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Does Poverty Level Influence Household Energy Choices? Empirical Evidence from Kwara State, Nigeria

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Abstract

Energy remains very crucial to human livelihood, but poor access poses great challenge to its utilization. The study explores poverty and household cooking and lighting fuel in the Kwara State, Nigeria. Data collected from 1,949 households across the six local government areas were subjected to Fuzzy set and multinomial regression analyses. The results showed that poverty level is a significant determinant of cooking fuel choices (charcoal, gas, electricity, kerosene) but is only significant for one of the lighting fuel choices (candle/flashlight/lamp). Education was also found to aid cleaner fuel choice while increased household size is detrimental to its usage. Heads of the households who are involved in other occupations apart from agriculture are also prone to select better and healthier energy types. Thus, there is a need for greater awareness on healthy energy choices through improved capacity building. Alternative energy choices to firewood should also be made affordable to the masses through fiscal responsibilities and the economy grown for better purchasing power.

Keywords: Multidimensional Poverty, Sustainable Energy, Environmental Health, Nigeria

JEL Classification: C21, D12, I32, Q42

Paper Classification: Research Paper

Introduction

Globally, energy is essential to the growth and development of any nation. This is because of the crucial role it plays in poverty eradication as well as improvement in socio-economic and human development (Oyedepo, 2012). Household accessibility to current power source is crucial to economic progress through its contribution to improved health conditions, saving of time, reduction in indoor air pollution, increased production and productivity through the use of modern technologies and machinery (Barnes *et al*., 2011). On the contrary, lack of both physical and economic access to reliable power supply could hamper development; there by reduce the welfare of its citizens (Chakravarty and Tavoni, 2013).

Globally, at approximate over three billion men and women depend on fossil and non-fossil fuels to meet their necessary energy demands such as animal waste, coal, biomass among others (Reddy *et al*, 1996). This energy is poorly processed in a crude way using the ineffective cook-stoves which result in discharge of harmful substance and products of imperfect incineration.

A continuous usage of these resources as a form energy is linked to increased morbidity and mortality (Pope *et al*., 2002). The World Health Organization observed that,air pollution emanating from individual accounts for over 4.3 million untimely deaths of household nation wide in 2012. Similarly, ambient air pollutants account for an additional 3.7 million deaths (Gordon *et al*., 2014; WHO, 2014). Several health defects are associated with household air pollution, such defects include chronic and acute respiratory disorders, systemic and pulmonary diseases as well as these vere respiratory tract infections which are the causes of infant child mortality in Nigeria especially between the ages of zero and five years (Titcombe and Simcik, 2011; Bello *et al*, 2014).

Access to reliable and affordable energy as well as energy security has shown limited promising improvements for developing countries (Birol, 2007; Pereira *et al*., 2010; Barnes *et al*., 2011). GIZ (2013) submitted that one out of every eight rural households across sub-Saharan Africa (SSA) depend primarily on inferior fossil energy for heating and cooking to fulfill their basic energy requirements. However, these fuels are characterized with emissions of harmful substances that are dangerous to human health and external environment. Also, the time needed to assemble, convey and utilize these fuels is greater as it lessens the prospects of investing the time in more prolific and educative activities (Ekholm *et al*., 2010). Over dependence and indiscriminate utilization of wood to generate household energy contributed to loss of biodiversity, greenhouse gas emission, soil degradation and deforestation of thousands of hectares of woodland which result to desert encroachment throughout SSA and particularly characterized the rural Nigeria where households regularly have easy access to traditional forms of energy (Baiyegunhi, 2014). Mekonnen, Bryan, Alemn and Ringler, (2017) observed that, using fuel wood as a means of heating and cooking is predominant in most African countries like Angola, Gabon, Ghana, Malawi, Nigeria,South Africa and Zimbabwe.

Nigeria is ranked among the low-middle income countries with an average per capita income of about $2790, estimated at 53 per cent rate of poverty (World Bank, 2017). The country was rated 8 thamong the world's largest natural gas deposit in the world and 10th among the oil exporting nations. Nevertheless, agriculture is still considered as the mainstay of the Nigerian economy, closely followed by trading and non-trading activities (National Bureau of Statistics, 2016). However, energy sector is considered among the key players that have been slowing down the nation's economic growth and industrial development not only in Nigeria, but Africa as a whole. The annual reports conducted by the International Energy Agency (IEA), in 2015 put the electricity consumption/capita /annum at 140 kWh, with the monthly estimated consumption of 12 kWh per capita (International Energy Agency, 2017). Nigeria is anticipated to increase to 264 million by the year 2030 to become the third largest population in the world (UNDESA, 2017). The anticipated increase in the country's growth and population is expected to alter the lifestyle of its citizenry, and invariably increase its energy demand in future. At present, it is estimated that over hundred consumers may not have access to electricity consumption under the existing access rate.

