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Evaluating households' willingness to pay for private water supply services in Wakiso District, Uganda

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Abstract

Accessing water supply services remains a serious challenge in Wakiso District in Uganda, where most households travel long distances to collect water – a process that threatens their health, productivity and economic wellbeing. Although addressing this challenge requires huge financial investment, the value households attach to accessing private water supply services at their premises is not clear. This study used data from 243 households to determine their willingness to pay (WTP) for private water supply services. The analysis applied the Heckman model to check for sample selection bias, and the contingent valuation method (CVM) to estimate the WTP. The mean WTP was estimated at UGX 203.07 (USD 0.06) per 20 litre jerry can. Socioeconomic and demographic factors that influence WTP were also determined. These findings could guide the design of policies on sustainable water supply and cost recovery in the long run.

Key words: Uganda, WTP, CVM, Heckman model, potable water, sample selection

1. Introduction

Accessing water supply services is a global challenge of our time, and an aspect that has attracted the attention of researchers, policymakers and development partners. Globally, 844 million people lack access to a clean water supply, despite modest progress made over the years (UN-Water 2018). Asia and Sub-Saharan Africa (SSA) are the regions affected the most (WHO and UNICEF 2015). According to the Government of Uganda's Ministry of Water and Environment ([MWE] 2018), 70% and 77% of households have access to clean water in the rural and urban areas of Uganda, respectively. Although these statistics have improved in the recent past, accessing water supply services in the country is still a serious problem, particularly in rural areas, where 75% of the population lives (Uganda Bureau of Statistics [UBOS] 2016). Previous findings (Asaba *et al*. 2013;

Musoke *et al*. 2017) suggest that limited access to water supply services threatens human health, productivity and wellbeing.

Many households face considerable hardships, often borne by women and children. In underserved areas, water users sometimes travel long distances to collect water (Wright *et al*. 2014). This curtails productivity for other domestic and development activities, since a substantial amount of time is lost during water collection. Long queues at water collection points further aggravate the problem (Baguma *et al*. 2013). Furthermore, women and children, who are those mainly burdened with water collection, often walk long distances on poor and hilly roads carrying water jerry cans on their heads. As a result, they suffer health-related complications, such as chest pain, prolonged fatigue and headaches (Asaba *et al*. 2013). Moreover, water from unprotected sources in Uganda (such as wells, springs, ponds and boreholes) is not treated and often associated with poor quality. Past studies that looked at selected unprotected water sources in Wakiso District revealed that the water is unsafe for drinking, since it is contaminated with microorganisms and thereby contributes to the spread of waterborne diseases (such as diarrhoea), especially among children under the age of five (Musoke *et al*. 2017). Ultimately, it increases the mortality rate and medical bills, and puts more pressure on health facilities. While water quality is not the focus of this paper, the past findings on water quality and associated problems should serve as an issue of concern for the government of Uganda to consider in its policy efforts to improve potable water services to private individual households using a piped water network. This would reduce the burden of collecting water from distant, unreliable sources located far away from their homes.

Another challenge faced by households in Uganda is that private water vendors charge high prices for 20 litre jerry cans of water compared to the water tariff charged by the National Water and Sewerage Corporation (NWSC) for the same volume of water. This is the case especially during periods of water shortages, adding to the financial strains on households (Pangare & Pangare 2008). The competition between water users (especially between domestic and agricultural users) further limits households' access to the current water supply services as the population and consumption levels increase (Postel 2000). Access to a potable water supply is also limited by the non-functionality of water sources, especially boreholes, where poor management and operation of the water infrastructure results in sinking pipes, a lack of repairs, corrosion and water salinity. These challenges occur where water-user committees (WUCs) are inactive or non-existent, or due to a lack of funds to buy spare parts and equipment, or a lack of maintenance of rural water infrastructure (Naiga *et al*. 2015). This implies that even where community institutions function, finance could be a constraint. Therefore, understanding the value private households attach to private water connections is important.

More efficient use of water can support economic development, contribute to poverty reduction, and promote food security and gender equity (WHO and UNICEF 2015). Increasing public investment in infrastructure to improve water-use efficiency is necessary to promote households' access to water and decouple economic growth from water use in major sectors (UN-Water 2018). However, this requires large financial resources. Understanding whether the beneficiaries of the proposed programme are willing to pay to access private water supply services therefore is imperative to determine the possibility of recovering funds for water supply equipment and installation, and assess whether maintenance and operation costs will be recovered in the long run.

