried, thirty seven (12.09%) were divorced, and nineteen (6.21%) were widowed. Further, out of 231 married respondents, 188 respondents show they are willing, while 43 were not willing to pay the pre specified bid. And from 19 unmarried respondents, 11 respondents were willing to pay and 8 were not, from 37 divorced 18 respondent shows positive answer while 19 were not, and of 19 widowed 6 agreed to pay the randomly distributed initial bid while 13 disagree to pay.

Further, the sample respondents also report their educational status. From total respondents about 18 respondents did not attend any formal education, 85 falls under category of primary school, and 125 under secondary and 78 respondents completed college and above. Out of 18 respondents who never attend the formal education, 9 shows positive response while 9 were not; out of 85 who attends primary school, about 47 were willing to pay the random initial bid while 38 were not; from 125 secondary schools attendant, 98 were willing while 27 were not, and from 78 respondent who completed college and above, 69 were willing and 9 were not willing to pay the initial bid randomly posed to them.

Table 4. 2: Summary statistics of categorical explanatory variables

Variable	**Category**	**Total**	**Willing**	**Non-Willing**	χ^2
Marital Status	Married	231	188	43	37.9986*
	Unmarried	19	11	8	
	Divorced	37	18	19	
	Widowed	19	6	13	
Education Status	Never attend	18	9	9	29.5727*
	Primary	85	47	38	
	Secondary	125	98	27	
	College & above	78	69	9	

Source: Own survey, 2020.

* Significant at 1% probability level

The other important variable of the study was age. The reported mean age of total respondent was 40.183 years, with a minimum and a maximum of 20 and 78 years old respectively. While the mean age of willing to pay the pre specified bid was found to be 38.15 years and non-willing were 45.65 years.

As expected before; as the age of respondent increases, his/her willingness to pay for improved water service decreases. Further, the significant mean difference reveals that, the age of respondent explains the willingness to pay decision negatively.

The reported average incomes of total respondent were 3,125.163 Birr per month, with a monthly income of minimum and maximum of 300 and 14,000Birr respectively. Accordingly, the average monthly income of the willing and non-willing household becomes 3,552.242ETB and 1,977.711ETB respectively. The result reveals that, the respondent's willingness to pay increases with increase in income, as the mean difference is significant. The result is in line with the economic theory which states the income of the consumer affect his/her demand positively, for this case as incomes of respondent increase his/her willingness to pay increases.

Additionally, the number of people in the family was another regressor. The mean family size for the total sample household were 4.57 people in one family, with a minimum and maximum of 1 and 12 people respectively in one family. From that, the mean number of people for willing household becomes 4.49, and 4.78 people in one family on average for non-willing. There is no significant difference between a number of people in the family for willing and non-willing respondents.

Similarly, the average year of residency in the town for the total sample was found to be 17.043 years of a shorter residency of 1 year and a longer of 65 years. Further, the mean year of residency for willing and non-willing respondents was found to be 18.15 and 14.073 years respectively. The result shows that the respondent who lives a long period of time in the town were more willing to pay than who lives short period of time, as shown from the significant t-test result.

Table 4. 3: Summary statistics of Continuous explanatory variables

Variable	**Total**			**Mean**		**Mean Difference**	**T-value**
	Mean	Min	Max	Willing	Non-willing		
Age	40.183	20	78	38.148	45.651	7.50262	5.1603*
Residency	17.043	1	65	18.148	14.073	-4.075693	-2.1622**
Income	3125.163	300	14,000	3552.242	1977.71	-1574.531	-7.0734*
Family size	4.572	1	12	4.489	4.7952	0.3063915	1.2018

Source: Own survey, 2020. Mean difference = mean(No) - mean(Yes),

*, **significant at 1% and 5% probability level respectively

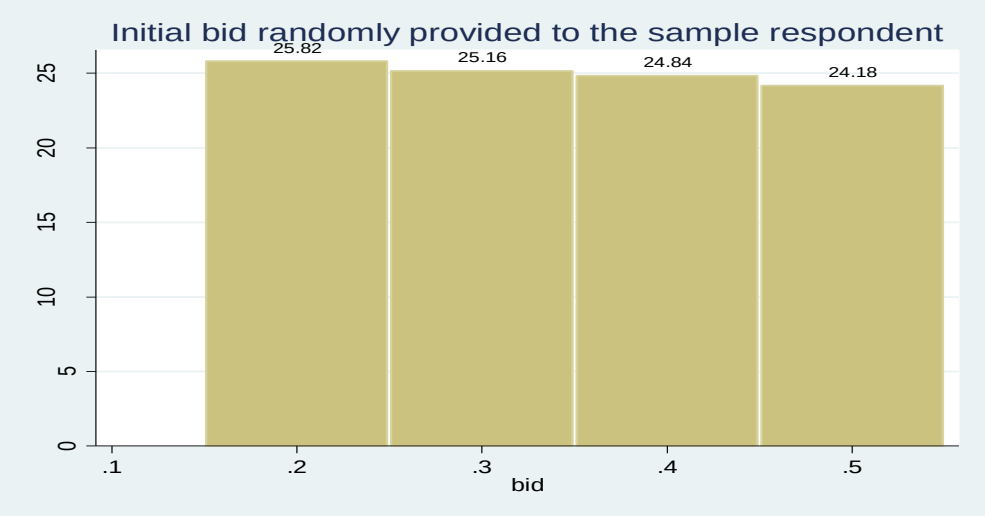

Figure 4. 1: Graphical representation of initial bid randomly offered to the respondent

Source: Own computation, 2020.

Finally, the initial bid randomly provided to the respondent was set by employing pilot survey prior to main survey using open ended questions. From the pilot survey result, the most frequent four bids (0.20, 0.30, 0.40 and 0.50 ETB per 20 liter) were selected as initial bid for the main survey. Out of the complete information 79 respondent were asked 0.20, 77 were asked 0.30, 76 were asked 0.40 and 74 were asked 0.50 ETB as initial bid. The distributions of bid across sample were almost equal as shown in figure above.

Further, of 79 respondents who were asked 0.20ETB as initial bid, about 74 respondents show that they are willing to pay, whereas 5 respondents' refuses to pay the pre specified bid. Out of 77 respondents who were asked 0.30ETB as initial bid, about 58 respondents were willing to pay while 19 were not. From 76 respondents who were asked 0.40ETB as initial bid, about 56 respondents were willing to pay while 20 were not. Finally, from those who were asked 0.50ETB as initial bid, about 35 respondents were willing and 39 were not.

Moreover; the main issue to be considered in CV survey result is, validity issue according to Devicienti *et al*., (2004). Since the CV method remains subject to criticism, a good CV survey result should be theoretically valid. Further, theoretical validity can be measured by examining the relationship between explanatory variable and WTP. One of the critical explanatory in CV survey was bid posed.

The economic theory suggests that the percentage of the respondents willing to pay for a particular service should decrease as the price they are asked to pay increases. Similarly, the economic concept of

demand law states that; as the price of a given service increases its demand decreases. Hence, the result of this study is in line with this law. As initial bid randomly offered to the respondent increases, the respondent's demand toward the service declines, so their WTP declines.

4.1.2. Current Water Consumption Pattern of the Town

The residents of Bonga town were using water from different sources. Because of the shortage of improved water services in the town, the residents are forced to use even rivers, although their numbers were very low. The information from the town's water bureau shows that there is only 2,200 private water connections in the town (BoTWSSA, 2019). From the total data gathered for this study; about 83 sample respondents were using private tap, 120 were using collective tap (from municipal or neighbors tap), 78 were using spring and 25 were using water from the river. Further, the pictures showing the water service of the town captured during the survey were attached in appendix (see appendix VII).

Out of 83 private tap users, 61 were willing to pay the initial bid while 22 were not; from 120 collective tap users, 89 were willing to pay, while 31 were not. Similarly, from 78 spring users 60 were willing while 18 were not; and from 25 river users 13 were willing while 12 were not.

Table 4. 4: Structure of current water service in the town and Households WTP

WTP	**Currently Existing Service**				**Total**	χ^2
	Private tap	**Collective tap**	**Spring**	**River**		
No	22	31	18	12	83	
Yes	61	89	60	13	223	6.2753***
Total	83	120	78	25	306	

Source: Own Survey, 2020.
Non-Willing is a "No" answer for the first bid while willing is a "Yes" answer for the first bid.
*** Significant 10% probability level

Additionally, households in the study area also reported their daily water consumption. The reported average litre of water consumed by total sample household was 65.033 litres per household or total of 19,900.1 litre /day for the total sample, with a minimum and maximum consumption of 20 and 150 litre respectively. Of this; the average litre of water consumed daily by willing respondent becomes 67.96 litre per day, while 57.17 litre for unwilling respondents. Generally, the daily water consumed in Bonga town is below the internationally accepted standard according to Ali and Terfa (2012). Further, this proves that, the study areas are subjected to water stress.