The relationship that exists between energy consumption and poverty is evidence that the poor pay more for their daily power consumed as a result of destructive firewood inhaled. Women are more susceptible to inefficiency in energy use, as they are usually the main users of these fuel for cooking and otherwise responsible for its strenuous collection; children, are deprived of good care and often designated into fuel gathering, women and children particularly girls are susceptible to poor health as well as being unable to have adequate time and facilities for good education, such as proper lighting, thereby extremely reducing their future potential of gainful employment (Masud *et al*., 2007; IAE, 2014)

In developing countries such as Nigeria, issues relating to energy choices are required for a guide. The option of household cooking fuel and lighting in the rural areas of Nigeria calls for concern to tackle the problem of excessive deforestation and health implications of inhaling enclosed toxic wastes. The purpose of encouraging families to utilize alternative energy source is to enable them has adequate use of energy and reduce its negative consequence on the life of the people. Hence, the study examines the determinants of various energy choices available to households in Kwara State, Nigeria.

Literature Review

Several studies have assessed the determinants of household energy choices using different methodologies which include Ordinary Least Square (OLS) method (Trotta, 2018), logit method (Bisuetal., 2016), multinomial probit (Mwaura, Okoboi and Ahaibwe, 2014) and multinomial logit (Lay, Ondraczek, and Stoever, 2013; Rahut, Das, Groote and Behera, 2014; Nlon and Karimov 2015; Adeyemi and Adereleye 2016; Giri and Goswami 2017). Mwaura *et al* (2014) used multinomial probit model to examine the determinants of household's choice of cooking energy in Uganda. Their finding revealed that only four percent of households utilized modern cooking and lighting fuels. The findings revealed that, household residing either in rural or urban centre, regional location of households' consumption expenditure, household size and educational qualifications beyond primary level were the determinants of household energy choices. Baiyegunhi and Hassan (2014) examined the rural household fuel energy transition in Giwa local government area of Kaduna State in Nigeria. The results revealed that age, price of fuel wood, educational status, income, household size, duration of food cooked, and dwelling unit type were the significant determinants of households' choice of cooking fuel.

Nnaji *et al*. (2012) used multinomial logit model and found out that existence of internal cooking facilities, age of women, households' total income, occupation of women and education status of women were the major factors determining household cooking fuel choice. While income was an important factor, they suggested that policy makers need to consider alternative means of income generation while addressing issues related to household energy consumption.

Danlami *et al*. (2015) conceptualized the determinants of household energy choice and consumption in order to provide information on current understanding of the pattern of household energy. The study concluded that not all factors have equal importance in determining the pattern and behavior of household energy consumption for different areas due to the differences in socio-economic settings, environmental factors, cultural factors as well as the average level of development in the area. Also, the study pointed that the differences in study areas led to the differences and inconsistencies in conclusion of literatures on household energy consumption.

Giri and Goswami (2017) used multinomial logit regression to investigate the determinants of households' choice of energy for lighting in Nepal. The research review shows that richer households utilize better quality energy source, which confirmed the strength of energy hierarchical level of hypothesis. Other factors determining energy choice of lighting were education status of household heads, gender, distance from the market, family size, and household location and the proportion of family dependents. Hence, the study suggested the use of small hydropower generating sets to provide constant electricity to the remote areas. Furthermore, Olang *et al*. (2018) used multidimensional poverty indicator to determine poverty severity on both lighting and cooking fuels in low income households.

Makonese *et al*. (2017) investigated the household cooking fuel patterns across some selected African countries comprising Angola, Lesotho, Malawi, Namibia, Swaziland, Zambia and Zimbabwe. The results of the study sample showed that, 66 per cent of the households relied more on the use of biomass for cooking, while 25 per cent were opportune to connect to national grid. The household level of schooling, opportunity to constant power supply, and the size of the household, the level of family affluence had contributed significantly to the mode of cooking fuel adopted in the area under study.

Chidiebere-Mark *et al*. (2018) investigated the determinants of cooking energy consumption among farming households in Owerri Agricultural Zone in Imo State. The study found that majority of the households use various kinds of cooking energy fuel; however, higher proportion use fuel wood, in spite of the consequences on health, environment and development, while sex and household's income were the significant determinants of cooking energy choice. The study recommended that the government should put up measures aimed at increasing household's income levels and develop affordable, modern and cleaner cooking energy materials that could ease the level of negative effect of fuel wood usage in the environs.

Mangula *et al*. (2019) employed multinomial logistic regression technique to analyze the effect of using energy cooking fuels on the choice of rural dwellers of Tanzania. The study observed that fire wood, charcoal, liquefied petroleum gas and electricity are commonly used by the rural people of Tanzania in that order. The study analysis also revealed that, the household years of schooling, the family size, nature of occupation, level of income, and age of the household heads are strong determinants of the choice of energy use for cooking in the rural areas. Therefore, in order to ensure adequate provision of sustainable energy use in the rural area; family planning, enlightenment campaigns and reforestation programmes on the use of modern cooking methods were recommended.

