

Household Demand for Improved Water Supply in Ibadan Metropolis of Oyo State, Nigeria

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Abstract: This study examined household demand for improved water supply within Ibadan Metropolis of Oyo State, Nigeria with a view to proffering possible remedies to the water consumption shortage. The study specifically estimated demand for water in the metropolis, and examined the relationship between socio-economic characteristics of the household heads and the demand for improved water. One hundred and fifty household heads were selected by multistage, purposive and random sampling methods. Data were collected using structured questionnaire administered by means of personal interview. Multiple regressions were used for data analysis. Price of water and household heads' income significantly influenced the demand for water. The demand for water was found to be price inelastic, and had inverse relationship with the price of water. Household heads' income elasticity was relatively inelastic and had positive relationship with demand for water. Level of education and family size statistically and significantly determined demand for water while as age, sex, price of competing goods, marital status, occupation, religion and water sources were otherwise. Expanding the capacity of existing public water supply and the adoption of sustainable maintenance culture would ensure regular improved water supply to the households at a cheaper rate.

Keywords: Improved Water Demand, Elasticities, Determinants, Ibadan Metropolis, Nigeria.

1. INTRODUCTION

Water is essential for the life of people living in this planet and its availability in the required proportion and quality for human consumption has assumed a crisis dimension across the globe [1]. Water use (demand) is a function of availability (supply). The number of people who rely on the earth's limited freshwater reserves is increasing every day. In fact, a scarcity of clean, fresh water is one of the world's most pressing environmental problems [2]. About 1.1 billion people in the world do not have access to safe drinking water and 2.4 billion live without proper sanitation [3]. The resulting human toll is roughly 3.3 billion cases of illness and 2 million deaths per year. The UN predicts that by 2025, two-thirds of the world's population will experience water scarcities, with severe lack of water blighting the lives and livelihoods of 1.8 billion. According to the UN World Water Assessment Programme, by 2050, 7 billion people in 60 countries may have to cope with water scarcity [4].

The commodity once viewed as infinitely renewable and as a bountiful resource is today under pressure as never before [5]. Water supports all forms of life and creates jobs

and wealth in the water sector, tourism, recreation and fisheries [6]. Water is "life" has been the commonest term that is often used in describing the important role of water to man. Amongst the diverse resources with which mankind has been blessed, water ranks the highest in importance. According to [7], water is the most fundamental necessity making life possible on earth. Water represents unique and significant feature in any settlement; for drinking, sanitation, washing, planting, recreation, industrial process and the list continues like that [8]. Irrespective of the sources, its availability and quantity often affect or determine the type of use.

The total domestic water needs in homes with piped water and inside sanitation is at least 115 liters per head per day. The actual amount used may be greater depending on the ease and convenience of supply [9]. According to World Health Organization, 75 liters of water a day is necessary to protect against household diseases and 50 liters a day necessary for basic family sanitation. The international consumption figures released by the 4th World Water Forum (March, 2006), indicate that a person living in an urban area, uses an average of 250 liters/day. The WHO and UNICEF Joint Monitoring Programme currently estimates that 1.1 billion people (17% of the global population) lack access to water resources, where access is defined as the availability of at least 20 liters of water per person per day from an improved water source within a distance of 1 km [10].

Recent National Water Supply and Sanitation Baseline Survey Report shows that there are over 40,000 water supply infrastructures in Nigeria. Of the number, 11% are based on surface water. The remaining 89% is based on groundwater with 34% using motorized pumps and 55% on hand-pumps. The total combined installed capacity of all the schemes is about 5.1 million cubic meters per day. This total installed capacity is about 38% of the current water demand of the population based on the population and water supply coverage of the country in 2011. There are about 264 medium and large dams with a combined storage capacity of 33 billion cubic meters of water for multipurpose uses of which 210 are owned by the Federal Government, 34 by the States and 20 by Private organizations.

The demand for water is fast outpacing its availability for consumption and the supply of domestic water is seriously constrained by the rising population [11]. On account of this, the price of water, of whatever grade, increases daily and, this is not helped by commercial water vendors who adopt arbitrary pricing of the product. For

instance, a 25-liter can of water is sold for ₦30 in most parts of Lagos State. In Kano, as in most cities and towns in the Northern part of the country, a 25-liter can of water sells for ₦50 and is rising. The farther away the source of water supplies, the higher the cost [11].

In Ibadan, one of Nigeria's major cities, the tap installed in buildings located at many parts of the metropolis and linked with the public mains never run for years due to inefficiency and inadequacies of the government water works. The problems of capital intensive nature of piped water supply; continuous increase in population without a corresponding increase in installed water supply plants and equipment, to mention but a few also existed. This development resulted in widening demand-supply gap and the emergence of private water supply businesses. Following from this backdrop, the study on household demand for improved water supply among the habitants of Ibadan metropolis became inevitable and was initiated.