Similarly, the reported average monthly payment of the total sample to whom is currently using private tap was 69.58 and to collective tap users are 59 ETB, with a minimum payment of 20 ETB and a maximum payment of 150ETB per month. Out of this; the average monthly water payment of willing respondent becomes 70.08 and 61.24 for private and collective tap users respectively. However, the mean difference is not significant.

Table 4. 5: Summary description of continuous (current water service) attributes

Variable	Total			Mean		Mean Difference	T-value
	Mean	Min	Max	Willing	Non Willing		
Daily Consumption	65.033	20	150	67.96	57.169	10.79097	-2.8741*
Monthly Payment	42.01	0	150	43.61	38.20694	5.899022	-1.2378

Source: Own survey, 2020. Mean difference = mean(No) - mean(Yes).

*significant at 1% probability

Moreover, the residents was also reported their perception about the current water service regarding its quality, quantity and frequency per week. Regarding the quality of current service; 30.39% respondents were reported as good, 36.93% respondent as average, and 32.68% responded as poor. Regarding its quantity; 18.95% respondent reports as sufficient, 28.43% as average and 52.61 as insufficient. Likewise; regarding the frequency of water per week, 12.75% respondent reports that; it is below 3 days, 46.73% as from 3-4 day and 40.52% respondent, reports as available above 4 days per week.

Table 4. 6: The perception of household about the level of existing water service

Variable	Level of Available Service			χ^2
Quantity of current service	Sufficient	Average	Insufficient	9.3336*
	50 (18.95%)	87 (28.43%)	161 (52.61%)	
Quality of existing service	Good	Average	Poor	10.0934*
	93 (30.39%)	113 (36.93%)	100 (32.68%)	
Frequency of existing service per week	Below 3 day	3-4 day	Above 4 day	2.0290
	39 (12.75%)	143 (46.73%)	124 (40.52%)	

Source: Own survey, 2020.

*significant at 1% probability level

4.1.3. Households' Willingness to Pay for Improved Water Services

The first specific objective of this study was assessing whether residents of Bonga are willing to pay for improved water service or not. To estimate the willingness to pay for improved water service in Bonga town, double bounded dichotomous choice model was used. To obtain initial bid pilot survey was conducted using open ended questionnaires. From pilot survey, the study used four the most frequent bids (20, 30, 40 and 50ETB per 20 litre) as starting bids which will be lowered or increased depending on the 'yes' or 'no' answer of the respondent to the initial bids.

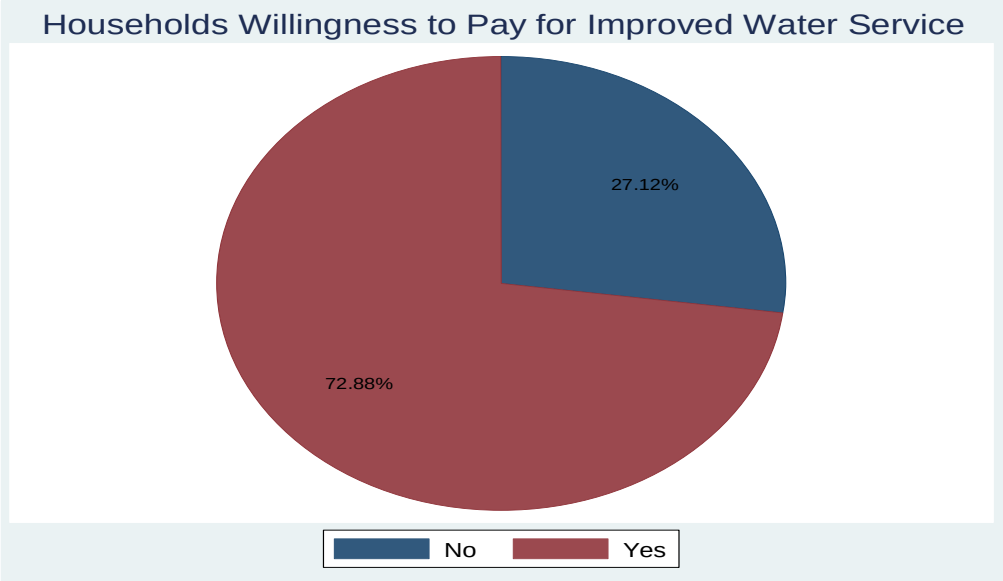

Figure 4. 2: Households WTP (Bid1) for improved water service in Bonga town.

Source: Own Survey, 2020.

"Non-Willing is a 'No' answer for the first bid while willing is a 'Yes' answer for the first bid".

Of the total sample respondents, about two hundred twenty three (72.88%) respondent has said 'yes' for the pre-specified bid provided to them randomly which differs across the sample, while eighty three (27.12%) respondents were refusing to pay. The descriptive result reveals, if the proposed water project implemented, most households are interested or willing to pay the cost recovery tariff rate. Hence, concluded as, households in Bonga town are willing to pay.

4.1.4. Reasons for Not Satisfied with Existing Services in the Study Area

From the total sample households, around two hundred fifty seven (84%) respondent reports that they are not satisfied with the existing water services of the town, and only forty nine (16%) respondent answers as they are satisfied with the current service. The reasons for being not satisfied according to

the respondents answer were; poor quality, insufficient quantity which limits the use of water for every necessary service, and unavailability when needed or low frequency of the water per week are the major reason among others.

Table 4. 7: Reason for being unsatisfied with currently existing services of the town

WTP	Reason for not-satisfied			Total	χ^2
	Low quality	Low quantity	Infrequent availability		
Yes	59	75	88	222	
No	14	11	10	35	2.9393
Total	73	86	98	257	

Source: Own survey; 2020

4.1.5. Reasons for Not WTP the Pre-Specified Bid for the Improved Water Service

The respondent households were also asked about the reasons why they are not interested to pay the initial bid provided to them randomly.

Of the total non-willing households, about 92.771% stated their reasons for not WTP. From total non-willing respondents, about 28.92% responds as it is the responsibility of government to provide improved water service for its people, 21.69% responding as unable to pay because of being poor and the rest 13.25% and 15.66% responding as not trusting the project or government and I don't think that I am responsible for the project to take place respectively. Similarly, about 13.25% of non-willing respondent shows their reason for not willing to pay as "I don't want the service"; this response is possibly because of satisfied with current service.

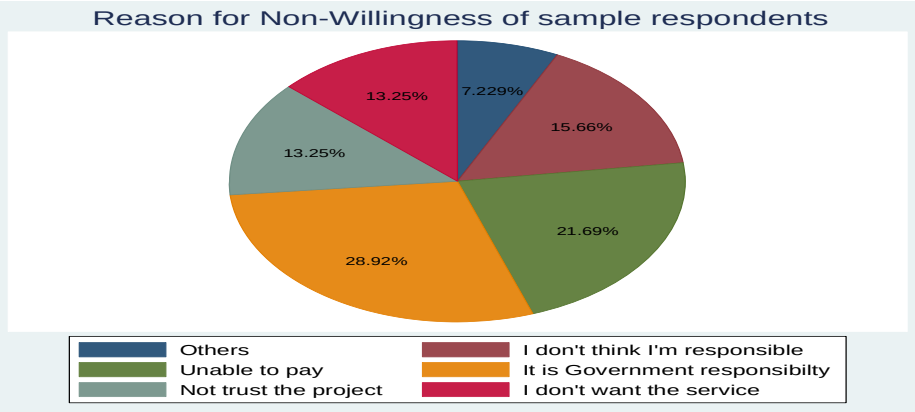

Figure 4. 3: Reasons for not willing to pay for improved water service in the study area.

Source: Own survey, 2020.

4.2. Econometrics Analysis

4.2.1. Factors of Household's WTP for Improved Water Service in the Study Area

The second specific objective of this study was analyzing factors affecting household's willingness to pay decision for improved water service in Bonga town. Thus; to perform this task, logistic regression model was used as econometric model. But, before applying logistic regression for analysis, taking model diagnostic test becomes necessary. The model diagnostic test was performed to insure that the model fits well. The model diagnostic test can be done by running linear probability model (LPM) using OLS regression model (see appendix II).

The rationale behind running model diagnostic test is to check whether the model is correctly specified or not, to check the correlation between explanatory variables, and checking the overall significance of the model. For testing misspecification, Ramsey specification was run and the result shows misspecification is not the problem for this model. Additionally, VIF test was used to check the problem of multicollinearity and the result shows also multicollinearity is not the problem of the model.

