IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Households' Water Use Demand and Willingness To Pay (WTP) For Improved Water Services in Abobo Wereda, Gambella Regional State, Ethiopia.

Dr. Akshaya Kumar Mohanty (Ph.D. ; M.Phil. ; M.A. ; L.L.B. ; Q.I.P. & F.D.P.)
Associate Professor Of Economics, Department Of Economics
School of Economics Management and Information Sciences,
Mizoram University,Tanhril ,Aizawl-796004,P.O.Box No: 190 ,Mizoram,India

ABSTRACT

The main objective of this study was to assess household water demand and willingness to pay (WTP) for improved water services in Abobo Woreda of Gambella Region. The specific objectives of the research were to estimate mean WTP and establish factors that influence per capita water consumption and WTP for improved water service. The survey data were collected from 260 households using both purposive and cluster sampling methods, in the month of April 2019, mainly in four villages, namely; Tegny, Village 14, Village 17 and Chebukier. The study used the Contingent Valuation Method (CVM) to estimate WTP using a double-bounded dichotomous choice elicitation format. In assessing the determinants of WTP and water consumption, the study employed both the probit model and double-log regression model, respectively. Results from the study showed that about 67% of households in the study areas were willing to pay the initial bid offered for an improvement in their water services. Generally, about 93% of the sampled households were willing to pay something for the improvement in water services. The study further showed that the estimated mean WTP for a 20 liter of water was 0.40 Cents. On household water demand, results showed that the mean daily per capita water consumption was 26.18 liters. Results from the probit model showed that gender, household size, household income, distance and owning a backyard garden positively and significantly affect WTP. Moreover, age, household daily water used, household averting behavior, current water quality, and the initial bid offered negatively and significantly affected WTP for improved water. On the other hand, results from the double-log regression model showed that gender and years of using source were positive factors influencing household water consumption. In addition, distance, household size, and education level were negative determinants of household water consumption. The implications of the study are that factors such as age, income, level of education, gender, distance, and household size should be considered when setting domestic water tariffs and designing strategies on demand management.

***Key Words**: Probit model, CVM, WTP, discrete choice method.*

I. Introduction

In today's world, 5.2 billion people used safely managed drinking water; the remaining 2.1 billion people without safely managed services in 2015 (WHO, 2018). Sub Saharan Africa is the home to 319 million of peoples who have no access to safe and clean water. In Ethiopia, only 52 percent of the total population has access to improved drinking water services (WHO, 2014, p. 59). According to the report of (MoWIE, 2014, p. 8), more than 30 percent of the population does not access the minimum clean drinking water supply of 15 liters per day per person in a radius of 1.5 kilometers in rural areas and while in urban areas, 20 liters per person per day in a radius of 0.5 kilometers from potable water supply source.

Abobo is one of the 6 woredas in Anguwa Zone of Gambella National Region State of Ethiopia which located 45 KM far from the capital city of the region. The main source of water for most villages far from the area is hand pump. There is no guarantee that hand pump water is safe for drinking any longer when the groundwater has already been polluted. Consuming unsafe water from these sources contributed to a downward spiral of health or travel long distances for clean water, thus further forces them to a harsh poverty snare. This reality represents that, poor communities far apart from the urban are plagued by unsafe water. This would indicate that, despite the progressive improvement of services to the poor by the government, there are still reasons for concern. Therefore, based on the willingness to pay of consumers, public utilities have to come up with new paradigm-shift from supply-driven to demand-driven policy (Getahun, 2013, p. 15).

Many poor households in rural areas still do not have access to safe drinking water. As a result they are forced enough to have high level of water-borne diseases and hygiene problems that cause high mortality rates, more health costs and less labor productivity to the poor class. (Dlamini, 2015, p. 18).Therefore, the purpose of this study was to examine the factors affecing WTP for improved water services in Abobo Woreda, particularly Village 17, Village 14, Tegny and Chebukier which can potentially enhance the understanding of the demand side for improved water services in these areas..

