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Determinants of rural household willingness to pay for safe water in Kwara State, Nigeria

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Abstract. The paper examines the use of the contingent valuation method to study the determinants of rural households' willingness to pay (WTP) for safe water in Kwara State. A sample of 120 households was surveyed and a Tobit model was applied to explain household preferences for quality and quantity of domestic water supply and derive estimates of WTP for such a service. The results confirm that household age had a negative and statistically significant impact on WTP for both quantity and quality. Income, water consumption and water source are positively associated with WTP for better quantity but with a negative sign. This implies that the more the income, water consumes, water source, the less that household would be WTP for better water quantity. Willingness to pay for improved water quality is positively related to waiting time and education. Rural households showed a much higher WTP for better water quantity than for improved water quality. There is therefore scope to improve water service levels in the study area.
Key Words: Willingness to pay, water, rural, quality, quantity.

Introduction. Access to safe water supply has been one of the top priorities in developing countries over the past three to four decades and money had been invested in pursuit of the goal of universal service (World Bank 2005) and yet the general consensus at the 2002 United Nation World Summit on sustainable development was that the current reality as well as the situation expected in the near future are far from the goal (United Nations 2002). In fact recent reports emphasize that the world is facing a serious water crisis and water access and service delivery in the developing world need to be improved dramatically and urgently especially if we are to make gains in fight against poverty, hunger and disease (UN/WWAP 2003).

World leaders not only agree that water is an important part of core development agenda but have also committed to ambitious targets for expanding access to water services. At the United Nations Millennium Summit in 2000 and subsequently at the Johannesburg Earth Summit in 2002, world leaders agreed to a set of time bound and measurable development targets widely known as the Millennium Development Goals for 2015 which include a commitment to halve the proportion of people without access to safe drinking water.

Many experts seem to agree that poor access to water supply is often a result of poor policies and management practices; however there is significant disagreement over the approach to addressing the problem. In direct opposition to lobbies demanding that water be treated as a human right, experts at agencies such as the United Nations and the World Bank argue that a first or crucial step toward improving the water situation and its management is to treat water as an economic good (World Bank 2003; UN/WWAP 2003).

Water is an essential commodity to mankind. Plants and animals which are the major users of water as in their make up 50% and 90% of water respectively. In Nigeria, water is useful in the generation of electricity to the whole populace, recently Kanji dam have been reported to suffer stress due to the fact that there is inadequate

water for electricity generation which in turn has lead to incessant electricity supply experience throughout the country (WHO 2002).

The demand for safe water refers to the relationship between prices charged for safe water and the amount of safe water use by households. Virtually all of the existing studies of residential water demand have focused on water systems serving large populations and neglecting small systems in light of difficulties encountered in efforts to acquire data due to low education level (Ronald et al 2007).

In Nigeria, water is generally regarded more or less as a nature given resource. It is also seen as a public good, however, the form in which water is used either in terms of consumption or production activities are not free in the strict economic sense, access to clean potable water is identified. Water can also be considered as a unitary service since all water in the hydrological cycle forms part of one whole (Olowa & Omonona 2008).

The development of the water resources in Nigeria holds immense potential for development and growth of the agricultural sector and overall economic growth. Intense studies have been carried out on rural water, rural water demand, management and planning but with different debates on its efficiency, source and utility. Study on rural household demand for safe water becomes necessary because of its inclusion in almost every life activities. The life activities could be direct drinking, heat drinking (eating), cleaning, to mention but a few. Rural household demand for safe water encompasses the provision of potable water as its absence could lead to detrimental effects on animals and plants. Also, water determines the extent to which microbes in staple food, fresh food and the environments would be eliminated thus increasing humanity safety margin (Duane & Boland 2001).

Many scholars claimed that water supply projects could be sustainable when consumers are willing to pay users charges that are sufficient to cover all costs in excess of grants. Willingness to pay (WTP) can be construed as an indication of the demand for improved services and their potential sustainability (Kaliba et al 2003). In contrast, other observers have concluded those rural water systems are unlikely to be sustainable unless grants are available to finance most or all initial construction cost (Bohm et al 1998).

