

A Contingent Valuation Approach to Household's Willingness to Pay for Improved Piped Water Access in North Wollo Zone, Ethiopia

Tadele Bayu Genet¹, and Sisay Genanu Mulaw²

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Abstract

This study explores the demographic, economic, and infrastructure-related factors influencing households' willingness to pay (WTP) for improved piped water services in the North Wollo Zone, Ethiopia. Both descriptive statistics and econometric models, using the double bounded contingent valuation method (CVM), were applied to assess variations in water access across four woredas: Gidan, Meket, Bugna, and Lasta. The descriptive results show spatial variations in factors such as gender and education across the study areas. In particular, Gidan experiences severe water shortages, combined with low literacy levels and a predominance of male-headed households, creating challenges for inclusive water governance. Econometric analysis further indicates that higher bid prices reduce WTP, reflecting households' budget constraints. At the same time, factors such as large family size, monthly water expenditure, and the age of the household head positively influence WTP. The findings also suggest that even relatively wealthier households face competing financial priorities. The sex of the household head appears to be a significant determinant for WTP, with male-headed households showing a greater willingness to pay for improved services. Overall, the study shows the need for addressing educational disparities and promoting gender inclusivity to strengthen community engagement in water management. It also underscores the need for targeted interventions for larger households and those with lower expenditure, as these groups face unique financial constraints despite their expressed willingness to pay. Finally, investments in sustainable water infrastructure and community engagement are critical, but pricing strategies must ensure both affordability and widespread participation. These insights provide valuable guidance for designing effective, locally tailored water management strategies in the zone.

Keywords: Willingness to pay, Water, SDGs, North Wollo, Access to water.

JEL Classification: G5, G50.

¹ Bahir Dar University

² Woldia University

1. Introduction

Clean and safe water is essential for the survival of humans, animals, and plants. Without adequate access, life cannot be sustained, production activities are hindered, and health outcomes deteriorate. Globally, water-related problems remain a major challenge, contributing to both health and developmental issues. Diarrheal diseases, predominantly caused by unsafe water, inadequate sanitation, and poor hygiene, rank among the leading global health burdens (Kimani, 2013; Liu et al., 2024; Nwokoro et al., 2020).

Beyond health effects, inadequate water access has substantial socio-economic implications. In many contexts, women and children are disproportionately affected, often spending long hours and expending considerable effort fetching water from distant sources (Azevedo et al., 2023). This reduces their capacity to engage in income-generating activities or attend school (Sani & Scholz, 2022). Reliable access to safe water has been shown to improve school attendance, especially for girls (Rhue et al., 2023). When water is readily available, children are freed from water collection duties and can dedicate more time to their studies (Grimmett, 2021).

From an anthropological perspective, water security is understood not merely as a physical or environmental issue but also as a sociopolitical process shaped by unequal access and governance structures. Water insecurity has far-reaching effects on communities, particularly in low-income and marginalized regions, where it exacerbates food insecurity, mental health problems, and social inequalities (Jacob et al., 2024; Rosinger, 2023). In the Oxford Research Encyclopedia of Anthropology, Wutich et al. (2022) outline four important concepts to understand water scarcity. These are political ecology, water economics, human-water relations, and water insecurity. These frameworks show how the lack of access to clean, reliable water sources goes beyond immediate survival needs; it also affects community well-being, economic stability, and social cohesion. Thus, improving water security is vital not only for public health but also for addressing broader socio-economic and mental health challenges that communities face.

Although water has critical importance for public health and overall well-being, substantial gaps remain in research and interventions that are geared to address these issues, particularly in low-income regions. As of December 2022, about 2 billion people still lacked access to basic sanitation services, leaving many exposed to preventable diseases (WHO & UNICEF, 2021). Research shows that better access to water and sanitation could prevent up to 297,000 child deaths annually (UNICEF,

2021, cited in Asgedom et al., 2023), highlighting the urgent need for targeted action. Furthermore, Prüss-Ustün et al. (2019) found that poor water, sanitation, and hygiene contribute to a significant proportion of the global disease burden. However, the broader social and economic benefits of improved water and sanitation access, such as increased productivity and gender equality, remain underexplored. Hutton (2016) indicates that more focused research in these areas is necessary to fully understand and address the far-reaching impacts of water insecurity on communities.

The introduction of the Sustainable Development Goals (SDGs) in 2015 aimed to improve access to clean water, but progress has been uneven. By 2017, 844 million people globally still lacked basic drinking water services, with 263 million people spending more than 30 minutes per trip to collect water from an improved source and 159 million people relying on surface water sources (WHO & UNICEF, 2017). The majority of these vulnerable populations, approximately 58%, live in Sub-Saharan Africa, indicating the stark regional disparities in water access. At current rates of improvement, over one-third of countries will not meet the 2030 target for universal access to safe drinking water (WHO, 2017). These statistics highlight the critical need for effective water management policies and infrastructure in resource-constrained regions like Ethiopia.

Ethiopia, despite being endowed with abundant water resources, faces a severe water security crisis largely driven by weak institutional capacity, limited infrastructure, extreme hydrological variability, and a vulnerable economy (Moges & Gebregiorgis, 2013). This implies that it is primarily due to poor management rather than a shortage of supply. Despite having 12 major river basins (Lemma et al., 2022) and considerable groundwater potential (Kassahun & Mohamed, 2018), only a small share of the population has access to safely managed drinking water. Limited infrastructure and insufficient government attention further exacerbate the situation, leaving many communities dependent on unsafe sources (Teshome et al., 2021). The country's water systems are also highly vulnerable to climate variability, with recurring droughts significantly reducing freshwater availability (Moges & Gebregiorgis, 2013). Despite the groundwater potential being estimated between 2.5 and 47 billion cubic meters, it remains underutilized due to gaps in research on rechargeable rates and pollution, which hinders effective management (Mengistu et al., 2021). The coexistence of vast water resources with low access levels illustrates a paradox of abundance amid deprivation, particularly visible in regions like the Amhara National Regional State, where potable water coverage is as low as 30% (Ministry of Water Resource, 2007, cited in Kibret & Tulu, 2014). Addressing this

paradox requires stronger governance frameworks to ensure sustainable water resource management and mitigate conflict risks (Wouters, 2010).

Among the key barriers to Ethiopia's effective utilization of its water resources is the absence of comprehensive cost-benefit analyses in water service management. Establishing a well-structured water pricing system, one that balances the need for infrastructure investment with household affordability, is essential. According to the Ministry of Water and Energy (MoWE, 2013), tariffs should at least cover operational costs while also generating revenue for future expansion. Effective water tariff design requires attention to both supply and demand-side considerations (Liu et al., 2024; Nouicer et al., 2023). On the supply side, utilities must account for the costs of sourcing, treating, and distributing water, as well as maintaining infrastructure. Enhancing production efficiency and upgrading distribution systems can reduce unit costs, thereby improving affordability. On the demand side, however, tariff structures that neglect consumers' willingness and ability to pay can lead to public dissatisfaction and undermine water management efforts.

Households' income and expenditure surveys provide valuable insights into the socioeconomic determinants of water access by examining consumers' willingness to pay for improved water services (Aminu Beshir et al., 2024). The contingent valuation method (CVM), a commonly applied approach, helps guide the design of fair and sustainable pricing strategies that capture the actual value households assign to water (Baymuminova et al., 2023).

Although evidence-based water pricing policies are urgently needed to support government-led infrastructure interventions, limited research has examined household-level socioeconomic drivers of water access and willingness to pay (WTP) in Ethiopia's drought-prone areas like North Wollo. Existing studies, including Getinet et al. (2024), Hundie, and Abdisa (2016), have applied the contingent valuation method (CVM) to assess WTP for improved water services, but their focus has largely been on urban or less drought-affected regions, making them less relevant to the specific realities of North Wollo. Unlike the Central Rift Valley, North Wollo faces compounded challenges such as drought and conflict, which intensify water scarcity. Moreover, Hundie and Abdisa's (2016) emphasis on urban households reduces the applicability of their findings to rural North Wollo, where drought impacts and infrastructure gaps are far more severe.