II. Objectives of the Study

i. Examine the factors affecting WTP for improved water service.
ii. Determine the factors affecting per capita water consumption.

III. Literature Review

Mbata (2006) used the CVM to estimate households WTP for water service in a rural economy of Kanye in Southern Botswana and showed a positive relationship between WTP and education level of the head of household. Household heads with some formal education are more likely to be aware of the health implication of alternative source water and thus more willing to pay for a conveniently improved water source.

So-Yoon Kwak, 2013 conducted a survey to measure WTP for tap water quality improvement in Pusan by using CVM and revealed a negative relationship between household education level and WTP. Thus, more highly educated households are less willing to pay than less well-educated households.

Gidey K. and Zeleke E (2012) using CVM examined households' willingness to pay for improved water services in urban areas in Nebelet town, Ethiopia. Further, the study showed a positive relationship between WTP and gender. A significant difference was recorded between males and females in WTP for improved water service. They concluded that female-headed households were more willing to pay for the provision of improved water service than their male counterparts.

Tolulope J. Akeju1, 2018 used the CVM to analyze WTP for improved water supply in Owo Local Government, Ondo State, Nigeria and showed that The relationship between gender and WTP in this study was negative implying male-headed household were more willing to pay for improved water supply than their counterparts.

Aloyce R. M. Kaliba (2003) used the CVM as an analytical tool, their study sought to estimate WTP to improve community-based rural water utilities in the Dodoma and Singida Regions of Central Tanzania, and revealed a positive relationship between WTP and family size. A large family implies the need for more frequent water collection trip and thus, households of more family size were willing to pay more to improve community water project.

Ibrahim A. and Robert H.,(2010) using CVM examined the total economic value of domestic water services in Ramallah Governorate, Palestine and revealed that the age, income and the use of filters have a positive and significant impact on WTP. Water consumption has a negative relationship with WTP implying the more a household consumes the less willing to pay.

In Accra, Ghana, **Daniel K. T** (2015) used the CVM to analyze households' willingness to pay for potable water. Results from the model revealed that household income, time spent to fetch water from existing sources; the level of education, sanitation facility, perceived quality of current water supply; sex and marital status were associated with households WTP for potable water. Household's perception of the quality of existing water was negatively associated with WTP.

Jin Jianjun (2016) adopted a CVM to measure the WTP for drinking water quality improvement in Songzi, China. The result shows that more educated respondents and households with higher income and with fewer household members are, on average, willing to pay more. The finding further revealed a negative association between WTP and bid value which indicates that the respondents were less inclined to say 'yes' to the WTP question if they were presented with a higher bid amount.

Emmy C. R (2018) examined the determinants of WTP for improved management of water project among households of Baringo Country, Kenya using CVM and found that the married respondents were more likely willing to pay for the provision of improved water as compared to their unmarried counterparts. This is because married people are more cautious of health and other risks involved in poor water supply service due to family responsibility in the future than their single counterparts.

Whittington D and Briscoe J (1990) Estimated water demand behaviors in Ukunda rural Kenya and showed that the collection time was significant but with a negative sign meaning that the more time spent on water collection the less water consumed per day. The number of women in a household significantly affects a household's decision on which source of water to use, while, income appears to be relatively unimportant.

Rizaiza (1991) Studied household water usage and revealed that family size, average temperature, income and availability of a garden within the household were statistically significant with a positive sign from both sources. This means that an increase in the family size increases demand for water. Similarly, an increase in income, temperature, and ownership of a garden raise the household annual water demand. The study further showed that the residential water uses in houses supplied by a public pipe network are 1.4 to 2 times greater than the residential water uses in houses supplied by tankers.

Coster (2014) in Nigeria, Ogun State estimated both household use and WTP for improved water services and showed that the connection charges, household size, marital status and availability and quality of water were positive and statistically significant to water use. Distance to water source and unit price for pipe water also proved to be statistically significant to water use but with a negative sign. This shows that the longer the distance to the water source, the less water used by a household.

