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Full Length Research Article

Demand Elasticity for Selected Cooking Fuels in Oyo State of Nigeria

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The high population growth and the low purchasing power of Nigerians dictate their demand. Therefore, this study evaluated demand elasticity for cooking fuels, in the urban areas of Oyo State in 2008. The study analyzed; socio-economic characteristics of household, household expenditure on selected cooking fuels, own price, cross price and income elasticity of demand for selected cooking fuels. Systematic sampling procedure was employed to select 150 respondents (household heads). The primary data were subjected to descriptive statistics and the Linear Approximate of Almost Ideal Demand System (LA/AIDS) model. This study revealed an average household size of 5. The income elasticity was -0.04E-03, 0.02 and 3.0 for fuel wood, Kerosene and cooking gas respectively: thus, fuel wood was an inferior commodity; kerosene was a necessity while, cooking gas was a luxury. The result of the cross elasticity indicated that the cooking fuels (fuel wood, Kerosene and cooking gas) were substitutes. It was concluded that the demand of kerosene and cooking gas should be encouraged at expense of the demand for fuel wood. This was to encourage aforestation.

Key words: Cooking fuels, demand elasticity**,** household heads, LA/AIDS model.

INTRODUCTION

Cooking fuels has the major share in total household energy demand. Accessibility and availability of cooking fuels at affordable prices is becoming more difficult day by day for poor people, many of whom are outside the modern energy system. Cooking fuels in the developing countries are predominantly unprocessed bio-fuels, such as fuel-wood (Vijay et al., 2003). Nigerians demand extensively for cooking gas, kerosene and fuel wood. The estimated daily demand were 12 million litres and 780 metric tons (1.4 million litres) for kerosene and cooking gas (LPG) (DPK) respectively (Braide, 1997). Those who were unable to afford the modern cooking fuels resorted to felling of trees for fuel wood. Nouvellet et al. (2003) stated that, fuel wood supply national energy needs, and virtually all species of shrubs and trees are used as fuel wood. Fuel wood generates income for men, women and children. Examples of major fuel woods are: *Tamarindus indica, Parkia biglobosa, Diospyros mespiliforms, Prosopis african,* e.t.c. Kerosene is known as paraffin, this was because its name was derived from word keros which means wax (Wikipedia, 2009). In the developing countries, kerosene remains one of the major fuels among the less privileged household. Africa has the highest rate of urbanization in the world, with urban population doubling every 14 years as cities grow at 1.5% per annum (Huntley et al., 1989; Todaro, 1997 and United Nations, 2002). A very large percentage of African urban household demand for cooking fuels. Thus, the urban population threatens the demand for the cooking fuels.

The objectives of this study are to:

i. examine socio-economic characteristics of household in the study area.
ii. analyze household expenditure on selected cooking fuels in the study area.
iv. estimate own price, cross price and income elasticity of demand for selected cooking fuels in the study area.

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MATERIALS AND METHODS

Oyo –State is in the southwestern Nigeria. It covers a total area of 28, 454 km^2 and has a population of 5, 591, 589 by the 2006 population census (NPC, 2006). It is bounded in the North by Kwara State, in the East by Osun State, in the South by Ogun State, and in West partly by the Republic of Benin and partly by Ogun State. It consists of 33 Local Government Areas. It is an homogenouse state that is inhabited mainly by the Yoruba ethnic group and they are primarily agrarian. It is located between 7^{0}3' and 9^{0}12' North of the equator and longitudes 2^{0}47' and 4^{0}23' East of the meridian. This location confers on the State the equatorial climatic conditions. There are two distinct seasons: the wet and dry season. Rainfall figures over the state vary from an average of 1200 mm at the onset of heavy rains to 1800 mm at its peak in the southern part of the state to an average of between 800 mm and 1500 mm at the northern part of the state (Handbook on Agricultural Activities in Oyo State, 2001). Average daily temperature ranges between 25^{0}C and 35^{0}C.

