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Fuel Switching and Stacking Behaviour of Households in Odo-Otin Local Government Area of Osun State, Nigeria

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Abstract

Households in Nigeria often choose from the available energy commodities at their disposal based on its availability and affordability. The paper examined the expenditure pattern of household, investigated household energy consumption pattern, and access the determinant of fuel switching and stacking behaviour. These were with a view to examining the fuel stacking and switching behaviour of household and appraise the implications of energy pricing reform on switching and stacking behaviour in Odo-Otin Local Government Area of Osun State, Nigeria. The study adopted both descriptive and analytical techniques. The results showed that the major determinants of switching and stacking behaviour are household energy expenditure, accessibility of different energy choices and household energy prices. The study also showed that petroleum pricing reform is significant in explaining stacking and switching behaviour of households in Odo-Otin Local Goverment. The finding revealed that prior to the removal of subsidy on kerosene, majority of the households' sampled used kerosene for cooking in urban areas while those in the rural areas mostly used fuel wood and charcoal. Thereafter, a partial switch in the pattern of domestic energy consumption was observed, with more households using charcoal and LPG in urban areas while those in rural areas mainly used fuel wood and other more polluting, less efficient, energy sources for cooking. The paper recommends a transition towards more environmental friendly energy sources for household usage

Keywords: Fuel switching; stacking behaviour; households; Osun State

1. Background to the Study

The use of traditional energy sources such as wood, animal dung and agricultural residue by households has been in practice since time immemorial. This has however been identified as a cause of environmental problems such as excessive deforestation, and also causing the premature death of about 4.3 million people yearly; it caused the death of about 396,000 people in sub-Saharan Africa, 2002. It was also responsible for 2.7 % of the global burden of disease in that year (Ayodele, 1998). In a scenario where households have relatively higher access to high carbon energy services such as fuel wood and charcoal as against low carbon energy such as electricity, the households are termed to be energy poor. It is estimated that approximately 2.5 billion people in developing countries rely on biomass fuels to meet their cooking needs; and. for many of these countries, more than 90 percent of total household fuel is biomass. And without new policies, the number of people that rely on biomass fuel is expected to increase to 2.6 billion by 2019, and 2.7 billion by 2030 (International Energy Agency, 2014), which represents about one-thirds of the world's projected population.

Energy is a key ingredient for the social, economic and industrial development of every nation *(*Oyedepo 2012; Baiyegunhi & Hassan 2014). However, access to modern, affordable and reliable energy services is an enormous challenge facing the African continent, particularly Nigeria (1wayemi 2001; Adenikinju 2017). The African Development Bank Group (2014) reported that the national electricity access and per capita energy consumption for Nigeria were merely 48 % and 149 kWh, respectively in 2012. This is less than for Senegal (at 56 % and 187 kWh/person), Cote d'Ivoire (at 59.5 % and 212 kWh/person) and Ghana (at 72 % and 344 kWh/person), countries that have far less amounts of energy resources than Nigeria. This energy poverty is experienced more by the Nigerian rural dwellers that mostly have an access rate of less than 30 %. this has rendered the "public supply a standby source as many consumers who cannot afford irregular and poor quality service substitute more expensive supply alternatives to minimize the negative consequences of power supply interruptions on their production activities and profitability", thus causing about 20 % of the investment in industrial projects to be allocated to mostly more expensive alternative sources of electricity *(*Iwayemi 2008). This acute shortage and irregular supply of clean energy sources has also caused more households in Nigeria to depend on traditional energy sources such as wood, animal dung and agricultural residue; this phenomenon is seen to be causing personal health and environmental problems, particularly excessive deforestation (Mwampamba et al 2013), estimated at 300,000 ha per year.

In Nigeria, about 65 % of the total energy consumption is taken up by the household, probably due to underdevelopment of the industrial sector. Cooking accounts for about 91 % of the total domestic energy consumption (Oyedepo 2012). Despite the abundance of renewable, and environmentally friendly energy sources *(*Hassan 2012*)*, about three billion people worldwide still use solid fuels for their basic needs; these include cooking, boiling water and space heating. The use of liquefied petroleum gas (LPG) has also remained low at 1.1 % throughout the period (Ogwumike 2014). The problem seems to be worsening as about 86 % of households still depend on fuel wood as their source of energy *(*Oyedepo 2012).