Berg (2006) studied households' water safety perception and sanitation practices in Southwest Sri Lanka and revealed that the more the number of people living in a household, the lower the water consumed per day which is a strange result. The use of a storage water tank was also positively and statistically significant to both households with private water connection and those without.

Wa'el A. Hussien (2016) in North-Western Iraq, Duhok City investigated domestic water consumption pattern and revealed that total built-up area of the household, number of household occupants, income, number of children, number of male adults and number of adult females were statistically significant to water consumption.

Further, the findings showed that the per capita water consumption increases with income. Additionally, per capita consumption increases with the number of adult female members in the household.

Rouwendal (2000) in his study estimated the household water demand in Salatiga City, Indonesia and cocluded that household size was statistically significant with a positive sign, indicating that an increase in household size results in increases in water used. The use of an extra source of water also showed to be statistically significant but with a negative sign.

It is clear that community water services possess the characteristics of public goods, hence have missing markets.

IV. Research Methodology

The study used both primary and secondary sources of data to gather information. Primary data was collected through a contingent valuation survey from sampled households through personal interviews using structured questionnaires. Five enumerators from the Woreda were hired to conduct face to face interviews. Prior to data collection, training for enumerators on undertaking a Contingent Valuation survey was provided by the principal researcher. This study will use the dichotomous choice method with a follow-up question where households were asked a sequence of questions which led to WTP. The dichotomous choice method with a follow-up question is preferred mainly. Through the pilot survey, some initial bids for the dichotomous double bound model were elicited with the use of open-ended elicitation format.To select the study areas purposive method of sampling was adopted. Succeeding the purposive method stratified sampling method was used where Villages in the study areas will be used as strata. In each stratum, a simple random sampling method will be employed where households were selected with population proportion to size sampling technique to acquire the desired sample size.

To calculate the sample size, n, given the population size N and the estimated population proportion in the selected study site, the study employs the sample size determination as follows (Kothari, 2009, p. 179):

$$n = \frac{z^2 pqN}{e^2(N-1)+z^2 pq}$$

Where: z = (1.96 at $\boldsymbol{\alpha}$ = 0.05) = the z-value of the desired degree of confidence, p = 0.5 = the population proportion of households of interest = (assumed to be 0.5 as this gives the maximum sample size), q =*0.5* = 1- p , and e = (0.05) = the absolute size of error and N = 799 = the population size.

The calculated n = sample size by using the formula = 260.

Secondary data for this study were published and unpublished sources such as reports from the Central Statistics Agency (CSA), Bureau of Water Development and relevant Journal articles.

This study used dichotomous models to estimate respondents' WTP from the sample. The study uses the Contingent Valuation Method (CVM) to estimate WTP using a double-bounded dichotomous choice elicitation format. To assess the determinants of WTP and water consumption, the study employed both the probit model and the multiple linear regression model, respectively.

V. Results and Discussion

V.1. Determinants of Willingness to Pay for improved domestic water.

The first objective of the study was to identify the determinants of willingness to pay, which is, willingness to pay the pre-specified initial bid presented for improved domestic water in the study area. A probit model was used in the analysis where the dependent variable (WTP) was binary taking values of 1 for "willing" and 0 for "not willing". Other variables were included in the model as independent variables. This included both dummy and continuous variables which were households' socio-economic variables, perceptions and other practices related to water use.

Prior to the probit and logit model, a Linear Probability Model (LPM) was run using OLS regressors. From the LPM, the Breusch-Pagan / Cook-Weisberg test for heteroskedasticity in the model and results showed the data was not free from heteroskedasticity. Hence we run robust standard error to get true result with heteroskedasticity problem. Among the 12 explanatory variables used in both models the probability level without and with the robust standard error was shown in Table 1. The result indicates that in the probit model, the variable gender of household head was significant without and with robust but not significant in the logit model in both cases. On the other hand, the averting behavior of household was statistically insignificant without robust and significant with robust in both models.