After diagnostic test, Logit model was used for the analysis in which the dependent variable (WTP) was a binary response variable taking value of 1 and 0, for willing and not willing to pay respectively. The independent variable used in the model contains dummy, categorical and continuous variables.

In Logit model; the overall significance of the model is shown from the result of chi-square ($\chi 2$), and the significance p-value shows that goodness-of-fit model. In a logistic regression model, the pseudo R^2 is more accepted, because pseudo R^2 tells us the variance extraction by the independent variable, therefore, the result of this study shows that the independent variable explains the dependent variable well.

Performing all the stated procedures above, the logistic regression model was run. A total of 12 explanatory were used to explain the dependent variable. From those 12 explanatory variables used for analysis, 9 variables were significant at less than 5% probability level. However, together all the regressors have a significant effect on WTP decision as chi-square is significant with significant p-value. The regression output of Logit model is presented in table 4.8.

However, the result from Logit model, whether it is coefficient report or odds ratio; it shows only the direction of the effect of the explanatory variable on the dependent variable, but not the magnitude. Unlike the slope coefficient measures directly the change in the probability of an event occurring as the

result of a unit change in the value of a regressor in the LPM; in logistic regression model, the slope coefficient of a variable gives the change in the log of the odds associated with a unit change in that variable, ceteris paribus.

Therefore, with the logistic regression coefficient or odds ratio, we don't have a sense of magnitude. Thus, to show the magnitude of the explanatory variables effect on dependent variables, it is essential to calculate the marginal effect (dy/dx) of explanatory variable on the dependent variable. According to different Econometrics books; Greene (2002) and Gujarati (2004); the calculated marginal effect shows the expected change in the probability of a particular choice being made with respect to a unit change in an explanatory variable, ceteris paribus.

Moreover, marginal effect can be computed by keeping all covariates are at their mean (Marginal Effect at the Mean (MEM)) or Average Marginal Effects (AME). Even there is no significant difference between them, Average Marginal Effects were the popular one (Williams, 2019). Therefore, AME was computed and used for interpretation in this study. The detail of calculated marginal effect is attached at the back in appendix IV.

Table 4. 8: Parameter estimates and marginal effect of Logit model

Logistic regression — Number of obs = 306

LR chi2(12) = 315.11

Prob > chi2 = 0.0000

Log likelihood = -21.297645 — Pseudo R^2 = 0.8809

WTP	Coefficient	Standard Error	Z-value	Marginal Effect	Z-value
Age	-.3879252*	.1447625	-2.68	-.0080707*	-3.12
Sex	-1.093139	1.388157	-0.79	-.0227426	-0.79
Marital Status (Married)	---	---	---	---	---
Unmarried	-3.581452	2.252243	-1.59	-.0871881	-1.67
Divorced	-.3856466	2.107026	-0.18	-.0075459	-0.18
Widowed	8.022822**	3.981149	2.02	.0999349*	4.25
NHH	-.60242	.4966822	-1.21	-.0125333	-1.26
Education (Never attend)	---	---	---	---	---
Primary(1-8)	-5.512507**	2.795913	-1.97	-.0781559**	-2.37
Secondary(9-12)	-6.58224**	2.983933	-2.21	-.0990604*	-2.68
College &above	-2.631646	2.600563	-1.01	-.0375919	-1.02
Employment Status	3.887435*	1.328193	2.93	.0808777*	3.70
Average Monthly Income	.0043537*	.0012593	3.46	.0000906*	4.64
Year of Residency	.1316262**	.0652266	2.02	.0027385**	2.17
Satisfaction	12.00041*	3.303169	3.63	.2496674*	5.08
Diseases Exposition	1.941206	1.371483	1.42	.0403866	1.47
Substitute Source	10.87675 *	3.35321	3.24	.2262897*	4.13
Initial Bid	-27.5859*	8.441163	-3.27	-.5739219*	-4.22
-cons	.5677754	4.177199	0.14		

Source: Own survey, 2020.

* and ** significant at 1% and 5% probability level respectively.

Below is the interpretation of the marginal effect of the explanatory variables on WTP decision of households.

Age of the respondent (AGE): The age explanatory variable affects the dependent variable negatively and significantly at less than 1% probability level. The negative significant relation between respondent's age and willingness to pay decision for the improved water service represents that, as age increases his/her willingness to pay decision declines.

The marginal effect result shows that, a one year increase in the age of the respondent leads to 0.81% decline in the probability of accepting the initial bid by the respondent. The result is in line with a prior expectation. Further, the result proved to be as the respondents age gets older s/he doesn't care about the project to be implemented in the future. The result is consistent with findings of Megersa (2011); Dlamini *et al.*, (2016) and Hundie and Tariku (2016).

Marital Status (MS): Marital status of the respondent was another regressor. The marital status was measured taking the married category as a reference group. Further, in comparison to married categories, widowed respondents were more likely to pay the pre-specified bid by about 9% at 5% probability level. This positive response is may be because; the widowed respondents were marginalized from accessing improved service and using unimproved service currently compared to their counterparts. Lower expenditure for family consumption by widowed may be another possibility for positive response. Further, the result is contrary with a prior expectation. Similarly, there is no previous study similar with this result.

Education level (EDU): Education level of the household head was another explanatory variable used in this study. Educational status were measured taking the never-attend group as a reference category. The regression result shows that, in comparison to never-attend category, respondents who attend the primary and secondary school were less likely to pay the initial bid posed to them. The result is significant at 5% probability level. The negative effect is possibly because of respondent who attend higher level of schooling are using improved services currently. Additionally, educated persons may believe that service provision is government's responsibility. Further, the finding doesn't show the expected sign. However, similar with finding of (Moffat *et al*, 2011).

Employment status of the respondent (ES): Another strong variable to explain WTP decision was the employment status of the household head. The regression result proved to be consistent with prior expectations as the variable takes a positive sign and was significant at 99% confidence level. The result revealed that, been engaged in any economic activity increases the probability of the respondent's decision to pay for improved water service.

The marginal effect of the Logit model also showed that the employment status of the respondent significantly and positively affect the probability of accepting the initial bid. Respondents who are employed were more likely to accept the initial bid by 8.088% compared to base group, ceteris paribus. This can be mainly because of an employed person has his/her own income and which makes the consumption of the service easy or likely. The result is true with a prior expectation of the study. Also true with economic theory (Maloma, 2014).

Average Monthly income of the household (INC): Average monthly income of households was another strong factor of WTP. This was shown by the positive coefficient and statistical significance at greater than 99% confidence level from the Logit result. Similarly, the marginal effect result for household income showed a positive and significant relationship with households WTP. This meant that, keeping the influences of other factors constant at their mean values, a one Birr increase in household income increases the probability of accepting the first bid by about 0.00906%.

Generally, this implies that an increase in income of a household shifts the demand curve for clean and potable water to the right. This result was in-line with the a priori expectation of the study, most previous studies and economic theory, as higher income families have better chances of maximizing utility and enjoy better and high quality goods and services.

Respondent's year of residency (RESID): Year of residency by the respondent was one explanatory variable. The year continuous variable, explained the dependent variable positively and significantly at less than 5% probability level. Further, the direct relation between year of residency and WTP decision implies, as the year a respondent resides in the town increases, his/her decision to accept the initial bid also increases. Accordingly, the result of marginal effect reveals that, as respondent's residency in the town increases by one year, his/her probability of accepting the randomly offered bid increases by 0.274%. The result is true with a prior expectation. And also similar with the finding of (Lohano, 2019).

Household's satisfaction from the existing service (SATS): Another strong explanatory variable in this study was the level of satisfaction derived from current water service of the town. This variable was dummy taking satisfied as base group. The regression result reveals that there is a positive and significant relation between level of satisfaction and WTP at less than 1% probability level, meaning household who were not satisfied with currently existing service shows maximum willingness to pay as compared to the base group.

The marginal effect result also reveals that unsatisfied respondents are more interested to pay for the improved water service by about 24.97% when compared to the satisfied respondents, ceteris paribus. The result is as expected earlier, and similar to the finding of Egziabher and Adnew (2007); Kidu and Ewnetu (2015) and Lohano (2019) in their respective areas.

Substitute source during a shortage of primary source (SUBS): Another highly significant independent variable in this study was the type of secondary source used by the resident during a shortage of primary source. This variable is dummy taking 0 and 1 for good (improved) and poor (unimproved) substitute service respectively. The positive and significant result at less than 1% probability level implies that the respondent who are using the unimproved substitute service are more likely willing to pay than their counterparts.

The result from the marginal effect represents that; the households who are using unimproved water service during shortages of their primary service were more willing to pay the initial bid provided to them by about 22.63%, when compared to their counterparts. The finding is in agreement with prior expectation. Similarly, the result is comparable with economic theory (Rousu *et al*., 2008).

