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Households' Willingness to Pay for Improved Rural Water Service Provision: Application of Contingent Valuation Method in Eastern Ethiopia

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ABSTRACT Water problem in rural areas of Ethiopia is two-fold: low coverage levels and poor quality that require urgent attention to reduce associated health and social implications. Women and children spend hours a day collecting water: time that would be better spent in education or productive employment. Cognizant of this fact, the government and donor organizations are currently performing a number of activities to improve the coverage and quality of water supply with partial cost recovery systems. Hence, the affordability and willingness of the consumers that are supposed to be served need to be examined. The primary objective of this study is, therefore, to estimate willingness to pay (WTP) of rural households for improved water service provision and identify its determinant by employing contingent valuation method (CVM) in Haramaya district. The study used primary data obtained from a survey conducted on randomly selected rural households. We used double bounded dichotomous choice elicitation method administered by in-person interview. The data was analyzed using descriptive statistics and bivariate probit model. Response to the hypothetical scenario revealed that sampled households expressed their WTP with a mean WTP of 27.30 cents per 20 liters jerrycan. The results of bivariate probit model revealed that household income, education, sex, time spent to fetch water, water treatment practice, quality of water and expenditure on water have positive and significant effects on WTP for improved water service provision, while age of the respondent has a negative and significant effect.

INTRODUCTION

Water, which is a non-substitutable resource, is one of the most essential elements of life. We humans depend not only on an intake of water to replace the continual loss of body fluids, but also the food we depend on needs water (Kargbo 2003). The provision of water and sanitation is an important sector that improves the wellbeing of the people (Teshome 2007). Clean water is a merit good that confers relatively large social benefits on society, which far outweighs the cost of its provision. It is a good whose consumption is deemed to be intrinsically desirable. In the case of such goods, it is argued that consumer sovereignty does not hold and that if consumers are unwilling to purchase adequate quantities of such goods, they should be encouraged to do so (Kargbo 2003).

Historically, water was available in ample supply and therefore was treated as a free good, and continued to remain so even with increase in population and economic growth. As a consequence, many rivers and groundwater sources have become polluted and water is now a scarce resource. Hence, effective water resource management requires that water be treated as an economic good. To argue for water to be treated as an economic good does not necessarily imply that a market price must be paid for it. What it means is that water is a scarce and valuable resource that should not be wasted, and that proper valuation will ensure efficient utilization. Some people feared that the adoption of this principle would lead to economic pricing of water, which would damage the interests of the poor. As a result, a number of disclaimers were stating that water is also social good and that it should be affordable to the poor (Borgoyary 1988).

The Millennium Development Goals (MDGs) are international targets to halve world poverty by 2015, agreed upon by all 189 United Nations member states at the UN Millennium Summit in 2000. As part of MDG7 there is an indicator target to halve the proportion of people living without sustainable access to safe drinking water and basic sanitation by the same year. The definition of sustainable access to safe drinking water by World Health Organization (WHO) is safe water source less than one kilometer from point of use, from which it is possible to reliably obtain 20 liters of water per person per day (Norman 2007).

Every year, millions of the world's poorest people die from preventable diseases caused by inadequate water supply and sanitation services. Women and children are the main victims. Burdened by the need to carry water long distances every day, their poverty is aggravated and their productivity impaired, while their sickness puts severe strains on health services and hospitals. On the other hand, increased water and sanitation access promotion creates improvements in people's health and has an indirect positive effect on educational opportunities, gender equality, and the empowerment of women. Studies demonstrate that provision of improved water services increases school enrollment of girls and frees women from spending hours every day drawing and carrying water home (WSP 2003). Access to safe water also supports economic growth. Income benefits for both households and government may result from a reduction in the costs of health treatment and gains in productivity. Productivity gains stem from time saved from collecting water, the availability of water as an input to the productive sector, and a decline in water and sanitation related illnesses.