The data used were mainly primary: these were obtained through the use of a well-structured questionnaire and interview schedule. This was employed to make enquiries on socio-economic characteristics of the household. Multistage sampling technique was used, and it involved four stages. The first stage involved the purposive sampling of Ibadan/Ibarapa Agricultural Development Programme (ADP) zone: from the 4 ADP zones in the state, which includes; Ibadan/Ibarapa, Ogbomoso, Oyo and Saki zones. The second stage was the purposive sampling of 3 Local Government Areas from the zone. Moreover, the third stage involved random sampling of wards from each of the 3 Local Government Areas namely; Ibadan North East, Ibadan North, Ibadan South East. The fourth stage was the systematic sampling of 150 household heads (respondents). This study was carried out in the year 2008. Descriptive statistics were employed. They are the mean, percentages and frequency distribution. These were used as tools to describe preferential characteristics and socioeconomic information of the individual and household selected for the survey. Theoretical model of demand are

single and system of demand equations. Systems of demand include models such as; Translog model, Rotterdam model, Linear Expenditure System (LES) model, Armington model and Almost Ideal Demand System (AIDS) model (Giancarlo *et al.*, 1994). The main difference between single equation model and AIDS is that the latter employs budget share as dependent variable: while the single equation make use of quantity consumed as dependent variable. AIDS was used in this study because of its desirable properties relatives to the other models (Deaton and Muellbauer, 1980). The functional form is general allowing variable to be either substitute or complement. AIDS flexibility allows it to encompass broad ranges of behaviour and it avoids nonlinear estimation. It's flexibility permit wide range of variable to be included in the household demand modelling. It is consistence with the theory of demand, additivity, substitution, homogeneity and the postulate that household maximize utility (minimize cost) in their consumption decision making process. Since Deaton and Muellbauer (1980) proposed AIDS model, it has been widely applied in many empirical studies for consumer behaviour for both cross sectional and time series data. The Linear Approximate AIDS (LA/AIDS) of Deaton and Muellbauer (1980), that uses Stone (expenditure) share weighted price instead of the nonlinear general price index of full AIDS model is used to estimate the demand system. The relationship of consumers' income and prices of different items to the portion of total expenditure can be expressed as:

$W_i = a_i + b_i \ln (M/P^*) + \sum Y_{ij} \ln P_j + EV + U_i$ .....(1)

For; i = 1 (cooking fuels) items.
j = 1,.....,3 (cooking fuel) group.

Where;

W_i = budget share of item i,
a_i = average value of the budget share of item i in the absence of price and income effects,
b_i = effects of real income on the budget share of item i,
Y_{ij} = effects of the prices of items in group j on the budget share of item i,
M = total expenditure on the group of items being analyzed,
P_i = weighted average price of items in group j,
V = vector of other independent variables,
E = coefficient of other independent variable,
P* = price index approximated by Stone price index,
U = error term

Given equation (1), any AIDS model that uses Stone's price index, is called the Linear Approximate AIDS (Alston and Green, 1990).

Therefore in equation (1)

$\ln P = W_j \ln P_j$ ..... (2)

Where:

W_j = the budget share of j group,
P_j = the average price of j group
M/P could be defined as a proxy for real income.

Thus, equation (1) can be expressed as:

$W_i = a_i + b_i \log m + \sum Y_{ij} \log P_i + EV + U$ .....(3)

For; i = 1 (cooking fuels) items.
j = 1,.....,3 (cooking fuel) group.
M = M/P, the proxy for the income

Some socio-economic characteristics variables were included in the model as explanatory variables other than price and income variable specified in AIDS model this is to satisfy the objective of this study. This was done by replacing the average market price P for each group of items by scaled price, where the scale function of household characteristic known as market price scale factor (Muellbauer, 1976; Savadogo and Brandt, 1988).

The extended model now becomes:

$W_i = a_i + b_i \ln m + \sum Y_{ij} \ln P_i + (\sum Y_{ij} - b_i)$ .....(4)

For; i = 1 (cooking fuels) items.
j = 1,.....,3 (cooking fuel) group.

Theoretical inconsistencies could be avoided by placing the following restrictions on the AIDS model:

i. $\sum Y_{ij} = O$; this is known as the homogeneity restriction, and
ii. from equation (4), $\sum a_i = 1$ and $\sum b_i = O$; these are known as the addivity restrictions.

Moreover, cross price elasticity, income elasticity and own price elasticity by using the following formulae (Olayemi and Olajide, 1981; Umo, 1994 and Tanko, 2000).