This study seeks to bridge that gap by investigating how household characteristics, including income, education, marital status, and access to infrastructure, shape WTP

for improved piped water services in North Wollo. By employing CVM, it generates practical evidence to guide policymakers in designing fair water tariffs that both enhance access and support sustainable infrastructure investment. Given North Wollo's heightened vulnerability to water scarcity under current drought conditions, this research is both timely and critical for Ethiopia's water management and advancing Sustainable Development Goal 6 (clean water and sanitation). Moreover, it explores households' perceived satisfaction with the current water supply services, offering crucial insights for shaping effective pricing frameworks and improving water access in the region.

2. Literature Review

2.1. Theoretical Framework

Access to water is universally recognized as a fundamental human need (United Nations Children's Fund & World Health Organization, 2024) yet achieving a reliable and high-quality water supply remains a challenge, particularly in developing countries (Onu et al., 2023). Particularly in Sub-Saharan Africa, infrastructure and governance challenges often lead to water scarcity despite the abundance of natural resources (George-Williams et al., 2024; Nyika & Dinka, 2023). In 2017, the World Health Organization and UNICEF reported that 844 million people globally lacked even basic drinking water services, with a disproportionate number of these individuals residing in Sub-Saharan Africa (WHO & UNICEF, 2017). Ethiopia, despite being endowed with significant water resources, suffers from low access rates, especially in rural and peri-urban areas such as North Wollo Zone.

2.2. Water Access and Socioeconomic Determinants

Numerous studies have explored the role of socioeconomic factors such as income, education, and household composition in shaping access to water. Tarfasa and Brouwer (2013) examined the role of income in households' willingness to pay for improved water services in urban Ethiopia, concluding that higher-income households were more likely to pay for enhanced water services. Similarly, Wendimu and Bekele (2011) found that education levels were positively correlated with the likelihood of households opting for better quality water sources in Ethiopia. These studies emphasize the importance of considering how socioeconomic disparities influence access to water services, especially in rural settings where infrastructure development is often inadequate. In rural areas, studies such as those

by Wendimu and Bekele (2011) and Fentaw (2013) in Oromia and Tigray regions, respectively, demonstrated that households were willing to pay more than the prevailing tariff rates for reliable water access. Similarly, Getinet et al. (2024) found estimates for WTP (1.80 ETB per 20 liters) in the Central Rift Valley, identifying positive determinants (sex, income, fetching time, water treatment) and negative ones (household size, water quality perceptions). In addition, Hundie and Abdisa (2016) obtained an estimated WTP of 94 cents per 20 liters in Jiggiga Town and identified key determinants such as income, family size, water source, age, and bid value. It underscores the importance of socioeconomic factors in urban water pricing. These findings suggest that there is potential for improving cost recovery in the water sector through appropriate pricing strategies that reflect consumer preferences and WTP, whose findings could be a guide to check in other areas like North Wollo in our case.

2.3. Policy and Institutional Factors

Policy frameworks and institutional capacities play a critical role in shaping water access. Ethiopia's water sector is still in its developmental stage, hindered by a variety of factors that include poor cost recovery, institutional inefficiencies, and a lack of infrastructure (Kidanewold et al., 2014). Studies such as that of Anteneh et al. (2019) in Central Ethiopia have highlighted the need for more robust governance structures to ensure efficient water service delivery. The water tariff system in Ethiopia, as noted by MoWE (2013), is designed to cover operational costs, but its current structure may not be sufficient to promote long-term investments in water infrastructure. This underscores the need for further research into demand-side solutions, such as determining household WTP for water services to inform policy decisions on pricing and investment.

Table 1: Summaries of Related Literature Review

Author/s (Year)	Country Studied	Method	Main findings and recommendations
Nisa and Yaseen (2020)	Pakistan	Descriptive analysis, chi-square test, ordinary least squares method	Household head's income, age, and water quality significantly affect willingness to pay (WTP). Household income and water consumption positively affect WTP. They recommended targeted subsidy for low income households.
Mehmood and Arshad (2024)	Pakistan	Logit Regression Model, Ordered Logit Model	Unimproved water source is a significant determinant of childhood diarrhoea and household WTP for safe drinking water. About 24 % of households reported at least one child with diarrhoea in the past month while 80% of households use unimproved water sources and about 73% of households are willing to pay an average of \$2.32 per month for safe drinking water. The paper's recommendations include increasing awareness about water contamination and promoting hygienic practices.
Ahsan et al. (2021)	Bangladesh	Discrete Choice Experiment	Households in Khulna City Corporation (KCC) area are willing to pay BDT 243.6 (≈US\$ 2.87) per month for improved water supply. In the study, key improvements desired include water quality, regularity of supply, water pressure, and filtering. The recommendations of the paper includes investment in improving the water supply system is economically sustainable and a 'no-regret' decision.
Wendimu and Bekele (2011)	Ethiopia	Contingent Valuation Method (CVM), Tobit Model	Factors' such household income, education level, reliability on existing water supply, perception about water quality, family size, and age significantly affect willingness to pay (WTP). The mean WTP for quality water supply is \$0.025 per 20 L container, higher than the current tariff of \$0.005 per 20 L container. The study also found that demand for safe drinking water is high in the study area.
Entele and Lee (2020)	Ethiopia	Ordinary Least Squares (OLS) Method	From this study, the estimated willingness to pay (WTP) for 2 m ³ of fluoride-safe water connected at home is USD 13.70 per month. WTP for the same amount of water at the nearest public tap is USD 6.84 per month. Significant determinants of WTP include household income, education level, and awareness of fluoride contamination.

Eridadi et al. (2021)	Ethiopia	Contingent Valuation Method (CVM)	Like the previous studies, significant determinants of households WTP include income, education level, and current water supply reliability. The study also found that households in Sebeta town are willing to pay for improved water supply services. It suggested that the community would financially support water supply service improvement.
Odworu (2020)	Kenya	Chi-square test	The study indicated that the average WTP is Ksh. 500 (≈US\$ 5) per month. About 78% of households are willing to pay for improved water supply services. Age, gender, education, income, household history of water-related illnesses, sanitation facility, monthly water tariffs, water connection charges, time spent fetching water, walking distances to water source, perceived water quality, adequacy of supply, water source reliability, and attitudes towards water management are among the significant determinants of WTP in study area.
Turpie and Letley (2023)	South Africa	Contingent Valuation Method (CVM), Choice Experiment	The study found that for a secure and environmentally sustainable water supply residents are willing to pay more. Moreover, the key factors influencing willingness to pay include income, education, and environmental awareness.
Nouri-Khajebelagh et al. (2023)	Iran	Two-stage Heckman approach	In this study, education, age, water health concern, income, household cost, household size, and water quality satisfaction significantly influence willingness to pay extra (WTP). Water bill concerns and health concerns about water and children negatively affect WTP. Government can increase public participation by informing people about water value and improving water quality.
Aminu Beshir et al. (2024)	Ethiopia	Contingent valuation (CV) technique using field surveys, key informant interviews (KII), and household (HH) interviews with 435 respondents.	The study found that a substantial number (92%) of households were willing to pay an additional \$7.26 USD above their average monthly water cost of \$3.58 USD to improve water delivery services. Factors influencing WTP include gender, age, marital status, education level, monthly income, water quantity, quality, availability, and affordability. 39.77% and 26.21% of residents were dissatisfied with the quality and quantity of available water supply, respectively.

Source: Authors' compilation (2024)

2.4. Gaps in Literature

Despite the growing body of research on water access in Ethiopia, there are significant gaps in understanding the specific socioeconomic determinants of water access in rural and peri-urban regions like North Wollo Zone. Many studies have focused on urban areas or broader regional trends, leaving a lack of empirical data on rural household preferences and behaviors regarding water access and households' WTP. Additionally, while much attention has been given to infrastructural challenges, there is insufficient exploration of how alternative water sources are utilized and prioritized by households in times of shortage.