Thus, this paper will be adopting multinomial logit to analyze the determinants of lighting and cooking fuels in the Kwara State. Specifically, the study will look at the role of poverty in energy choice. Multidimensional method of poverty measurement will be adopted for the study, since most recent studies on poverty are adopting multidimensional approaches to unidimensional approaches to poverty indicators (Oyekale and Okunmadewa, 2008).This is because poverty affects many facets of human condition including economic, psychological, physical and moral aspects (Duclos *et al*., 2004).

Methodology

The Study Area

The study was conducted in Kwara state, Nigeria. Kwara state is in the north-central geopolitical zone and shares boundaries with the Benin Republic to the west; Niger state to the north; Kogi to the east and Ekiti, Osun and Oyo states to the south respectively. Kwara state is mostly wooded savannah in the north and forested in the south. Most of the inhabitants of the state are farmers engaged in the cultivation of yam, maize, millet, onion and beans. The flood plains of the state also afford the farmers the opportunity of Fadama farming. Kwara State comprises 16 local government areas in three geopolitical zones and scattered over an approximately 36,825 sq. km. The local government are: Baruten, Edu, Patigi, Kaima and Moro (Kwara North); Asa, Ilorin East, Ilorin South, Ilorin West and Offa (Kwara Central); Ekiti, Oke-ero, Ifelodun, Irepodun, Isin, Oyun (Kwara South).

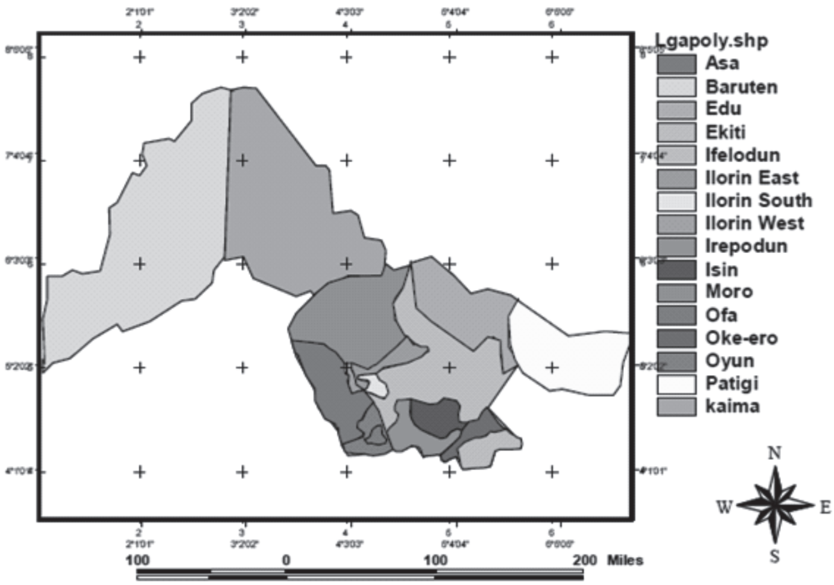

Figure 1: Kwara State map indicating all Local Government Areas

Source: Olabode and Oluwafemi (2016)

Data Collection

Data were collected from six out of the 16 local government areas of the state through administration of a structured questionnaire and interactive interview. The survey area comprises the three senatorial districts that is Kwara north, south and central respectively. The questionnaire used for this research work was adopted from the World Bank Living Standards Measurement Study on the method of measuring and analyzing the welfare of developing nations. A cluster method of sampling technique was adopted to choose the representative for the study. This was achieved through selecting the larger grouping called clusters and then selecting the sample units from the clusters (see Barnett, 1991). At the first stage, the selection of sample was based on classification of the state into three. The second stage was the random sampling of the two local government areas from each of the senatorial. Sampled settlements were based on the rural nature and population size in the range of 5000 and below. The choice of four settlements per local government area was based on the approximation of five percent (5%) of rural settlements in each of the districts. This brings the total number of the communities sampled to twenty-four (24). The households sampled were drawn randomly to allow a degree of representativeness.

Analytical Procedure

The main methods of analysis employed include the Fuzzy set approach for measuring multidimensional poverty and the multinomial logit regression for assessing factors determining choice of energy.

Fuzzy Set Approach

Unlike the unidimensional method of poverty measurement which accounts for either income or expenditure, the multidimensional measure to poverty involves the identification of some poverty indicators. Hence, the multidimensional measurement establishes and examines a vector of variables and attributes that retained some form of indicators of exclusion, deprivation or poverty (Costa, 2002).The study used fuzzy set earlier proposed by Zadeh, (1965) and applied by Oyekale and Okumadewa(2008) to poverty analysis. Zadeh (1965) categorized fuzzy set into classes of range using grades of members. Thus, given a total population P of nth households [P $=p_1, p_2, p_3, \ldots\ldots, p_n$], the subset of poor households comprises all household $p_{i\varepsilon\in}$g. These household possess some form of deprivations in some of the z poverty attributes (X) (Costa 2002).The degree of household being poor by the it h individual is given as (i=1,…..n) subject to a particular attribute (j), such that, (j=1,…..z) given as: $\mu B[X_j (p_i)] = X_{ij}$,0 d” X_{ij} d” 1. Thus, $X_{ij} = 0$ if household does not possess any welfare improving element and $X_{ij} = 1$ if household possesses it.