Ethiopia is one of the few countries with a constitutional provision to a formal right to water (Anand 2007). It is also one of the countries who are currently promoting a number of activities to realize the water supply and sanitation target of MDGs. The success of the country to achieve these goals may encounter some challenges. A number of rural water supply and sanitation projects lack financial and material resources, largely depend on foreign aid or loan, lack necessary skilled personnel, and both users and service providers lack awareness regarding the government rule and regulation on water supply and sanitation. Water related problems in rural areas of Ethiopia relate not only to low coverage levels but also poor water quality. Both require urgent attention to reach the MDG target, and to lessen associated health and social implications. The health problem is increased susceptibility to water-borne diseases such as diarrhea and dysentery, water-washed diseases such as trachoma and scabies, water-based diseases such as schistosomiasis, and water-related insect vectors including malaria.

The Government of Ethiopia has implemented policies, strategies, and sector development programs that help to achieve MDG targets. These include the comprehensive National Water Resources Management Policy (MoWR 1999) and Ethiopian Water Sector Strategy (MoWR 2001), providing guidance for investments in rural, town and urban water supply and sanitation. Some of the key aspects of the water sector policy and strategy include high priority to urban and rural water supply with full cost recovery for urban systems and recovery of operation and maintenance costs for rural systems by promoting decentralized decision-making, and stakeholder involvement. However, these interventions that aim to improve the coverage and quality of water supply are not demand oriented, as they are supply driven in project design, that is, improve water supply and management strategies. The affordability and willingness of the consumers that are supposed to be served is not considered. Moreover, the fundamental importance of the value the consumers place on the improved water has been ignored. This study is, therefore, aimed at analyzing the demand for and the value attached to improved rural water supply by final beneficiaries employing Contingent Valuation Method (CVM) based on data generated from household survey in Haramaya district of eastern Ethiopia.

Conceptual and Theoretical Understanding

A market is an exchange institution that serves society by organizing economic activity. It uses prices to communicate the work of a diffuse and diverse society so as to bring about coordinated economic decisions in the most efficient manner. The power of a perfectly functioning market rests in its decentralized process of decision-making and exchange, no omnipotent central planner is needed to allocate resources (Hanley et al. 1997). However, the principle that public goods are not efficiently allocated by the market suggests the possibility of improvement by public action. Whether the public action in fact yields net benefit requires measurement. To meet the demands for measurement, economists have devised empirical valuation methods for estimating the benefits and cost of public actions (Haab and McConnel 2002).

A number of valuation methods have been developed by economists to estimate the value consumers place on non-market goods and services among which contingent valuation method (CVM) is the most often used. CVM is among the stated preference valuation approaches and is based on direct expression of individuals' willingness to pay or willingness to accept in compensation for any change in environmental quantities, qualities, or both. That is, direct valuation method involves direct estimation of environmental value based on the responses of individuals to the hypothetical valuation questions and hence it does not depend on market information (Freeman 1993). CVM enables economic values to be estimated for a wide range of commodities, which are not marketable, measured in relation to utility functions through the concepts of willingness to pay (WTP) and willingness to accept (WTA) compensation, as well as through the related measures of consumer's surplus.

For an individual, WTP is the amount of income that compensates for (or in equivalent to) an increase in public good expressed as:

$$V(y - WTP, p, q_1) = V(y, p, q_0) \quad (1)$$

Where *V* denotes the indirect utility function, *y* is income, *p* is a vector of prices faced by the individual, and q_0 and q_1 are the alternative levels of the good (with $q_1 > q_0$ and increase in q is desirable). Willingness to accept is the change in income that makes an individual indifferent between two situations: original public good, q_0, but income at y +WTA and the new level of public good, q_1, but income at y. It is defined implicitly in the following equality:

$$V(y + WTA, p, q_0) = V(y, p, q_1) \quad (2)$$

Even though the use of CVM provides sufficient flexibility to enable the estimation of total economic values associated with environmental impacts, its use has been the subject of considerable criticism. These criticisms have been centered on the technique's reliance on people's statements of preference. However, available studies on community forest, water service, sanitation service and wildlife protection areas suggest that it can be successfully applied both in developed and developing countries (Alemu 2000; FAO 2000; Kinfe and Berhanu 2007; Hayatudin et al. 2008; Adenike and Titus 2009; Kremer et al. 2009).