Initial bid randomly provided to the respondent (BID1): Finally, the bid offered to households had a negative sign and statistical significance as economic theory predicts. The bid was found to be significantly associated with WTP at less than 1% probability level. The marginal effect result also showed a similar sign and statistical significance. This implied that, holding other factors at their mean values, a 0.10ETB increase in the bid offered to respondent decreases the probability of accepting it by 57.393%. Moreover, the result is compatible with the economic theory of demand, which state; the higher the price of a good, the less the demand and vice versa.

4.2.2. Validity and Reliability Test of CVM for Improved Water Service

Even CVM is prominently used in valuation of natural and environmental resources, remained controversial till today. The debates arise from its hypothetical nature and argued validity and reliability of its results. Therefore, once the regression model is estimated employing the stated explanatory variables above, before proceeding to the estimation of mean WTP, it is essential to take validity and reliability test for CVM survey results.

The importance of taking the validity test is to examine whether an instrument actually measures what it is designed to measure (Bateman *et al.,* 2002). While reliability is about whether the derived results are consistent across various surveys conducted to value the same quality and quantity of the same resource

(Freeman *et al*., 2014). However; there are no previous studies that would prove the reliability of the estimated WTP for improved water service in Bonga town. But, the finding of this study is reliable, as the result is consistent with other studies conducted in different areas of Ethiopia.

Accordingly, the available information marks possible the examination of the result validity. Further, validity is subdivided as 'internal validity'- representing theoretical and content validity, and 'external validity' sometimes referred to as "concurrent validity", which contains criterion and convergent validity. The external validity can be checked by comparing the study result with findings from other studies found by applying other techniques than CVM. Similarly, the internal validity can be checked by as stated above, especially the theoretical validity.

Further, the theoretical validity of CVM survey originates from the hypothesized relations between dependent and independent variables (Wattage, 2011). That is, if the explanatory variables show statistical significance in the hypothesized relationship with the dependent variable, the WTP values from the CV survey can be considered as valid. More specifically; to be valid, the hypothesized relations should be in line with economic theory.

Table 4. 9: Logistic regression for validity test of the result from CVM

Logistic regression — Number of obs = 306; LR chi2(9) = 187.73; Prob > chi2 = 0.0000; Log likelihood = -84.989557; Pseudo R^2 = 0.5248

WTP	Coefficient	Standard Error	Z-value	P>|Z|
Education Level (Never attend)	---	---	---	---
Primary (1-8)	-.4187385	.7153479	-0.59	0.558
Secondary (9-12)	1.398764***	.7616048	1.84	0.066
College & above	1.276679	.8772236	1.46	0.146
Average Monthly Income	.0011125*	.0002157	5.16	0.000
Diseases Exposition	2.15082*	.4696391	4.58	0.000
Substitute Availability	2.974274*	.5587589	5.32	0.000
Initial Bid	-11.17031*	2.194756	-5.09	0.000
Monthly Payment	-.0197032***	.0108558	-1.81	0.070
Per capita Consumption	.0188384	.0139415	1.35	0.177
cons	-2.401577	1.274547	-1.88	0.060

Source: Own survey, 2020.

* and ***, significant at 1% and 10% respectively.

According to Gunatilake *et al.*, (2007), among many hypothesized relationship between WTP and explanatory variables; Household income, education level, monthly per capita consumption, monthly payment, water related diseases exposition, the availability of substitute source was strongly hypothesized independent variables used for checking the validity of responses to the elicitation question. Moreover, the estimated CVM can be valid, if the result found is positive and significant coefficient for average monthly income, education level, monthly per capita consumption, and water-related disease expositions; and negative and significant coefficient for the bid, connection charges, and availability of good substitute sources.

Here of, the result of this study is valid and accurate as household's average monthly income and diseases exposition explained WTP positively and significantly. Similarly, the random bid posed to respondents, monthly payment and type of substitute service, explained the dependent variable negatively and significantly. Note that, the coefficient for substitute source is positive is because the base group is respondent who were using good source.

Although, the effect is not statistically significant; the level of education explained WTP decision positively; except for the case of primary school attendant. Similarly, per capita consumption shows positive direction to explain the WTP decision.

From economic point of view, the result validity should be supplemented with economic theory. For "good" services, the income effect is positive, and the price effect is negative (Nicholson and Snyder, 2008). Thus, the result of this study is also in agreement with this economic theory, as improved water service is "good", not "bad".

4.2.3. Estimation of Mean WTP from Double Bounded Dichotomous Choice Model

The third specific objective of this study was estimating the user's willingness to pay for improved water service in Bonga town. Total respondents were classified in to four groups, with approximately the same number of individuals in each bid as shown above (see figure 4.1).

Accordingly; as explained earlier, for DBDC, households were randomly offered an initial bid and depending on the response to the first bid, a follow-up (double or half to the initial bid) bid was offered. In the following table the descriptive statistics of the initial and follow up bids and the responses of the households were presented. The results from the table shows that the "yes" responses from the first and second bid were about 72.88% and 73.2%, respectively.

In table below, the first row for each initial bid summarizes the 'yes' responses and the second row summarizes the 'no' responses to that bid. This therefore means each randomly assigned bid is summarized in two rows as per the nature of double bounded questions.

Table 4. 10: Responses to double bounded questions across bid sets

BID1		BID2	First question		Second question	
			No of ''yes'' to bid1	No of ''no'' to bid1	No of ''yes'' to bid2	No of ''no'' to bid2
0.20	Bidup	0.40	74	0	62	12
	Bidlow	0.10	0	5	4	1
0.30	Bidup	0.60	58	0	34	24
	Bidlow	0.15	0	19	17	2
0.40	Bidup	0.80	56	0	32	24
	Bidlow	0.20	0	20	20	0
0.50	Bidup	1.00	35	0	17	18
	Bidlow	0.25	0	39	38	1

Source: Own computation, 2020

The initial bid of 0.20ETB resulted in 74 'yes' and 5 'no' response. Of the 74 'yes' responses to bid1=0.20ETB, the follow up question, bid2=0.40ETB, resulted in 62 'yes' and 12 'no' response. The 5 'no' response to bid1=0.20ETB, the follow up bid2=0.10ETB, resulted in 4 'yes' and 1' no' responses.

Similarly, the second initial bid 0.30ETB, resulted in 58 'yes' and 19 'no' responses. Of the 'yes' responses to bid1=0.30ETB, the follow up question, bid2=0.60ETB, gave out 34 'yes' and 24 'no' responses. Again on the 19 'no' responses for bid1=0.30ETB, the follow up question bid2=0.15ETB resulted to 17 'yes' and 2 'no' response. The third and fourth bid can be interpreted correspondingly.

The study also categorized households based on the joint responses of the offered bids (Initial and follow up). The results of the joint responses are shown in Table 4.11. As can be seen, the response "Yes-Yes" occupies the largest percentage of the joint responses with 145 (47.37%). Following the Yes-Yes response, was the "No-Yes" occupies response of 79 (25.82%), which is also followed by "Yes-No" response with 78 (25.5%). Finally, the joint response with least responses was the "No-No" response with about 4 (1.3%).

Table 4. 11: Joint frequencies of discrete responses

WTP joint responses	Frequency	Percentage
Yes-Yes	145	47.37
No-Yes	79	25.82
Yes-No	78	25.5
No-No	4	1.3
Total	306	100

Source: Own computation, 2020

Moreover; using the information collected using double bounded dichotomous choice format from the sample households, we can calculate the mean willingness to pay for improved water service of Bonga town. From DBDC, mean WTP can be estimated directly using Lopez-Feldman (2012) approach from software STATA, with 'doubleb' command.

As already discussed earlier, this study employed double bounded dichotomous format; because the method allows the efficient use of the data to estimate willingness to pay. The probability of an individual i accepting the initial and follow up bid and the likelihood equation to maximize was described earlier (see section 3.7). Therefore, it is straightforward to compute mean willingness to pay for improved water service from the data; the result is presented in table below. However, for mere comparison, the estimated mean from single bounded elicitation format is also attached at back (see appendix VIII)

In table below, the mean willingness to pay was found to be approximately 0.65ETB per 20L of water. The mean willingness to pay is computed by using equation 20. In this case, the mean willingness to pay is equal to the constant, since there are no explanatory variables included in the estimation.

Table 4. 12 Double bounded estimation result of mean willingness to pay without control variable

Number of obs = 306

Wald chi2(0) = .

Log likelihood = -353.02563 Prob > chi2 = .

	Coefficient	Standard Error	z -value	P>|z|
Beta				
_cons	.6443241*	.0224022	28.76	0.000
Sigma				
_cons	.3184091*	.0196187	16.23	0.000

Source: Own survey, 2020.