Furthermore, studies using single-bound CVM models can sometimes result in starting-point bias, where the initial bid influences the respondents' WTP estimates. Yet, in double-bounded models, an attempt is made to mitigate this issue of strategic bias (Flachaire & Hollard, 2006), where respondents may answer in a way they believe will influence future policy or service delivery based on consecutive questions.

Lastly, while existing studies provide valuable insights into the determinants of WTP, they often overlook the intersectional factors such as gender, income disparities, and household size that could affect WTP estimates. Studies like those of Bitew et al. (2020) and Eridadi et al. (2021) do not sufficiently address how marginalized groups, such as women-headed households or low-income families, might experience water shortages differently and have varying capacities to pay for improved services.

While Hundie and Abdisa (2016) studied WTP in urban Jijjiga and Getinet et al. (2024) focused on the Central Rift Valley, our study extends CVM to North Wollo, examining socioeconomic determinants such as income, education, infrastructure access, and the like in a context of intensified environmental and conflict-related constraints. Given the gaps identified in existing research, particularly the lack of focus on rural and peri-urban contexts in Ethiopia, this study aims to fill the existing gap by exploring the socioeconomic factors influencing household WTP for improved water services in North Wollo Zone, Amhara region. Moreover, the study also considered perceived household beliefs about the causes of water shortage and the level of satisfaction with the current system. In doing so, the research contained a comprehensive analysis of both demand-side preferences and the infrastructural challenges faced by households in the study area. The findings are expected to offer actionable insights for policymakers on how to design equitable and efficient water

tariffs that reflect local preferences and economic realities, contributing to the broader discourse on sustainable water management in the region.

3. Materials and Methods

3.1. Description of the Study Area

The study was conducted in North Wollo Zone, part of Ethiopia's Amhara National Regional State (ANRS). The zone's economy is predominantly based on agriculture, complemented by trade as a key livelihood activity for many households. North Wollo also possesses rich, yet underutilized, historical and cultural sites, offering considerable potential for tourism development. Based on the 2007 census by the Central Statistical Agency (CSA), the population exceeded 1.5 million, while the 2023 CSA projection places it at 1,989,563, comprising 997,098 males and 992,465 females (CSA, 2023). Despite these economic opportunities, North Wollo continues to struggle with severe water supply challenges, making it a suitable context for investigating household willingness to pay (WTP) for improved water services.

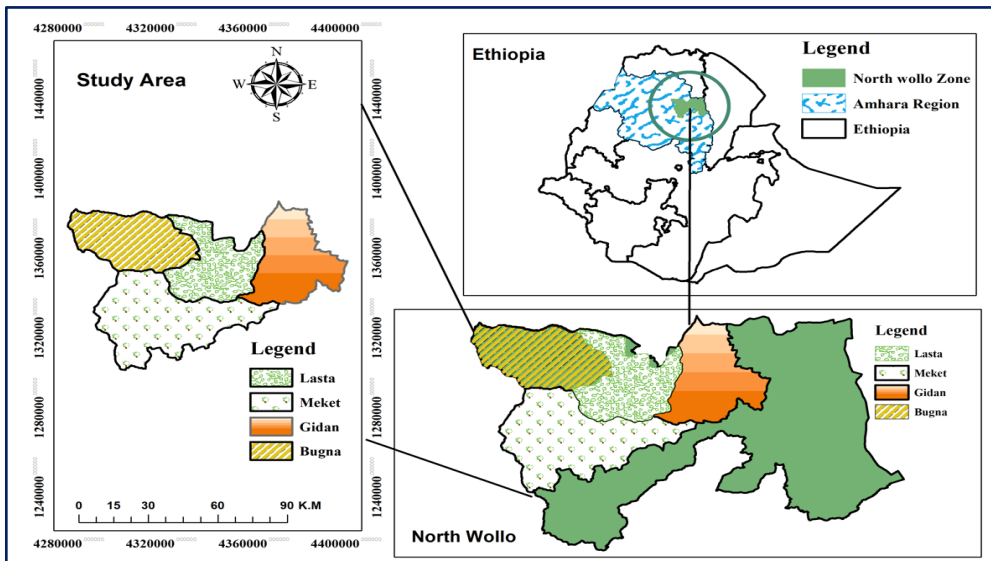


Figure 1: Map of the Study Area

3.2. Target Population, Sample Size, and Sampling Techniques

This study employed a two-stage stratified sampling technique to ensure representative coverage of households in the North Wollo Zone, Amhara National Regional State, Ethiopia. In the first stage, four Woredas—Gidan, Lasta, Bugna, and

Meket—were randomly selected from the total Woredas in North Wollo using Stata's Mersenne Twister algorithm. We determined the number of Woredas to be four purposively, primarily due to limited resources to cover all Woredas in the Zone. These four Woredas were considered sufficient to represent the demographic diversity and water supply challenges, as most Woredas in the Zone are known for recurrent droughts, poor infrastructure, and limited access to improved water. In the second stage, households were sampled using a stratified proportional sampling method, with the sample size allocated to each Woreda based on its total population to reflect the demographic weight of each stratum. This allocation ensures that larger Woredas, like Meket, contribute more to the sample, reflecting their demographic significance. Moreover, the proportional allocation was chosen to ensure representativeness across the diverse demographic and socioeconomic profiles of the Woredas, which vary in population size and water access challenges. In our case, while water access varies across Woredas—for example, Gidan faces severe shortages due to drought, while Lasta has some functional water points—the proportional approach captures these variations by including sufficient households from each Woreda to reflect local conditions. Moreover, to address potential heterogeneity in water access, data were collected on household-level factors like water availability for the household, distance to water points, infrastructure access, and analyzed using stratified methods like Woreda-specific tabulations to account for variations in water supply reliability.

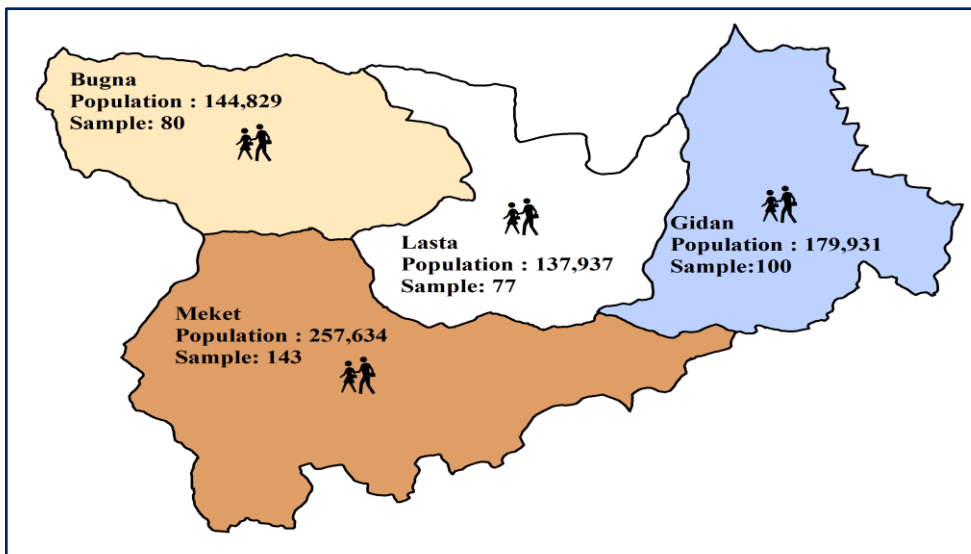


Figure 2: Map of Total Population and Sample Size by Word

In the second stage, a proportional sampling method was applied to determine the number of respondents from each Woreda (see Figure 2). The sample size calculation is based on Yamane's (1967) formula, which is commonly used to determine an optimal sample size for large populations. The estimated sample size for the study is 400 households, with a margin of error $\pm 5\%$.

$$n = \frac{N}{1 + N(e)^2}$$

Where:

n = Sample size

N = Total Population

e = Margin of error

$$= \frac{720,331}{1 + (720,331)(0.05)^2} \approx 400$$

3.3. Data Collection Instruments

For this study, quantitative data were collected using a structured questionnaire. The questionnaire was designed to capture relevant information regarding household demographics, socio-economic conditions, and their willingness to pay (WTP) for improved water services. It incorporated a series of close-ended and Likert-scale questions aimed at assessing respondents' attitudes, preferences, and socio-economic characteristics that influence their WTP. Prior to administering the survey, the questionnaire was pre-tested with a small sample of 20 households to ensure clarity, reliability, and relevance. Necessary adjustments were made based on the feedback from this pre-test. The final version was then distributed to 400 randomly selected households across the four Woredas, ensuring a representative sample of the population.

