Determinants of Household Cooking Energy Choice in Oyo State, Nigeria

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Abstract
This study examined the economic and social determining factors of household cooking energy choice in urban and rural local governments in Oyo State, Nigeria. Primary data via questionnaire and personal interview was collected from 180 randomly selected respondents in Oyo state. Descriptive statistics and the multinomial logit model were used for data analysis. In rural areas, the significant social determinants of household cooking energy are meals per day, education, household size, occupation and cooking facility, while the significant economic determinant of household cooking energy is appliance price. In urban areas, the significant social determinants of household cooking energy are household size and cooking facility while the significant economic determinants of household cooking energy are income, appliance price and expenditure on energy. It was discovered that in rural areas household cooking energy is determined more by social factors than economic factors, while the reverse is the case for urban areas. Thus, it is recommended that government should ensure that price of appliance prices are reduced and the need to improve the social conditions especially of households living in rural areas.

Keywords: *Multinomial logit model; Household energy choice; Oyo State*

JEL classifications: *C31, Q41*

Introduction

Energy universally is referred to as the ability/capacity to do work or to generate heat. Energy is very important to human continued existence and survival as it's required for cooking, heating and lighting. It is also of great relevance in some sectors of the economy like transportation, industry and agriculture. Furthermore, it is a yardstick for determining the socio-economic development of a country in terms of its affordability, reliability, efficiency and safety. Moreso, of its effective forms of energy used by households, fuel wood takes a larger proportion as it contains about 80% of household energy on income, health and productivity. However, the choice of households' energy source to satisfy any particular need depends on several factors; socio economic factors, demographic characteristics of households, availability and accessibility of energy source and environmental factors (Barness and Floor,1996 & Ogwumike, et al, 2014).

Nigeria is highly populated country with about 183million people and is greatly endowed with energy resources. Major sectors using energy are; transport, commercial, industrial, agriculture and household sectors. Among the major economic agents in the economy, the household are considered the highest consumers of energy as about 65% of the total energy use comes from them (Sesan, 2009; ECN, 2005). The households majorly consume different forms of energy ranging from fuel wood, electricity, kerosine as well as liquified petroleum gas (LPG). Amongst the forms of energy used by households, fuelwood takes a larger proportion as it contains about 80 percent of household energy use and the remaining 20 percent comes from other sources. (Sesan, 2009; Famuyide *et al.*, 2011).

In most developing countries, especially in rural areas, traditional fuels such as fuel woods, charcoal and agricultural waste make up a major fraction of a total household energy consumption, with adverse effects environmentally (negative externalities), this includes deforestation which obliterates an essential CO_2 sink (Oladosu & Adegbulugbe, 1994), soil erosion and desertification. However, in urban areas, other energy sources like kerosene, electricity and gas are embraced but they are expensive, supply is deficient and could be unreliable (Onakoya et al, (2013), unhealthy pollutants and causes fire outbreaks due to nonchalant attitude of households to safety measures. In addition, there are also health challenges attributed to these energy sources like tuberculosis, respiratory tract infections, lung cancer and so on. This has thwarted the socio economic activities of the country and has brought poverty on the people of the country posing a challenge to the health and development of the country and her citizens.

Thus, this study seeks to investigate some economic and social factors influencing the choice of household cooking energy in urban and rural local government areas in Oyo state, Nigeria. It also sets to investigate the differences in the determinants of household cooking energy choice between the urban and rural households using the multinomial logit model based on cross section primary data collected in September, 2017. The research questions posed by this study are; do the selected economic factors influence the choice of household cooking energy in urban and rural areas? do the selected social factors affect the choice of household cooking energy in urban and rural areas? and are there differences in the determinants of household cooking energy choice between the urban and rural households?

Review of Empirical Literature

On the international level studies pertaining to household energy choice are scanty probably because energy consumption is low in those parts of the world. Couture et al., (2012) used econometric approach to evaluate fuelwood consumption by French households. The study revealed that the share of fuelwood in primary energy consumption is very low about 4%, fuelwood is chosen as the main energy source by the poorest households and consumption of fuelwood is sensitive to price variability. This implies that higher price reduces fuelwood consumption. Deshmukh et al., (2014) & Rahut et al., (2014) applied multinomial logit model to examine the determining factors of households' energy choice for food and heating system in India and Bhutan respectively. Their result showed that firewood is relied on by majority of surveyed households for their energy needs due to lack of income generating opportunities in the surveyed villages. In the same vein, Wik et al., (2015) explored the determinants households' energy consumption in ten villages of Shanxi province in China.

Adeyemi and Adereleye (2016), with the aid of data collected from randomly sampled 409 households in Ondo State, discovered that energy choice is significantly influenced by the household income and education. The authors recommended promotion of higher level of education and a promotion of standard of living. Also, investigating the causes of household energy choices in Timor-Leste, Rahut et al (2015) discovered that the major determinants of household energy choices are income, urbanisation and the level of education.