Indoor cooking using solid fuels have been described as a 'dangerous activity' that is responsible for the premature death of about 4.3 million people yearly *(*WHO 2010*)*. It was responsible for the death of about 396,000 people in sub-Saharan Africa in 2002. It was also responsible for 2.7 % of the global burden of disease in that year alone (WHO 2006). More than 40% of the world's population rely on solid fuels such as wood, crop residues or dung for their cooking and heating needs (Bonjour et al 2013) Household air pollution, caused by cooking indoors with solid fuels, is the third leading risk factor for morbidity and mortality globally. In 2010, about 3.5 million deaths and 4.3% of global disability adjusted life years were attributable to household air pollution (Lim et al 2012; Smith, 2014) Pollutants from inefficient combustion of solid fuels, especially black carbon particles, also contribute to global climate change (Rehfuess et al', 2014).

Various studies have been carried out on the determinants of household energy use but little has been done on energy substitutability in Nigeria (see: Oyekale 2012; Bamiro and Ogunjobi 2015; Ogwumike, 2014; Abd'razack et al 2012; Anyiro et al 2013; Baraya et al. 2023). However, in the context of earlier discussion and recent developments associated with health and environmental impact of fuel choice, the research does not seem to be in any danger of being over flogged. Perhaps no issue is more contentious in Nigeria's health socio- economic realm than accessibility to cleaner and environmental friendly fuel supply. Also, this study differs from previous ones by not only examining the determinants of household energy demand, but also investigating fuel stacking behaviour of households as a result of deregulation of dual-purpose kerosene (DPK) and household cooking gas (LPG). The main objective of this study is to investigate the determinant household's energy stacking behaviour and appraise the impact of petroleum pricing reform on household stacking behaviour in Odo-Otin Local Government of Osun State, Nigeria.

2. Conceptual, Theoretical and Empirical Issues

A household consists of all persons living under one roof or occupying a separate housing unit, having either direct access to the outside world, or to a public area, or even to a separate cooking facility. Ordinarily, where the members of a household are related by blood or law, they constitute a family, in economics, the household is said to be one of the existing micro economic units; the others being government and the firm. The household represents one of the major decision-making units in the economy; it could be concluded that the economy cannot be complete without the household.

Fuel stacking and fuel switching have dominated different empirical studies. Fuel stacking involves the use of more than one fuel type for household use, while fuel switching involves the transition from cheaper fuel choice (such as fuel wood) to more expensive and cleaner fuel (such as electricity). Household energy consumption is the amount of energy that is spent on the various appliances used for generating heat. The amount of energy used per household varies widely depending on several factors including standard of living in the country, climate, and the age and type of residence.

Household fuel choice has often been conceptualized using the "energy ladder" model (Heltberg, 2003; Leach, 1992; Barnes, Krutilla, and Hyde, 2002; Barnes and Floor, 1999). This model places heavy emphasis on income in explaining fuel choice and fuel switching. The energy ladder model envisions a three-stage fuel switching process. The first stage is marked by universal reliance on biomass. In the second stage, households move to "transition" fuels such as kerosene, coal and charcoal in response to higher incomes and factors such as deforestation and urbanization. In the last phase, households switch to LPG, natural gas, or electricity.

The main driver affecting the movement up the energy ladder is hypothesized to be income and relative fuel prices (Heltberg, 2005). The new perspective on household energy choice sees it as more of portfolio choice than as a ladder. Households' energy portfolio can be described by their size, composition, and diversification. The fuel portfolio of households can represent a combination of fuels from both lower and upper levels of the ladder. Masera et al (2000) revealed that it is not usual for households to make a complete fuel switch from one technology to another; rather, households prefer to use an additional technology without abandoning the old one. Heltberg (2003) outlines how a household economic model can help incorporate opportunity costs – influenced by factors such as education and the availability of labor and natural resources to study energy use.