Adenike and Titus (2009) analyzed the willingness to pay for improved water supply service by households in Osogbo metropolis, Nigeria. A multistage random sampling technique was employed to select 142 households from areas with public water services and those without connection to public water. The researchers used logit model to analysis factors that determine the willingness to pay for improved water services. The results revealed that age and educational level are positively related to WTP for improved water services. The result indicates that as the age and the level of education increase the tendencies to adopt and pay for improved water source will also increase. The coefficient of household expenditure, a proxy for income and the proportion of income that a household is willing to pay for improved services are positive, indicating that an increase in income will increase the probability and the proportion of income that households would be willing to pay for improved water services.

Kaliba et al. (2003) estimated willingness to pay of households from 30 villages in Tanzania to improve community-based rural water utilities. The study showed that households in the study areas are willing to pay higher than the existing tariff charges. Respondents' socio-economic factors like age, wealth and household size are determinants of WTP. Willingness to pay for improved water services is negatively affected by age and wealth. This is because older individuals do not directly participate in fetching water and wealthier households have their own water sources or they delegate others to collect water for them at lower costs. The family size is positively related to WTP as households with larger family need more water and thus they are willing to pay more.

Kargbo (2003) used the contingency valuation method with bidding game to analyze households' willingness to pay for improved water services in Makeni, Sierra Leone. The results revealed that starting point bias affects the final willingness to pay bids of the respondents. The OLS results depicted that willingness to pay is positively related to income, education and water quality while it is negatively related to the age of the respondent.

Based on the above theories and empirical evidences, it is possible to suggest that CVM is a powerful tool for measuring the economic benefits of the provision of non-marketed goods like improved water services in developing countries including Ethiopia.

METHODOLOGY

Source of Data and Sampling Design

The study area, Haramaya District, is one of the 18 districts in East Hararghe zone. The district has a total area of 521.63 km^2, accounting for about 14% of the total area of East Hararghe zone. Its capital, Haramaya is about 417 kms far away from Addis Ababa to the east direction along Addis Ababa – Harar main road. The district has midlands (90%) and lowlands (10%) agro-climate zones. Average annual rainfall and temperature of the district range between 118 mm and 866 mm and 9.4^0c and 24^0c, respectively. The total population of the district was estimated to be 271,394 in 2007. Rainfed agriculture is the dominant economic activity and the base of livelihood of the majority of the residents of the district. The agricultural activities in the district is characterized with peasant farming system that involves mixed farming, that is, crop and livestock production.

Data used in this paper is cross-sectional collected from randomly selected farm households of Haramaya District in 2010/2011 production year. It is collected by using carefully designed CV survey questionnaire to solicit respondents' WTP for improved water supply. Three-stage sampling techniques were implemented. First, simple random sampling was employed to select three peasant associations (PAs) from 33 PAs in the district. In the second stage, two villages from each of three PAs were randomly selected. Finally, 126 households were allocated to the selected PAs using probability proportional to size sampling technique and then derived systematically from the two villages of each PA.

A series of focus group discussions and pretesting of draft questionnaire was undertaken aimed at determining the bid sets, to check community water use practices, and wording and ordering of the draft questions. It has also an advantage of enabling the enumerators to have experience in administering the CV survey. From pre-test and focus group discussions, three most frequent bid values were selected as starting point price for double bounded dichotomous choice (DBDC) format. These are 25, 40 and 50 cents of ETB for one jerrycan (20 liters) of water. Using these initial bids, sets of bids were determined for follow up question based on whether the response is "no" or "yes" for the initial bid. These sets of bids were (25, 15, 40), (40, 20, 60) and (50, 25, 75) cents for per jerrycan.