Income elasticity (e_{ij}) = $\frac{\partial w_i}{\partial Y_{ij}} \bullet \frac{Y_{ij}}{w_i}$ ..... (5)

Where;

$\frac{\partial w_i}{\partial Y_{ij}}$ (First partial derivatives of Y_{ij} with respect to w_i)

Y_{ij} = Geometric mean of income of the household (total monetary contribution to household expenditures)
w_i = Geometric mean of budget share (dependent variable)
∂w_i = Partial change in budget share of cooking fuels
∂Y_{ij} = Partial change in income of the household (total monetary contribution to household expenditure)

Own price elasticity (e_{ij}) = $\frac{\partial w_i}{\partial P_{ij}} \bullet \frac{P_{ij}}{w_i}$ ..... (6)

Where $\frac{\partial w_i}{\partial P_{ij}}$ (First partial derivatives of P_{ij} with respect to w_i)

P_{ij} = Geometric mean of own price of cooking fuels.
w_i = Geometric mean of budget share (dependent variable)
∂w_i = Partial change in budget share of cooking fuels.
∂P_{ij} = Partial change in own price of cooking fuels.

Cross price elasticity (e_{ij}) = $\frac{\partial w_i}{\partial K_{ij}} \bullet \frac{K_{ij}}{w_i}$ ..... (7)

Where;

$\frac{\partial w_i}{\partial K_{ij}}$ (First partial derivatives of K_{ij} with respect to w_i)

K_{ij} = Geometric mean of price of each of the other cooking fuels
w_i = Geometric mean of the budget share (dependent variable)
∂w_i = Partial change in budget share of cooking fuels
∂K_{ij} = Partial change in price of each of the other cooking fuels

RESULTS

The household with a number of 5 was 25.3% which was the highest percentage: this household size was also the mean household size in the study. The result of Amao et al. (2006), was consistent with the result of this study that, household size of 5 was the average household size in Nigeria. Total monthly household income is the summation of monthly income of household heads, monthly income of wives and total monetary contribution of other household members to household expenditure. The mean of the total monthly household income was ₦49,390. Maximum and minimum total monthly household income were ₦850,000 and ₦5,500 respectively.

About 8% of the household demanded for cooking gas. Majority out of those who demanded for fuel wood spent less or equal to ₦1000 on it monthly. This amounts to 4.1% of the household. The mean of the amount spent on it was ₦29:06 per month. The income elasticity of fuel wood was -0.04E-03. This suggested that was an inferior good. The study revealed that the income elasticity of kerosene was 0.02. Thus, the household's demand for kerosene was income inelastic and the commodity was a necessity. Cooking gas had income elasticity of 3.0. Therefore, the demand was income elastic. Cooking gas was a luxury good, it was therefore not affordable by the less privileged (poor) household.

Table I: Definition of independent variable used in LA/AIDS model

Symbols in equation	Variable name and Description	Types of variable
AGE	Age of household head (years)	Continuous variable
EDU	Educational status of household head	Discrete variable
SIZE	Household size	Continuous variable
MKT	Nearness of household to cooking fuels market	Dummy = 1 for yes, Dummy = 2 for no
SOC	Nearness of household to sources of cooking fuels	Dummy = 1 for yes, Dummy = 2 for no
KNOWG	Knowledge of wives on food diet disease	Dummy = 1 for yes, Dummy = 2 for no
TOTALCOM	Total monthly monetary contribution to household expenditure (₦)	Continuous variable
PRWOD	Price of fuel wood (₦)	Continuous variable
PRKERO	Price of kerosene (₦)	Continuous variable
PRGAS	Price of cooking gas (₦)	Continuous variable

Source: Field survey, 2008.

Table II: Socio economic characteristics of the entire household members

Socio Economic Characteristics	Frequency	Percentage
Household size		
2-5	101	67.3
6-9	47	31.3
≥10	2	1.4
Mean = 5, Maximum = 12		
Total monthly household income (₦)		
≤ 10000	7	5.0
10001 – 40000	78	52
40001 – 80000	45	30
> 80000	20	13
Minimum = 5,500, Mean = 49,390, Maximum = 850,000		

Source: Field survey, 2008.

About 10% of the household demanded for fuel wood. Majority out of those who demanded for fuel wood spent between ₦401 to ₦800 on it monthly. This amounts to 6.1% of the household. The mean of the amount spent on it was ₦69:33 per month. The entire households demanded for kerosene. Expenditure on kerosene was up to above ₦ 1500 per month, while the mean of the amount spent on it was ₦ 944:80 monthly. Kerosene took very large part of the household expenditure.