A growing body of empirical studies on household energy use show that the energy transition does not occur as a series of simple, discrete steps; instead, multiple fuel use seems more common (Leach 1992; Campbell et 2003; Bonjour et al 2013) With increasing income, households adopt new fuels and technologies that serve as partial, rather than perfect, substitutes for more tradition alone (Elias and Victor 2005). Income is the most frequently used indicator to distinguish households from one another. It is also the most important influencing factor related to fuel switching according to the energy ladder theory. The relationship between income and fuel switching has therefore, being addressed in the literature (Rao and Reddy 2007; Hertberg 2005; Davis 1998; Ouedraogo 2006); however, Mekonnen and Kohlin (2008) discovered that households with higher expenditure levels are less likely to use solid fuels only, although cannot attribute the switch from non-solid fuels to a mix of solid and non-solid fuels to household expenditures only. Hence, income does not appear to be the expected key factor according to the energy ladder model. House ownership is also one of the factors examined in the existing studies. Being an owner of a house does not imply higher purchasing power than a tenant, although it does provide freedom of space management in the house (Wolf 1986). Tenants must adhere to occupancy rules, possibly limiting their energy options (Pundo and Praser 2006).

House size measured by the number of rooms has been associated with a move away from fuel wood towards exclusive LPG use (Hertberg 2005) while households who only have outdoor cooking facilities are more likely to use firewood than those with indoor facilities (Ouedraogo 2006) Human capital as an important asset refers to both the quantity and quality of available labour in the household, including educational level, knowledge and professional skills. Education is seen as an important determinant of fuel switching behavior; this is because most studies find positive effects of education on the probability that households use modern commercial fuels such as LPG and Kerosene (Ouedraogo 2006; Hertberg 2005; 2004; Masera et al 2000; Hosier and Kipondya 1993; Soussan et al 1990; ESMAP 1999). Furthermore, fuel switching is not unidirectional as people may switch back to traditional biomass even after adopting modern energy carriers (Masera et al 2000; Arnold et al 2006; Maconachiea et al 2009). The multiple fuel model is gaining increasing support in the literature, (Heltberg2005, 2004; Mekonnen and Kohlin 2008; Mirsa and kemp 2009). Several complementary reasons have been put forward to explain fuel stacking behaviour by households in both urban and rural areas. First, Davis (1998) argues that fuel stacking is inherent to the poor's livelihood strategies. Irregular and variable income flows of households (derived from agricultural work or informal hawking of goods) prohibit the regular consumption of modern energy. Therefore, specific budget strategies are applied in order to maximize fuel security. Second, fuel stacking behaviour is observed due to fuel supply problems (Masera et al 2000; Hosier and Kipondya 1993; Soussan et al 1990; ESMAP 1999). The supply of modern fuels is erratic and the reliability of supply channels are equally low. Therefore, households must have one or two fuels which can be used as backups in the event that their primary fuels are temporarily unavailable (Hosier and Kipondya 1993). Third, fluctuations of commercial energy prices might make the preferred fuel temporarily unaffordable (Hosier and Kipondya 1993). Finally, culture and traditions also play a role in constraining a complete transition to modern fuels. Traditional methods of cooking are often rooted in local cultures, preventing the use of modern fuels (Masera et al 2000; Murphy 2001).

Van der Kroon et al (2013) distinguishes between three categories of influencing factors: (i) the country's external environment shaping the boundaries within which a society has to function (such as climate, geographic location and history); (ii) the decision context reflecting household external and country internal factors based on the institutional, political and market situations of a specified location (factors include capital market, government policies, and consumer markets); and (iii) the household opportunity set representing a group of household internal factors based upon the characteristics and factor endowment of the household. The interaction between factors across categories determines the decision environment, which is unique for each individual household.