Empirical Model Specification and Analysis

A bivariate probit model was employed to analyze the data because the bivariate normal density function is appealing in the sense that it allows for non-zero correlation, while the logistic distribution does not (Cameron and Quiggin 1994; Jeanty et al. 2007). Following Haab and McConnell (2002), econometrically modeling data generated by this format relies on the formulation given by:

$$WTP_{ij} = \mu_i + \varepsilon_{ij} \tag{3}$$

Where WTP_{ij} = j^{th} respondent's WTP and i=1, 2 represents first and second answers; μ_1, μ_2 = mean value for first and second responses; ε_{ij} = unobservable random component.

The probability of observing each of the possible two–bid response sequences (yes-yes, yes-no, no-yes, no-no) can be expressed as follows. The probability that respondent *j* answers to the initial bid and to the second is given by (Haab and McConnell, 2002):

$$\begin{aligned}
Pr(no, no) &= Pr(WTP_{1j} < t^1, WTP_{2j} < t^2)\\
&= Pr(\mu_1 + \varepsilon_{1j} < t^1, \mu_2 + \varepsilon_{2j} < t^2)\\
Pr(no, yes) &= Pr(WTP_{1j} < t^1, WTP_{2j} \geq t^2)\\
&= Pr(\mu_1 + \varepsilon_{1j} < t^1, \mu_2 + \varepsilon_{2j} \geq t^2)\\
Pr(yes, no) &= Pr(WTP_{1j} \geq t^1, WTP_{2j} < t^2)\\
&= Pr(\mu_1 + \varepsilon_{1j} \geq t^1, \mu_2 + \varepsilon_{2j} < t^2)\\
Pr(yes, yes) &= Pr(WTP_{1j} \geq t^1, WTP_{2j} \geq t^2)\\
&= Pr(\mu_1 + \varepsilon_{11j} \geq t^1, \mu_2 + \varepsilon_{12j} \geq t^2)
\end{aligned} \tag{4}$$

Where t^1 = first bid price and t^2 = second bid price.

This formulation is referred to as the bivariate discrete choice model. Assuming normally distributed error terms with mean 0 and respective variances s^2_1 and s^2_2, then WTP_{1j} and WTP_{2j} have a bivariate normal distribution with means μ_1 and μ_2, variances s^2_1 and s^2_2, and correlation coefficient r.Given the dichotomous choice responses to each question, the normally distributed model is referred to as bivariate probit model.

After running regression of dependent variable (the yes/no indicator), on a constant and on independent variable consisting of the bid level, the mean willingness to pay value (Mean WTP) is calculated employing the following equation depending on the normality assumption of WTP distribution (Haab and McConnell 2002):

$$\text{Mean WTP} = ß_0 / ß_1 \tag{5}$$

Where $ß_0$ = intercept of the model which is constant; $ß_1$ = slope coefficient of bid values.

Based on review of empirical studies, specific household characteristics and attributes of water source which are hypothesized to affect the household's decisions on WTP for improved rural water supply were identified. These include household income (TINCOME), wealth of the household (VSTOCK), household size

(HHSIZE), sex of respondent (SEX), age of respondent (AGE), education level of the respondent (EDUC), time taken to fetch water (TOTIME), daily water consumption by the household (CONSUME), initial bid (BID), annual expenditure on water (WEXP), alternative water source (SSOURCE), water treatment practice (TREAT), access to credit (CREDIT), source of water the household uses currently (SWATER), and marital status (MARITAL) of the respondent.