Though income is a very significant determinant of household energy choice, the role of non-income factors in household energy choice cannot be ignored. Using Ethiopian data, the studies by Kebede et al. (2002) discovered some significant factors that affects the adoption of modern energy amongst these are the extent of the availability of fuel and other demographic features. Mekonnen and Kohlin (2008) found factors such as taste preferences, availability and reliability of fuel supply, cost, cooking and food consumption habits which may explain the slow transition into modern energy even among the higher income earner. Risseeuw (2012) established the significant role of social and cultural factors in choice of energy use among families and its transition in Mozambique. Eakins (2013) made analysis of the determining factors of domestic energy expenses using data collected from the Irish Household Budget Survey. The researcher found out that economic factors affect fuel choice with income having a less significant effect as also discovered by Rahut, (2014). Furthermore, studies done in Nigeria; Adeyemi and Adereleye (2016) in Ondo state, Bamiro and Ogunjobi (2015) in Ogun state, Baiyegunhi and Hassan (2013)'s survey in Kaduna State and by Ogwumike et al (2014) and Buba et al (2017) on Nigeria, using Multinomial logit regression revealed that economic and social factors significantly influence energy choice and most households depend largely on firewood as its primary cooking fuel.

In studies centring on the traditional and social and cultural magnitudes of household cooking choice. A study carried out by Atanassov, (2010) in Catembe, Mozambique, the researcher concluded that the energy model is not the sole determining factor of family fuel but socio-cultural needs of the society must be taken into consideration. Similarly, Masera et al. (2000) study on Mexico found that households combine several energy sources and still rely on traditional energy for certain cooking activities. This finding is corroborated by Taylor et al. (2011) who found that households in Guatemala usually use traditional cooking fuels even though LPG is available and affordable.

While most studies identified determinants of energy choice in states or countries without differentiating rural areas from urban areas. Fewer studies on urban or rural areas studied each in isolation. The current research study fills the gap in literature by investigating the determinants of energy choice on rural areas independent of urban areas and vice versa, while also going further to determine if differences could be identified in the socio economic determinants of energy choice between them.

Theoretical Framework of the Study

The Utility Theory

The theory clearly explains the quantum of satisfaction which a consumer derives from consuming some certain level of commodities. The development of this theory is attributed to a British economist, William Stanley Jevons (1871). The classicalists and neo-classicalists were of the opinion that utility can be cardinally measured, i.e. quantitatively (Dwivedi, 2005). This explains the theory of consumer behaviour premised on the cardinal utility concept. Total Utility, a concept under cardinal utility, is defined as the sum of all utilities gotten from the consumption of a commodity. This is total utility with respect to a single commodity. If a consumer consumes n units of a commodity, the total utility accruing to him will be

$$TU= U_1+U_2+U_3+U_4+U_5+ \ldots..+U_n \quad (1)$$

Where; TU ----- Total utility
U ------ Utility

On the other hand, if the commodities consumed are more than one, the total utility will be the sum of their individual utilities.

$$TU=TU_x+TU_y+TU_z+ \ldots\ldots+TU_n. \quad (2)$$

Where x, y, z and n represent the commodities. The marginal utility of a commodity can be defined as the utility derived from the consumption of an additional unit of the commodity. It is derived as:

$$MU=\Delta TU/\Delta Q \text{ or } MU=TU_n-TU_{n-1}. \quad (3)$$

Where: MU ---- Marginal utility
Δ ----------- Change and Q------------- is Quantity

The consumer reaches his equilibrium at the point where he maximizes total utility given his income and market prices of goods and services he consumes (Dwivedi, 2005)

This implies that a utility function can be used to describe the preference system of a consumer. Hence, the consumer will consume goods and service which maximize his utility subject to his income level. In the course of this study, a consumer maximizes his utility subject to a set of economic and social constraints. Economic constraints/factors used in this study are; income, appliance price and expenditure. Social constraints/factors used in this study are; household size, eating habits (meals per day, long meals), education, occupation and cooking facility. The use of the utility theory as a theoretical framework for household energy choice and determinants can be related to the studies by Ogwumike *et al*. (2014) & Mekonnen and Kohlin (2009) who used the random utility theory.

Energy Ladder Model

In the 1970s and 1980s there was a fuel wood crisis which gave rise to the notion of the energy ladder (Kowsari & Zarriffi 2010; Taylor 2011). Since the 1980s the energy ladder model has been used by researchers and policy makers in analyzing household energy demand and decision making in order to maximize utility (Hosier & Dowd 1987; Kowsari & Zerriffi 2011). The energy ladder model places modern energy types on the upper tier of the 'ladder' and traditional The energy ladder model hypothesizes income as the major factor that influences energy transition along the energy ladder. According to Arthur *et al*. (2010), one of the pioneer papers to discuss a relationship between income and levels of fuel types is credited to Hosier and Dowd in 1987. The transition involves the shift from the use of one fuel to another as income increases. This model assumes that as income increases more "superior goods" in this context superior energy types will be purchased and less of "inferior goods" such as fire wood and charcoal which are less efficient (Narasimha Rao, 2007)