Table 1. Probit and Logit regression without and with robust

	Probit regression		Logit regression	
bid1	p-value Without Robust	p-value With Robust	p-value Without Robust	p-value With Robust
Gender	0.040	0.033	0.052	0.067
Age	0.001	0.000	0.001	0.000
S.position	0.377	0.358	0.387	0.389
HHSize	0.000	0.000	0.000	0.000
EducLevel	0.988	0.986	0.956	0.950
HHIncome	0.001	0.000	0.001	0.000
Distance	0.000	0.001	0.001	0.002
Waterused	0.032	0.004	0.030	0.004
HHGarden	0.050	0.008	0.035	0.012
AvertingB	0.094	0.030	0.094	0.040
Qulcurent	0.032	0.029	0.029	0.033
Amountbid1	0.000	0.000	0.000	0.000
Constant	0.027	0.013	0.038	0.028

Source: Research Survey, 2019

Furthermore, the pair-wise correlation was performed on variables and perfectly correlated variables were dropped from the model. Multicollinearity was then tested using VIF and the result again virtually showed no signs of multicollinearity as the VIF values were far less than the 10 thresholds. The Contingency Coefficient (CC) for dummy variables was used to test for association amongst dummy independent variables used in the model and results showed no serious associations.

After the tests were performed, the probit and logit model with robust was run and results are shown in Table 2. In both models, the Wald chi-square ($\chi 2$) distribution is used as the measure of the overall significance of a model in probit model estimation. The result from the models shows that the explanatory variables included in the model fit the model at less than 1% probability level. This is shown by the chi-square value of 55.32 with 12 degrees of freedom and 43.13 with 12 degrees of freedom respectively. Generally, this result from the probit and logit model showed that the variables used in the model fit the model very well.

The marginal effects of both probit and logit model estimation results are also reported in Table 2. For the discussion purpose, the marginal effect of the probit model was used. A total of 12 explanatory variables were used in the analysis and the variables not contributing to the log-likelihood of the model were left out and correlated variables were also dropped. Furthermore, From the 12 explanatory variables used, nine variables were significant at less than 5% level in both probit and logit model as shown in Table 2. However, the variable gender was significant only in the probit model but not in logit.

Hosmer & Lemeshow test showed that there was a goodness-of-fit of the model. For this study since the significance of the test for probit and logit was 0.9121 and 0.9692 respectively with the default group 10 which is greater than 0.05, then the model adequately fitted the data. When we increase the group size the probability chi-square increase and vice versa.

Table 2: Probit and Logit Marginal Effect Results for Willingness to Pay

	Probit regression					Margins of Logit regression	
bid1	**Coef.**	**Robust St.Err.**	**z-value**	**margins**	**z-value**	**margins**	**z-value**
Gender	1.096**	0.513	2.14	0.079**	2.130	0.077	1.820
Age	-0.069***	0.015	-4.66	-0.005***	-4.900	-0.005***	-4.670
S.position	-0.376	0.409	-0.92	-0.027	-0.920	-0.027	-0.860
HHSize	0.557***	0.103	5.39	0.040***	6.880	0.040***	6.820
EducLevel	-0.001	0.043	-0.02	-0.000	-0.020	0.000	0.060
HHIncome	0.003***	0.001	3.83	0.002***	4.500	0.001***	4.360
Distance	0.002***	0.001	3.37	0.001***	3.950	0.001***	3.730
Waterused	-0.006**	0.002	-2.89	-0.001**	-3.100	-0.001**	-3.080
HHGarden	1.701**	0.646	2.63	0.123**	2.910	0.134**	3.060
AvertingB	-0.744**	0.344	-2.17	-0.054**	-2.180	-0.053**	-2.030
Qlcurent	-0.289**	0.133	-2.18	-0.021**	-2.280	-0.022**	-2.300
Amountbid1	-0.148***	0.031	-4.82	-0.011***	-7.920	-0.011***	-7.160
Constant	2.603	1.046	2.49				

Mean dependent var	0.735	SD dependent var	0.442
Pseudo r-squared	0.774	Number of obs	260.000
Chi-square	55.323	Prob > chi2	0.000
Akaike crit. (AIC)	93.964	Bayesian crit. (BIC)	140.253