The attributes used for the study include access to formal education, not attending school at all, access to health facilities, distance to health centers, house ownership, type of toilet facilities, sharing of toilet, and number of meals per day, disposal al of garbage and source of drinking water. Often, non-monetary deprivation of individual takes simple structure of ‘yes’ or ‘no’ dichotomies; hence, X_{ij} equals to 0 or 1. None the less, some could take order categories, indicating a different level of deprivations. From a universal case, d = 1 to D ordered categories of deprivation index, such that d = 1 which indicates the most deprived household and d = D indicating the least deprived. The symbol D_i represents the category to which individual ‘i’ belongs. Cerioli and Zani (1990), assumed the rank of the individual categories stand for an equal spaced metric variable assigned to the individual deprivation score as:

$$ij = (D - d)/(D - 1) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

where: 1 d” d_1 d” D. Thus, X_{ij} may not have to be compulsorily 0 or 1, but 0 d” X_{ij} d” 1 when there are many categories of the j_{th} indicator when the household possesses the attributes of intensity. The multidimensional welfare index of a household poverty (p_i), shows the level of welfare and membership to set B, and is defined as the weighted average of X_{ij} ,

$$\mu B(p_i) = \sum_{j=1}^{n} X_{ij} w_j \Big/ \sum_{j=1}^{m} w_j \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where w_i represent the weight attached to the individual j_th attribute.

The household intensity of deprivation with respect to X_j is calculated as weight w_j. This shows an inverse function of the degree of deprivation. The smaller the household size, the lesser the amount of their deprivations, and the greater will be the weight.

$$w_j = \log [\sum_{j=1}^{n} g(a_i) / \sum_{j=1}^{n} X_{ij}\, g(a_i) = 0 \ldots\ldots\ldots\ldots (3)$$

Multinomial Logit Regression

The discrete choice forms the model that was used to determine the influence of household choice in cooking and lighting fuel that a household chooses between alternative sources of energy. For the study, the multinomial logistic regression model which provides an effective and reliable method of analyzing the factors that affect the inclination of a particular energy basis which is the response variable and estimate of odds ratio of certain factors on the preference of a particular energy units chosen, is used in analyzing data collected.

For each choice of cooking energy charcoal (y_i = 1), firewood (y_i = 2), gas (y_i = 3), electricity (y_i = 4), kerosene (y_i = 5) and lighting energy none (y_i = 1), candlelight, flashlight, or oil lamps (y_i = 2), gas (y_i = 3), electricity (y_i = 4), two different regression would be run to predict the probability of y_i (the dependent variable for any observation) being in that category as opposed to being in the reference or baseline category of y_i = 0. As follows:

$$y_i = X_i\beta_n + e_n \text{ ....(4)}$$

The model is stated more explicitly as follows:

$$V_{ci} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + e_i \text{ ....(5)}$$

Where V_ci denotes the measurable utility derived from any of the five and four choices for cooking and lighting energy respectively, x_i denotes the attributes that predispose a household has choice to the source, β_n measures the estimated parameters and e_i is the error term. Probability of household choice to cooking or lighting source i.e. Pr(y_i)is given below:

$$\Pr(y_i) = \frac{\exp \beta_o + \beta_{11}x_1 + \beta_{22}x_2 \dots\dots + \beta_{k1}x_k}{\sum \exp(\beta_{0n} + \beta_{1n}x_1 + \beta_{2n}x_2 + .. + \beta_{kn}x_k)} \text{.....(6)}$$

With y_i = 0 as the reference category, $\Pr(y_i = 0) = \frac{1}{1 + \sum_{j=1}^{j} \exp(x_i \beta_j)}$ ....(7)

In the results, a positive coefficient implied that the independent variable increases the probability of the household choice to cooking or lighting energy source whereas a negative coefficient implied a decreasing effect. In other words, an estimated coefficient measures the change in the logit for a unit change in the predictor variable holding other predictor variables 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 a less likelihood of household changing to alternative power source. The log likelihood function for the multinomial logit, which gives the relative probability of choice to energy sources to the probability of the reference group, is written as:

$$\text{In } \frac{py_i}{py_0} = \beta_i X_i \text{ ....(8)}$$

Where p y_i = probability of choice to cooking or lighting energy source, py_0 = probability of being in the reference group and X is the individual household characteristics. However, the individual household characteristics include age of household, gender, household size, marital status, educational attainment, occupation of household head, household location (local government area) and household multidimensional poverty (mdp). For the categorical variables, other variables are explained with respect to the baseline variables which are as follows: female (sex), single (marital status), no formal education (educational level), agriculture/fishing (occupation) and Asa LGEA (location).