* Significant at 1% probability level

But, it is necessary to check whether the computed mean WTP is correct or not. Therefore, for this purpose, more explanatory variables can be added, and the mean WTP can be computed again. If the computed result with including more explanatory variable changed by significant number, the computed mean WTP is not correct and the reverse is true.

Therefore, below is the estimated mean WTP, by including 'age, sex, and income' as additional explanatory variables. Further, from the result, one can observe that all covariates are statistically significant. The significant result shows that, the respondents WTP decision depends on age, sex, and income of the respondents.

Furthermore; the result proved that, even more control variables were included in the estimation; there is no significant change in mean WTP. Therefore, the computed WTP is correct. Hence, mean WTP in Bonga town evaluated using the average values for the explanatory variables are approximately equal to 0.65ETB per 20 litre of improved water service.

The negative coefficient for age represents that, as the respondent's age increases the probability of respondent's decision toward accepting the bid decreases. And the negative sign for sex also represents, females were less likely to pay for improved water service when compared to their counterparts. Similarly, the positive sign for income reveals, as income of the household increases, their decision to

pay the proposed bid increases and the reverse is true. At the end, the estimated mean WTP for different age group, sex category, and income levels is attached in appendix (see Appendix VI).

Table 4. 13 Double bounded estimation result of mean willingness to pay with control variables

Number of obs = 306

Wald chi2(3) = 92.03

Log likelihood = -308.66791 Prob > chi2 = 0.0000

	Coefficient	Standard Error	z-value	P>|z|
Beta				
Age of respondent	-.0072623*	.0015066	-4.82	0.000
Sex of respondent	-.1156806*	.0429185	-2.70	0.007
Average monthly income	.0000839*	.0000128	6.53	0.000
cons	.7121567*	.0760475	9.36	0.000
Sigma				
_cons	.2602117*	.0160498	16.21	0.000
WTP	.6471512*	.0193673	33.41	0.000

Source: Own survey, 2020.

* Significant at 1% probability level

4.2.4. Estimated Total Willingness to Pay of the Town for Improved Water Service

In contingent valuation method, there are steps to be followed while estimating the economic values of natural and environmental resources. The basic steps were discussed in previous section of the paper. Further, the final step was aggregating the result or the average estimated values. In the above sections, the estimated mean willing to pay for improved water service in Bonga town becomes 0.65ETB per 20 litre of bucket.

Moreover; in descriptive statistics part of analysis, the average household daily water consumption was found to be 65.03268 litre or 3.252 bucket per day across the sample household. Therefore, the average household's willingness to pay was estimated to be 63.42ETB per month, if the proposed scenario is implemented. Thus, this represents that the average household's willingness to pay is 760.97ETB per year. This is equivalent to 2.03% of average annual income (37,501.956ETB) of sampled households.

Further, the estimated budget allocation by sample household is affordable and economically sound, as it is below 5% of average income.

Accordingly; having all the above information, it is simple and straightforward to calculate the total willingness to pay for improved water service in Bonga town per month as well as per year. We can calculate the monthly WTP for the town by multiplying household's monthly WTP by the number of households of the town. Total WTP is simply the average or mean times the relevant population (Perman *et al.*, 2003). The estimated current household of Bonga town is 6,937 according to (KaZFDD (2019). Therefore, the household's average WTP for the town is about 439,944.54ETB per month or 5,279,334.48ETB per year. However, the computed total willingness to pay is only revenue not profit, because the total cost of the project is not deducted here.

Therefore, in general, the total economic value of improved water service in Bonga town becomes 5,279,334.48 Ethiopian Birr yearly, because total economic value is equal to total willingness to pay (Gunatilake *et al.*, 2007; Tietenberg and Lewis, 2012). However, the estimated total value is not the stock value, but the value of change in stock from status quo to new or improved level.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1. Conclusion

The empirical result of this paper are generally in agreement with previous contingent valuation studies conducted to estimate willingness to pay for improved water service over the world, as well as in Ethiopia specifically. Hence, the finding is valid and reliable.

Water is among the resource which is essential for the survival of life, including human beings. Moreover, strong economy, healthy society, and stable politics were unlikely without water service, especially the improved one. Therefore, conserving as well as improving the available water is important for better performance in health, and socio-economic advancement.

However, the demand for improved water service increases over its supply due to rising population, and the like reason in Bonga town. Therefore, increasing the supply of such service to meet the rising demand is essential. But, such activity incurs cost to the provider. And those cost need to be covered by users of the services. This cost can be covered by tariff paid for accessing the services. Thus, calls for establishment of cost-recovery tariff. Finally, the tariff rate can be derived from the estimated economic value of the service, since this service is non-market service.

It is therefore, necessary to value, and avail the service for such populations with cost recovery price. For this reason, this study used stated preference method to value the improved water service, through user's willingness to pay. Further, to address the study objectives and to answer the research questions, the study employed both Logit model and DBDC approach.

The main objective of this study was to estimate willingness to pay for improved water service in Bonga town. Accordingly, assessing the household's willingness to pay, analyzing factors of WTP, and estimating WTP in monetary value were the specific objectives of this study.

The first specific objective of this study was assessing household's willingness to pay for improved water service. The result from the descriptive statistics of the study indicated that, about 72.88% of the surveyed households were willing to pay the stated initial bid, while 27.12% were not. However, generally about 98.7% of the surveyed households were willing to contribute something for the improved water services. Therefore, it is concluded as; households in Bonga town were willing to pay for improved water service.

The second specific objective of this study was to assess the factors affecting user's willingness to pay decision for improved water service in the study area. A Logit model was used to assess the factors of WTP for improved water using 12 explanatory variables. However, out of them; only nine explanatory variables were found to be significant regressors at below 5% probability level, while three were not significant at any probability level. However, together all explanatory variables explained the dependent variable significantly as seen from higher chi square and the significant p-value.

The significant variables were age of respondent, marital status, education level, employment status, average monthly income of household, year of residency, level of satisfaction from existing service, type of substitute water service, and initial bid randomly provided to the respondents. Therefore, it is concluded as, households WTP decision heavily depends on socio-economic characteristics of consumers, current service attributes and the preference for improved services.

The other objective of the study was to estimate the mean willingness to pay for improved water services using the double bounded dichotomous choice elicitation format. To address this objective, the study used Lopez-Feldman's approach for double bounded dichotomous choice model. Results showed that bids offered to households were significantly associated with households WTP decision negatively. This result is also consistent with economic theory.

Furthermore, the estimated mean WTP for improved water per 20 litres was found to be 0.65ETB or 0.0325ETB/litre. This reveals that households in the study area are willing to pay for an improvement in their water services with a price which can fit with a cost recovery mechanism. Therefore it is concluded as; it is likely to make justifiable the service provision through implementation of appropriate water tariff.

In general, there is a problem of improved water service provision in Bonga town. Residents of the town were aware of the problems. For that reason, they are interested to pay the cost-recovery tariff rate for accessing the service, if the service provided to them. However, their decision is highly dependent on their socio-economic characteristics.

5.2. Recommendation

The magnitude of explanatory variables effect on households WTP decision in the study area varies by their complexity and severity. Thus, based on the findings, the study recommends the following points which need to be considered in the planning and implementation of the water project in the study area.

The stated preference approach used in this study showed that the residents in Bonga town were worried with the availability and quality of currently existing water service. That is why households in the study area were showing positive response for the proposed scenario. This awareness of respondent is also witnessed from positive impact of year of residency from regression analysis. This further reveals, residents of the town were more interested to pay the cost recovery tariff, if the proposed project implemented in the area.

Therefore, if the stated hypothetical project implemented in the town, there is an opportunity to provide improved service with a high potential of income generation. Further, the implementation of the proposed project in the town benefits both service provider and service consumers, through high revenue generation and improved service consumption respectively.

Besides, the result of the study revealed that the employment status of respondent, and average monthly income of the family, positively and significantly explained households WTP decision. This therefore implies that the sustainability of households WTP decision highly depends on employment status, and income level. But, provision of improved water service creates employment opportunity by itself. This further, heightens the income generating capacity of households in the study area. Therefore, the implementation of improved water service indirectly contributes for its own sustainability. Hence, the project implementation is highly recommended in the town.

Moreover, the view of resident about currently existing water service of the town was strong factor influencing their decision to accept the pre-specified bid. That is why the level of satisfaction, and type of substitute water source was significantly explaining WTP decision. This suggests that residents of the town are conscious about the water stress of the town.

Thus, for the service provider, there is a need for considering such issues while implementing the forthcoming project. Further, as the residents are initiated, for sustainability as well as profitability, project implementation is highly encouraged in the town.