The main objectives of this study were to determine how much Nigerian rural households are willing to pay (WTP) for an improvement in their water quality and quantity as well as establishing the possible factors affecting their WTP. Specifically, the study is designed to:

- examine the water source and the source characteristics;
- quantify the WTP for improved water quality and quantity by the households in rural area;
- investigate the determinants of their WTP.

Material and Method. The study was carried out in Asa Local Government Area of Kwara State, between March and June 2008. It is situated in the exterior part of Kwara State, which is located in the middle belt region of Nigeria. The Local Government is large and some of the important villages are Otte, Atogbede, Afon, Owode, Budo Adio and Odunjo. The population of the study area is 126435 according to 2006 census. The people are predominantly farmers.

The target population of this study was defined as households that use water for domestic purposes in Asa Local Government Area of Kwara State. A multistage random sampling technique was used in selecting the respondents. The three districts were taken as the sampling units as a first stage of sampling. At the second stage, two villages were randomly selected to represent the district making a total of six villages. The last stage involved random selection of twenty respondents in each village making a total of one hundred and twenty respondents (120). Primary data was collected with the aid of a well structured questionnaires and interview schedules (see Annex 1). The data was analyzed using descriptive statistics and Tobit regression.

The contingent valuation method (CVM) was selected for its appropriateness when dealing with estimation of non-use values. The CVM can be used to elicit consumers' WTP for almost any environmental good or service, including more abundant and cleaner

water (Mitchell & Carson 1989). Whittington et al (1993) have carried out contingent valuation studies of households' WTP for improved sanitation services. Banda et al (2004) applied a CVM to analyze determinants of quality and quantity values of water for domestic uses in the Steelpoort sub-basin of South Africa. A Tobit model was applied to household survey data, to explain household preferences for quality and quantity of domestic water supply and to derive estimates of WTP for such a service. The Tobit model takes the following functional form (Tobin 1958):

$$y_i = x_i \beta + \varepsilon_i \quad (1)$$

where:

$$y_i = y_i \text{ if } y_i > 0 \quad (2)$$

or:

$$y_i = 0 \text{ if } y_i \leq 0 \quad (3)$$

The variable y_i is the observed contingent valuation bid by individual i, y_i is a latent measure, x_i are the independent variables. β is a vector of parameters and ε_i the error term distributed as independent normal with zero mean and constant variance (σ^2). The explanatory variables in the regression model are a set of variables dealing with demographic characteristics, socio-economic characteristics, water source and source characteristics. The method elicits the probability and not the actual value of WTP_1 which is subsequently calculated through descriptive statistics. Following Greene (1997), the WTP probability is computed as:

$$P(Y=1) = \frac{e^{zi}}{1 + e^{zi}} \quad (4)$$

where:

$$E(Y/X) = 0\,[1 - F(\beta^1 X)] + 1\,[F(\beta^1 X)] \quad (5)$$

and F(.) is the cumulative density function. Irrespective of the distribution used, the marginal effect is obtained as follows:

$$\frac{\delta E(Y/X)}{\delta X} = \left(\frac{d\,F(\beta^1 X)}{d(\beta^1 X)} \right) \beta = F(\beta^1 X)\,\beta \quad (6)$$

The response for WTP is a binary variable that takes the value of 0 if the response to the question 'yes' and 1 if the response is no. Let the binary variable be WTP and the underlying latent variable be WTP*. Then the general formulation of the empirical Tobit model is given as:

$$WTP_i^* = \beta^1 X_i + E_i \quad (7)$$

where x_i is a vector of explanatory factors in the regression for the individual i, β is a vector of fitted coefficients and WTP_i^* is the stated WTP for individual i since WTP* is observed, it is the underlying latent variable that is related to the observed WTP as follows:

$$WTP_i = 1 \text{ if } WTP_i^* > 0 \quad (8)$$

and:

$$WTP_i = 0 \text{ if } WTP_i^* \leq 0 \quad (9)$$

An econometric analysis was used to test the relationship between WTP and socio-economic factors. Questions were asked in an ordered, categorical form and then were transformed into binary variables. The respondents were asked if they were WTP for a better quantity and improvement in the quality of water.