3.4. Method of Data Analysis

3.4.1. Contingent Valuation Method (CVM) Framework

The contingent valuation method is widely used to estimate individuals' WTP for non-marketed goods, such as improved water services. As noted by Lopez-Feldman (2012), CVM relies on a hypothetical scenario presented to respondents, where they are asked to express their WTP for a proposed good or service. The responses are contingent on the specific scenario, hence the name "contingent valuation" (Portney,

1994). This flexible method is well-suited for estimating the value of public goods or services that have not yet been implemented.

Both single-bounded and double-bounded dichotomous choice models were employed to elicit households' willingness to pay (WTP) for improved piped water services. These models are particularly effective in generating robust WTP estimates by presenting respondents with hypothetical scenarios involving enhanced water services. The single-bounded probit model was employed as a baseline due to its simplicity and robustness in capturing initial household preferences, while the double-bounded probit model was used to enhance precision by incorporating follow-up bids, providing additional information to refine WTP estimates.

The improvements proposed include better water quality, increased quantity, and more convenient payment methods. Specifically, the scenario described how the water would be treated to ensure it is clean and safe for drinking, free from harmful contaminants, and supplied at a consistent pressure to meet household needs. Additionally, respondents were informed that payment options would be made more flexible, allowing for monthly, quarterly, or pre-paid mobile payment methods.

Respondents were initially asked whether they would be willing to pay a specific amount (Initial Bid Ethiopian Birr) for the improved water services in a single-bounded dichotomous choice format. Following their response, a double-bounded follow-up question was introduced. If the respondent answered "yes," they were presented with a higher bid (BidH Ethiopian Birr) to assess their upper bound of WTP. Conversely, if the respondent answered "no," a lower bid (BidL Ethiopian Birr) was offered to determine their minimum WTP. This two-step process enhances the precision of WTP estimates by narrowing down the range of acceptable values for each respondent.

3.4.2. Econometric model specification

The econometric model for the single-bounded dichotomous choice contingent valuation method is typically based on the random utility framework, where a household's willingness to pay (WTP) is modeled as a function of various explanatory variables. The binary response variable takes the value of 1 if the household is willing to pay the proposed bid and 0 otherwise. The likelihood of a household agreeing to pay the bid amount is modeled using a probit model. In the probit model, the probability that a household is willing to pay for improved piped water services is modeled as

$$\Pr(Y_i = 1) = \Phi(\beta_0 + \beta_{1+k}Z_i)$$

Where: Φ is the cumulative distribution function (CDF) of the standard normal distribution

β_0 is the intercept or constant term.

β_{1+k} are the coefficients for the explanatory variables.

The coefficient (β_i) is estimated using maximum likelihood estimation (MLE), where the log-likelihood function for the Probit model is:

$$\log L = \sum_{i=1} [Y_i \log(\Phi(X_i\beta)) + (1 - Y_i) \log(1 - \Phi(X_i\beta))]$$

3.4.3. Double-Bounded or Interval Data Model

The method known as the double-bounded or interval data model allows the efficient use of data to estimate willingness to pay. One way to proceed with the estimation is to construct a likelihood function to directly obtain estimates for parameters using maximum likelihood estimation (Lopez-Feldman, 2012). The function that needs to be maximized in order to find the parameters of the model is:

$$\begin{aligned} \sum_{i=1}^N \left[d_i^{SN} \ln \left(\Phi \left(z_i' \frac{\beta}{\sigma} - \frac{BID_1}{\sigma} \right) - \Phi \left(z_i' \frac{\beta}{\sigma} - \frac{BID_2}{\sigma} \right) \right) + d_i^{SS} \ln \left(\Phi \left(z_i' \frac{\beta}{\sigma} - \frac{BID_2}{\sigma} \right) \right) \right. \\ \left. + d_i^{NS} \ln \left(\Phi \left(z_i' \frac{\beta}{\sigma} - \frac{BID_2}{\sigma} \right) - \Phi \left(z_i' \frac{\beta}{\sigma} - \frac{BID_1}{\sigma} \right) \right) \right. \\ \left. + d_i^{NN} \ln \left(1 - \Phi \left(z_i' \frac{\beta}{\sigma} - \frac{BID_1}{\sigma} \right) \right) \right] \end{aligned}$$

3.4.4. Quantitative Data Analysis

The quantitative data were analyzed using descriptive statistics to summarize key household characteristics (such as age, gender, income, and household size) and water access patterns. The distribution of WTP responses was analyzed using econometric techniques of single and double-bounded approaches to estimate the probability of households' willingness to pay based on their socio-economic attributes.

4. Results

This section presents the findings from the analysis of the survey data collected from households in the North Wollo Zone of Ethiopia. The results address key demographic characteristics of the respondents, their experiences with water shortages, and the perceived causes of these shortages.

4.1. Demographic Characteristics of Respondents

4.1.1. Sex of the respondent

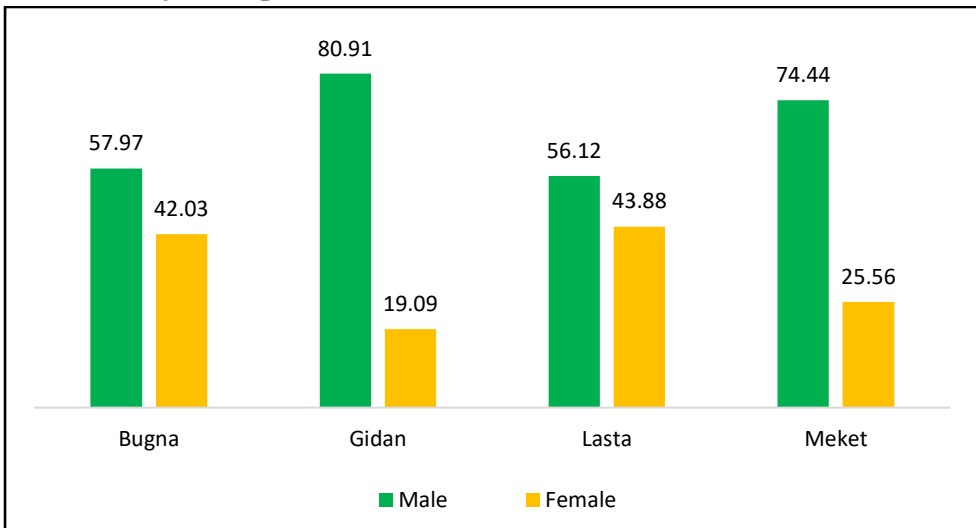


Figure 3: Sample respondents distribution by sex and woreda

In Figure 3 above, the chart presents the distribution of household heads across four Woredas in North Wollo: Bugna, Gidan, Lasta, and Meket, based on 410 respondents. Figure 3 reveals distinct demographic patterns. Gidan and Meket reported higher male participation, with 80.91% and 74.44% male respondents, respectively, compared to Bugna (57.97%) and Lasta (56.12%). Similarly, female representation was highest in Lasta (43.88%) and lowest in Gidan (19.09%). Overall, males comprised 69.02% of the total sample (283 individuals), while females accounted for 30.98% (127 individuals), reflecting a male-dominated respondent pool across the Woredas.