Generally, implementation of the forthcoming project in the town is highly recommended, as residents of the town are aware of the problems of the service in the town, and shows maximum willingness to pay for improved water service if the proposed scenario implemented and provide the proposed services.

To the end, public services including improved water service were provided by political orders rather than as a response to market signals, and become a monopoly. Thus, the absence of competition in the

area is one reason for poor service provision. Hence, for good service provision, there must be competent service providers. Therefore, there is a need for government to create enabling the policy for public-private partnership in the improvement and provision of water supply service in the study area, and in Ethiopia generally.

5.3. Further research area

The study estimated the demand side for improved water services in the study area by monetary contribution; however, there are further areas of interest to the researcher which can possibly be an extension to this study and thus to inform policy accordingly. These extensions are as follows;

- ✓ Given the proposed water project in these study area, it would be virtuous to know if households in these area can assist government in-terms of labour for project implementation. This could be willingness to pay for the water project, and could be through human labour. Such knowledge can enhance planning processes while also diverting government expenditures to other national priorities.
- ✓ The study used stated preference method in estimating willingness to pay for improved water service in the study area. Other estimation techniques like revealed preference method can further be used to compare the values of WTP. This would further give the same water managers more scope on the economic value of water service and on the setting of a socially acceptable tariff of water service.
- ✓ For testing the validity and reliability of the survey result, further research in the study area are recommended, as a comparison of the result from different study makes the valuation accurate and valid. Thus, for recommending strong policy intervention in the project implementation, further researches in the study area by employing different valuation method other than CVM are highly encouraged.
- ✓ There is an interesting approach to estimate mean Willingness to pay from double bounded dichotomous choice model called Krinsky and Robb Confidence Interval method. Therefore, future researchers can use this approach to estimate mean WTP. This further, extends methodologies for estimating mean WTP from contingent valuation survey.

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APPENDICES

JIMMA UNIVERSITY

COLLEGE OF BUSINESS AND ECONOMICS

DEPARTMENT OF ECONOMICS

APPENDIX I: SURVEY QUESTIONNAIRE

SECTION I. INTRODUCTION TO THE RESPONDENT

How are you, my name is Mathiwos Kifle. I am conducting research on a title 'estimating willingness to pay for improved water service in Bonga town' for the partial fulfillment of my MSc. Thesis in Economics (Development Economics) at Jimma University.

The following questionnaire is designed to obtain information on the current situation of water supply in Bonga town and resident's willingness to pay for improved water supply services by taking some selected households in the town. From the gathered information, the study aims at identifying the socio economic and institutional factors affecting household willingness to pay and water demand in the study areas. So the information you provide will use as necessary input for officials and policy makers to make sound decision on the existing water services and to improve the service to meet the increasing demand in the town.

Moreover, your opinion and perception will help us to understand the attitude of the residents towards drinking water quality improvement program and their involvement. The interview will take a few minutes or maximum of 15-20 minutes and the answer will be completely confidential and strictly for academic purpose only. Your name will never be associated with your answers. Dear, there are no correct or wrong answers. Thus please answer the questions honestly and as truthfully as you can. To this end, your willingness and cooperation to give honest information is valuable for the success of the research project.

Thank you very much for your time and co-operation in advance.

Circle your answer among the given choices and fill your own idea in the blank space if your choice is not available in the alternatives

Place of interview (kebele) _____

Interview code_____

Date of Interview_____

Length of Interview_____ (minutes

House number_____

SECTION II: QUESTIONS ABOUT THE WATER DEMAND AND THE PATTERN OF WATER USE IN THE TOWN

Under this section, I would like to ask you the existing situation of water service and your demand to use the services.

1. Where do your families get water from?

   A. Private tap B. Collective tap C. Springs D. River E. others, specify _____

   If private or collective tap, continue question number 2, and jump to 15 except A and B if.

2. Where is it located?

   A. Inside yard B. Outside yard

   If outside, answer question number 3 and 4, and jump to question number 9

3. How far is it from your house (round trip)?

   A. Less than 100m B. 100-200m C. More than 200m

4. Who is the owner of pipe?

   A. Mine B. My neighbor C. The municipality D. Others, Specify_____

5. Who usually collects the water from this source?

   A. Husband B. Wife C. Daughter D. Boy E. Other, specify_____

6. How much time do you spent on water collection from this source? ____ min/day or___min/week
7. How much water on average do you use per day on household activities? _____ (litres)
8. For how many year/s have you been using water from this source?_____year/s
9. How do you rank the existing water service from this source regarding its quality, quantity, and frequency per week?

9.1.Quality	A. Good	B. Average	C. Poor
9.2.Quantity	A. Sufficient	B. Average	C. Insufficient
9.3.Frequency	A. Below 3 days	B. 3-4 days	C. Above 4 days

10. Generally, are you satisfied with current water service?

A. Satisfied B. Not satisfied

10.1. What makes you say so?_____

11. During shortage, what is your families' alternative or secondary source?

A. Public tap B. Bore Holes C. Spring D. Others, Specify_____

12. How do you rank the substitute service

A. Good B. Poor

13. Do you believe that the alternative is risk free?

A. Yes B. No

14. Who do you think is mainly responsible for provision of improved water service?

A. Government B. Community C. Private D. Others, specify_____

15. If not private or collective tap for question number 1, what are the reasons of not having a tap water connection?

A. I don't want the service

B. I'm not able to pay the charges

C. Unavailability of services

D. Others, specify_____

16. Have any of your family members suffered from diseases caused by poor water quality like diarrhea, typhoid, cholera and other water borne diseases?

A. Yes B. No

17. If "YES" for question number 16, by what mechanism you treat him/her?

A. Using traditional medicine B. Visiting doctors C. Others, specify_____

18. Do you think that unprotected water has a health risk?

A. Yes B. No

If yes, answer question number 19, 20 and 21, and jump to 22 if no

19. Have you heard about water related problems, like diseases caused by contaminated water?

A. Yes B. No

20. If "YES" for question no18, what are your sources of information?

A. Radio B. Television C. Newspaper D. others, specify_____

21. If "YES" for question number 18, what should be done to reduce the risk?

A. Clean water should be provided by government

B. The user must treat (boil) the available water before using it

C. Other, specify_____

22. Do you pay for the current water services? A. Yes B. No
23. If "YES" for question number 22, how much on average are you paying per month for current water supply services? _____ Birr per month
24. How do you rate this payment for the service provided?

A. Fair and affordable B. Too cheap C. Too expensive D. It is difficult to judge

25. If "NO" for question number 22, why are you not paying?

_____

Section III. Willingness to pay questions

Hypothetical scenario

Now I am going to ask you the fundamental value you place on improved water service. That is how much the improved water service provision is worth to you in monetary term.

Now a day as you know there is a big difference between the supply and the demand for clean potable drinking water in Bonga town, the residents always raised questions regarding water supply services. There are different reasons for the shortage of water supply below its demand in the town. To balance the supply and demand for the water service, it requires the construction of additional water pumps to be operational and construction of pipelines from the boreholes or other water sources to the public and private taps in the town.

However, any improvement to the water supply system will cost money and the provider would expect to be paid for the investment it put into the system, presumably through higher monthly bills. I want you to suppose that it was possible for the improved system to provide customers a level of service with the following features; available for 24-hour service with good pressure; 7 days a week, Prompt repair and efficient customer service, Water that is safe to drink from the tap and Meters that would function accurately and be read properly

The implementation of the proposed water project starts its operation when the resident agrees to share the costs. The proposed water project provides; a good quality, quantity, healthy, available whole days of the week if it implemented. However, all household of the town, including yours, who have the probability to have use the improved service, would have to pay initial investment and Operation and Maintenance costs which will be added to your water bill (surcharge), but you may not be required to

pay initially the costs of connection to the new service, instead it will be distributed for the next 10-15 years in your monthly bills.

26. Do you understand the idea/scenario? A. Yes B. No

If NO, repeat the scenario until the respondent understand

27. Would you vote for the project to take place? A. Yes B. No

28. If "YES" for question number 27, read the following statement (*interviewer*)

Assume that the town's water service office made the improved water service available, and to access the water, the authority set a charge of EB0.20/0.30/0.40/0.50 per bucket (20 liter). Those fees will help the authority to run and maintain the sustainability of the service.