Source: Research Survey, 2019.*** *p<0.01, ** p<0.05, * p<0.1*

Gender of the respondents (Gender): Results from the probit model show that gender of the respondents and WTP for water service improvement is significantly and positively related below 5%, as shown in Table 2. The binary nature of the gender variable (Women=0: Men=1) showed that men-headed were more willing to pay for improved water services than their women counterparts. This implies that men-headed households were found to be willing to pay more for water service improvement than women-headed households. The marginal effect result of the probit model was significant at 5% significant level with a positive sign. The result also reveals that keeping other factors constant, being men increases the probability of saying "yes" to the specified initial bid by 7.9%. This is because since it's the women who carry the burden of water collection in most rural households, it was expected that they will be more willing to pay than mens. However, the result may be so because in Ethiopia, mens are regarded to be the heads and hence responsibilities or decisions of making any payments rely upon them, other than women.

Age of household head (Age): The age of the household head proved to be significant and negatively associated with WTP for improved water service at less than 1% probability level. The negative association between WTP and age of the household head means that as age increase, the probability of a respondent saying "yes" decrease and vice versa. Similarly, the marginal effect result also had a negative sign. This basically implies that holding all other variables constant at their means, a one year increase in the age of the household head reduces the probability of accepting the initial bid by 0.5%. This result, therefore, indicates that younger household heads are more willing to pay for improved domestic water than older heads in the study area.

Social Position (S. Position): It was expected that heads in social positions would be more willing to pay for an improvement in the community's water services. This was mainly because being in social (leadership) positions inspire some form of social responsibility, thus being more willing to pay for community-driven development such as an improvement in community water services. Both the probit analysis and it's marginal effects results reported no significant association between WTP and being in a societal position.

Household size (HHSize): In contrast to social position, the probit result for household size also showed to be significantly related to WTP at less than 1% probability level with a positive sign. This implies that large household has a higher probability of willing to pay for improved water service than small household. The marginal effect was also significant with a positive sign. The result shows that keeping all other variables constant at their mean values, the one member increase in the household size increases the probability of accepting an initial bid by the probability of 4%.

Education Level (Educlevel): The number of years the household head attended school proved to be consistent with *a priori* expectations as the variable took a positive sign. This can be mainly because the more educated household heads the more aware of the importance of clean water utilization hence the more willing to pay for an improvement in such a service. However, both the probit and marginal effect result showed no statistically significant association between WTP and household education level. The plausible explanation for this finding is that education level in itself is not an important sociological variable affecting WTP for improved water service and in other words, more and less educated heads of households' value improved water service equally. This is because, the households in Abobo accessed different trainings formally and informally on sanitation and hygiene. Therefore, they are aware of the health implications of alternative sources of water.

Household Income (HHIncome): Average monthly income of households was shown by the positive coefficient and statistical significance at less than 5% probability level on the probit result. Similarly, the marginal effect result for household income showed a positive and significant relationship with households' WTP. This meant that keeping the influences of other factors constant at their mean values, the one Birr increase in household income increases the probability of accepting the first bid in by about 0.02%. Generally, this implies that an increase in income of a household shifts the demand curve for clean and potable water to the right. This shows that higher-income families have better chances of maximizing utility and enjoy better and high-quality goods.

Distance to a water source (Distance): The result showed that the more the distance traveled, the higher the disutility to the household involved. The result was significant at 1% probability level with a positive sign. Similarly, the marginal effect coefficient was also positive and statistically significant. Thus, it implies that households who travel long distances to fetch water are more likely to be willing to pay for an improved water source and nearer water source as compared to their counterparts. Holding all other factors constant, the one-meter increase in the average distance traveled by households increases the probability of WTP by 0.1%.

Water Consumption (Waterused): The amount of water in liters used per day in a household showed statistically significant and negative influence on WTP for improved water service. This was mainly because households using large quantities of water may be satisfied thus not be willing to pay for an improvement of such a service. The marginal effect result shows, holding all other factors constant, one-liter increase in the average quantity of water consumed by households decreases the probability of WTP by 0.1%.