4.1.2. Educational status of the respondent

Table 2 presents the educational status of respondents, indicating varying levels of literacy and education across the different Woredas.

Table 2: Sample respondents' educational status by Woreda

Woreda	Education (%)					Total
	Can't Read and Write	Can Read and Write	1-8	9-12	>12	
Bugna	4.35	11.59	14.49	24.64	44.93	100.00
Gidan	20.56	20.56	14.95	17.76	26.17	100.00
Lasta	2.04	11.22	5.10	16.33	65.31	100.00
Meket	0.76	3.79	0.00	8.33	87.12	100.00
Total	6.90	11.33	7.64	15.52	58.62	100.00

Source: Authors' computation

The results presented in Table 2 depict how educational attainment varies across the Woredas of Bugna, Gidan, Lasta, and Meket, reflecting significant variation. The table illustrates the distribution of education levels among surveyed households, with percentages calculated row-wise to sum to 100% within each Woreda. Meket stands out with the highest proportion of respondents having education beyond grade 12 (87.12%), indicating robust access to higher education, possibly due to proximity to educational institutions or targeted interventions. In contrast, Gidan reports the highest illiteracy rate (20.56% unable to read and write), highlighting potential barriers such as limited school access or economic constraints. Lasta also shows a strong inclination toward higher education (65.31% above grade 12), while Bugna displays a more balanced distribution, with 44.93% above grade 12 and 24.64% in grades 9–12. Across all Woredas, 58.62% of respondents have education beyond grade 12, underscoring a regional trend toward higher educational attainment despite challenges like drought and infrastructure deficits. These findings, derived from stratified household surveys, inform water pricing and access policies by linking education to socioeconomic factors influencing willingness to pay. The variability of the educational status of respondents across the Woredas suggests a critical barrier to community engagement in discussions about water management. Conversely, Meket shows a higher percentage of individuals with education beyond 12 years, potentially equipping them with better resources to understand and advocate for effective water management solutions. This disparity in educational attainment may

influence the overall effectiveness of educational campaigns targeting water conservation in the study area.

4.1.3. Marital status of the respondent

Table 3 illustrates the marital status of respondents, providing insight into the social structure within the surveyed households.

Table 3: Marital Status of the Sample Respondent

Woreda	Marital status of respondents (%)				
	Single	Married	Divorced	Widowed	Total
Bugna	39.13	44.93	8.70	7.25	100.00
Gidan	22.43	58.88	7.48	11.21	100.00
Lasta	37.76	55.10	5.10	2.04	100.00
Meket	18.80	78.95	2.26	0.00	100.00
Total	27.76	62.16	5.41	4.67	100.00

Source: Authors' computation

In the Zone, the marital status distribution of surveyed households across Bugna, Gidan, Lasta, and Meket Woredas shows diverse demographic profiles relevant to water access and policy design (see Table 3). From the results, Meket has the highest proportion of married respondents (78.95%) and no widowed individuals, suggesting stable household structures possibly linked to socioeconomic factors. Gidan reports the highest widowhood rate (11.21%), potentially reflecting higher vulnerability, while Bugna and Lasta show balanced distributions with significant single (39.13% and 37.76%, respectively) and married populations. Overall, 62.16% of respondents are married, indicating a regional predominance of married households, which may influence water demand and willingness to pay for improved services.

4.2. Water Shortage Experience

The result presented in Figure 4 provides a comprehensive overview of respondents' experiences with water shortages across four Woredas. Overall, the findings reveal significant variability in the frequency of water shortages experienced by residents. Notably, Gidan has the highest percentage of respondents reporting that they "always" face water shortages, at 63.64%, indicating a severe and chronic issue in this area.

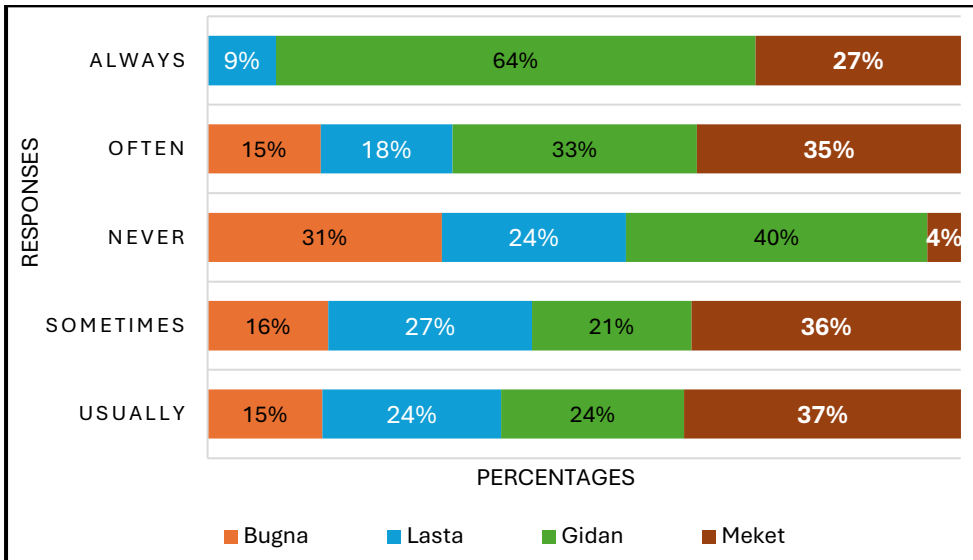


Figure 4: How often do you experience Water Shortage in your area?

In contrast, Bugna shows a relatively higher percentage (31.11%) of respondents claiming they never experience water shortages, indicating potential disparities in access to water resources. The frequency of water shortages experienced may influence the community's overall health and well-being, stressing the urgency of effective water management strategies.

4.3. Perceived Causes of Piped Water Shortage

The result presented in Table 4 shows the various perceived causes of piped water shortages as reported by respondents across four woredas. Each woreda displays unique challenges that contribute to the scarcity of piped water, highlighting the complexity of the issue. To clarify, the section intentionally focuses on households' perceived causes, derived from survey responses reflecting their subjective beliefs and local experiences rather than empirical causal linkages. Such an approach aligns with the study's objective to capture community perceptions in North Wollo, where factors like recurrent droughts and infrastructural deficits shape residents' views on water scarcity. These perceptions help to bridge gaps between perceptions and actual drivers of water issues in the study area.

Table 4: Perceived Causes of Piped Water Shortage

Woredas	What do you think are the main causes of pipe water shortage in the area?					Total
	Drought	Geography	Poor Infrastructure	High Demand	Other	
Bugna	66.67	5.80	15.94	5.80	5.80	100.00
Gidan	30.00	29.09	37.27	2.73	0.91	100.00
Lasta	50.00	13.27	21.43	12.24	3.06	100.00
Meket	15.79	28.57	46.62	6.77	2.26	100.00
Total	36.34	21.22	32.93	6.83	2.68	100.00

Source: Authors' computation

In the Zone, households' perceived causes of piped water shortages across Bugna, Gidan, Lasta, and Meket Woredas, as captured through survey responses, exhibit notable variation with implications for targeted water management interventions. The table presents row-wise percentages, highlighting Bugna's dominant attribution to drought (66.67%), likely reflecting its vulnerability to seasonal rainfall deficits. In contrast, Meket identifies poor infrastructure as the primary cause (46.62%), pointing to maintenance and distribution challenges, while Gidan shows a balanced distribution with poor infrastructure (37.27%) and geography (29.09%) as key factors. Lasta emphasizes drought (50.00%), consistent with its arid terrain. Overall, drought (36.34%) and poor infrastructure (32.93%) emerge as the most cited causes regionally, informing policy on community perceptions to enhance resilience in water-scarce areas.