Several studies conducted in Uganda address different aspects of water supply. For example, a study by Whittington *et al*. (1998) investigated households' WTP for public and private taps, while Wright *et al*. (2014) focused on households' WTP for public taps. Other studies (Asaba *et al*. 2013; Baguma *et al*. 2013; Naiga *et al*. 2015) examined the challenges of accessing water from distant sources, using a gender lens. The results of these studies reveal that the burden of collecting water is mainly borne by women and children. Another challenge facing poor households with limited access to water is the issue of buying water from private vendors. For example, Pangare and Pangare (2008) examined informal water vending and service providers in Uganda and indicated that water vendors charge high prices, especially during periods of water shortages, which places more pressure on households' income. The other issue about water is quality. Most poor households rely on unreliable water sources, mostly accessed a distance away from their homes. Musoke *et al*. (2017) investigated the quality of water from selected sources in Uganda and found that most of the water sources had quality issues, since they were contaminated with microorganisms. Latinopolous (2014) reported that several studies have used different non-market valuation methods to estimate the value households place on water access, such as averting behaviour models, cost of illness (COI) models, the choice experiment (CE) method and the contingent valuation method (CVM). The current study applied the CVM, which is a stated preference method of environmental valuation that is employed mainly to estimate the value households place on accessing water. Several studies (Farolfi *et al*. 2007; Moffat *et al*. 2011; Wondimu & Bekele 2011; Mezgebo & Ewnetu 2015; Kassahun *et al*. 2016; Akeju *et al*. 2018) have applied the CVM to value different aspects of water supply in developing countries. Most of these studies focused on improvements in water quality and quantity, and a few studies looked at access to water. As noted by Wright *et al*. (2014), CVM studies are site specific due to different socioeconomic factors in different areas, and they normally vary across time and space. To contribute to the issue of water supply, this study investigates households' WTP for access to private water supply services in Wakiso District, Uganda. This study applies the CVM, using the double-bounded dichotomous choice elicitation technique. A probit model was adopted to estimate the WTP, using survey data from 243 sampled households that did not have private water supply connections at their premises in Wakiso District at the time of data collection in 2018.

2. Materials and methods

2.1 Study area and sample design

The study used primary data from a survey sample of 243 households collected in 2018. The study targeted households that use water for domestic purposes without having access to a source of potable water in Wakiso District, central Uganda, covering the following villages: Kasenge, Nakirama, Kikajjo and Kazinga. With a population of 1 997 418, Wakiso District is the most populated district in the country, with the population comprising 1 048 383 female and 949 035 male residents (UBOS 2016). Entebbe International Airport and part of Lake Victoria, the world's largest tropical freshwater lake, are found in Wakiso District. The district experiences heavy rain and temperate sunshine throughout the course of the year, and has two wet seasons (Verschuren *et al*. 2002; Musoke *et al*. 2017). Yet accessing a reliable private water supply remains a serious challenge for poor households.

Wakiso District was selected for the study due to the presence of distant water sources (Baguma *et al*. 2013) with poor water quality (Musoke *et al*. 2017), and also for the high demand for a potable water supply in the district, given its large population compared to the other districts in the country. Although a piped water system has already been installed in some areas in Wakiso District, only a few residents are connected to a potable water supply at their premises (MWE 2018). Most of the residents travel long distances to collect free water from springs, boreholes and wells, while others buy water from water vendors, especially during periods of water shortages.

Following the National Oceanic and Atmospheric Administration (NOAA) panel recommendations (Arrow *et al*. 1993), the study used face-to-face interviews to collect data from households using a questionnaire. A total sample of 280 was considered representative, and purposive (as it focused on households without private water supply on their premises) and random sampling methods were used. Enumerators were asked to knock on the door of every tenth house, alternating between right and left at every turn. In the case of non-response, they were asked to consider the next house. Since some respondents did not answer questions about the WTP elicitation and their financial status, the final dataset for the analysis had 243 observations, which consisted of 60, 57, 68 and 58 respondents from Kikajjo, Kasenge, Nakirama and Kazinga villages respectively.