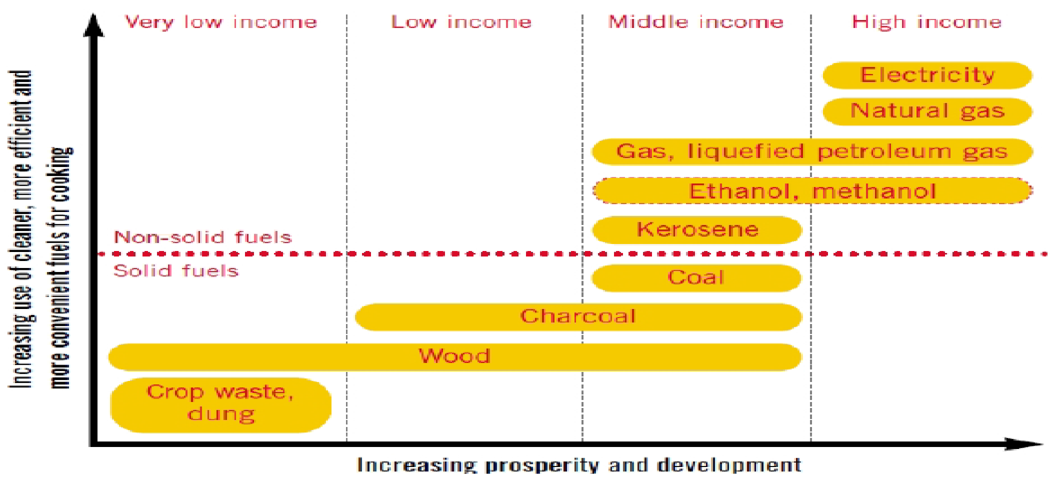

Figure 1: Schematic representation of the household energy ladder
Source: *UNDP, 2004*

Methodology

The study was carried out within Oyo State, located in south-western Nigeria, with Ibadan as the state capital. Oyo state has been chosen as it seems to be the state where rural areas can be easily defined and identified as distinct from urban areas. Again, the state houses the traditional seat of power in South West Nigeria, has a relatively lower cost of living and is relatively peaceful. Primary data was used through the aid of questionnaires and personal interviews by the researcher to collect data for the study in 2017. The state is divided into 5 zones according to the official website of Oyo State but only 4 zones was used because the last zone consists only of semi urban areas. Four local government areas (one from each zone) having rural and urban centres were purposively selected from thirty- three local government areas in Oyo State. Thus 200 questionnaires were administered (50 per local government area) but only the 180 valid ones were analysed.

Questionnaires used were arranged into three sections: section A captured the demographic data and social variables while section B captured economic factors which influence household cooking energy choice. Section C was designed to find out the domestic choice of cooking energy. The questions in the questionnaire are in both closed and open- ended format. The study was carried out in September, 2017.

Model Specification

This study makes use of the multinomial logit model (MLM) to estimate the significance of the factors assumed to determine household cooking energy choice in urban and rural areas. The behaviour of consumers when they are faced with a set of diverse goods with a common consumption objective can best be described using a multinomial logit model. In discrete choice studies, this method has been confirmed to perform better (McFadden, 1974 & Beraho, 2008). It should be noted that the goods must be highly differentiated with respect to their individual characteristics as revealed by Pundo & Fraser (2006). In this case, the model analyses choice between a set of mutually exclusive and highly differentiated cooking energy types such as firewood, charcoal, kerosene, gas and electricity.

Using the scale of 1 – 5 presupposes that the chances of an individual household choosing one type of cooking fuel lies between 1-5. The model makes an assumption that there will not be any reallocation in the alternative set and no change in energy prices or energy attributes. The multinomial logit model assumes that households make energy choices that maximize their utility (McFadden, 1974). The model for the social factors can be expressed as:

$$Pr[Y_i=j]= \frac{\exp\ (\beta jXi)}{\sum_{j=0}^{j} \exp\ (\beta jXi)} \qquad (1)$$

Where:

$Pr[Y_i=j]$ is the probability of choosing either charcoal, kerosene, gas or electricity with firewood as the reference cooking energy category. Firewood=1, charcoal=2, kerosene=3, gas=4 and electricity=5.
J is the number of energy types in the choice set,
J=0 is firewood,
X_i is a vector of the explanatory(exogenous) social factors
X_1 represents household size
X_2 represents meals per day
X_3 represents long meals
X_4 represents education
X_5 represents occupation
X_6 represents cooking facility
β_j is a vector of the estimated parameters.

The model for the economic factors can be expressed as:

$$Pr[Y_i=j]=\frac{\exp(\beta jXi)}{\sum_{j=0}^{j}\exp(\beta jXi)} \quad (2)$$

Where:

$Pr[Y_i=j]$ is the probability of choosing either charcoal, kerosene, gas or electricity with firewood as the reference cooking energy category. Firewood=1, charcoal=2, kerosene=3, gas=4 and electricity=5.
J is the number of energy types in the choice set,
J=0 is firewood,
X_i is a vector of the explanatory(exogenous) economic factors
X_1 represents income
X_2 represents appliance price
X_3 represents expenditure
β_j is a vector of the estimated parameters.