Discussion of Results

Socio -demographic Distribution of Household in Kwara State

Table 1 below shows the respondents distribution based on their socio-demographic characteristics and energy use. Three-quarters of the respondents are males and four-fifths are married. Approximately, one-third had no formal education, but higher proportion is educated up to secondary and post-secondary levels. Agriculture is the main occupation of more than half of the respondents. Very significant percentages are also into trade and in the civil service. The respondents are also equally distributed across all the local government areas. With respect to energy type for cooking, seven (7) out of every ten (10) respondents use firewood for cooking while one-fourth use charcoal. On lighting energy, more than half depend on electricity while 40% uses candle/flashlight/lamp.

Table 1: Socio-demographic Distribution of Households in Kwara State

Variable	Category	Frequency	Percentage
Sex	Female	498	25.55
	Male	1,451	74.45
Marital Status	Single	91	4.67
	Married	1,611	82.66
	Divorced/separated	122	6.26
	Widow	125	6.41
Educational level	No formal	836	37.24
	Primary	330	14.70
	Junior secondary	116	5.17
	Senior secondary	563	25.08
	Post-secondary	400	17.82
Occupation	Agriculture/fishing	1,100	56.44
	Trade	299	15.34
	Transport	108	5.54
	Technical	127	6.52
	Civil servant	251	12.88
	Construction	18	0.92
	Handcraft	30	1.54
	Others	16	0.82
Location	ASA	313	16.06
	BRT	350	17.96
	EDU	356	18.27
	ILE	316	16.21
	IRP	354	18.16
	ISN	260	13.34
	Total	**1949**	**100.0**

Cooking energy categories	Charcoal	473	24.27
	Firewood	1409	72.29
	Gas	18	0.92
	Electricity	38	1.95
	Kerosene	11	0.56
	Total	**1949**	**100.0**
Lighting energy categories	None	82	4.22
	Candle/Flashlight/ Lamp	771	39.66
	Gas	12	0.62
	Electricity	1079	55.50
	Total	**1944**	**100.0**

Source: Field Survey, 2018

Multidimensional Poverty Analysis

Figure 2 shows the distribution of the mean multidimensional poverty (mdp) for all the respondents. The distribution mimics a normal distribution but has two peaks which imply that the respondents are almost in two distinct distributions. Most of the respondents are also found around the middle of the distribution with the kernel plot tapering at the upper end of the distribution suggesting that a few people are at high poverty level. To buttress this, the mean multidimensional poverty rate of 0.4461± 0.1525 indicates that the relative poverty level in the study area is below average.

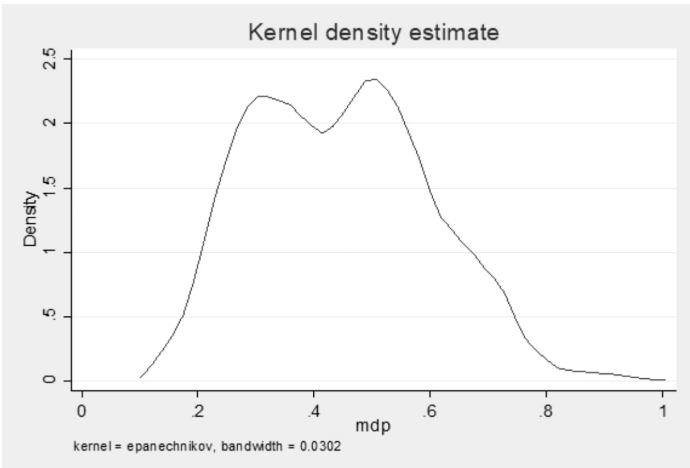

Figure 2: Distribution of the multidimensional poverty of the respondents

Mean= 0.4461; Standard deviation: 0.1525; Minimum= 0.1308; Maximum: 0.9742

Table 2 presents the decomposition of multidimensional poverty indices based on their attributes. The expectation is that the sum of multidimensional poverty indices must be equal to the average of that computed for the whole population. The result shows that distance to health centers, sharing of toilet, not attending school at all, source of drinking water, do not own a house and type of toilet facilities are the most important attributes in decreasing order of importance. The least important attributes are disposal of garbage and access to health. This implies that though the respondents have health centers around, the distance to the centers contributed more to poverty.

Table 2: Contribution of poverty attributes to overall multidimensional poverty

Attribute	Unidimensional poverty ratio	Weight	Contribution	% contribution	Share of average Mdp index
Access to formal education	0.6357	0.1967	0.1027	10.27	4.5807
No school at all	0.2899	0.5378	0.1280	12.80	5.7096
Health access	0.8856	0.0528	0.0384	3.84	1.7116
Do not own a house	0.5721	0.2425	0.1139	11.39	5.0818
Sharing of toilet	0.3038	0.5175	0.1291	12.91	5.7569
Distance to health centers	0.3205	0.4942	0.1300	13.00	5.8006
Number of meals per day	0.7576	0.1206	0.0750	7.50	3.3455
Disposal of garbage	0.8310	0.0804	0.0548	5.48	2.4468
Type of toilet facilities	0.5893	0.2297	0.1111	11.11	4.9570
Source of drinking water	0.5118	0.2582	0.1170	11.70	5.2184
Average multidimensional poverty index	100.00	44.6088			