RESULTS AND DISCUSSION

Descriptive Analysis of Survey Data

A total of 126 sample households were interviewed in the survey. Out of this total sample, 122 were valid and the remaining 4 were incomplete response. From the respondents for which responses were valid, about 50.8% (62) are males and 49.2% (60) are females; 56.6% (69) are household heads and the rest 43.4% (53) are spouses of household heads. The average age of respondents is 34.4 years: About 9.8% have attended high school (grade 9 to 12) and above, 16.4% had completed grade 5 to grade 8, 16.4% had completed primary level schooling, while 13.9% had participated in adult education program and about 43.4% had never gone to school. The average family size of the total sampled household is 6. About 115 respondents (94.3%) are married and had one or more children, 3 (2.4%) are single and 4 (3.3%) are widowed.

Majority of the sampled households make a living out of subsistence agriculture and animal rising. The result shows that only 13.4% (20) of all the total sample households have other sources of income than farming. The mean non-farm/off-farm income of households and the average value of farm produce by households for the year 2009/10 were ETB 1,083 and 15,440 per year respectively. The total value of livestock holdings range from 0 to ETB 64,500 across households and the average is ETB 6,530**.**

Households in the study area primary depend on six types of water sources for drinking and other domestic uses. These are spring developed, unprotected spring, well, river, harvested lake and tap water from venders. Among the sampled households, 52.5% uses water with poor quality from well, harvested lake, river and unprotected spring while 47.5% use protected spring and tap water (from urban venders). The primary source, however, varies across the sampled PAs. Fetching of water for various uses is almost exclusively the responsibility of women and children, which has an implication on their participation in income generating activities and education, respectively. The average walking time to fetch water is 45 minutes and ranges from 0 to 4 hours. The waiting time at the sources varies from 0 to 2 hours, with a mean duration of 21 minutes and standard deviation of 30 minutes. Average total time taken by households to fetch water from primary sources is 65 minutes and ranges from 0 to 270 minutes[1].

About 68.9% of households use human power, 17.2% use donkey and 13.9% use both to carry water from the source to their home for domestic use. The households use an average of 66.06 liters a day for drinking and domestic purpose. Per capital water consumption across sampled household ranges from 0.67 to 40 litters and the mean is 11.55 litters. The estimated average per capital consumption is significantly lower than the minimum sufficient quantity of water, which is defined as 20 liters per person per day (Wolday 2005). The per capital consumption for about 80% of the sampled households is less than 20 liters per day.

Monetary cost for water service varies depending on the source of water the households are using and quantity of water they are consuming. About 34.4% are using from water vendors and pay daily for water service while the rest 65.6% of households do not pay for it. Daily water cost ranges from ETB 0.50 to 4.00 among households using from vendors and the average is ETB 1.15. Results also revealed that almost 59% of the respondents do not practice any type of treatment method, 12.3% use filtering, 15.6% use chemicals, 8.2% use boiling and the rest use combination of these methods (Table 1).

Willingness to Pay for Improved Rural Water Supply

As discussed earlier, the study used three sets of bid prices that were chosen during the pilot survey which were proportionally distributed to survey questionnaire. From the total respondent, 78.7% and 64.8% responded “yes” for first and second bid, respectively. The distribution of “yes” and “no” for the first and sec-

Table 1: Summary of descriptive statistics for explanatory variables (N=122)

Variable	*Description*	*Mean*	*Std. dev.*	*Min.*	*Max.*
BID	Initial bid in cents	38.40	10.11	25	50
SSOUCE	Alternative water source (1=Yes)	0.713	0.454	0	1
TOTIME	Time taken to fetch water in minutes	65.37	74.53	0	270
CONSUME	Daily water consumption in liters	66.06	40.09	2	240
TREAT	Water treatment practice (1=Yes)	0.41	0.494	0	1
SEX	Sex of the respondent (1=Female)	0.49	0.502	0	1
AGE	Age of the respondent in years	34.38	13.65	18	70
MARITAL	Marital status (1=Married)	0.943	0.234	0	1
HHSIZE	Household size	6.164	2.354	1	15
CREDIT	Access to formal credit (1=Yes)	0.057	0.234	0	1
TINCOME	Total household income	16523.76	10974.38	2513	63735
VSTOCK	Wealth of the household in ETB	6529.67	9158.32	0	64500
EDUC	Education level of the respondent (EDUC)	0.442	0.498	0	1
SWATER	Source of water (1=low in quality)	0.131	0.339	0	1
WEXP	Annual water expenditure in ETB	144.62	263.71	0	1460

ond bids across the different initial bids reveals that as the initial bid gets higher the frequency of "yes" response decreases and that of 'no' increases (Table 2).