The above logit equations (1 & 2) can be rearranged using algebra, the regression equation will be:

$$P_i=\frac{e^{(b_0+b_1x_1+\ldots+b_px_p)}}{1+e^{(b_0+b_1x_1+\ldots+b_px_p)}} \quad (3)$$

The below equation is used to estimate the coefficients

$$\ln[\frac{p_i}{1-p_i}] = b_0 + b_1x_1 + \ldots + b_vx_v \quad (4)$$

We can interpret from equation 4, that Pi/(1 – Pi) is the odds ratio. Actually, equation 4 has articulated the logit (log odds) as a linear function of the independent factors (Xs). Equation 4 explains the logit weights for variables as expressed in linear regressions. For example, the variable weights refer to the degree to which the probability of choosing one alternative (dependent variable) would change with a one-year change in the independent variable.

The dependent variables are the cooking fuel choices (firewood, charcoal, kerosene, gas or electricity) with firewood as the reference choice (j = 0, in eqn 1&2). Also, estimated coefficients measure the estimated change in the logit for a one-unit change in the predictor variable while the other predictor variables are held constant. A positive estimated coefficient implies an increase in the likelihood that a household will choose the alternative energy source. A negative estimated coefficient indicates that there is less likelihood that a household will change to alternative energy source. P-value indicates whether or not a change in the predictor is significant or not significant at the acceptance level.

The apriori expectations in household cooking energy choice are that the coefficient of education, cooking facility, meals cooked per day, meals requiring more than 1hour of cooking per week (long meals) and occupation of household head is expected to have negative sign. Average monthly income of household head, price of appliance and monthly expenditure on energy are expected to have positive signs.

Analysis and Presentation of Results

Descriptive Analysis of Data

Table 1(i): Demographic Statistics of Households

CHARACTERISTICS	RURAL		URBAN		TOTAL	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
GENDER						
Male	83	92.2	80	88.9	163	90.6
Female	7	7.8	10	11.1	17	9.4
Total	90	100	90	100	180	100
SIZEOF FAMILY						
1-2	4	4.4	3	3.3	7	3.89
3-5	45	50	52	57.8	97	53.9
6-8	33	36.7	28	31.1	61	33.9
9 or more	8	8.9	7	7.8	15	8.37
Total	90	100	90	100	180	100
AGE						
20-30	14	15.6	13	14.4	27	15
31-40	33	36.7	37	41.1	70	38.9
41-50	32	35.6	19	21.1	51	28.3
51-60	11	12.2	21	23.3	32	17.8
Total	90	100	90	100	180	100
MARITAL STATUS						
Single	4	4.4	8	8.8	12	6.67
Married	82	91.1	77	85.6	159	88.3
Divorced	4	4.4	1	1.1	5	2.78
Others	0	0	4	4.4	4	2.25
Total	90	100	90	100	180	100
RELIGION						
Christian	77	85.6	50	55.6	127	70.56
Muslim	13	14.4	40	44.4	53	29.44
Others	0	0	0	0	0	0
Total	90	100	90	100	180	100
EDUCATIONAL LEVEL						
Primary	8	8.9	13	14.4	21	11.67
Secondary	20	22.2	17	18.9	37	20.56
Tertiary	61	67.8	58	64.4	119	66.11
None	1	1.1	2	2.2	3	1.66
Total	90	100	90	100	180	100
Occupational Distribution						
Farming	4	4.4	1	1.1	5	2.78
Business	18	20	35	38.9	53	29.44
Civil Servant	51	56.7	45	50	96	53.33
Private Sector Employee	16	17.8	4	4.4	20	11.11
Others	1	1.1	5	5.6	6	3.34
Total	90	100	90	100	180	100
ENERGY CHOICE						
Firewood	5	5.6	13	14.4	18	10

Charcoal	27	30	28	31.1	55	30.56
Kerosene	13	14.4	31	34.4	44	24.4
Gas	43	47.8	18	20	61	33.89
Electricity	2	2.2	0	0	2	1.11
Total	**90**	**100**	**90**	**100**	**180**	**100**
HOUSE OWNERSHIP						
Owned	46	51.1	**55**	**61.1**	101	56.11
Rented	44	48.9	**35**	**38.9**	79	43.89
Total	**90**	**100**	**90**	**100**	**180**	**100**
COOKING FACILITY						
Internal	79	87.8	75	83.3	154	85.6
External	11	12.2	15	16.7	26	14.4
TOTAL	**90**	**100**	**90**	**100**	**180**	**100**
ASSESSABILITY OF OTHER ENERGY TYPES						
Yes	58	64.4	51	56.7	109	60.56
No	32	35.6	39	43.3	71	39.44
Total	**90**	**100**	**90**	**100**	**180**	**100**
AFFORDABILITY OF OTHER ENERGY TYPES						
Yes	56	62.2	49	54.4	105	58.33
No	34	37.8	41	45.6	75	41.67
Total	**90**	**100**	**90**	**100**	**180**	**100**
MONTHLY EXPENDITURE ON ENERGY						
Less than #500	1	1.1	5	5.6	6	3.33
#500-#1,000	15	16.7	21	23.3	36	20
#1,100-#5,000	64	71.1	60	66.7	124	68.89
More than #5,000	10	11.1	4	4.4	14	7.78
Total	**90**	**100**	**90**	**100**	**180**	**100**
APPLIANCE PRICE						
Less than1,000	7	7.8	24	26.7	31	17.22
#1,100-#5,000	43	47.8	49	54.4	92	51.11
#5,100-#20,000	23	25.6	9	10	32	17.78
More than #20,000	17	18.9	8	8.9	25	13.89
Total	**90**	**100**	**90**	**100**	**180**	**100**