Determinants of Cooking and Lighting Fuel Choices in Kwara State, Nigeria

Determinants of choice of household cooking fuel in Kwara State, Nigeria

Several factors determining the choice of cooking fuels are presented in Table 3. Multidimensional poverty variable was found to be significant across all the cooking fuel types at 1% significance level, except in the case of kerosene in which it was significant at 10%. The same positive signs across all the fuel types indicate positive relationship between the energy choices and multidimensional poverty. Specifically, a unit increase in multidimensional poverty increases the use of charcoal, gas, electricity and kerosene by 0.1457, 0.0665, 0.0530 and 0.0188 units, respectively relative to firewood. The implication is that households prefer the use of charcoal most and kerosene least in comparison to firewood probably as a result of easy access or lower health hazard.

The coefficient for household head occupation appears positive and significant for the level of household choice of charcoal, gas, electricity and kerosene as a major energy source for cooking fuel and lighting in relation to firewood. The analysis suggests that, when household engage in other occupations apart from agriculture, it could translate into better income thereby enabling household easy accessibility and usage of any of the cooking fuels (charcoal, gas, electricity, kerosene) over the choice of firewood.

The estimated coefficient of household heads' education is positive and significant in the regression results. This implies that, the probability of a household choice of gas and electricity as their main cooking fuels in relation to firewood implies that an increase in household head's education is likely to influence the choice of gas and electricity above firewood. The explanation to this is that an increase in the level of educational attainment of the household improves the knowledge on the hazards of using fuel wood as a source of energy, likewise the taste and preference of modern clean fuels would also improve as income increases. A literate woman is not likely to have time to start gathering firewood because of her time consciousness to leave to work. The alternative would be to prefer cleaner but rather expensive fuel for cooking, or otherwise. The finding is in line with the studies carried out by Baiyegunhi and Hassan (2014) and Bisu *et al*. (2016) who found that when women level of education is higher, they would prefer less firewood for cooking compared to high opportunity cost of using firewood.

The coefficient of household size also indicates negative and statistically significant household probability transition from firewood to electricity. This translates that a rise in household size decreases the probability of the transition from firewood to electricity. The level of household size is expected to have negative impact on the use of firewood alternative source of cooking fuels and lighting such as charcoal, kerosene, gas, and electricity. This is because households with many members may find it economically cheaper to use compared to modern cooking fuel which could be relatively higher in price. A significant coefficient of multidimensional poverty and decrease in household size could lead to transition from electricity to firewood. This supports the findings of Mwaura *et al*. (2014) that decrease in the number of persons in the household to source for income could plunge a household into poverty.

Determinants of choice of household lighting fuel

The coefficient of household education as a proxy for household cooking and lighting fuel is negative and significant for candle/oil lamps/flashlight and those without any source of lighting energy. This implies that, with an increase in educational attainment, households are less likely to use the old sources of energy compared to modern means of lightening such as electricity which provides better-quality services given available options. Given the increase in purchasing power and educational attainment and awareness level, this would increase the choice for cleaner and more efficient energy sources. The results are in conformity with the study of Giri and Goswami (2017). The coefficient of household size appears negative and statistically significant for candle/oil lamps/flashlight, which is an indication that, an increase in household size reduces the possibility of household using candle/oil lamps/flashlight to electricity.

The use of candle/oil lamps/flashlight was found to be positive and significant among unmarried (singles) household. This could be attributed to a smaller number of dependent persons and the cost that might be incurred in using electricity. Its coefficient was also found to be significant but negative among traders. This is an indication that the households are less likely to use electricity as a means of lighting. The type of their trade even though not accounted for, would have influenced their choices. The multidimensional poverty coefficient for households using candle/oil lamps/flashlight as a source of lighting energy is positive and significant. The implication is that increase in poverty level of household increases the usage of candle/oil lamps/flashlight relative to electricity. The alternative or multiple uses of these (candle/oil lamps/flashlight) sources, its prices and access might have influenced their choices. The result of the finding corroborates with Olang *et al*. (2018) who found that some household use multiple number of energy source to provide lightening to household members in different locations during the same period.

Conclusion

The interrelationship between energy use and poverty has implications for sustainable livelihood. To this end, this study assessed the impact of household poverty on energy choice in Kwara State, Nigeria. Using instrument fashioned out of the Living Standard Measurement Study (LSMS), data were collected from household energy use and socio-demographic characteristics of the respondents from Kwara State. Total samples of 1,949 households' questionnaire were administered across the six (6) local government areas (LGEAs) of the State. Fuzzy set methodology was adopted for multidimensional poverty estimation while multinomial logit was used to verify issues controlling the choice of energy use.