Table 2: Response to double bounded question across bid sets

1st bid (cents)	*2nd bid (cents)*	*No. of response to 1st question*		*No. of response to 2nd question*	
		No	*Yes*	*No*	*Yes*
25	15	6	0	4	2
25	40	0	33	2	31
40	20	10	0	9	1
40	60	0	34	11	23
50	25	10	0	7	3
50	75	0	29	10	19

From 39 respondents offered with 25 cent initial bid price, about 79.48% (31) accepted both first and second bid, 10.26% (4) reject both the first and the second bid, 5.13 % (2) accepted the first bid and rejected the follow up higher bid, and the remaining 5.13% (2) rejected the first bid and accept the follow up lower price. That is, of the 6 'No' and 33 'Yes' responses to initial bid, the follow up bids resulted in 4 'No' and 2 'Yes' responses and 2 'No' and 31 'Yes' responses, respectively.

From respondents of the 40 cent initial bid, about 52.27% (23) accepted both first and second bid, 20.46% (9) rejected both the first and the second bid, 25% (11) accepted the first bid and rejected the second higher bid, and 2.27% (1) rejected the first bid and accepted the follow up lower price. Similarly about 48.72% (19) of the respondents of the 50 cent initial bid accepted both first and second bid, 25.64% (10) accepted the first bid and rejected the second higher bid price, 17.95% (7) rejected both the first and the second bid and the remaining 7.69% (3) rejected the first bid and accepted the follow up lower price.

Moreover, from the joint frequencies of discrete responses, we can notice that about 60% responded "Yes" for both the 1st and 2nd bids, about 16% responded "No-No", about 19% responded "Yes-No" and about 5% responded "No-Yes" (Table 3). Another interesting result is that 76% of the respondents who accepted the 1st bid gave similar response for the follow up question and 77% of those who rejected the 1st bid again rejected the 2nd bid. This could indicate the presence of the first response effect on response for the follow up question, which is consistent with prior studies done by Solomon (2004) on valuation of multi-purpose tree resource using DBDC elicitation format and Cameron and Quiggin (1994).

Table 3: Joint frequencies of discrete response

Response	*Frequency*	*Percentage (%)*
Yes-Yes	73	59.84
Yes-No	23	18.85
No-Yes	6	4.92
No-No	20	16.39
Total	122	100

Econometric Analysis

Variance Inflation Factor (VIF) and contingency coefficients were computed to check the existence of serious multicollinearity problem among continuous and discrete explanatory variables, respectively. The results indicated that there is no serious multicollinearity problem among explanatory variables and hence all the hypothesized variables were included in the analysis.

Bivariate probit model as specified in the preceding section has been employed to identify explanatory variables that influence households' WTP for improved rural water supply. In line with Mitchell and Carson (1989) and Hanemann et al. (1991) which highlighted the problem of non-normality and outliers in CV studies, and advocated the use of robust estimators as a way to control the potential bias from this source, this research runs bivariate probit robust estimation. This form of regression is also helpful to reduce the effects of heteroscedasticity.