Source: *Author's Compilation*

In table 1 above the gender distribution showed that most respondents in both urban (88.9%) and rural areas (92. 2%) are males, however, rural areas have more male respondents and less female respondents compared to urban areas. Also, averagely, household size ranges between 3-5 with the urban areas having more of this size than rural areas. From the table, it can be deduced from the age distribution of respondents that most respondents in both urban and rural areas fall between 31-40 years and are married. In urban areas 55.6% and 44.4% are Christians and Muslims respectively while in rural areas, 85.6% and 14.45% are Christians and Muslims respectively. There are no other religions.

In terms of educational level, most respondents in both urban and rural areas are educated having tertiary education (66.11%) and so few without education (1.66). Concerning occupation, most respondents are civil servants. Gas is the energy choice of majority of respondents in urban areas (47.8%), while kerosene is that of rural areas (34.4%). However, no respondent in rural areas use electricity for cooking. Most urban (51%) and rural respondents (48.9%) own a housing unit.

In table 1, it can be observed that there is less accessibility of other energy types in rural areas (56.7%) than in urban areas (64.4%). In terms of cooking facilities used, most respondents in urban (87.8%) and rural areas (83.3%) have more internal cooking facilities and less external cooking facilities. This implies that more households cannot afford other energy types in rural areas. Most respondents spend between #1100-#5000 on energy per month (more of which are in urban areas) and respondents spend between #1100-#5000 on energy appliances (more of whom are in rural areas).

Empirical Results

Research Question 1: Do these economic factors (income, appliance price and expenditure) affect the choice of household cooking energy in urban and rural areas?

Table 2: Multinomial logit analysis (MLA) of economic variables for charcoal, kerosene, gas and electricity as compared to firewood in rural areas

Variable name	Charcoal Coeff.	P-value	Odds Ratio	Kerosene Coeff.	P-value	Odds Ratio	Gas Coeff.	P-value	Odds Ratio
Constant	-2.08	.008	-	-1.59	.044	-	-4.31	.000	-
Income	.000	.632	1.00	.000	.741	1.00	.000	.346	1.00
Appliance price	.002	.001 ***	1.00	.002	.001***	1.00	.003	.000 ***	1.00
Expenditure	.000	.320	1.00	.000	.485	1.00	.000	.966	1.00
X^2 (sig) 9 degree of freedom, 69.973 (0.000) ***									
McFadden pseudo R^2: 0.292									

*Notes: ***significant at1% level, **significant at 5% level, *significant at 10% level.*
***Source:** Results from multinomial regression output (MRO)*

Table 2 reports the result of the estimates of the b coefficients of the MLA for economic factors. The value of the x^2 statistic for this model is 69.973 and is significant at 1% which implies that the full model is a better predicative value than the null model. The value of the McFadden pseudo R^2 is 0.292; this performs a similar function with the coefficient of determination as presented in multiple regression, but is not interpreted as the amount of variance in the dependent variable accounted for by the independent variables. A McFadden pseudo R^2 ranging from 0.2-0.4 indicates a very good model fit.

The p-value for charcoal as compared to firewood, kerosene as compared to firewood and gas as compared to firewood show that appliance price is statistically significant at 1%, while income and expenditure are not statistically significant at 1%, 5% or 1%. This finding is similar to that of Stolyarova et al (2014) that appliance price was the only significant determinant of household energy choice.

The estimates obtained from table 2 shows that as appliance price increases by 1%, the odds that a household would choose charcoal compared to firewood increases by 0.2%. This could be because modern energy types use more expensive appliances. As appliance price increases by 1%, the odds that a household would choose kerosene compared to firewood increases by 0.2%. As appliance price increases by 1%, the odds that a household would choose gas compared to firewood increases by 0.3%. This implies that as appliance price increase, households in rural areas would prefer to first change to gas, then charcoal and kerosene. As income and expenditure increase by 1%, the odds of choosing charcoal as compared to firewood, kerosene as compared to firewood and gas as compared to firewood changes by 0%, i.e. a change in income or expenditure does not affect the choice of energy.