28.1. Are you willing to pay this amount?

A. Yes B. No

If YES for the statement, continue question number 29 and 30, and jump to number 31 if NO

29. What is your reason to say yes? (Allow them to answer on their own. If yes answer, then prompt with the following)

A. I really want/need the improved water service
B. The posed bid is not too high
C. I am worried about the health risks of the existing water service
D. I like the idea of having a private connection to the water supply system
E. Don't know/not sure
F. Other (please specify): _____

30. Would you willing to pay double (2x) of the above bid or cost (EB0.40/0.60/0.80/1.00) per bucket (20 liter)? A. Yes B. No

31. Would you willing to pay half (1/2) of the above bid or cost (EB0.10/0.15/0.10/0.25) per bucket? A. Yes B. No

32. If "NO" for question number 31, what is your reason to say no?

A. It is the responsibility of government
B. I don't think that I should have to pay for the good
C. The posed bid is too high; I cannot afford it (being poor)
D. I don't trust the proposed project (government)
E. I am not worried about the health risks of the existing water service
F. Don't know/not sure

G. Other, specify_____

SECTION IV. DEMOGRAPHIC AND SOCIOECONOMIC BACKGROUND OF THE RESPONDENT

33. Sex of the respondent A. Male B. Female

34. How old are you?_____years old

35. What is your marital status? A. Married B. Unmarried C. Divorced D. Widowed

36. Who is the head of the family? A. Father B. Mother C. other, specify____

37. How many are you in the family including yourself? _____persons.

37.1. is there children under five in your family? If yes, how many____

38. How many year you spent in school?_____year/s

38.1. Show the level you attained. A. Never Attended B. Primary (1-8)

C. Secondary (9-12) D. College and above

39. What is your employment status

A. Employed B. Unemployed

If employed continue to question number 39 and 40, and jump to 41.

40. If 'employed', what is your occupation?

A. Employed for salary B. Private business (private organization) C. Self-employee

D. other, specify_____

41. If 'employed', where do you currently employed?

A. Formally employed professional (teacher, government worker, administration, health worker, clerical)

B. Informally employed skilled laborer (tailor, wood work, metal work, business, etc)

42. If "unemployed", specify the reason to be unemployed_____

A. Unavailability of job C. Unwillingness to be employed

B. Low salary D. Other, specify_____

43. How much is your monthly income (of the household head)?

A. Below 500Birr B. Between 501-1000 C. Between 1001-3000 D. 3001-5000 E. Above 500

44. What is your source of income? A. Salary B. Pension grant C. Business D. labor force

C. other, specify_____

45. Is there anyone who has his/her own income in your family? If yes, how much?_____

45.1. Average monthly income of spouse_____

45.2. Average monthly income of boy and/daughter_____

46. How much (in Birr) is the total monthly income is from employment/own business/gifts and any other source in the Household? _____birr

47. What is your estimated expenditure per month in the following items or on different goods and services, like food, school fees, clothing, electricity and others?

A. Below 500Birr B. Between 501-1000 C. Between 1001-3000 D. Above 3001

48. How do you rank or order your expenditure for water service in comparison to other expenditures?

A. Higher B. Reasonable C. Lower

49. How many year you lived in this town? ___years.

Appendix II: Linear regression for Diagnostic test

```
. reg WTP AGE SEX MS NHH EDU ES INC RESID SATS DEX SUBS BID1
```

Source	SS	df	MS	Number of obs	=	306
				F(12, 293)	=	56.46
Model	42.225064	12	3.51875533	Prob > F	=	0.0000
Residual	18.2618641	293	.062327181	R-squared	=	0.6981
				Adj R-squared	=	0.6857
Total	60.4869281	305	.198317797	Root MSE	=	.24965

WTP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
AGE	-.0030493	.0021784	-1.40	0.163	-.0073367	.001238
SEX	-.0420291	.0380712	-1.10	0.271	-.1169568	.0328985
MS	-.0209737	.019808	-1.06	0.291	-.0599576	.0180102
NHH	-.0299071	.0128296	-2.33	0.020	-.055157	-.0046571
EDU	-.0087386	.0204495	-0.43	0.669	-.0489851	.0315079
ES	.1951504	.0453286	4.31	0.000	.1059395	.2843614
INC	.0000578	9.76e-06	5.92	0.000	.0000386	.000077
RESID	.0020879	.0013286	1.57	0.117	-.0005269	.0047027
SATS	.5375247	.0521453	10.31	0.000	.4348978	.6401515
DEX	.0020698	.0373604	0.06	0.956	-.0714589	.0755986
SUBS	.2581397	.0402823	6.41	0.000	.1788604	.3374189
BID1	-.6557552	.1349097	-4.86	0.000	-.9212701	-.3902404
_cons	.2224063	.1164353	1.91	0.057	-.0067493	.4515618

A. Contingency coefficient for discrete variables

```
. corr SEX MS EDU ES SATS DEX SUBS BID1
(obs=306)
```

	SEX	MS	EDU	ES	SATS	DEX	SUBS
SEX	1.0000						
MS	0.4185	1.0000					
EDU	-0.2767	-0.1988	1.0000				
ES	-0.3061	-0.2472	0.2877	1.0000			
SATS	-0.2115	-0.2970	0.2278	0.4959	1.0000		
DEX	-0.1855	-0.1947	-0.0971	0.2627	0.4367	1.0000	
SUBS	-0.0458	-0.2177	-0.0517	0.0832	0.1435	0.2175	1.0000
BID1	-0.0541	0.1004	-0.0900	-0.1251	-0.2613	-0.1036	-0.1073

	BID1
BID1	1.0000

B. Heteroskedasticity test

```
. hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of WTP

         chi2(1)      =    25.83
         Prob > chi2  =   0.0000
```

C. VIF Stata output for Explanatory Variables used in analysis

```
. vif
```

Variable	VIF	1/VIF
AGE	3.22	0.310686
NHH	3.17	0.315308
RESID	1.88	0.532261
SATS	1.80	0.556980
MS	1.66	0.600648
INC	1.62	0.616990
ES	1.61	0.621095
EDU	1.54	0.650965
SEX	1.51	0.660302
DEX	1.51	0.663298
SUBS	1.26	0.796315
BID1	1.12	0.895772
Mean VIF	1.82	

D. Stata results for Ramsey Specification Test for LPM

```
. ovtest

Ramsey RESET test using powers of the fitted values of WTP
       Ho:  model has no omitted variables
                 F(3, 290) =     44.23
                  Prob > F =      0.0000
```

Appendix III: Logistic regression

```
Logistic regression                               Number of obs     =        306
                                                  LR chi2(16)       =     315.11
                                                  Prob > chi2       =     0.0000
Log likelihood = -21.297645                       Pseudo R2         =     0.8809
```

WTP	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
AGE	-.3879252	.1447625	-2.68	0.007	-.6716545	-.1041958
SEX	-1.093139	1.388157	-0.79	0.431	-3.813876	1.627598
MS						
Unmarried	-3.581452	2.252243	-1.59	0.112	-7.995767	.8328635
Divorced	-.3856466	2.107026	-0.18	0.855	-4.515341	3.744048
Widowed	8.022822	3.981149	2.02	0.044	.2199121	15.82573
NHH	-.60242	.4966822	-1.21	0.225	-1.575899	.3710592
EDU						
Primary (1-8)	-5.512507	2.795913	-1.97	0.049	-10.9924	-.0326182
Secondary (9-12)	-6.58224	2.983933	-2.21	0.027	-12.43064	-.7338398
College and above	-2.631646	2.600563	-1.01	0.312	-7.728657	2.465364
ES	3.887435	1.328193	2.93	0.003	1.284226	6.490645
INC	.0043537	.0012593	3.46	0.001	.0018855	.006822
RESID	.1316262	.0652266	2.02	0.044	.0037844	.2594679
DEX	1.941206	1.371483	1.42	0.157	-.7468511	4.629262
SATS	12.00041	3.303169	3.63	0.000	5.526321	18.47451
SUBS	10.87675	3.35321	3.24	0.001	4.304578	17.44892
BID1	-27.5859	8.441163	-3.27	0.001	-44.13028	-11.04153
_cons	.5677754	4.177199	0.14	0.892	-7.619384	8.754935

APPENDIX IV: Marginal effect

```
. margins, dydx(*)

Average marginal effects                        Number of obs     =        306
Model VCE    : OIM

Expression   : Pr(WTP), predict()
dy/dx w.r.t. : AGE SEX 1.MS 2.MS 3.MS NHH 1.EDU 2.EDU 3.EDU ES INC RESID SATS DEX SUBS BID1
```

	dy/dx	Delta-method Std. Err.	z	P>|z|	[95% Conf.	Interval]
AGE	-.0080707	.0025833	-3.12	0.002	-.0131339	-.0030076
SEX	-.0227426	.0286392	-0.79	0.427	-.0788744	.0333891
MS						
Unmarried	-.0871881	.0520934	-1.67	0.094	-.1892893	.0149131
Divorced	-.0075459	.042553	-0.18	0.859	-.0909483	.0758564
Widowed	.0999349	.0235232	4.25	0.000	.0538302	.1460396
NHH	-.0125333	.009976	-1.26	0.209	-.0320858	.0070193
EDU						
Primary	-.0781559	.0329713	-2.37	0.018	-.1427784	-.0135333
Secondary	-.0990604	.0369557	-2.68	0.007	-.1714922	-.0266286
College & above	-.0375919	.036964	-1.02	0.309	-.11004	.0348562
ES	.0808777	.0218655	3.70	0.000	.0380222	.1237332
INC	.0000906	.0000195	4.64	0.000	.0000523	.0001289
RESID	.0027385	.0012637	2.17	0.030	.0002616	.0052153
SATS	.2496674	.049164	5.08	0.000	.1533077	.3460271
DEX	.0403866	.0274146	1.47	0.141	-.013345	.0941182
SUBS	.2262897	.054834	4.13	0.000	.118817	.3337623
BID1	-.5739219	.1361393	-4.22	0.000	-.84075	-.3070938

Note: dy/dx for factor levels is the discrete change from the base level.