WTP can be functionally expressed as follows:

WTP = f (HMI, WATCON, WATSOU, AGE, HSZ, GEN, WAITIM, EDU) or, in a linear regression form:

$WTP = \beta_0 + \beta_1 HMI + \beta_2 WATCON + \beta_3 WATSOU + \beta_4 AGE + \beta_5 HSZ + \beta_6 GEN + \beta_7 WAITIM + \beta_8 EDU + \varepsilon_i$,

where: HMI is household's monthly income expressed in Naira (₦); WATCON is water consumption expressed in liters/month/household; WATSOU is the water source for the

household; AGE is the age of household individual (in years); HSZ is household size expressed in number of individuals; GEN is gender a dummy variable indicating the sex of household's individual; WAITIM is waiting time to collect water; EDU is household individual's level of education expressed in number of years spent in education; and ε_i is the error term representing the unpredicted or unexplained variation in the dependent variable and is assumed to be regularly distributed.

Results and Discussion

Socio-economic characteristics of the respondents. The summary of the socio-economic variables is presented in Table 1.

Table 1

Summary statistics of socio-economic variables (Source: field survey, 2009)

Variable	*Mean*	*Standard deviation*	*Minimum*	*Maximum*
Age (years)	34.37	10.06	18	65
Education (years)	7.92	3.27	0	18
Household size (number)	7.9	4.28	1	24
Monthly income (₦)	6779.28	5834.73	1500	50000

The result indicates that, the mean age of the respondents was 34.37 years with standard deviation of 10.06 years. The survey also reveals that all respondents were within the age defined by FAO (1983) as economically productive population. The mean year of education was 7.92 years. This is in accordance with common fact that majority of rural farmers are characterized by high rate of illiteracy (Obibuaku 1983). The average monthly income was 6779.28 ₦.

Sources of water. Table 2 shows that about 35% of the water consumers use borehole and 54.3% use unsafe sources such as unprotected well and stream. This is in line with the findings by Alaba (2001) who reported that 31.1% of the rural water consumers in Nigeria use borehole while over 50% uses unsafe sources such as water holes, ponds, unprotected well and stream. About 31% collected water from mechanized sources of which only 20% are piped and treated (FOS 1999).

Table 2

Distribution of respondents by sources of water (Source: field survey, 2009)

Source of water	*Frequency*	*Percentage*
Borehole	42	35.0
Protected well	12	10.0
Unprotected well	50	41.7
Hand pump	2	1.7
Stream	14	12.6
Total	**120**	**100.0**

Rural household Willingness To Pay for improvement in quantity and quality Willingness To Pay (WTP) for better water quantity and improved water quality. The data in Table 3 shows that 75 percent of respondents are willing to pay for better water quantity, while 25 percent of respondents are unwilling to pay for better water quantity. It reveals that respondents are willing to pay because they need more water than they have now. The table also shows that 56.7 percent of respondents are willing to pay for improved water quality while 43.3 percent of respondents are not willing to pay for improved water quality. It reveals that respondents do not only need quantity but also quality for the avoidance of water-related diseases. In this study household were WTP for increased water quantity than improved water quality. This finding is contrary to

the study conducted by Farolfi et al (2007) in Swaziland where rural households are more WTP for improved water quality than for increased water quantity.

Table 3

Distribution of respondents WTP for improved water quantity (n=120)
(Source: field survey, 2009)

WTP	*Frequency*	*Percentage*
Better water quantity		
YES	90	75.0
NO	30	25.0
Improved water quality		
YES	68	56.7
NO	52	43.3

Amount willing to pay. For the households that were WTP, the study inquired about the amount of money they declared to be WTP for better water quantity and improved quality. Table 4 provides the amounts households would be WTP in Naira/household/month. It is noted that rural households are WTP a higher amount of money for a better water quantity than improved water quality despite their much lower income.