2.2 Contingent valuation method (CVM)

The contingent valuation method (CVM) is the stated preference (SP) method used to estimate the value that people attach to non-market goods. The CVM was considered the most appropriate method in this study due to its ability to estimate use and non-use values of changes in water supply, as opposed to revealed preference (RP) methods such as the hedonic pricing method, which only estimates use values, thereby underestimating changes in water supply (Haab & McConnell 2002). The study also opted for the CVM over choice experiments (CE), since the hypothetical scenario of the CVM presents respondents with cognitively simple alternative WTP preferences that are simple to understand, compared to the numerous choice sets applied in the CE (Mathieu *et al*. 2014). Due to the absence of a market for improved access to water supply services, CVM has been applied in similar empirical studies (Baidoo *et al*. 2013; Namyenya *et al*. 2014; Kassahun *et al*. 2016). This study employed a double-bounded elicitation format, based on its capacity to generate more efficient and reliable information compared to other elicitation methods, such as the single-bounded elicitation format (Hanemann *et al*. 1991; Haab & McConnell 2002; León & León 2003). In this case, respondents were presented with a simple dichotomous ('yes' or 'no') question. A second bid, also in a dichotomous format, is then presented – higher than the first bid if the answer was 'yes' to the first bid, and lower if it was 'no'. This method minimises the non-response rate, as it mimics bargaining in a real market scenario (Wondimu & Bekele 2011).

2.3 Survey design and implementation

In WTP studies, pre-testing is important for the design of clear and reliable contingent valuation questionnaires through a well-adjusted presentation of information (Johnston *et al*. 2017). This study conducted interviews with 15 households for the pilot. A survey questionnaire was pre-tested to determine the starting bids for the study, define a payment vehicle, and to ascertain whether respondents understood the questions and the hypothetical scenario (Johnston *et al*. 2017). Respondents demonstrated that they understood the questions and the hypothetical scenario, and the bid values were based on the existing prices charged by water vendors. The starting bids were determined as UGX 150[1] (USD 0.045), UGX 200 (USD 0.060) and UGX 250 (USD 0.075), which were randomly presented to the households under investigation. A charge per 20 litres of water drawn from a potable water source was selected as the payment vehicle, based on similar charges by water vendors with which the households were familiar.

2.4 Hypothetical scenarios

The WTP hypothetical scenarios were developed to illustrate both the status quo of the current water supply, and the proposed improved access to a private water supply service. In the status quo, it is mostly women and children who are burdened with the responsibility for fetching water from distant sources. They travel long distances over difficult terrain, carrying water jerry cans (20 litre containers) on their heads, and consequently suffer from health-related problems (Asaba *et al*. 2017). Where

[1] 1 USD was equivalent to 3 750 UGX at the time of the survey, from August to October 2018.

water points are located nearby, the water is not reliable and queues for water collection are long (Baguma *et al*. 2013). As a result, valuable time for other livelihood activities is lost. Water vendors charge relatively high prices for water. All these factors prompt some individuals to risk collecting water from distant sources, which at times are not safe due to unprotected wells and springs, with limited water supply.

For the private water access scenario, the National Water and Sewerage Corporation (NWSC) would extend the piped water supply system throughout Wakiso District. Each household would receive a private water supply connection at their premises, without any interruptions in supply. Any potential water interruptions would be fixed within one to days of being reported. The NWSC would recover the project cost by charging users a fee per 20 litres drawn from the private water tap.

2.5 Empirical models

2.5.1 The Heckman model

The Heckman method was applied to check for sample selection bias. This method estimates the selection (the probability of being selected in the survey) and WTP equations simultaneously. The multiple regression method was used to model the selection equation (participation or non-participation) in the first stage by considering the whole sample, including the protest zeros. On the other hand, the probit model was used to model the WTP equation in the second stage, considering only respondents who were willing to pay. In this case, respondents in the survey with zero WTP values were dropped from the analysis, as they could induce sample selection bias. The value of the probability coefficient (Prob > Chi^2) generated was then used to determine whether there was sample selection bias or not (Prob > $Chi^2 \leq 0.05$ or Prob > $Chi^2 > 0.05$). Alternatively, the generated rho (ρ) coefficient, which indicates the degree of independence between the WTP and the selection equations, could also be used to determine the sample selection bias. When rho (ρ) ≥ 0 we reject the hypothesis, and when rho (ρ) < 0 we fail to reject the hypothesis, that there is a correlation or no correlation between the selection and WTP equations respectively. If there is no correlation between the two equations, the implication is that sample selection bias cannot be induced when protest zeros are dropped from the analysis and the equations in question could be estimated separately, and the reverse is also true (Strazzera *et al*. 2003).