Table 3 : Estimated factors affecting cooking and lightening fuels in Kwara State, Nigeria

Variables	Charcoal			Gas			Electricity			Kerosene		
	Coeff.	Std. error	dy/dx	Coeff.	Std. error	dy/dx	Coeff.	Std. error	dy/dx	Coeff.	Std. error	dy/dx
Age	-0.0025	0.0066	-1.81e-04	-0.0160	0.0258	-1.25e-04	0.0024	0.0180	5.66e-05	-0.0387	0.0348	-1.97e-04
Household size	-0.0188	0.0193	-1.73e-03	-0.0402	0.0949	-2.49e-04	-0.2208***	0.0648	-3.84-03	0.0529	0.0611	3.49e-04
Sex: male	-0.1472	0.1680	-0.2397	1.0844	0.8669	0.0074	0.8280	0.5832	0.0123	0.0524	0.7457	5.63e-04
Poverty level	1.5080***	0.4821	0.1457	8.4562***	1.7580	0.0665	3.3753***	1.2876	0.0530	4.5259*	2.5109	0.0188
Marital status												
Married	0.4646	0.3846	0.0709	-0.6727	1.1721	-0.0092	1.4923	1.0681	0.0163	-2.0909*	1.1126	-0.0355
Divorced/ Sep.	0.3583	0.4940	0.0646	-0.8670	1.5788	-0.0101	-14.5725	1944.9	-0.0056	-15.9963	2035.9	-0.0405
Widowed	0.5685	0.4938	0.0885	-15.003	1949.2	-0.0185	1.8936	1.4052	0.0256	-16.3729	2080.9	-0.0405
Educational level												
Primary	0.1159	0.2020	0.0178	-0.4990	0.8745	-0.0034	0.7801	0.6099	0.0121	-1.3861	1.1708	-0.0075
Junior Sec.	0.1719	0.3210	0.0176	1.4526*	0.8444	0.0214	0.8615	0.8556	0.0128	-15.4159	2553.63	-0.0100
Senior Sec.	-0.0738	0.1921	-0.0065	-1.1853	1.1283	-0.0058	0.8671*	0.5061	0.0149	-1.0989	0.9671	-0.0063
Tertiary	-0.0806	0.2071	-0.0130	0.8026	0.6759	0.0096	0.5586	0.5681	0.0080	-0.3788	0.8881	-0.0029
Occupation												
Trade	0.1184	0.2032	0.0061	1.3136*	0.7235	0.0123	0.9644**	0.4582	0.0186	1.2137	1.0647	0.0048
Transport	0.5208*	0.2754	0.0667	1.3353	0.9440	0.0115	-15.2362	1993.5	-0.0137	1.1593	1.3807	0.0035
Technical/ Prof.	-0.0747	0.2730	-0.0173	1.1215	0.9492	0.0099	1.6141**	0.6602	0.0451	-15.403	2723.43	-0.0024
Civil servant	1.0169***	0.1984	0.1356	0.9328	0.8656	0.0039	0.5362	0.5511	0.0047	2.5733***	0.9364	0.0157
Construction	0.3234	0.5957	0.0332	2.3644**	1.2048	0.0383	-16.1441	8128.6	-0.0137	-16.3928	19367.8	-0.0024
Handicraft	0.6303	0.4774	0.0711	-14.6514	6177.93	-0.0058	1.6112	1.1239	0.0396	2.3916	1.4719	0.0159
Others	0.8972	0.6861	0.1198	-15.3352	11614.5	-0.0058	1.6967	1.2297	0.0411	-15.2913	11924.6	-0.0024

Location												
Baruten	0.0062	0.2930	-0.0030	-1.3859	1.5897	-0.0031	1.9911**	0.8462	0.0403	-2.7666	1.7275	-0.0099
Edu	-0.6580**	0.3012	-0.0555	1.6409	1.1936	0.0155	1.5215*	0.8339	0.0252	-15.5183	1582.5	-0.0107
Ilorin East	1.3219***	0.2527	0.1919	2.3557*	1.2122	0.0209	1.4495	0.9749	0.0135	0.6016	1.3649	0.0017
Irepodun	2.8408***	0.2489	0.5264	2.7548**	1.2928	0.0128	0.2655	1.0887	-0.0042	2.4046**	1.1928	0.0175
Isin	0.1444	0.2838	0.0109	1.7046	1.2950	0.0147	1.1454	0.9125	0.0136	0.0730	1.5108	-0.0001
Constant	-2.9808***	0.5576		-9.9162***	2.2469		-8.3052***	1.6395		-4.1839*	2.3993	
	Number of obs. = 1,949 Log-likelihood = -1050.54 LR chi2(92) = 734.49 Prob>chi2 = 0.0000 Pseudo R2 = 0.2590											

*Level of significance: ***1%, **5% and *10%.*

Table 4: Estimates of the factors affecting choice of lighting fuel in Kwara State, Nigeria