The estimated coefficient for household income (TINCOME) does not show clear effect of total household income on willingness to pay as it is negative and insignificant for the first equation, and positive and significant for the second equation (Table 4). But the marginal effect clearly shows that total income of household has positive and significant effect on willingness to pay for improved domestic water service provision. The marginal effect result indicates that those households with higher income are willing to pay more for an improved water service than their counterparts with lower income. This finding is in conformity with the general demand theory that income is positively related with demand for normal goods. Dunfa (1998), Fisseha (1997), Alebel (2002) and Assefa (1998), who also conducted CV studies on clean water in Ethiopia, obtained positive and significant effect of household income on WTP.

The effect of education (EDUC) was found to be positive and significant at 1% probability level. The implication is that the higher the educational level, the greater the awareness about health benefits of improved water supply and the higher the opportunity cost of time spent in collecting water. This shows that higher level of schooling leads to higher willingness to pay for improved rural water supply. The marginal effect of this variable indicates that, keeping other variables constant at their mean values, being literate will increase the probability to agree with the first and follow up bid prices proposed for improved rural water by 36.87%.

Age of the respondent (AGE) has a negative sign, as expected, and is significant indicating that young people are more willing to pay for an improved rural water service than their elderly counterparts. Elderly people have low preference and less willing to pay for sources that will require charge as they traditionally used to free water supply. The marginal-effect results also

Table 4: Bivariate probit regression results

Variable	WTP1		WTP2		Marginal effects	
	Coefficients	*Robust std. err.*	*Coefficients*	*Robust std. err.*	*dy/dx*	*Std. err*
BID	-0.0234	0.01691	-0.037	0.0145**	-0.0127	0.00474***
SOURCE	0.0351	0.38149	-0.528	0.3569	-0.1479	0.10358
TOTIME	0.0055	0.0024**	0.0049	0.0022**	0.00181	0.00071**
CONSUME	-0.009	0.0042**	-0.0026	0.0036	-0.0012	0.00129
TREAT	0.4387	0.3127	0.5329	0.2904*	0.18176	0.09054**
SEX	0.7597	0.3279**	0.4544	0.3076	0.1807	0.09991*
AGE	-0.0247	0.0132*	-0.025	0.0107**	-0.0091	0.00342***
MARITAL	0.7747	0.6263	-0.126	0.6248	0.0487	0.14869
HHSIZE	0.1199	0.0755	0.0465	0.0689	0.0207	0.02325
CREDIT	4.8167	0.5795***	-0.593	0.5847	-0.179	0.23186
TIMCOME	-8.39e-06	0.000016	0.00004	0.000018**	0.000012	0.00001**
VSTOCK	0.000018	0.000017	7.41e-06	0.000018	3.24e-06	0.00001
EDUC	1.1645	0.4224***	1.0788	0.3123***	0.3687	0.08948***
SWATER	0.8035	0.6729	0.5502	0.4269	0.1794	0.10582*
WEXP	0.0034	0.00079***	0.0022	0.0007***	0.00085	0.00023***
Cons	-0.643	1.213	0.494	1.0346		
P = 0.52					y=Pr(WTP1=1, WTP2=1)	
Log pseudo likelihood = -89.67					(predict) = 0.701	

Note: ***, ** and * significant at 1%, 5% and 10% probability levels, respectively show that an increase in age of respondent by one year will decrease the probability of willing to pay both the first and the second bid value by 0.91%, holding other variables constant. Likewise, the coefficient of gender (SEX) is positive as expected and significant for first equation, indicating that female respondents are more willing to pay than male respondents. The result contradicts with the study by Alebel (2002) in Adama town. The reason could be that since water collection for family use in the study area is almost exclusively done by females, they are more conscious of the problem related to poor water source and attaches more importance to the improved one than would men. The marginal effect of the variable indicates that, keeping others constant, being female will increase the probability of willing to pay the proposed bid prices in the first and second question by 18.07%.