2.5.2 The double-bounded probit model

This study employed a double-bounded probit model to determine the mean WTP for households based on its capacity to generate efficient welfare measures compared to the single-bounded model. The model assumes that the error term is normally distributed, with a mean of zero, and it is assumed to be independent and identically distributed. Each respondent was presented with WTP monetary value bids. The second bid was dependent on the response to the first bid. If the respondent answered 'yes' to the first bid, the value of the second bid was increased, and if the respondent answered 'no' to the first bid, the second bid was reduced. This generated four responses, namely: yes-yes, yes-no, no-yes and no-no. The log-likelihoods of the responses in question were calculated by the maximum likelihood method to generate the WTP for private water supply services. The double-bounded probit model for WTP is expressed by the following equation:

$$WTP_{ij} = \mu_i + \epsilon_{ij}, \quad (1)$$

where:

WTP_{ij} = the j[th] respondent's WTP
i = 1, 2 represents the first and second question
μ_1 = mean of the first response
μ_2 = mean of the second response
ϵ_{ij} = error term for the j[th] respondent's WTP for question 1 and 2 (this is zero based on the assumption of standard normal distribution).

Thus, $WTP_{ij} = X_{ij}\beta_1$. This implies that the means are dependent on the characteristics of the respondent, as indicated in Equation (2). The variables applied in the WTP model were informed by economic theory and the empirical literature, and are presented in Equation 2.

$$WTP = \beta_0 + \beta_1 Gender + \beta_2\, Quantity + \beta_3 Price + \beta_4 Age + \beta_5 Quality + \beta_6\, Expenditure + \epsilon, \quad (2)$$

where:

WTP = the mean willingness to pay
β_0 = constant
β_i = coefficients, where i = 1 to 6
ϵ = the error term, indicating the unpredicted variation in the dependent variable
Gender = sex of the household head (1 = female, 0 = male)
Quantity = having sufficient water from the main source (1 = yes, 0 = otherwise)
Price = the current price of water per 20 L charged by water vendors at alternative sources in UGX
Age = age of the household head (1 if age ≤ 34 (young), 0 if age ≥ 35 (old))
Quality = water quality concern (1 = yes, 0 = otherwise)
Expenditure = households' average monthly expenditure in UGX

The Heckman model also applies the variables in Equation (2), and the variable that captured the duration the respondent had lived in the present locality is treated as an exclusion. This variable influences the probability of being selected in the survey, but does not influence the magnitude of the WTP. For this reason, it is assumed that the influence of this variable would only be in the selection stage, i.e. in the selection equation. This is done because the Heckman model should include at least one variable (exclusion restriction) in the first stage that is different from the variables included in the second stage of the WTP valuation equation, involving only participants, to mitigate the multicollinearity problem between variables (Heckman 1977).

3. Results

3.1 Water sources

Although most of the households collect water from spring wells (65.43%) and public wells (14.81%) free of charge, some households buy water from public taps (11.52%). A few households (4.12%) harvest rainwater at their premises in water-collection tanks, since they have free access to water from boreholes and other related sources. These results imply that the burden of collecting water away from homesteads, and its associated effects on the health, wellbeing and productivity of households, is a serious challenge affecting most of the residents. These results are presented in Table 1.

Table 1: Access to water by source

Main water source	Percentage (%)
Spring wells	65.43
Public wells	14.81
Public taps	11.52
Boreholes	4.12
Rainwater harvesting	4.12

3.2 Analysis of the bid distribution

The analysis applied the double-bounded elicitation format, and the results are represented in Figure 3. Most of the households (40.77%) answered 'no' to the first bid and 'yes' to the second bid (no-yes option). While 27.04% answered 'yes' to the first bid and 'no' to the second bid (yes-no option), 18.45% answered 'yes' to the first and second bids (yes-yes option). Only 13.73% answered 'no' to both the first and second bids (no-no option). The implication is that 86.27% of the households approved the proposed project for accessing a potable water supply at their premises and displayed a positive WTP for it. The 13.73% represent respondents who placed zero value on the proposed programme for accessing a potable water supply at their premises, since they could not afford to pay for it due to their budget constraint, or they valued the proposed project less than the bid value presented to them. It is important to note that further analysis showed that these respondents (zero responses) did not reject the proposed programme for accessing potable water supply at their premises, but rather had issues related to the affordability and valuation of the proposed project.