Variable	None			Candles, Flashlights and Lamps			Gas		
	Coeff.	Std. error	dy/dx	Coeff.	Std. error	dy/dx	Coeff.	Std. error	dy/dx
Age	0.0109	0.0110	4.48e-04	-0.0010	0.0051	-4.17e-04	-0.0169	0.0329	-1.00e-04
Household size	-0.0299	0.0291	-4.23e-04	-0.0346***	0.0130	-6.34e-03	0.1120	0.1521	7.12e-04
Sex	0.1826	0.3594	0.0077	-0.0446	0.1511	-0.0120	-0.4802	0.7307	-0.0029
Poverty level	0.2804	0.8996	-0.0123	1.0640***	0.3920	0.2034	0.8571	2.3621	0.0038
Marital status									
Married	0.5492	0.5843	0.0093	0.5572**	0.2616	0.0946	13.7156	3053.7	0.0045
Divorced/Separated	0.1531	0.7815	-0.0059	0.6504*	0.3398	0.1186	14.9806	3053.7	0.0151
Widow	0.4157	0.8258	0.0088	0.3192	0.3611	0.0464	15.7626	3053.7	0.0325
Educational level									
Primary	-0.2206	0.4291	-0.0080	0.0318	0.1730	0.0112	-0.9054	1.1689	-0.0044
Junior Sec.	-0.2785	0.7717	-0.0172	0.5321**	0.2543	0.1137	-13.7444	1371.36	-0.0075
Senior Sec.	-0.1596	0.3449	-0.0041	-0.0880	0.1513	-0.0146	0.2395	0.7644	0.0021
Tertiary	0.7163**	0.3310	0.0237	0.3751**	0.1644	0.0580	-1.0327	1.1929	-.0051
Occupation									
Trade	-0.0230	0.3616	0.0038	-0.1906	0.1637	-0.0373	-0.8306	1.0037	-0.0038
Transportation	-0.9465	0.6300	-0.0149	-1.1182***	0.2698	-0.1894	-15.6755	3572.47	-0.0071
Technical/Professional	-0.1415	0.5248	0.0009	-0.3014	0.2440	-0.0589	0.7911	1.0630	0.0087
Civil servant	-1.0243**	0.4652	-0.0232	-0.5586***	0.1816	-0.0922	-0.1300	0.9922	-8.28e-05
Construction	-17.1768	4570.5	-0.0468	-2.6329***	1.0652	-0.3498	-16.3800	10202.1	-0.0071
Handicrafts	-16.1444	3415.1	-0.0468	0.2019	0.4295	0.0693	-15.4265	5252.2	-0.0071
Others	-16.7154	4424.8	-0.0468	-0.4457	0.6303	-0.0584	-15.9076	10275.4	-0.0071
Location									
Baruten	3.2697***	0.6842	0.0722	1.8725***	0.2207	0.3676	-16.3449	1839.3	-0.0147
Edu	3.2159***	0.6314	0.0854	1.5315***	0.1872	0.2906	-15.4617	1127.8	-0.0147

Ilorin East	0.8684	0.7445	0.0097	0.2493	0.2035	0.0463	-0.6180	0.9958	-0.0071
Irepodun	0.8987	0.7344	0.0150	-0.8230***	0.2318	-0.1233	0.3686	0.9616	0.0086
Isin	1.8869***	0.7164	0.0205	1.4301***	0.2024	0.3081	-15.3726	1664.6	-0.0147
Constant	-5.4710***	1.0402		-1.6627***	0.4030		-17.7795	3053.7	
	Number of obs. = 1,944 Log-likelihood = -1416.72 LR chi2(69) = 504.37 Prob>chi2 = 0.0000 Pseudo R2 = 0.1511								

*Level of significance: ***1%, **5% and *10%.*

Households were male head dominated and agriculture was the main occupation of the household heads. Majority (~70%) of the households used firewood for cooking while >50% depended on electricity for lighting. The multidimensional poverty (MDP) index for the respondents was 44.6% while distance to health centers (13.0%), sharing of toilet (12.9%), non-attendance of school (12.8%), source of drinking water (11.7%) and not owing house (11.4%) contributed most to MDP in decreasing order of importance.

The choice model results showed that MDP is positive and statistically significant. This affects the use of charcoal, kerosene, gas and electricity as a means of cooking fuel relative to firewood while it was only positively significant for the usage of candle/oil lamps/flashlight relative to electricity. Furthermore, being educated and engaging in occupations other than agriculture encouraged households to adopt better fuel options for cooking and lighting while large household sizes discouraged more efficient fuel-type use, especially for cooking and caused dependence on electricity for lighting.

The implications of the results are far-reaching. Respondents in the study area may have resorted to better cooking fuel options as a result of urbanization and health/environmental considerations by urban dwellers or increased population and deforestation that have made firewood to be scarce in the rural areas. The dependence of households on not too adequate electricity infrastructure might negatively impact their activities (productive and non-productive) and poverty might have prevented exploring other (candle/oil lamps/flashlight) lighting options. Thus, there is need for policies that will be tailored towards raising awareness on health and environmental implications of less-efficient fuel usage. The economy should also be grown for high per capita income for the citizens to be able to afford healthier and more environmentally friendly fuel alternatives.

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