Household Garden (HHGarden): This (Ownership of a small garden in a household) is shown by the significant p-value at 5% with the positive sign, suggesting that households owning gardens in their backyard were more willing to pay than their counterparts. The marginal effects also reported a similar result. This meant that a household owning a garden has a higher probability of accepting the initial bid by 12.3% ,*ceteris paribus*. As household gardens helps in enhancing both food security and nutrition levels in households, households owing gardens are aware of that they would appreciate a closer source of water to enhance their production.

Averting behaviors (AvertingB.): Awareness of the importance of using clean water encourages households to practice preventive measures on the water before consumption. Such measures included boiling, refrigerating, use of chemicals and others. This variable was significant at less than 5% probability level with a negative sign. Households practicing such measures showed to be less willing to pay than households not practicing such measures. The marginal effect was also significant with a negative sign. This basically implies, holding the effect of other variables constant, households practicing preventive measures before using has a lower probability of accepting the initial bid by 5.4%.

Water Quality (Qulcurent): The result implied that the higher the quality households perceive their current water to be, the less they are willing to pay for water. This was mainly so because of the negative sign on the coefficient and statistically significant p-value at less than 5% probability level. The marginal effect result on water quality also maintained the same sign and significance level. Holding all other factors constant, one unit increases in the quality of water as perceived by households lowers the probability of saying “yes” by 2.1%. This result shows that it is a rational human behavior that households using safe water may be satisfied and thus not willing to pay more for a similar good.

Initial bid value (Amountbid1) : For probit model, the result indicates that the initial bid (IBID) have a statistically significant negative impact on the respondents’ decision towards a willingness to contribute the specified cash for improvement of water service at 1% probability level. This implies that the probability of a ‘yes’ response to the initial bid increases with decrease in the offered initial bid which indicates that the likelihood of accepting an offered bid amount increases as the bid amount goes down and vice versa which is consistent with the economic theory. The marginal effect results showed a similar sign and statistical significance. This implies that keeping other factors at their mean values, a 10% increase in the bid offered to households decreases the probability of accepting it by 1.1%. This shows that the higher the price of a good, the less the demand and vice versa.

V.2. Factors affecting household water consumption

Finally, the last objective of the study was to identify the determinants of per capita water consumption. Using the double-log regression model, the log of daily household water used per capita in liters, was used as the dependent variable explained by nine explanatory variables. These included gender of household head, ownership of a water tank, distance traveled to collect water, household size, marital status of a household, education years of household head, a log of the age of household head, the log of household income and log number of years using water source.

For this objective, the study used the multiple linear regression model. In our model, data suggested both non-constant variance and non-linearity condition on the errors and regression coefficients respectively. For this reason a transformation of the model to a double-log model was chosen to control both for non-constant variance and non-linearity. However, the result from the Breusch-Pagan / Cook-Weisberg test for heteroskedasticity in the model showed that the data were not free from heteroskedasticity . Therefore, the researcher run a robust standard error to get true result with heteroskedasticity problem. Among the 9 explanatory variables used in the model, the variable gender was insignificant without robust but the robust regression showed significant value. In contrast, the variable household ownership of water tank was significant without robust but not with robust standard error as shown in Table 3.

A preliminary analysis of variables was conducted to ensure that the variables included in the model explain the dependent variable and are not highly correlated. Highly correlated and irrelevant explanatory variables were dropped from the model. The results from the correlation matrix of variables used in the model showed that there were no signs of highly correlated variables reaching the standard rule of thumb 0.7. In addition, variables were also tested for multicollinearity using the VIF test and again results showed no signs of multicollinearity problem .

From the Table 3, the variance explained (R^2) was found to be 0.4759 which implies that the explanatory variables included in the model were only able to explain about 48% of the variance in daily per capita water demand. The F-test shows that the overall model is significant at less than 1% probability level. This shows that the model was correctly specified. Furthermore, the post-estimation test of the Ramsey test showed that the model is not underspecified.