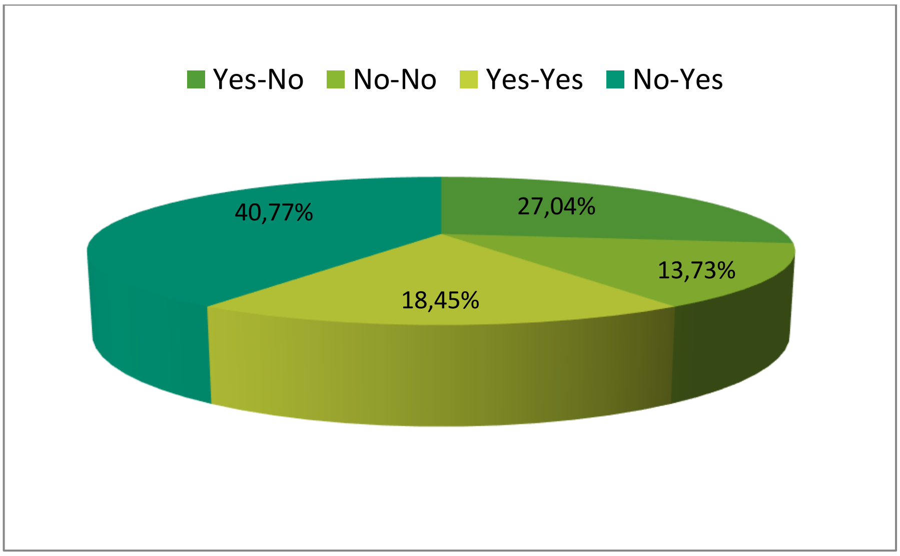

Figure 3: Bid distribution

3.3 Descriptive statistics

The descriptive statistics for the variables used in the models (refer to Table 2) indicate that the majority of respondents surveyed were female, accounting for 61.32%, were aged between 18 and 34 years, and had an average monthly expenditure of UGX 662 368.90.[2] Although 90% of the respondents received enough water from their current sources at that time, the burden of collecting water from such sources was a serious challenge, since they were located far away from their premises. While water from distant sources is not treated, most of the respondents (69.96%) acknowledged that water quality was not a serious issue. The average price charged by water vendors

[2] 1 USD was equivalent to 3 750 UGX at the time of the survey, from August to October 2018.

was equivalent to UGX 225.51 (USD 0.07) per 20 litre jerry can. The results also indicate that most of the respondents (94.65%) had lived at their present location for the entire year and therefore were familiar with the challenge of accessing water from distant sources.

Table 2: Description and statistics of variables

Variables	Description	Percentage (%)	Mean
Gender	Gender of the household – Female (1)	61.32	-
	Male (0)	38.68	-
Quantity	Having sufficient water from the main source (1)	90.12	-
	otherwise (0)	9.88	-
Price	Current price charged by water vendors in UGX	100	225.51
Age	Age of the household head: ≤ 18 years – young (1)	52.26	-
	≥ 35 years – old (0)	47.74	-
Quality	Concerns about water quality (1)	69.96	-
	otherwise (0)	30.04	-
Expenditure	Households' average monthly expenditure in UGX	100	662 368.60
Duration	How long the respondent has lived at the present location –– whole year (1)	94.65	-
	– otherwise (0)	5.35	-

3.4. Testing for sample selection bias

According to the empirical literature (Halstead *et al*. 1992; Strazzera *et al*. 2003), a significant number of respondents place zero value on improvements in environmental quality (like access to water supply). These values are categorised into protest zeros and true zeros (positive responses). On the one hand, protest zeros are obtained from respondents who deliberately place a zero value on an improvement they actually value due to free riding, a negative reaction to the survey or a payment vehicle rejection. On the other hand, true zeros are generated from respondents who truthfully place a zero value on an improvement, especially due to a budget constraint. It is critical to identify protest zeros and positive responses, and ultimately to determine whether or not to drop protest zeros from the analysis. Nevertheless, dropping protest zeros from the analysis may generate a sample selection bias (Fonta & Omoke 2008).

Following the procedure applied by Strazzera *et al*. (2003), protest zeros and positive responses were identified using debriefing questions. These questions were presented to the respondents after they had voted against accessing potable water at their premises. Consequently, the identified protest zeros and positive responses were first analysed with a sample T-test to check for sample selection bias. The results for the positive and protest zeros are presented in Table 3. The statistics of the explanatory variables for the positive responses and protest zeros are insignificant. This implies that the difference between the WTP groups (positive responses and protest zeros) is not significant. These findings suggest that dropping protest zeros from the analysis cannot generate sample selection bias. A study by Fonta and Omoke (2008) tested sample selection bias using a similar method and found that the difference between positive responses and protest zeros was statistically significant, based on the t-statistics of their respective socioeconomic variables.