2. MATERIALS AND METHODS

The study was conducted in Ibadan metropolis of Oyo State, Nigeria. Ibadan is located between 7°20" and 7°40" east of the Greenwich Meridian and between latitude 3°55' and 4°11' of the equator. The city lies in the equatorial rain forest belt and has a land area of between 440 and 445km². Ibadan regarded as the 14th largest metropolitan city in Africa [12] is densely populated with an estimated population of 2.762 million people [13]. Ibadan, the capital of Oyo State has many industries and firms, higher institutions and many Government and Non-Governmental Organizations, several recreational centers, and hospitals.

Multistage, purposive and random sampling techniques were used to select 150 respondents for the study. Ibadan metropolis is divided into four districts, namely Jerico, Oke Ado, Agodi and Egbeda districts; however, due to logistics problems Jericho and Oke Ado districts were purposively selected at stage I. At stage II, a total of 75 household heads were randomly selected from each of the two selected districts to arrive at 150 respondents for the study.

Data for the study were collected from primary sources. The primary data were collected by means of well structured questionnaires administered to the respondents using personal interview. Primary data were collected on socio-economic characteristics of the respondents such as age, sex, marital status, level of education, family size, religion, type of occupation, average monthly income, available water sources and price of competing goods.

Two multiple regression models were used to estimate the demand for water and examine the relationship between socio-economic characteristics of the household heads and the demand for improved water. The multiple regression model used to examine the relationship between respondents' socio-economic characteristics and the demand for water is implicitly specified as:

$$Y=f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10}, e_i)$$

Where:

- Y=Average monthly consumption per household (liter)
- X₁=Age of the household head (years)
- X₂=Sex of the household head (dummy: male = 1; female = 2)
- X₃=Marital status (dummy: married = 1; otherwise = 2)
- X₄=Religion (dummy: christian = 1; otherwise = 2)
- X₅=Level of education (years)
- X₆=Type of occupation (dummy: public servant = 1; otherwise = 2)
- X₇=Family size (number in a household)
- X₈=Average household monthly income (₦)
- X₉=Available water sources per household (number of sources)
- X₁₀=Price of competing goods (eg fruits and soft drinks) (₦)
- e_i=Error term.

Four functional forms of the regression model were tried with the data. They are:-

Linear: $Y=b_0+ b_1X_1 + b_2X_2 + b_3 X_3 + \dots + b_{10}X_{10} + e_i$

Semi-Log: $Y= b_0 + b_1\log X_1 + b_2\log X_2 + b_3\log X_3 \dots + b_{10}\log X_{10} + e_i$

Double-log: $\log Y = b_0 + b_1\log X_1 + b_2\log X_2 + \dots + b_{10}\log X_{10} + e_i$.

Exponential: $\log Y =b_0 + b_1X_1 + b_2X_2 + b_3X_3 + \dots + b_{10}X_{10} + e_i$

Also the implicit model of the demand function is given by the equation:

$$Y =f(X_1, X_2, X_3, e_i)$$

Where:

- Y=Average monthly consumption (demand per household) (liter)
- X₁=Price of water (₦/ litre)
- X₂=Average household monthly income (₦)
- X₃=Quantity of water supplied by the existing sources of water (liter)
- e_i=Error term.

The functional forms used are:-

Linear: $Y=b_0 + b_1X_1 + b_2X_2 + b_3X_3 + e_i$

Semi-log: $Y=b_0 + b_1\log X_1 + b_2\log X_2 + b_3\log X_3 + e_i$

Double-log: $\log Y=b_0 + b_1\log X_1 + b_2\log X_2 + b_3\log X_3 + e_i$

Exponential: $\log Y=b_0 + b_1X_1 + b_2X_2 + b_3X_3 + e_i$

3. RESULTS AND DISCUSSIONS

Price and income elasticity of household demand for water:

Table 1 shows result of data analysis on the effect of price of water and average household heads' monthly income on average monthly consumption of water per household. Out of the four functional forms of the regression model tried with the data, the double log output gave the best result in terms of economic and statistical criteria and was chosen as the lead equation.

The coefficient of price of water which is significant at 1% level is -0.268. This shows that the demand for water is relatively price inelastic and the negative sign indicates an inverse relationship between price of water and demand for water by household head in the study area. This

implies that as the price of water increases, the average monthly demand for water decreases. This finding agrees with the law of demand which states that the price and quantity demanded of a commodity are inversely related, in other word, the quantity demanded of a commodity decreases as the price of the commodity increases. The variable is also significant, thus a major explanatory variable in the demand for water.