4.4. Respondents' Levels of Satisfaction with the Current Water Supply

To assess household satisfaction with the piped water supply in North Wollo Zone (Bugna, Gidan, Lasta, Meket Woredas), we surveyed 400 households using a single-choice question: "How satisfied are you with the current water supply in your area?" Responses were recorded on a five-point ordinal scale (1 = Strongly Dissatisfied, 2 = Dissatisfied, 3 = Neutral, 4 = Satisfied, 5 = Very Satisfied), defined by the number of days per month with adequate piped water: 0–5 days (Strongly Dissatisfied), 6–10 days (Dissatisfied), 11–15 days (Neutral), 16–25 days (Satisfied), and 26–30 days (Very Satisfied).

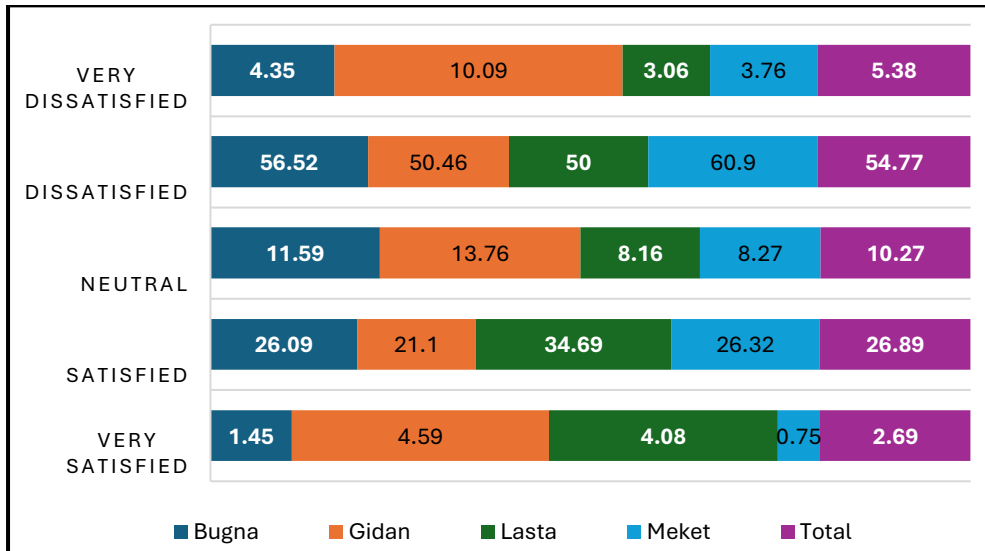


Figure 5: How satisfied are you with the Current Water Supply in your area?

The result presented in Figure 5 above shows subjective perceptions of water supply reliability, offering insights into the community's experiences of water scarcity, where only 43% of rural households access improved water sources. While valuable for informing targeted interventions, the reliance on subjective satisfaction ratings limits causal inference, and high dissatisfaction levels may reflect amplified awareness of systemic issues rather than objective water availability. Yet, the varying perceptions of service adequacy could be tied to local supply issues or differing water infrastructure quality across the Woredas, which informs the responsible body to check their services. The table reveals widespread dissatisfaction with piped water supply across North Wollo, with 54.77% of respondents region-wide reporting dissatisfaction, reflecting the region's severe water access challenges, exacerbated by recurrent droughts and poor infrastructure. Meket exhibits the highest dissatisfaction (60.90%), likely due to its heavy reliance on inadequate infrastructure, as evidenced by 46.62% of respondents citing poor infrastructure as a primary perceived cause of shortages in a related survey (see Table 5). This high dissatisfaction, despite Meket's high educational attainment (87.12% above grade 12, see Table 2), suggests that educated households may have greater awareness of systemic deficiencies, inflating dissatisfaction ratings. Bugna follows closely with 56.52% dissatisfied, aligning with its high attribution to drought (66.67%), indicating that climatic factors shape negative perceptions, though the low "Very Dissatisfied" rate (4.35%) suggests some resilience or adaptation. Here, the result for Gidan indicates the presence of

significant dissatisfaction (50.46%) and the highest "Very Dissatisfied" rate (10.09%), consistent with its severe drought conditions and balanced attribution to poor infrastructure (37.27%) and geography (29.09%) as perceived shortage causes. This suggests that Gidan's households perceive multiple barriers, amplifying frustration with water supply reliability in the study. On the other hand, Lasta shows a relatively balanced response, with 50.00% dissatisfied but the highest satisfaction rate (34.69%), possibly reflecting access to some functional water points. Overall, these differences suggest varying perceptions of service adequacy, which could be linked to local supply issues or differing water infrastructure quality across the Woredas.

4.5. Main Sources of Drinking Water

The main sources of drinking water further illuminate the diverse water resource landscape in the North Wollo Zone. Households in Gidan overwhelmingly rely on Bono (traditional wells or local water sources), with 83% of respondents indicating this as their primary source. This heavy reliance on Bono underscores the limited access to modern water supply systems in Gidan, which may contribute to the high frequency of water shortages reported in the Woreda. In contrast, Meket shows a more diverse utilization of water sources, with 43% of households relying on spring water, 35% on piped water, and 17% on Bono. The high reliance on spring water in Meket could be linked to the area's geographical features, which may provide natural springs as a water source; however, this diversity also reflects a more developed, though still challenged, water infrastructure. Lasta demonstrates a relatively balanced usage of water sources, with 29% of households using spring water and 28% using piped water, indicating a moderate level of access to different water resources. In Bugna, while spring water is the most utilized source at 29%, piped water also plays a significant role at 20%, and no households reported using Bono. This suggests that Bugna may have better access to modern water supply systems compared to the other Woredas, potentially explaining the lower frequency of water shortages in the area.

4.6. Analysis of Willingness to Pay for Different Bid Prices

Figure 6 provides insights into households' responses to the initial bid amounts (20, 40, 80, and 120 Birr) for willingness to pay (WTP) for improved piped water supply. The responses are categorized into two groups: "Yes" for those willing to pay the proposed amount and "No" for those unwilling to pay. The data reveal notable

variations in acceptance rates across different bid levels, highlighting how bid amounts influence households' willingness to pay.

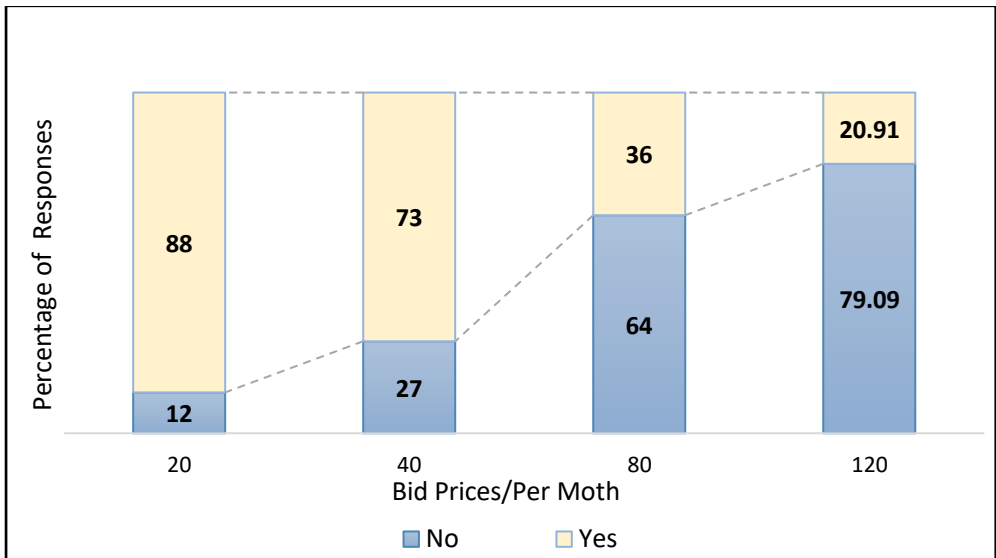


Figure 6: Analysis of Willingness to Pay for Different Bid Prices

At the lowest bid of 20 Birr, the majority of respondents (88%) are willing to pay, indicating a high level of acceptance at this price point. This high willingness suggests that 20 Birr is perceived as affordable or fair by most households, making it the most widely accepted bid. Only 12% of respondents decline to pay at this level, reflecting minimal resistance when the cost is low.