Table 3: Comparing positive responses and protest zeros

	Positive responses			Protest zeros				
Variable	**Obs**	**Mean**	**Std dev.**	**Obs**	**Mean**	**Std dev.**	**Probability**	**t-value**
Sex	233	0.61	0.49	10	0.60	0.52	0.93	0.09
Quantity	233	0.90	0.29	10	0.80	0.42	0.28	1.09
Price	187	226.47	44.08	9	205.56	46.40	0.17	1.39
Age	233	0.53	0.50	10	0.30	0.48	0.15	1.44
Quality	233	0.70	0.46	10	0.50	0.53	0.58	-0.55
Expenditure	174	669 686.50	305 925	9	520 888.9	305 034.20	0.16	1.42

Furthermore, the Heckman sample selection model was applied to test for sample selection bias. The referendum variable generated from the responses to the dichotomous bids was used as the dependent variable for the selection equation. Using the whole sample before dropping the protest zeros, the Heckman model was applied to estimate the selection and WTP equations simultaneously to determine sample selection bias. Since the ρ coefficient generated was approximately zero ($\rho = -0.01$, Prob > $chi^2 = 0.99$), we could reject the hypothesis that there is correlation between the selection and WTP equations, and dropping protest zeros from the analysis therefore cannot generate sample selection bias (see Table 4). We therefore dropped the protest zeros and applied the double-bounded probit model to determine the unbiased mean WTP value.

Table 4: The Heckman test

	Selection equation	**WTP equation**
Variables	**Coefficients**	**Coefficients**
Constant	-1.58 (0.92)	0.62 (0.44)
Bid1	-	-0.00 *** (0.00)
Gender	0.40 (0.29)	0.19** (0.10)
Quantity	-0.46 (0.48)	-0.16 (0.13)
Price	0.00 * (0.00)	0.00 *** (0.00)
Age	0.52 * (0.28)	0.12 (0.10)
Quality	0.18 (0.28)	0.06 (0.08)
Expenditure	0.00 * (0.00)	0.00 (0.00)
Duration	0.72 (0.53)	-
Mills lambda	-0.00 (0.31)	
Rho (ρ)	-0.01 (0.77)	
LR test of independent equations (rho = 0): chi^2 (1) = 0.00 Prob > chi^2 = 0.99		

Notes: Asterisks * and *** denote significance at the 10% and 1% level, respectively; Figures in brackets represent standard errors

The results in Table 4 indicate that price, age and expenditure are positive and significant at 10% in influencing households' probability of being selected in the survey. As expected, the first bid is negatively related to WTP, and is significant at the 1% level. The implication is that WTP will be reduced by an increase in the bid price, and this is consistent with economic theory regarding the negative relationship between the demand for and the price of a normal good.

The gender of the household head (is positive and significant at 5% in influencing the WTP. This implies that, all other things being equal, women are more willing to pay for accessing a potable water supply at their premises relative to men, since the burden of collecting water from distant sources is mainly borne by women. The price of water charged by water vendors is also positive and significant in influencing WTP, at 1%. This means that an increase in water vendors' price increases households' WTP (all other things being equal), since water vendors charge relatively higher water prices compared to the NWSC, the government piped-water provider.

3.5 Determining the mean WTP

The mean WTP was generated from the summation of mean values of the selected socioeconomic variables and their coefficients, as presented in Equation (2). The coefficients were determined by the maximum likelihood method and the results are shown in Table 5.

Table 5: Maximum likelihood estimates of a double-bounded probit model

Variable	**Coefficient** (log odds)	**Std error**	**P > z**	**Marginal effects** (odds ratios)
Constant	120.25	27.21	0.00	-
Gender	20.33 **	8.94	0.02	0.08
Quantity	-38.29 ***	14.48	0.01	-0.07
Price	0.32***	0.09	0.00	0.00
Age	21.63 ***	8.63	0.01	0.14
Quality	12.12	0.01	0.16	0.03
Expenditure	0.02 *	0.01	0.07	0.00
Prob > chi^2 = 0.00 Wald chi^2 (6) = 31.07				

Note: *, ** and *** indicate significance at the 10%, 5% and 1% level respectively

The statistical results from Table 5 present the complete model, which is statistically significant at the 1% level based on the probability of a chi-square of 0.00. The statistical significance of explanatory variables used in the model is shown by the Wald chi^2 (6) statistic of 31.07. The model used six explanatory variables, of which five were statistically significant in influencing individual households' WTP for accessing water supply services. However, the quality perception variable has no explanatory power for WTP. Following Gunatilake and Tachiiri (2012), the study applied households' monthly expenditure, which is relatively more reliable compared to income.