Table 3: MLA of economic variables for charcoal, kerosene, gas and electricity as compared to firewood in urban areas

Variable name	Charcoal Coeff.	P-value	Odds Ratio	Kerosene Coeff.	P-value	Odds Ratio	Gas Coeff.	P-value	Odds Ratio	Electricity Coeff.	P-value	Odds Ratio
Constant	-1466.03	.000		-1468.22	.000		-1469.3	.000		-1471.6	.000	
Income	.03	.000***	1.032	.031	.000***	1.032	.031	.000***	1.032	.031	.000***	1.032
Appliance price	1.24	.000***	3.461	1.241	.000***	3.460	1.242	.000***	3.462	1.241	.000***	3.461
Expenditure	-.21	.000***	.814	-.205	.000***	.815	-.205	.000***	.815	-.205	.000***	.815
X^2 (sig) 12 degree of freedom 103.284 (0.000)***												
McFadden pseudo R^2: 0.463												

*Notes: ***significant at1% level, **significant at 5% level, *significant at 10% level.*
Source: *Results from the MRO*

From Table 3, the value of the x^2 statistic for this model is 103.284 and is significant at 1%. Also, a McFadden pseudo of 0.463 indicates a very good model fit. The p-values for charcoal, kerosene, gas and electricity as compared to firewood show that income, appliance price and expenditure are statistically significant predictors at 1% (also at 5%). This is in line with the findings Mackenzie and Weaver (1986) where price and income and education (Adeyemi and Adereleye, 2016), were found to be significant on the probability of a household using fuelwood.

Also, table 3 shows that a 1% increase in income increases the odds of choosing charcoal as compared to firewood by 3.2% (1.032-1). As appliance price increases by 1%, the odds of choosing charcoal as compared to firewood increases by 3.461. As expenditure on energy increases by 1%, the odds of choosing charcoal as compared to firewood decreases by 18.6% (1-0.814). This is due to the fact that modern energy types are not necessarily accompanied by high expenditure (as expenditure in this sense reflects the price of the energy type). This means that as income of the household increases and appliance price increase, the likelihood of choosing charcoal over firewood is a possibility but the reverse is the case with expenditure on energy.

A 1% increase in income increases the odds of choosing kerosene as compared to firewood by 3.2%. As appliance price increases by unit, the odd of choosing kerosene as compared to firewood increases by 3.460. As expenditure on energy increases by 1%, the odds of choosing kerosene as compared to firewood decreases by 18.5%. This is due to the fact that modern energy types are not necessarily accompanied by high expenditure. This means that as income of the household increases and appliance price increase, the household will prefer kerosine over firewood, but the reverse is the case with expenditure on energy.

A 1% increase in income and appliance price increases the odds of choosing gas as compared to firewood by 3.2% and 3.4%. As expenditure on energy increases by 1%, the odds of choosing gas as compared to firewood decreases by 18.5%. This implies that as income of the household increases and appliance price increase, the likelihood of choosing gas as against firewood is possible, but the reverse is the case with expenditure on energy.

A 1% increase in income increases the odds of choosing electricity as compared to firewood by 3.2% and decreases by 18.5% when expenditure on energy increases by 1%. As appliance price increases by 1 unit, the odd of choosing electricity as compared to firewood increases by 3.461. This is due to the fact that modern energy types are not necessarily accompanied by high expenditure.

Research Question 2: Do these social factors (household size, meals per day, long meals, education, occupation and cooking facility) affect the choice of household cooking energy in urban and rural areas?

Table 4: MLA of social variables for charcoal, kerosene, gas and electricity as compared to firewood in rural areas

Variable name	Charcoal Coeff.	P-value	Odds Ratio	Kerosene Coeff.	P-value	Odds Ratio	Gas Coeff.	P-value	Odds Ratio
Constant	4.109	.062		4.12	.077		1.77	.479	
Household size	.004	.979	1.004	-.42	.022**	.657	-.32	.103	.728
Meals per day	-.395	.566	.674	.050	.948	1.051	.57	.489	1.766
Long meals	-.529	.078*	.589	.233	.359	1.262	.29	.246	1.340
Education	-2.15	.103	.117	.247	.846	1.281	-18.7	-	0.000
Occupation	-.716	.397	.489	-2.4	.018**	.090	-21.0	.997	0.000
Cooking facility	-.956	.271	.271	-22.2	.998	2.2E-10	-3.9	.03**	.021
X^2 (sig) 18 degree of freedom 74.632(0.000)***									
McFadden pseudo R^2: 0.311									

Notes: ***significant at1% level, **significant at 5% level, *significant at 10% level.
Source: Results from MRO

In Table 4, the value of the x^2 statistic for this model is 74.632 and is significant at 1%. The value of the McFadden pseudo R^2 is 0.311 indicating a very good model fit. The p-values for charcoal as compared to firewood shows that long meals are statistically significant at 10%. Household size, meals per day, education, occupation, cooking facility are not statistically significant at 1%, 5% or 10%. Similar finding is the work of Stolyarova et al (2014) who discovered that social characteristics of households were not significant in determining energy choice.