As the bid amount increases to 40 Birr, the willingness to pay declines, with 73% of respondents indicating a "Yes" response. Although still a majority, the acceptance rate has dropped compared to the 20 Birr bid, suggesting that affordability concerns or perceived value start influencing decisions at this price point. The proportion of households unwilling to pay increases to 27%, highlighting growing reluctance as the cost rises.

The trend continues with the bid set at 80 Birr, where only 36% of respondents are willing to pay, marking a significant drop in acceptance. The majority of households (64%) decline this bid, indicating that the price may be perceived as too high relative to the perceived benefits of improved water supply. This substantial decrease in willingness to pay suggests a critical price threshold beyond which most households feel the cost is prohibitive.

At the highest bid of 120 Birr, acceptance further diminishes, with only 20.91% of households willing to pay, and a significant 79.09% declining the offer. This sharp decline in willingness demonstrates that 120 Birr is generally perceived as unaffordable or not worth the expense for improved water services. The high refusal rate underscores the sensitivity of household willingness to pay to increases in bid amounts, highlighting affordability as a primary concern. Overall, the data reveal that willingness to pay for improved piped water supply significantly decreases as bid amounts increase. Households show a strong preference for lower bids, with high acceptance at 20 Birr and a steep decline in willingness at higher amounts. This pattern suggests that any pricing strategy for improved water supply services needs to carefully consider affordability constraints to ensure broader acceptance among households. The results underscore the importance of balancing cost recovery with household financial capabilities to achieve sustainable and equitable water service improvements.

4.7. Econometric Results

In this section, we present the results of the econometric models estimating the factors influencing household willingness to pay (WTP) for improved water services. The single-bounded probit model was employed as a baseline due to its simplicity and robustness in capturing initial household preferences, while the double-bounded probit model was used to enhance precision by incorporating follow-up bids, providing us with additional information to refine WTP estimates.

The key independent variables include the household head's sex and age, family size, monthly expenditure, and family income, along with interaction terms between these variables. The results, summarized in Table 5, provide insights into the significance of each factor and its direction of influence.

The econometric analysis evaluated both the Single Bounded Probit Model (SBPM) and the Double Bounded Contingent Valuation Method (CVM) model. From the results of SBPM, the coefficient for the bid amount is negative and highly significant, indicating that higher bid levels reduce the likelihood of acceptance, which aligns with expectations, theory, and Figure 6 above. The theory of demand states that as the price of the commodity increases, the quantity demanded for the commodity under consideration declines, other things remaining constant. This suggests that households are less willing to pay higher amounts for improved water services as the bid amount increases.

Table 5: Double Bounded CVM Model Result

Variables	Coefficient
Sex (Male = 1)	45.126** (-19.166)
Age	2.376*** (-0.786)
Sex × Age	-1.267** (-0.514)
Family Size	5.403* (-2.803)
Monthly Expenditure	0.313*** (-0.084)
Family Income	0.0001 (-0.001)
Family Size × Expenditure	-0.042** (-0.018)
Constant	-53.474* (-32.047)
Sigma	
Constant	43.115*** (-2.256)
Mean WTP	73.158*** (-2.569)
Number of Observations	409.000
Wald chi ² (7)	32.710
Log Likelihood	-616.025

Standard errors in the parenthesis

***, **, *statistically significant at 1%, 5% and 10%

The results from the Double Bounded Contingent Valuation Method (CVM) model presented in Table 5 show significant insights into the factors influencing households' willingness to pay (WTP) for improved water services. The variable Sex (male = 1) shows a positive coefficient of 45.126, indicating that male-headed households exhibit a greater willingness to pay compared to their female counterparts, with this effect being statistically significant at the 5% level. The coefficient for Age is statistically significant at the 1% level, with a value of 2.376, suggesting that older household heads are more inclined to pay for enhanced water services. This might be associated with different factors. First, older people might face more difficulty fetching water from distant sources than younger people, and as such, they might be more willing to sacrifice more for reliable water availability. Second, older people may have more resources, like land; as such, they may have higher purchasing power. Yet, the negative interaction term sex × age (i.e., -1.267**) which is significant at the 5% level indicates that while males generally show higher WTP, this tendency diminishes as they become older. The fact that older male heads of households are less likely to accept the higher bid values in our analysis might

stem from the roles of men and women in rural households. Unlike in cities, in most rural areas, handling (fetching) items like water is the role of women. Hence, this suggests a complex dynamic where older men may become more financially conservative as they age due to their roles in the household. As such, relatively older female-headed households may tend to pay more for improved piped water access due to the difficulties they may face fetching water from alternative sources.

The analysis also reveals that family size significantly impacts WTP, with a coefficient of 5.403 at the 10% significance level. This may be attributed to increased water consumption as family size grows. The positive correlation between monthly expenditure and WTP (coefficient of 0.313 at the 1% significance level) emphasizes the role of economic capacity in households' willingness to invest in improved piped water services. Interestingly, the interaction between family size and expenditure shows a negative coefficient of -0.042 , suggesting that as family size increases, the marginal effect of additional expenditure on WTP diminishes. The model's goodness of fit is supported by a Wald χ^2 of 32.710, with 409 observations lending robustness to the findings.

5. Discussion

The study presented descriptive and econometric analyses of households' willingness to pay for improved piped water service. The discussion draws on both the descriptive statistics and the econometric models to provide a comprehensive understanding of households' willingness to pay (WTP) for improved water services in the study area (North Wollo Zone). The analysis reveals important demographic and economic factors that shape this willingness, providing insights for targeted policy interventions.

The descriptive statistics show significant demographic disparities across the four Woredas, particularly in gender distribution, educational attainment, perceived causes of water shortage, and marital status. In Gidan, a predominance of male-headed households, coupled with low literacy rates, signals potential barriers to community participation in water management, which aligns with insights from several studies on gender dynamics and community water management. For instance, Grishina (2024) discusses the gender dimensions of water supply in African communities, noting that increased female involvement in water management can reduce gender disparity, suggesting that male-dominated structures may limit equitable participation in water-related decision-making. Similarly, Naiga et al. (2023) examine gendered participation in Ugandan rural water schemes and

underscore that women's involvement in water governance is essential for effective community management, though they face substantial constraints in decision-making. This reflects how male-headed households could perpetuate exclusionary practices, limiting community engagement. In South India, Dasthagir and Arun (2024) explore participatory institutions and find that patriarchal norms in irrigation governance inhibit women's leadership, reinforcing the argument that male predominance may hinder inclusive management practices. Narain and Goodrich (2024) critique gender integration in South Asian water policies, noting that limited impact results from inadequate gender mainstreaming, which may also be exacerbated by low literacy levels in the community. Additionally, Raut et al. (2023) identify social and gender exclusions in Nepal's rural water management, noting that policies aiming for inclusion often struggle with implementation, indicating that both male dominance and low literacy could undermine effective community participation. Together, these studies elucidate that male-dominated and low-literacy contexts present significant barriers to equitable and effective water governance.