Several studies have been carried out on determinant of fuel switching behaviour. Wickramasinghe (2011) find households in semi- urban areas of Sri Lanka who had already adopted LPG to revert to fuel wood after a high increase in LPG prices. Taking a look at both fuel stacking and fuel switching, Alemu and Gunnar (2008) in their research had discovered that multiple fuel use in the form of fuel stacking better describes fuel-choice behaviour of households in developing countries, as opposed to the idea that households switch completely to other more expensive but cleaner fuels as their incomes rise, this is in support of recent arguments in the literature (using Latin American and Asian data). In line with Alemu and Gunnar in terms of fuel stacking and fuel switching, Rasmus (2003) identified expenditures, urbanization, electrification, water source, and education as important drivers of fuel switching: higher levels of each of these variables is associated with a shift towards cleaner and more efficient modern fuels – mostly LPG and kerosene – away from biomass and other solid fuels. Household size affects fuel choices but does not trigger switching: larger households are more likely to use multiple cooking fuels. There is evidence that fuel use reacts to fuel prices in the manner one would expect: the probability of using LPG use is lower where LPG prices are high or where the market price of kerosene and wood are low. Adamu et al. (2020) analyzed the applicability of the energy ladder hypothesis on household demand for energy in Nigeria. The findings reveals that the reliance on energy form at the bottom part of the ladder by majority of household in Nigeria is connected with increasing level of poverty consistent with the energy ladder model, but do not agrees with the view of total energy shifting because most household tend to have combination of different sources of energy for their uses. Baraya et al (2023) used logit regression technique to investigate the determinants of household energy consumption in Kebbi State, Nigeria. The data for the study were sourced from household heads within the study area. The study revealed that education and income have positive and significant impact on electricity, LPG, and kerosene usage, while negative impact was observed with biomass usage. Zamani et al (2024) applied Multinomial Logistic regression method to determine household energy consumption mix in Chikun Local Government Area, Kaduna State. The results further revealed that the major determinants of household energy mix are: household energy expenditure and ownership of electrical appliances.

3. Model, Data and Estimation Techniques

This study was conducted in Odo- Otin Local Government of Osun State. Odo Otin is a local government area in Osun State, Nigeria. The administrative office of the Local Government is in Okuku. It has an area of 294 km^2 and a population of 134,110 as of the 2006 Nigerian census. The council is projected to have 171,500 population, 259.4 km^2 Area and 661.1/km^2 Population Density in the year 2022 with annual population growth of 1.5 percent. Economic analysis of fuel stacking and switching behaviour of households in Odo -Otin Local Government is very important due to the agrarian nature of the area which has implication on their household's energy consumption pattern.

Odo Otin Local Goverment which comprises of three council development area was sub-divided into two strata (villages and towns) and sample households were drawn from each stratum. Four hundred questionnaires were administered using Yarmane, (1992) sampling size approach in three semi-urban towns of Okuku, Oyan and Inisa and several villages (Igbaye, Oore, Ijabe, Konta, Asi, Asabe, Agbeyi, Ila-Odo, Elesin-Funfun, Ekusa, Iyeku, Ikosin, Faji, Opete and Okua) using stratified multi- stage sampling technique. Survey research design was used to collect data from the sampled respondents using structured questionnaire. Multiple regression analysis was employed to assess the combined influence of the constructs (income level of households' educational level of households, family size and modern fuels supply security) on the dependent variable (households' fuels usage decisions).

The sampling frame is drawn from the population of households which stood at 37,561 households. Sample was selected from the population through simple random sampling. The sample size was determined using Krejcie & Morgan approach (Chua Lee, 2006) and also validated by Yarmane, (1992) formula for normal approximation at 95% confidence level and 5% error margin which translated into about 400 respondents. Thus, the Yarmane, (1992) stated below:

$$n = {}^{N}\!/_{1 + Ne^2} \tag{1}$$

Where; N = the population size (37,561), n = sample size, e = error margin.

$$n = {}^{37561}\!/_{1 + (37561)(0.5)^2} \cong 400$$

The study adopted logistic regression method to investigate households' fuel consumption patterns; this is because logistic regression technique is best suited for tasks requiring a predicted likelihood of a categorical dependent variable occurring from a fixed set of categories. Also, logistic regression technique not only predicts outcomes but also aids in understanding the dominant variables for these predictions. This makes logistic regression a practical tool for solving classification problems while providing clear insights into the data (Gujarati 2004). The research is an analytic study because it entailed testing a priori hypotheses related to household traditional energy consumption pattern, hence the use of descriptive and analytical cross-sectional surveys. Data collected were analysed using a number of techniques: household questionnaire survey, focus group discussion, key informant interview, and researcher's direct observation. Data analysis was carried out using SPSS and STATA