Table 3. Double-log Regression Analysis for Water Consumption

	Double-log regression without robust			**Double-log regression with robust**		
Lnpcwcon	Coefficients	St.Err.	t-value	Coefficients	Robust St.Err	t-value
Gender	0.143	0.083	1.73	0.143**	0.072	1.99
Martstatus	0.012	0.126	0.09	0.012	0.117	0.10
Distance	-0.001***	0.000	-3.79	-0.001***	0.001	-4.09
Lnyear	0.229***	0.057	4.01	0.229***	0.057	4.01
Lnage	0.057	0.151	0.38	0.057	0.162	0.35
HHSize	-0.195***	0.020	-9.63	-0.195***	0.024	-8.16
Lnincome	-0.072	0.066	-1.09	-0.072	0.057	-1.25
HHEducLevel	-0.040***	0.011	-3.70	-0.040***	0.012	-3.33
Watertank	0.198**	0.100	1.99	0.198	0.120	1.65
Constant	4.117	0.782	5.26	4.117	0.822	5.01

Mean dependent var	2.973	SD dependent var	0.707
R-squared	0.476	Number of obs	260.000
F-test	25.223	Prob > F	0.000
Akaike crit. (AIC)	408.746	Bayesian crit. (BIC)	444.353

*Source: Research Survey, 2019 ; *** p<0.01, ** p<0.05, * p<0.1*

Marital Status (Martstatus): The marital status of the household head does not affect household per capita water used. The variable was not significant at any level of significance but had a positive sign in line with *a priori* expectations.

Gender (Gender): The gender of household head (Gender) was statistically significant at less than 5% probability level with a positive sign. The result was not in-line with *a prior* expectation since a negative sign was expected. This basically implies that being a male household head will increase per capita water demand by

15%$(e^{0.143}-1)*100)$. This was not strange during the survey. Due to lack of water nearby their home, males are responsible to fetch domestic water from long distances by using bicycle and other transportations which are difficult for females.

Distance to a water source (Distance): Results from the study showed that distance to the water source was statistically significant at 1% level of significance and significantly associated with per capita water consumption with a negative sign which is in line with *a priori* expectations of the study. This implies that a one-meter decrease in the distance traveled to collect water will increase per capita water demand by 0.09% $(e^{-0.001}-1)*100$, *ceteris paribus*.

Water Tank (WaterTank): The variable, ownership of a water tank in a household was not statistically significant at any probability level with a positive sign which was true with *a priori* expectations of the study. This meant that households owning a water tank consume more water per capita than their counterparts.

Education Level (HHEducLevel): The coefficient of a number of years attending school by the household head appeared to be significant at less than 1% probability level with a negative sign that is not in-line with *prior* expectation. The implication of negative sign is that holding other factors constant, an1% increase in the level of education by the household head decreases daily water per capita consumed by 4% $(e^{-0.0397}-1)*100$. This is a strange result with economic theory in the way that increase in education levels means increase in incomes thus increased demand for goods like domestic water. When households increase their education level they are employed on government institutions like school and health center. Because of the current budget deficit of regional state, people of Abobo Woreda are expected to stay three to four months without salary as a result they consume less quantity of domestic water.

Household Size (HHSize): The variable (the size of the household) was statistically significant at less than 1% level of significance with a negative sign. The result implies that holding the effect of all other variables constant, an 1% increase in household size decreases water consumed per capita in the household by 18% $(e^{-0.195}-1)*100$. The result was not true with *prior* expectations as increases in household size can decreases the level of water consumed. This result is may be, when the dependent variable is total household consumption, larger households are found to have larger water use. However, the dependent variable is per capita consumption which was calculated by dividing the amount of water withdrawn or used by the number of people using it, scale effects are confirmed, i.e., per capita consumption decreases with the number of members in the household.