The frequency of water shortages is another critical factor, with Gidan facing the most severe challenges, as a large proportion of respondents experience constant water shortages. In contrast, Bugna experiences fewer shortages, though challenges related to water access persist. These discrepancies highlight the need for locally tailored interventions, as the causes of shortages vary according to households' perceptions of piped water shortages in the Zone. In Bugna and Lasta, drought is perceived as a major issue, while in Meket, infrastructure shortcomings are a primary concern. The results suggest that Woreda-specific interventions, such as infrastructure upgrades in Meket and drought mitigation in Bugna, are essential for improving water supply reliability. This aligns with broader research on climate-induced water scarcity (Asfaw & Yimer, 2024; Bahiru & Zewdu, 2021) and infrastructural deficits in developing regions (Du Plessis, 2023). These findings, while limited to subjective perceptions, align with Getinet et al. (2024) and Hundie and Abdisa (2016), who emphasize the role of socioeconomic factors in water access, and provide a foundation for community-driven awareness campaigns to address misperceptions and support equitable water pricing policies in Ethiopia's drought-prone regions.

Discussing the econometric analysis, both the Single Bounded Probit and Double Bounded Contingent Valuation Method (CVM) models offer clear insights into the factors influencing households' WTP for improved piped water services.

As expected, higher bid amounts significantly reduce the likelihood of acceptance across models, illustrating the budget constraints households might face. This outcome is consistent with economic theory, which emphasizes the inverse relationship between price and quantity demanded for goods and services. Household composition and economic capacity emerge as critical determinants. Larger families are more likely to pay more for improved water services, likely due to their greater dependence on stable water supplies. This aligns with the findings of Rosen and Vincent (1998), Lopez-Feldman (2012), and Zafar et al. (2022), who noted that households with more members prioritize access to utilities due to higher consumption needs. However, the interaction between family size and monthly expenditure shows that while wealthier families are more willing to pay, this effect diminishes in larger households, probably due to competing financial priorities—a finding that echoes the work of Beshir et al. (2024) and contrasts with the work of Ahlheim and Schneider (2013). They noted that larger households tend to show lower willingness to pay for environmental projects, suggesting tighter budgets despite potentially greater overall benefits from such projects.

Monthly expenditure positively influences WTP, similar to the findings of Bogale and Urgessa (2015), affirming that households with higher financial capacity are more inclined to invest in essential services. However, the slightly negative relationship between family income and WTP in the probit model suggests that wealthier households may have already addressed their water needs or have other financial priorities. While higher financial capacity generally correlates with increased WTP, difficulties arise, particularly among wealthier households who may prioritize other financial commitments. For instance, higher household income typically enhances WTP for drinking water services, as demonstrated by Zafar et al. (2022), who found significant correlations between income and WTP.

The interaction effects in the models reveal the complex role of gender and age in shaping financial decisions related to public services. Although the sex of the household head shows a positive but insignificant effect on WTP, the interaction between sex and age suggests that male-headed households with higher ages are more willing to pay for improved services. The combined findings from descriptive analysis and econometric models have important policy implications. Overall, the study found that the average willingness to pay (WTP) in the area is 73 Birr per month. This level of WTP reflects a general acceptance of the cost among households, likely influenced by factors such as perceived benefits of service improvements, household income levels, and demographic characteristics. Such

findings indicate a baseline economic valuation for public services within the community and provide a reference for policymakers aiming to balance service costs with public affordability. First, addressing educational disparities and ensuring gender inclusivity are critical for improving community engagement in water management. Second, tailored interventions are needed to target larger households and those with lower expenditures, as these groups face unique financial constraints despite their willingness to pay for better services.

Moreover, the significant role of bid amounts in determining WTP highlights the need for carefully calibrated pricing strategies that balance cost recovery with affordability. Policymakers must also consider the diverse causes of water shortages across Woredas, ranging from climate variability to infrastructural deficits, when designing interventions to improve water access, as households perceive these as major factors that affect water reliability in the study area.

6. Conclusion and Recommendations

The findings from the present study reveal a complex landscape of water access challenges, where household perceptions of shortages, satisfaction levels, and socioeconomic factors intersect to highlight systemic vulnerabilities in Bugna, Gidan, Lasta, and Meket Woredas. Based on households' perceived beliefs, about 55% of respondents express dissatisfaction with the piped water supply and about 43% report that they usually face water shortages. The households underscore the pervasive impact of drought (36.34% cited as the primary cause) and poor infrastructure (32.93%), particularly in drought-prone Bugna (66.67% drought attribution) and infrastructure-challenged Meket (46.62%), which provides ample information for the zone officials for clear area intervention. Moreover, the study also shows that the marital status of households is dominated by married households (62.16%), suggesting stable family structures that may amplify water demand pressures. The study provides a comprehensive analysis of the factors affecting households' willingness to pay (WTP) for improved water services in the North Wollo Zone, Ethiopia. The results indicate that economic factors such as monthly expenditure and family size play crucial roles in shaping households' decisions, with larger families and those with higher spending capacities more willing to invest in better water infrastructure. Demographic factors, including the age and gender of the household head, also influence WTP, with older individuals and male-headed households showing a greater propensity to pay. Additionally, higher bid amounts were negatively associated with the WTP amount, highlighting the sensitivity of

households to price when it comes to essential services. The findings reveal significant disparities across Woredas, particularly in Gidan, where water shortages and low educational levels are more prevalent, presenting unique challenges for effective water management. The study underscores the importance of local contexts, as water access issues are multifaceted, influenced by both infrastructure and socioeconomic dynamics. Moreover, households' perceived causes of water shortages significantly vary from place to place.

Based on the findings of the present study, policymakers should focus on targeted interventions. First, prioritize infrastructure upgrades in Meket and Gidan, where poor infrastructure is cited by 46.62% and 37.27% of respondents, respectively, through investments in resilient piped systems and maintenance programs, potentially funded by household WTP contributions. The woreda of Gidan, with its unique challenges of frequent water shortages and low levels of education, requires urgent attention. Second, implement drought mitigation initiatives in Bugna and Lasta, focusing on rainwater harvesting and early warning systems, given drought's dominance (66.67% and 50.00%) and high "Sometimes" shortage perceptions (27.01% in Lasta) found in the results section. Therefore, infrastructure improvements, including the expansion of piped water systems, installation of rainwater harvesting mechanisms, and the development of groundwater sources, are essential to provide consistent access to water in the zone. Furthermore, sustainable water management strategies, such as community-driven water conservation programs, could help alleviate water scarcity and enhance the resilience of local populations to environmental stresses like droughts. Introducing community-based educational programs that improve literacy and raise awareness about sustainable water use is essential. Moreover, community-level awareness campaigns are relevant to align households' perceived causes of water shortage with institutional-level causes. By enhancing education, particularly in communities where educational attainment is limited, residents can become more involved in water resource management efforts, fostering a more informed and active role in addressing local water challenges. Gender plays a significant role in influencing households' willingness to pay for improved water services, with male-headed households often making key financial decisions. To ensure equity and inclusivity, water service programs must be designed with gender-sensitive approaches that actively involve women in the decision-making processes.

Providing targeted financial support or incentives for female-headed households, who may face unique economic constraints, can promote gender equity in access to

improved water services. Encouraging local ownership of water projects through capacity building and inclusive governance structures can lead to more resilient water management systems and foster trust between the government and the community. Given the negative impact of higher bid amounts on households' willingness to pay, designing flexible and affordable pricing structures is essential for encouraging widespread participation. Policymakers should consider introducing a sliding scale tariff system, where households are charged based on their income levels and family size. This structure would reduce the financial burden on low-income families while ensuring that wealthier households contribute more proportionally. Additionally, providing subsidies or financial assistance to the most vulnerable households can help prevent exclusion and ensure that improved water services are accessible to all, regardless of economic status.

Future research in this area may explore the profitability and viability of alternative mechanisms for delivering piped water services, specifically through private investment. By examining private sector involvement, researchers can assess whether privatization could enhance service efficiency, timeliness, and accessibility for households. Such studies might evaluate the financial feasibility for private investors, identify potential cost savings, and explore ways to ensure that services remain affordable while meeting high standards of quality and reliability. Ultimately, this line of research could provide valuable insights into how private investment might contribute to a sustainable and effective water delivery system that addresses SDG 6.

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