Table III: Amount spent on cooking fuels monthly

Price (₦)	Frequency	Percentage
Fuel wood		
No demand/No price	136	90.6
≤ 400	2	1.3
401 – 800	9	6.1
801 – 1200	2	1.3
> 1200	1	0.7
Mean = ₦ 69:33		
Kerosene		
≤ 500	24	15.1
501 – 1000	68	45.1
1001 – 1500	47	31.1
> 1500	11	6.7
Mean = ₦ 944:80		
Cooking gas		
No demand/No price	138	92
≤ 10000	6	4.1
10001 - 20000	2	1.3
20001 - 30000	2	1.3
> 30000	2	1.3
Mean = ₦ 29:06		

Source: Field survey, 2008.

Table IV: Income elasticity for cooking fuels

Variable	Elasticity
Fuel wood	-0.04E-03
Kerosene	0.02
Cooking gas	3.0

Source: Computed from LA/AIDS estimates of the field survey, 2008.

Umo (1994), defined own price elasticity as the responsiveness of the budget share of a product to a change in price of the same product. The own price elasticity of kerosene was -0.57. It implied that, a 1% change in price of kerosene (PRKERO) resulted to a 0.57% change in the share of budget allocated to kerosene in the opposite direction. The own price elasticity of fuel wood and cooking gas were 0.35 and 0.86 respectively.

Table V: Own price elasticity for cooking fuels

Variable	Elasticity
Fuel wood	0.35***
Kerosene	-0.57***
Cooking gas	0.86***

*** 1% level of significance, ** 5% level of significance, * 10% level of significance

Source: Computed from LA/AIDS estimates of the field survey, 2008.

Cross price elasticity is the responsiveness of budget share of a commodity to the changes in the price of another commodity (Umo, 1994). The sign of cross price elasticity indicate whether the combination was complement with or substitute for one another (Tanko, 2000). The budget share of fuel wood (BSWOD) had cross price elasticity with the price of kerosene and price of cooking gas. The cross price elasticity was 0.160 and 0.002 for the price kerosene and cooking gas respectively. The positive sign suggested that, kerosene and cooking gas with respect to the dependent variable (BSWOD) were more of substitutes than complements. The demand here was cross price inelastic. Thus, a 1% change in the price of kerosene and cooking gas led to a less than proportional change in the budget share allocated to fuel wood (BSWOD).

The budget share of kerosene (BSKERO) had cross price elasticity with the price of fuel wood and price of cooking gas. The cross price elasticity was 0.020 and 0.040 for the price fuel wood and cooking gas respectively. The positive sign suggested that, fuel wood and cooking gas with respect to the dependent variable (BSKERO) were more of substitutes than complements. The demand here was cross price inelastic. Thus, a 1% change in the price of fuel wood and cooking gas led to a less than proportional change in the budget share allocated to kerosene (BSKERO). The budget share of cooking gas (BSGAS) had cross price elasticity with the price of fuel wood and price of kerosene. The cross price elasticity was 0.008 and 0.600 for the price fuel wood and kerosene respectively. The positive sign suggested that, fuel wood and kerosene with respect to the dependent variable (BSGAS) were more of substitutes than complements. The demand here was cross price inelastic. Thus, a 1% change in the price of fuel wood and cooking gas led to a less than proportional change in the budget share allocated to cooking gas (BSGAS).

Table VI: Cross price elasticity for cooking fuels

Dependent variable	Independent variable that had cross price elasticity	Elasticity
BSWOD	PRKERO	0.160
	PRGAS	0.002
BSKERO	PRWOD	0.020
	PRGAS	0.040*
BSGAS	PRWOD	0.008
	PRKERO	0.600***

*** 1% level of significance, ** 5% level of significance,
* 10% level of significance
Source: Computed from LA/AIDS estimates of the field survey, 2008.

DISCUSSIONS

The mean household size of 5 was to reduce poverty and malnutrition. Maximum total monthly household income of ₦850,000 versus the minimum total monthly household income of ₦5,500: indicated that there was very large gap between the poor and the rich. Tonny (2007), confirms this result that, income inequalities had increased in Nigeria. The demand of fuel wood was very low while the entire households demanded for kerosene. This relatively due to the fact it was affordable and accessible by the majority. The demand of cooking gas was very low. This may be probably be as a result of its expensiveness. The study revealed that fuel wood was an inferior good. Thus, the rich household demanded for less of fuel wood. Government should therefore improve the standard of living of the populace. The increase in the number of the rich household will in effect reduce the illegal encroachment of the forest reserve: thereby increasing forestation of the forest. Kerosene was a necessity good, while cooking gas was a luxury commodity. The policy makers should make both kerosene and cooking gas available and affordable. This will also reduce the threat on fuel wood (a forest product) so as to encourage aforestation.

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