The p-values for kerosene as compared to firewood show that household size and occupation are statistically significant at 5%. The p-values for gas as compared to firewood shows that cooking facility is statistically at 5%. The result obtained from table 4 for the significant variables show that as the amount of long meals, household size, being in the informal sector and having an external cooking facility increases by 1%, the odds of choosing charcoal as compared to firewood decreases by 41.1%, 97.8%, 82% and 68% respectively.

As household size increases by 1%, the odds of choosing charcoal compared to firewood increase by 0.4%. This does not follow the a priori expectation of a negative relationship. This can be due to the fact that charcoal and firewood are both biomass fuels and most people may use one for the other. As meals per day, being educated, having an external cooking facility and working in the informal sector increases by 1%, the odds of choosing charcoal compared to firewood decreases by 32.6%, 88.3%, 72.9% and 51% respectively. This implies that as meals per day increases, the less educated one is, working in the informal sector and having an external cooking facility will increase the probability of choosing firewood over charcoal. However, the reverse is the case in terms of household size.

As meals per day increases, being educated and long meals increase by 1% the odds of choosing kerosene as compared to firewood increases by 5.1%, 28.1% and 26.2% respectively. This implies that with increase in meals per day, the less educated the household is and as long meals increases, the household prefers kerosene to firewood. As household size, meals per day and long meals increases by 1%, the odds of choosing gas as compared to firewood decreases by 27.2%, increases by 76.6% and 34% respectively. That is as household size increases, households in the rural areas prefer firewood to gas but as meals per day increases, they would prefer gas to firewood.

Table 5: MLA of social variables for charcoal, kerosene, gas and electricity as compared to firewood in urban areas

Variable name	Charcoal			Kerosene			Gas			Electricity		
	Coeff.	P-value	Odds Ratio	Coeff.	P-value	Odds Ratio	Coeff.	P-value	Odds Ratio	Coeff.	P-value	Odds Ratio
Constant	3.634	.281	-	6.011	.124		4.236	.202		8.37	.257	
Household size	-.235	.275	.790	-.664	.057*	.515	-.248	.277	.780	-1.02	.299	.360
Meals per day	-.746	.537	.474	-.298	.818	.743	.108	.928	1.114	-.26	.902	.773
Long meals	.415	.389	1.514	.273	.600	1.314	.336	.493	1.399	-1.71	.274	.181
Education	-.191	.892	.826	.711	.657	2.036	-2.50	.141	.082	-19.72	-	.000
Occupation	3.192	.120	24.33	-.256	.904	.774	.346	.863	1.413	-3.28	.519	.038
Cooking facility	-4.171	.04**	.015	-4.091	.066*	.017	-4.866	.02**	.008	3.11	.592	22.3
X^2 (sig) 24 degree of freedom 71.193 (0.000)***												
McFadden pseudo R^2: 0.319												

*Notes: ***significant at1% level, **significant at 5% level, *significant at 10% level.*
Source: *Results from the MRO*

Table 6: MLA of income for charcoal, kerosene, gas and electricity as compared to firewood in urban areas

Variable	Charcoal			Kerosene			Gas			Electricity		
	Coeff.	P-value	Odds Ratio	Coeff.	P-value	Odds Ratio	Coeff.	P-value	Odds Ratio	Coefficient	P-value	Odds Ratio
Constant	.559	.674	-	-1.442	.309	-	-1.415	.303	-	-2.75	.173	-
Income	.000	.396	1.000	.000	.118	1.000	.000	.042**	1.000	.000	.307	1.000
X^2 (sig) 4 degree of freedom 30.795 (0.000)***												
McFadden pseudo R^2: 0.138												

*Notes: ***significant at1% level, **significant at 5% level, *significant at 10% level.*
Source: *Results from the MRO*

The value of the x^2 statistic for this model as presented in Table 5 is 71.193 and is significant at 1%, which implies that the full model predicts significantly better or more accurately than the null model. The value of the McFadden pseudo R^2 is 0.319 indicating a very good model fit. The p-values for charcoal as compared to firewood show that cooking facility is statistically significant at 5% as discovered by Jonathan and Victor (2013) While household size, meals per day, long meals, education and occupation are not statistically significant at 1%, 5% or 10%.

The p-values for kerosene as compared to firewood show that household size and cooking facility are statistically significant at 10%. The p-values for gas as compared to firewood show cooking facility is statistically significant at 5%. The p-values for electricity as compared to firewood show that none of the variables are statistically significant at 1%, 5% or 10%. The result obtained from table 5 shows that having an external cooking facility compared to an internal one reduces the odds of choosing charcoal as compared to firewood by 85%. As household size increases by 1%, the odds of choosing kerosene as compared to firewood decreases by 48.5%. Having an external cooking facility as compared to an internal cooking facility decreases the odds of choosing kerosene as compared to firewood by 83%. Having an external cooking facility as compared to an internal one reduces the odds of choosing gas as compared to firewood by 99.2%.