The average household monthly income which is significant at 1% level is also another explanatory variable in the demand for water. The income elasticity of demand is 0.205. The positive sign shows, just as expected, that the demand for water changes in the same direction as income. The elasticity coefficient, being less than unity and more than zero shows that the demand for water is relatively income inelastic or, in other words, that an income increase leads to a less than proportionate increase in quantity of water demanded. This result proves the fact that water as a commodity is usually a necessity. This is because a good is classified as a necessity only if a percentage increase in income results in a less than proportionate increase in the quantity demanded of such good.

Table 1: Estimated price and income elasticity of household demand for water

Predictor	Linear	Exponential	Semi-log	Double-log
Constant	8020.303	8.750	5810.425	7.384
Price of water per litre (X_1)	-57.485* (19.060)	-8.73* (0.003)	-1829.062* (657.771)	-0.268* (0.087)
Household monthly income (X_2)	2.023E-02 (0.013)	4.029* (0.00)	683.822 (591.747)	0.205* (0.79)
R ²	0.098	0.132	0.094	0.156
Adjusted R ²	0.078	0.112	0.073	0.136
F- value	4.748*	6.586*	4.505*	8.025*

Source: Computed from field survey data, 2012. Notes: * = Significant at 1% level. Values in parentheses are standard errors.

Determinants of demand for water:

On the relationship between socio-economic characteristic of the household heads and the demand for water (Table 2), out of the four functional forms tried with the data, the double-log functional form was selected as the lead equation on the basis of the high coefficient of determination, signs of the regression coefficients, as well as significance of the variables. The value of R² of the lead equation indicates that about 68% of variations in the dependent variable (Y) was explained by the independent socio-economic variables combined.

The result shows that level of education and family size are significant socio-economic factors determining the household demand for improved water supply. These variables are significant at the various levels of significance indicated. This shows that educated household heads/members would ask for improved water more than the non-educated ones. This is understandable in that, one expects that as level of education increases among household members, they would be more aware of the health benefits of improved water supplies and would thus be more likely to demand for it.

Family size is positively related to the quantity of water demanded by households. This agrees with *a priori* expectation, as the demand for water should increase proportionately as the size of household is increasing, considering the importance of multiplicity of uses, possibilities of waste and even variation of composition of the family size.

Table 2: Determinants of demand for improved water

Predictor	Linear	Exponential	Semi-log	Double-log
Constant	-5360.296	7.491	8141.520	7.039
Age (X_1)	12.876 (54.344)	-176E-03 (0.007)	1346.108 (2225.332)	0.119 (0.246)
Sex (X_2)	147.409 (768.498)	-1.18E-02 (0.101)	509.664 (892.275)	3.033E-02 (0.098)
Marital Status (X_3)	438.159 (1242.013)	-0.244 (0.163)	1121.265 (1524.526)	-6.621.02 (0.168)
Religion (X_4)	-9972.813 (784.410)	-5.94E-20 (0.103)	-2386.279 (2197.590)	-0.223 (0.168)
Education (X_5)	1134.913* (403.466)	0.116* (0.053)	2324.687** (1189.424)	0.269** (0.131)
Occupation (X_6)	199.726 (523.475)	-8.341-02 (0.069)	-474.103 (1293.247)	-0.198 (0.143)
Family Size (X_7)	1491.855* (186.450)	0.181* (0.024)	6431.191* (1121.170)	0.876* (0.126)
Monthly income (X_8)	1863.570* (0.011)	-2.02E-06 (0.00)	-280.264 (873.690)	-9.82E-02 (0.1240)
Sources (X_9)	1863.570* (620.541)	9.945E-02 (0.081)	2707.142* (1121.170)	0.128 (0.124)
Price of competing goods (X_{10})	-0.146** (0.078)	5.834E-02 (0.081)	-1708.066 (1498.188)	7.475E-02 (0.165)
R ²	0.605	0.642	0.504	0.681
Adjusted R ²	0.555	0.596	0.441	0.641
F- value	12.120*	14.154*	8.026*	16.901*

Source: Computed from field survey data, 2012. Notes: * = Significant at 1% level. ** = Significant at 5% level. Values in parentheses are standard errors.

4. CONCLUSION

The demand for improved water supply in Ibadan metropolis is price and income inelastic. The relationship between the demand for water and household income, educational level of household members and family size is positive and statistically significant.

The high cost of producing and distributing water could be a partial cause of the inability of Oyo State Water Corporation to supply regular and adequate water to residents in Ibadan. Significant attempts should be made to remove the financial constraints which presently inhibit the effective performance of the corporation. Measures in this respect should include larger disbursements to the agency by the state government and more effective tariff collection.

The provision of free and compulsory education at the primary and secondary levels and the subsidization of tertiary education would enable the people acquire formal education, earn better income, plan their family size and thus improve their demand for improved water for healthier living.

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