The variable time taken to fetch water (TOTIME) is positive as expected and statistically significant at 5%. This implies that the more the households incur time cost to fetch from existing source, the greater the probability of willing to pay for improved water service that save time. Similar effects have been observed in earlier studies conducted by Dunfa (1998), Assefa (1998) and Alebel (2002) in Ethiopia, and by World Bank team in other developing countries (Brazil, India, Haiti). The variable has a marginal effect of 0.0018 indicating that for each minute of additional time a household spends to fetch water at once, it will increase the probability of getting 'yes-yes' response by 0.18%, *ceteris paribus*.

Water treatment practice (TREAT) is a proxy for quality perception and found to be statistically significant at 10% level for second equation. This implies that households who practice water treatment method have more preference and are willingness to pay for improved water service than their counterpart. The result of marginal effect of the variable shows that being a member of household who practice water purification methods (like boiling) will increase the probability of willingness to pay both the offered bid values in the first and follow up questions by 18.18%. Results also indicate that annual household expenditure for water (WEXP) is positively and significantly associated with WTP. Rural households incurring monetary cost for existing water service attach higher value and willingness to pay for improved water supply. The value of marginal effect indicates that a Birr increase in expenditure for existing water service will increase household's willingness to pay both offered bids for the proposed improved water by 0.085%, holding other variables constant at their respective mean value.

Initial Bid (BID) has negative coefficient as expected and statistically significant at 5% for the follow up question. As the bid amount increases, the respondents would be less willing to accept the scenario and that is consistent with the law of demand. The variable daily water consumption (CONSUME) is found to have the unexpected negative sign but insignificant for coefficient estimate of follow up question and marginal effect. Another interesting result is that the error correlation is estimated to be 0.52, justifying the use of the bivariate probit model.

The mean WTP value of the sample households for improved water provision was calculated using equation (5) specified in the preceding section. Where $ß_0$ (intercept) and $ß_1$ (slope) are absolute coefficients estimated from bivariate probit model. However, in the model two sets of parameter estimates are available from double bounded question. In this case the researcher must decide which estimates to use to calculate the WTP measure (Haab and McConnell 2002). But, parameter estimates from the first equation are generally used in the computation of mean willingness to pay. The reason being the fact that the second equation parameters are likely to contain more noise in terms of anchoring bias where the respondent is assumed to take the cue from the first bid while forming his WTP for the second question. Accordingly, the estimated mean willing to pay is 27.30 cent per 20 liters of jerrycan. Since the average household daily water consumption was found to be 3.30 jerrycan, the average household's willingness to pay is estimated to be ETB 328.82 per year if the proposed scenario is to be implemented. This is equivalent to 1.99% of average income (ETB 16,523.76) of sampled households in which its affordability is credible. If the minimum sufficient per capital water requirement for domestic use is to be maintained, average household's willingness to pay becomes ETB 613.81 per year using 6.16 average household sizes. This is also 3.72% of average household income, which is affordable.

CONCLUSION

Motivated by the assumption that demand driven strategy is important during water project design as opposed to supply oriented, the study estimated households' WTP for improved rural water service provision and identified its determinants. More than 50% of the respondents expressed that the existing water source is not good and the time required to fetch water for daily domestic use is too long. About 90% of the respondents expressed their willingness to pay for the improved water service provision, with a mean WTP of 27.30 cents per jerrycan. On average, households were willing to pay about 1.99% of their annual income. The result also showed that out of fourteen socio-economic variables and variables related to existing water condition included in the model, at least seven of them were found to be statistically significant in influencing the probability of WTP for improved water service provision. Household income, education level of respondent and sex of respondent have positive effects on WTP for improved rural water supply whereas age of respondent has a negative effect on the probability of WTP for improved water provision. Variables related to existing water condition, namely time spent to fetch water from existing source, water treatment practice, quality of water source and water expenditure of the household have positive effects on WTP for improvement. Therefore, supply of rural water at affordable price is important to reduce financial burden of the government on the one hand and it also helps to enhance sustainable improved water service for the community on the other hand.

NOTE

1. Total time in this study is defined as time required for journey between home and source plus average waiting time at source to fetch water at once.

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