Table 4

WTP in Naira/household/month for better quantity and improved quality
(Source: field survey, 2009)

	Amount Willing to Pay	
Variable ↓	*Better water quantity*	*Improved water quality*
Mean	1320.00	1058.75
Standard deviation	1169.45	994.85
Maximum	6000	4800
Minimum	0	0

Factors affecting willingness to pay for safe water. Regression analysis was run in order to examine the factors affecting willingness to pay for safe water. Two regression analyses were conducted adopting the model illustrated in chapter three, where the probability that the household would be willing to pay (WTP) for higher water quantity was the dependent variable for the first regression, and the probability that the household would be WTP for an improved water quality was the dependent variable for the second regression. Probability of WTP was then related to a set of explanatory variables.

Tobit results of WTP for better water quantity. These results are shown in Table 5. The variable household income had a negative and statistically significant impact on WTP for quantity. Households with higher income are therefore less willing to pay for improved water quantity: this is not in line with earlier findings by Farolfi et al (2007) who reported a positive and significant impact between WTP for quantity and household income.

Water consumption was also statistically significant, but with a negative sign when regressed on WTP for quantity, this result is quite intuitive too. The negative sign means that the more a household consumes water, the less that household is WTP to have an improved water availability in terms of quantity.

The variable source of water was statistically significant with a negative coefficient for WTP for quantity. Households that have a regular supply of tap water were less willing to pay for improvements in the quantity. These households are more likely to choose to maintain the status quo.

Age of the respondents had a statistically significant and negative effect on the household WTP. Younger heads of households have higher WTP than their older counterparts: this is also not in consonance with the findings of Farolfi et al (2007).

Gender had a positive and significant impact on the WTP for quantity. Male household heads have lower WTP than female household heads. This result could be explained by the fact that younger women are usually involved in collecting water; they are the ones most likely to perceive the strain of walking long distances when collecting water in the study area.

Table 5

Tobit results of WTP for better water quantity (Source: field survey, 2009)

Water quantity	*Coefficient*	*Standard error*	*t*	P>/t/
Constant	0.215	0.096	2.231	
Income	-0.012	4.743	-2.530**	0.011
Water consumption	-0.745	0.223	-3.345**	0.001
Water source	-0.246	0.095	-2.602***	0.010
Age	-36.469	12.654	-2.2882***	004
Household size	0.060	0.261	0.230	0.818
Gender	0.153	0.034	4.465***	000
Waiting time	2.467	3.107	0.794	0.427
Education	-21.101	38.226	-0.552	0.581
Observation summary: 90 left-censored observations at WTP quantity $\leq$30 uncensored observations.				

** and *** means statistically significance at 5% and 1% levels respectively;
Number of observation = 120;
Pseudo R^2 = 0.207;
Log likelihood function = -663.506.

Tobit results of WTP for improved water quality. Table 6 indicates that age of the respondents had a statistically significant and negative effect on the household's WTP for improved water quality. This implies that older households have lower WTP for quality than their younger counterparts.

Table 6

Tobit results of WTP for improved water quality (Source: field survey, 2009)

Water quantity	*Coefficient*	*Standard error*	*t*	P>/t/
Constant	0.127	0.038	3.355	0008
Income	0.175	1.882	0.093	0.926
Water consumption	-15.048	21.528	-0.699	0.485
Water source	-2.246	4.206	-0.534	0.5930
Age	-0.102	0.049	-2.0728**	0.038
Household size	0.044	1.023	0.043	0.966
Gender	0.020	0.024	0.817	0.414
Waiting time	1.625	0.817	1.989**	0.047
Education	0.048	0.015	3.232***	0.001
Observation summary: 68 left-censored observations at WTP quality $\leq$52 uncensored observations.				