The Logit model assumes $P(y_t = {}^{1}\!/_{x_t}) = \exp\,(x\,,\beta)$

$$P(y_t = {}^{1}\!/_{x_t}) = 1 + \exp\,(x\,,\beta) \tag{2}$$

Binary logistic regression was used to determine the factors which affect the choice of households between traditional fuel and modern fuel for cooking. The general logistic regression model equation is given by:

$$\text{Logit (Y)} = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots + \beta_n X_n + \varepsilon \quad (3)$$

where: logit = $ln\left(\frac{p}{1-p}\right)$ and p is the probability of the study event; α is the Y intercept, β_i are regression coefficients, and X_i are a set of predictors.

Binary Logistic regression analysis will be used to test this hypothesis:

$$\text{Logit(Y)} = ln\left(\frac{\pi}{1-\pi}\right) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots + \beta_n X_n + \varepsilon_i \quad (4)$$

where: π is the probability of the event, α is the Y intercept, β_i are regression n coefficients, and X_i are a set of predictors.

4. Results and Discussions

In recent years, calls for the removal of petroleum products subsidy as a policy tool to enhance fiscal stability have kept the discussion on household energy accessibility and affordability alive. Hence, this section provide empirical fact on the subject matter.

4.1 Descriptive Results

This section presents the descriptive statistics; these include the dependent and independent variables used by households which are grouped into charcoal, kerosene, LPG and fire wood.

Table 1: Expenditure on Energy types

Variables	Rural		Urban	
	Mean	Standard dev	mean	Standard dev
Share of energy in total exp	0.13	0.06	0. 21	0.05
Share of LPG in energy exp	0.01	0.01	0.24	0.15
Share of charcoal in energy exp	0.24	0.21	0.42	0.41
Share of kerosene in energy exp	0.13	0.19	0.43	0.48
Share of fire wood in exp	0 .09	0.11	0.02	0.04
Using solid fuel	0.89	0.06	0.43	0.21
Using non-solid fuel	0.09	0.03	0.12	0.11
Using mixed fuel	0.02	0.05	0.82	0.08

Source: Authors' Compilation (2024)

The result in table 1 shows that on the average, the share of household energy expenditure is 13 percent in rural area and 21 percent in urban area. Households in rural areas spend more on solid fuel compared to those in urban areas. The survey also revealed that 82 percent of households in urban areas of the Local Government combined both solid and non-solid fuels for cooking. This revealed that energy stacking is high in the Local Government. It was also indicated that households in the urban towns of Okuku, Inisa and Oyan spent 42 percent of their energy expenditure on charcoal. Table 1 also revealed that 82 percent of households engage in fuel stacking. This reveal there is high fuel stacking in these areas, as majority of households in these communities combined traditional biomass with LPG for cooking.

Table 2: Pattern of Household Energy Utilisation in Odo –Otin Local Government

Energy /Year	Pre Deregulation				After Deregulation			
	Rural		Urban		Rural		Urban	
	HH	%	HH	%	HH	%	HH	%
Firewood	270	67.5	43	10.75	318	79.5	44	11.0
Kerosene	13	3.2	130	32.5	06	1.5	02	5.0
Electricity	02	0.5	59	14.75	10	2.5	23	57.5
LPG	10	2.5	44	11.0	05	1.2	12	3.0
Charcoal	100	25.0	123	30.75	58	14.5	317	79.25

Source: Authors' Computation (2024) Note: HH (No of Household) %(Percentage)

Table 2 shows the number and proportion of households using firewood, charcoal, kerosene and LPG for cooking. In the major towns of the urban areas, kerosene and charcoal are the major sources of energy before the reforms on price of kerosene and LPG. In the urban areas in general, majority households abandoned modern kerosene fuel to charcoal and fire wood. The few households that switched to LPG could be influenced by the presence of a tertiary institution, the Osun State University in the area. The situation in rural locations of the survey area is not different as there is little change in the pattern of fuel consumption. This signifies that the equity argument of fuel subsidy cannot be substantiated due to the fact that majority households in rural area of the Local Government still use solid fuel rather than consume subsidized fuel.