The estimated coefficient of gender was positive and statistically significant at 5% in explaining the WTP. This suggests that female respondents are more willing to pay for accessing a potable water supply service than their male counterparts. This finding is in line with empirical literature (Kanayo *et al*. 2013). The marginal effect shows that the probability of WTP for accessing private water supply increases by 8% for women, ceteris paribus.

The coefficient of the variable that captured whether the household receives sufficient water from the main source is negatively related to WTP and is statistically significant at 1%, as expected. This suggests that households that receive sufficient water from the main water sources are less willing to pay to access private water supply services compared with their counterparts who receive insufficient water from the main sources. This is in line with economic theory regarding the law of demand, which shows a negative relationship between price and the quantity demanded. The results also suggest that respondents who receive sufficient water from the main sources have a 7% lower probability of WTP for accessing private water supply services compared with those who receive insufficient water, ceteris paribus.

Besides, the estimated coefficient of the price of water charged by water vendors is also positive and significant at 1% in influencing WTP. This means that a unit increase in water price increases households' WTP for private water supply, ceteris paribus. The coefficient of the age of the respondent is significant at 1% and positively related to WTP. This implies that young respondents are more willing to pay to access a private potable water supply service compared to older respondents, who are used to accessing water sources free of charge. This relationship is confirmed by the findings of Wondimu and Bekele (2011). The results from the marginal effect reveal that young respondents have a 14% higher probability of WTP than older respondents, ceteris paribus.

There is a positive relationship between the average household monthly expenditure and WTP. Expenditure as a proxy for income increases with WTP, as expected. It is significant at the 10% level in explaining WTP. This finding also suggests that a unit increase in the average monthly income of the household would increase the probability of WTP, all other things being equal.

3.6 The mean WTP

The mean WTP value was calculated after estimating the constant and variable coefficients from the double-bounded probit models. Thus, the mean WTP was estimated at UGX 203.07 (USD 0.06) per 20 litre jerry can, with a 95% confidence interval of UGX [167.11, 255.64]. This is lower than the vendors' average price, which was estimated at UGX 225.5102 (USD 0.07) per 20 litre jerry can. The implication is that households will not only benefit from accessing water privately at their homes, but they will also pay less for the same quantity of water in comparison to the price they are currently paying to water vendors.

4. Conclusion and policy recommendations

The burden of collecting water far away from homesteads, and its associated effects on the health, wellbeing and productivity of households, is a serious challenge affecting most of the households in Wakiso District. This explains why they displayed a positive mean WTP for a private water supply service in their locality. The study used the CVM to estimate households' mean WTP for accessing a potable water supply at their premises in this Ugandan district. Several socioeconomic factors were significant in explaining households' WTP. Based on the positive mean WTP of this study, a policy geared towards extending a private potable water supply service in Wakiso District to meet households' demand will improve their welfare. To ensure sustainability, young households should be targeted, since households' age is significant and positively related to WTP. The policy should also provide a reliable water supply service at a given price that is competitive with the current average price charged by water vendors for a 20 litre jerry can, considering equity and affordability issues. Policies geared towards improving households' income would increase the demand for accessing private water supply services. Although Wakiso District receives a considerable amount of rainfall during the wet seasons, only a few households harvest rainwater (refer to Table 1). Therefore, promoting rainwater harvesting would also increase the demand for private water supply services in the district.

While the findings from our study have policy relevance in Uganda, there are some limitations that future studies should consider when conducting related work. The CVM applied to elicit households' WTP to access private water supply services is not the only appropriate method to measure an improvement in welfare. Applying other methods, such as a choice experiment to generate comparable findings, could be considered in future research. Moreover, the WTP estimates of this study might be season biased, since the study was conducted during the rainy season. To mitigate this limitation, future studies should consider collecting data in both the rainy and dry seasons to get a complete picture of the WTP estimates.

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