** and *** means statistically significance at 5% and 1% levels respectively;
Number of observation = 120;
Pseudo R^2 = 0.191;
Log likelihood function = -88.426.

Waiting time is an important variable explaining household's WTP for improved water quality. The regression coefficient was statistically significant. This implies that respondents who spend more time queuing to fetch water are more likely to be WTP for water quality improvement than those who spend less time.

Years of education of the respondents had a positive and statistical significant impact on the WTP for water quality. This implies that educated household has higher WTP for quality than illiterate households. Higher education levels are also associated with higher levels of water use, perhaps because consumers are more aware of hygienic practices. One might also expect that better educated people have higher incomes and can therefore afford better water services.

Conclusion. Provision of safe water is necessary in order to have hygienic and healthy rural dwellers. In line with these research findings, efforts should be intensified on reliability of most sources. Water been a necessity should be made available for all and sundry.

The study therefore recommends that government should help the public by providing tap water, improving water quality and quantity, and educating the general public on the importance of safe water.

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Annex 1

QUESTIONNAIRE

Determinants of Rural Household willingness to pay for Safe Water in Asa Local Government Area of Kwara State, Nigeria.

Please tick the appropriate answer to the questions below and kindly supply answer in the spaces provided.

SECTION A: Socio- Economic Characteristics of the Respondents

1. Name of village?----------
2. Gender of respondent? Male ☐ Female ☐
3. Age of respondent? ---------- years
4. Marital status of respondent? Married ☐ Single ☐ Widow(er) ☐
   Divorced ☐ Separated ☐ Others (specify) ----------
5. Years of education? ---------- years
6. Household size?
   (i)Number of wife (ves)----------
   (ii)Number of child (ren)----------
   (iii)Number of dependant----------
7. Major occupation? ----------
8. Secondary occupation? ----------
9. Household income? ₦---------- (monthly)

SECTION B: Household Demand Pattern for Safe Water

10. Do you have access to safe water? Yes ☐ No ☐
11. If yes, how readily available is your safe water? Always ☐ Not always ☐
    Others (specify) ----------
12. What is your opinion regarding your safe water? Favorable ☐ Not favorable ☐
13. What is the source, unit of measurement, quantity demanded, time spent and cost of safe water?

Source of water	Unit of measurement (kegs)	Quantity demanded	Walking time (hours)	Queuing time (hours)	Cost
Borehole					
Wells					
Rain water					
Streams					
Hand Pumps					
Rivers					
Ponds					

14. Is your source of safe water in your house? Yes ☐ No ☐
15. If no, do you transport yourself to your source of safe water? Yes ☐ No ☐
16. If yes, what is the distance? ---------- mile(s)/(km)

17. Do you purify your water? Yes ☐ No ☐

18. What is the source of water, cost of transporting water from source to user, cost of water treatment and the type of water treatment use?

Source of water	Cost of transporting water from source to users	Cost of water treatment	Type of water treatment use
Borehole			
Wells			
Rainwater			
Streams			
Hand pumps			
Rivers			
Ponds			

19. Do you pay for your safe water? Yes ☐ No ☐

20. How much are you willing to pay for water?----------(kegs)

21. If the price of safe water increases, will you still buy? Yes ☐ No ☐

22. Are you willing to pay for better water quantity? Yes ☐ No ☐

23. Are you willing to pay for improvement in water quality? Yes ☐ No ☐

24. Do you engage in avoidance measure against water-related disease?
Yes ☐ No ☐

25. What is the existing source, cost, quality and reliability against those of the improved water supply?

Existing source of water	Cost (~~₦~~)	Quality (Yes/No)	Reliability (Yes/No)

Improved water supply	Cost (~~₦~~)	Quality (Yes/No)	Reliability (Yes/No)

26. How many days in a week do you fetch water?----------

27. What is the amount of water used weekly in your household? ----------Kegs

28. In what way has Government being of help? Digging of boreholes ☐
Making of hand pumps ☐ Others (specify) ----------