As household size, being less educated and meals per day increases by 1%, the odds of choosing charcoal as compared to firewood decreases by 21%, 17.4% and 52.6% respectively and increases by 51.4% as long meals increase by 1%. Being in the informal sector as compared to the formal sector increases the odd of choosing charcoal as compared to firewood by 24.329units. This means that only when long meals are prepared or people work in the informal sector would charcoal be preferred to firewood, as apriori expected. This could be because charcoal and firewood to some people are close substitutes as they are both gotten from biomass.

As meals per day and working in the informal sector increases by 1%, the odds of choosing kerosene as compared to firewood decreases by 25.7% and 22.6% respectively and increases by 31.4% as long meals increase by 1%. Being less educated as compared to being educated increases the odds by 2.036 units. This means that only instances, when long meals are prepared or when one is less educated or work in the informal sector would kerosene be preferred to firewood

As household size, meals per day, working in the informal sector and long meal increases by 1% the odds of choosing electricity as compared to firewood decreases by 64%, 22.7%, 96.2% and 81.9% respectively.

Having an external cooking facility as compared to an internal one increases the odds of choosing electricity as compared to firewood by 22.303 units. This means that only when there exists an external cooking facility as compared to an internal one in the urban area, would electricity be preferred to firewood. As household size and being less educated increases by 1% the odds of choosing gas as compared to firewood decreases by 22% and 18% respectively. As meals per day, long meals and being in the informal sector increases by 1% the odds of choosing gas as compared to firewood increases by 11.4%, 39.9% and 41.3% respectively. This means that when long meals are prepared or people work in the informal sector in the urban areas, then gas would be preferred to firewood. The results above are in line with the findings of Adeyemi and Adereleye (2016) as supported by the findings by Bamiro and Ogunjobi (2015) and Baiyegunhi and Hassan (2013).

The value of the x^2 statistic presented in table 6 above is 30.795 and is significant at 1%. The value of the McFadden pseudo R^2 is 0.138 indicating a good model fit. The p-value for gas as compared to firewood shows that income is statistically significant at 5%. The result obtained from table 6 shows that a 1% increase in income changes the odds of choosing gas as compared to firewood by 0%. This means that an increase in income makes the household indifferent in their energy choice. As income increases by 1%, the odds of choosing charcoal, kerosene and electricity as compared to firewood changes by 0%. This also implies that an increase in income makes the household indifferent in their energy choice.

Summarily, changes in income do not influence the choice of household cooking energy in the urban study areas. Hence, household cooking energy choice in urban areas of Oyo state do not follow the energy ladder hypothesis which states that as income increases, households move up an energy ladder, traditional fuels being at the bottom of the ladder and modern fuels at the top. This supports the research discoveries Buba et al (2017)

Research Question 3: Are there differences in the determinants of household cooking energy choice between the urban and rural households?

The significant economic determinants of household cooking energy choice in urban areas are income, appliance price and expenditure for charcoal, kerosene, gas and electricity as compared to firewood. On the other hand, the significant economic determinant of household cooking energy choice in rural areas is appliance price for charcoal, kerosene and gas as compared to firewood. Income and expenditure do not significantly influence household cooking energy choice in rural areas.

The result reveals that cooking facility used for charcoal, kerosene and gas are significant social factors determining household cooking energy choice as compared to the use of firewood while household size is significant as compared to firewood. There are no significant social determinants for electricity as compared to firewood in urban areas. On the other hand, the significant social determinants of household cooking energy choice in rural areas as also revealed by Pundo & Fraser (2006) are long meals for charcoal as compared to firewood, household size and occupation for kerosene as compared to firewood and cooking facility for gas as compared to firewood. From the above it can be drawn that choice of cooking energy in urban areas is greatly influenced by economic factors than social factors. While choice of cooking energy in rural areas is greatly influenced by social factors than economic factors.

Conclusion and Policy Recommendations

The result from the multinomial logit model shows that for rural areas meals per day, education, household size, occupation and cooking facility are the social factors that significantly influence and appliance price is the only economic factor that significantly influences household choice of cooking energy in the study area. For urban areas, household size and cooking facility are the only social factors that significantly influence, while income, appliance price and expenditure on energy significantly influence household choice of cooking energy in the study area.

There exist differences in the economic and social factors influencing the choice of energy by households in Oyo state. Economic factors influence the choice in urban areas than in rural areas and social factors influence the choice in rural areas than in urban areas.

The state government through the ministry or other agencies responsible for environment and planning should ensure that every housing unit has an internal cooking facility rather than external cooking facility. The government in conjunction with non-governmental organisations (NGOs) should intensify efforts to sensitize people to the need for family planning and birth control so that household size can be reduced. As discovered increased household size significantly affects the choice of energy use towards more traditional energy source probably because it is cheaper and accessible especially in the rural areas.
The government should make policies to control appliance price so as to encourage households to use modern energy types, as traditional energy types cause environmental degradation. This is as a result of modern energy types being accompanied by high appliance prices. Furthermore, government should make policies that will improve the identified social factors especially in the rural areas.

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