Number of years using water source (Lnyear): Lastly, the variable number years of using current water source was also found to be statistically significant to per capita water use at less than 1% level with a positive sign. This implied that a 1% increase in the number of years a household using the same water source increases per capita water consumed by 0.23%$(1.01^{0.229}-1)*100$, holding other factors constant. This result was not in-line with *a prior* expectation of negative sign.

VI. Summary, Conclusions and Recommendations

VI.1. Summary of findings

The third objective of the study was to assess the determinants of willingness to pay for water in the study areas. A probit model was used to assess the determinants of WTP for improved water using 12 explanatory variables. Results showed that age of household head (Age), daily water consumption (Waterused), the averting behavior of household, current water quality (WaterQuality) and the initial bid offered (LowerBid1w) was significantly and negatively influencing WTP. On the other hand, sex of the household head (Gender), household size (HHSize), average household monthly income (HHIncome), distance to a water source (Distance) and ownership of a back-yard garden (HHgarden) were positively and significantly affecting household WTP decision for improved water.

Finally, the last objective of the study was to assess the factors affecting per capita daily water consumption. The study employed the double-log linear regression model in answering the objective. Results from the model showed that per capita water consumed was significantly and positively affected by the gender of household and the number of years using the current water source (Lnyear). On the other hand, education level of the household head (HHEducLevel), household size (HHsize) and distance to collect water source (Distance) were negatively and significantly influencing daily per capita water consumption.

VI.2. Conclusions

It is mportant for human kind to conserve such a resource in the face of increased demand due to increases in incomes and populations. For this reason, the study used both stated preference and utility data approaches in an effort to assess the demand side for domestic water services in the study area. Two models, probit model and double-log regression model, were estimated using household-level data to address the study objectives and questions.

Households' WTP shows that there is room for policies or projects aimed at improving rural domestic water using a water price system that can be used for both cost recovery and demand management purposes. This is important particularly because of the change in water demand management from a supply-oriented approach to demand oriented approach for water demand management in the study areas. Households in the study areas showed that they are capable of paying an amount of up to 40 Cents for a 20 liter of clean potable water. The implication of this is that partial recovery on investment costs and operating costs required for the sustainability of the project can be achieved through the introduction of water tariffs.

The results from the study further showed that socio-economic factors such as gender, household size, household income, education, distance, household age, current water quality, and others are responsible for both households WTP decision and water consumed. It is, therefore, important for policy and water managers to address the water problem in these areas have taken into consideration these important characteristics affecting water demand. Therefore, the study findings concluded that WTP for improved water and per capita water consumption depends on both consumers' and product sensory attributes.

VI.3. Recommendations

Based on the study findings, the study recommends the following points which need to be considered in the planning and implementation of the water project in these areas.

- Both water demand techniques (stated preference and survey utility) used in the study showed that residents in the study areas were concerned with the availability and quality of water. It is for that reason that households in the study areas were willing to pay an amount of up to 40 Cents per 20 liters of water. This amount translates to about 0.02 cents per liter of water. Therefore, this shows that there is room for improving semi-urban and rural water services through a cost recovery mechanism. Thus, as the proposed project introduces a demand-driven approach for water management to these areas, there is room to increase coverage of rural water schemes with the potential of charging even a higher price of water.
- The results from the study showed that family size negatively affects per capita household water consumed. This shows the extent of water scarcity in the study areas hence the government should look into it sothat the proposed water project is implemented. This water project has the potential to uplift rural livelihoods in the sense that with more water, households can use the water for non-domestic purposes like backyard garden irrigation, livestock rearing, traditional beer production, etc., which can enhance households' income and hence help in reducing poverty.
- Furthermore, household income significantly and positively influenced WTP in the study areas. This, therefore, implies that for successful implementation of the project, a subsidy is to be targeted for the poor.

- The results from the study also showed that distance from water sources significantly and positively influenced WTP. Adding to that, distance to a water source also statistically and negatively affected the household water consumption. This, therefore, shows that households traveling long distances to collect water were more willing to pay for water as the distance affects their current consumption negatively. There is, therefore, a need for the upcoming water project in the study areas to decentralize the kiosk centers targeting households traveling longer distances for water.

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