Appendix V: Regression for validity test

Logistic regression — Number of obs = 306
LR chi2(9) = 187.73
Prob > chi2 = 0.0000
Log likelihood = -84.989557 — Pseudo R2 = 0.5248

WTP	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
EDU						
Primary (1-8)	-.4187385	.7153479	-0.59	0.558	-1.820795	.9833176
Secondary (9-12)	1.398764	.7616048	1.84	0.066	-.0939538	2.891482
College and above	1.276679	.8772236	1.46	0.146	-.4426476	2.996006
INC	.0011125	.0002157	5.16	0.000	.0006898	.0015352
DEX	2.15082	.4696391	4.58	0.000	1.230344	3.071296
SUBS	2.974274	.5587589	5.32	0.000	1.879127	4.069421
BID1	-11.17031	2.194756	-5.09	0.000	-15.47195	-6.868671
PAY	-.0197032	.0108558	-1.81	0.070	-.0409801	.0015737
CONSU	.0188384	.0139415	1.35	0.177	-.0084863	.0461632
_cons	-2.401577	1.274547	-1.88	0.060	-4.899644	.0964886

APPENDIX VI: Mean WTP Estimation from Double Bounded Dichotomous Choice Model

```
. doubleb BID1 BID2 answer1 answer2

initial:       log likelihood =     -<inf>  (could not be evaluated)
feasible:      log likelihood = -398.26793
rescale:       log likelihood = -398.26793
rescale eq:    log likelihood = -387.01778
Iteration 0:   log likelihood = -387.01778
Iteration 1:   log likelihood = -356.45064
Iteration 2:   log likelihood = -353.02906
Iteration 3:   log likelihood = -353.02563
Iteration 4:   log likelihood = -353.02563

                                                Number of obs     =         306
                                                Wald chi2(0)      =           .
Log likelihood = -353.02563                     Prob > chi2       =           .
```

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Beta						
_cons	.6443241	.0224022	28.76	0.000	.6004165	.6882317
Sigma						
_cons	.3184091	.0196187	16.23	0.000	.2799572	.3568609

```
First-Bid Variable:              BID1
Second-Bid Variable:             BID2
First-Response Dummy Variable:   answer1
Second-Response Dummy Variable: answer2
```

Estimation of Mean Willingness to Pay Including More Explanatory Variables from DBDC Model

```
. doubleb BID1 BID2 answer1 answer2 AGE SEX INC

initial:       log likelihood =     -<inf>  (could not be evaluated)
feasible:      log likelihood = -398.26793
rescale:       log likelihood = -398.26793
rescale eq:    log likelihood = -387.01778
Iteration 0:   log likelihood = -387.01778
Iteration 1:   log likelihood =  -332.0942
Iteration 2:   log likelihood = -308.80916
Iteration 3:   log likelihood = -308.66826
Iteration 4:   log likelihood = -308.66791
Iteration 5:   log likelihood = -308.66791

                                                Number of obs     =         306
                                                Wald chi2(3)      =       92.03
Log likelihood = -308.66791                     Prob > chi2       =      0.0000
```

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Beta						
AGE	-.0072623	.0015066	-4.82	0.000	-.0102152	-.0043093
SEX	-.1156806	.0429185	-2.70	0.007	-.1997994	-.0315619
INC	.0000839	.0000128	6.53	0.000	.0000588	.0001091
_cons	.7121567	.0760475	9.36	0.000	.5631063	.8612071
Sigma						
_cons	.2602117	.0160498	16.21	0.000	.2287547	.2916686

```
First-Bid Variable:              BID1
Second-Bid Variable:             BID2
First-Response Dummy Variable:   answer1
Second-Response Dummy Variable: answer2
```

Estimated Mean Willingness to Pay With Including More Explanatory Variables from DBDC Model

```
. nlcom (WTP:(_b[_cons]+AGE_m*_b[AGE]+SEX_m*_b[SEX]+INC_m*_b[INC]))

         WTP:  (_b[_cons]+AGE_m*_b[AGE]+SEX_m*_b[SEX]+INC_m*_b[INC])
```

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
WTP	.6471512	.0193673	33.41	0.000	.6091919	.6851105

Estimated Mean Willingness to Pay for Different Level of Predictors

Estimated mean WTP for different age group

```
. nlcom (WTP:(_b[_cons]+2*AGE_m*_b[AGE]+SEX_m*_b[SEX]+INC_m*_b[INC]))

         WTP:  (_b[_cons]+2*AGE_m*_b[AGE]+SEX_m*_b[SEX]+INC_m*_b[INC])
```

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
WTP	.3553311	.061337	5.79	0.000	.2351128	.4755494

Estimated mean WTP for different income class

```
. nlcom (WTP:(_b[_cons]+AGE_m*_b[AGE]+SEX_m*_b[SEX]+3*INC_m*_b[INC]))

         WTP:  (_b[_cons]+AGE_m*_b[AGE]+SEX_m*_b[SEX]+3*INC_m*_b[INC])
```

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
WTP	1.171852	.0869704	13.47	0.000	1.001393	1.342311

Estimated mean WTP for different sex category

```
. nlcom (WTP:(_b[_cons]+AGE_m*_b[AGE]+0*SEX_m*_b[SEX]+INC_m*_b[INC]))

         WTP:  (_b[_cons]+AGE_m*_b[AGE]+0*SEX_m*_b[SEX]+INC_m*_b[INC])
```

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
WTP	.6826871	.023123	29.52	0.000	.6373669	.7280073

Appendix VII: Picture showing the currently existing water service of the town

Appendix VIII: Estimation of Mean WTP from Single Bound Dichotomous Choice Model, for comparison

```
. probit answer1 BID1

Iteration 0:   log likelihood = -178.85397
Iteration 1:   log likelihood = -158.89461
Iteration 2:   log likelihood = -158.72884
Iteration 3:   log likelihood = -158.72884

Probit regression                                 Number of obs     =        306
                                                  LR chi2(1)        =      40.25
                                                  Prob > chi2       =     0.0000
Log likelihood = -158.72884                       Pseudo R2         =     0.1125
```

answer1	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
BID1	-4.648647	.7675656	-6.06	0.000	-6.153048	-3.144246
_cons	2.306316	.2991039	7.71	0.000	1.720083	2.892549

Estimating Mean Willingness to Pay Including More Explanatory Variable from SBDC Model

```
. probit answer1 BID1 AGE SEX

Iteration 0:   log likelihood = -178.85397
Iteration 1:   log likelihood =  -132.0244
Iteration 2:   log likelihood = -130.94571
Iteration 3:   log likelihood = -130.94462
Iteration 4:   log likelihood = -130.94462

Probit regression                                 Number of obs     =        306
                                                  LR chi2(3)        =      95.82
                                                  Prob > chi2       =     0.0000
Log likelihood = -130.94462                       Pseudo R2         =     0.2679
```

answer1	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
BID1	-5.382978	.886391	-6.07	0.000	-7.120273	-3.645684
AGE	-.040764	.007629	-5.34	0.000	-.0557166	-.0258115
SEX	-1.190455	.2031855	-5.86	0.000	-1.588691	-.7922188
_cons	4.713138	.532774	8.85	0.000	3.66892	5.757355

Estimated Mean Willingness to pay with including More Explanatory variables from SBDC Model

```
.  nlcom (WTP:- (_b[_cons]+AGE_m*_b[AGE]+SEX_m*_b[SEX])/_b[BID1])

         WTP:  - (_b[_cons]+AGE_m*_b[AGE]+SEX_m*_b[SEX])/_b[BID1]
```

answer1	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
WTP	.5033313	.0257909	19.52	0.000	.452782	.5538806