Table 3: Sources of Fuel wood

Source	**Number of households**	**Percentage**
Natural forest	**139**	**34.75**
Land clearing	**19**	**4.75**
Government forest	**0**	**0**
Private land	**29**	**7.2**
Farmer's woodlot	**54**	**13.5**
Others	**154**	**38.5**

Source: Authors' Compilation (2024)

Table 3 revealed that the main sources of fuel wood in Odo – Otin Local Government include natural forest and farmer's woodlot (mainly farmlands containing trees, as most people do not plant trees in particular area for the sole purpose of yielding fire wood and charcoal). When private land is cleared for agricultural or for residential development, the trees are usually removed and used as firewood. The vast majority in the Local Government (over 38.5 %), designated "Others" in Table 3 buy from sellers. Households also obtain charcoal fuel in different ways. The bulk of them purchase charcoal from vendors who are located in different parts of the city. For example, in Inisa, Igbaye, Oyan, Igbaye, Ijabe and Ila – Odo, the vendors operate at their shops. They regularly sneak into the surrounding farms to obtain firewood, by cutting down trees and using them to make charcoal for cooking while others sell to their customers.

4.2 Empirical Results

Table 4 shows that kerosene, charcoal and firewood share as a percentage of the total expenditure decreases with the increasing income; this suggests that with increasing income levels, people tend to use modern fuel like LPG. This is in line with previous studies (see Marno Verbeek, 2000; Rajmohan and Weerahewa 2007; Farsi et. al., 2007, Gundimeda and Köhlin 2008).This could be due to increasing usage of modern energy appliances with increasing living standards. Moreover, number of rooms occupied by household, family size, and age of household head significantly influenced the decision to consume energy at 5%. The fact that educated household head with post-secondary school and college degree significantly negatively influenced the decision to consume fuel wood, charcoal and DPK implies that the higher the level of education, the less likely a household will consume Charcoal, DPK and fuel wood,. The results support Heltberg's (2004) main finding that higher level of education were associated with a greater probability of the household using modern fuels and a lower probability of using solid fuels. That the price of substitute significantly positively influences decision to consume fuel also conform to a priori expectation of the substitute nature of energy products. The fact that estimation behaves very well overall with high significance levels and expected sign attests to robustness of the model.

The study obtained adjusted low coefficient of determination in all the models in Table 4, it should be noted that this is not unusual in cross section studies using micro data of household due to a large degree of stochastic variation. In the major part of the empirical studies using this type of data, the values of these adjusted R^2 would attest a good adequacy of the model if and only if the individual coefficients are significant. And since the coefficients of budget elasticities are all significant at 5%, this means that an additional unit of total expenditure will lead to a significant increase in LPG share using the average household total expenditure.

Table 4: Elasticities for Households Energy Use

Variables	Firewood	Kerosene	Electricity	LPG	Charcoal
Constant	0.02161*	0.05821*	0.02177*	0.06211*	0.02131*
Income	-0.00172*	-0.03152*	0.064118	0.08218*	-0.03211*
Secondary	0.00213	0.11021	0.31217	0.32161	0.00021*
Post-Secondary	-0.42165*	-0.32101	0.21441*	0.11042	-0.19263
Household Size	0.13112*	0.01317*	0.31131*	0.22181*	0.21312*
Monthly Expenses	0.02152*	-0.31521	0.31226	0.12631*	0.18219*
Marital Status	0.01162*	0.11871	0.02182	0.18215*	0.31821*
Age	0.01910	0.02182	0.01141	0.02319*	0.02147*
Family Size	0.05213*	0.01937*	0.00312*	0.03288*	0.03185*
Price of Firewood	-0.00021*	0.01211*	0.31511*	0.11261*	-0.00211*
Price of Kerosene	0.00011*	-0.03219*	0.11321*	0.32154*	-0.34215*
Price of Electricity	0.02175*	0.06432*	-0.01542	0.04216*	0.11322*
Price of LPG	0.03881*	0.01181*	0.09712*	-0.34177*	0.02277*
Price of Charcoal	0.04211*	0.02319	0.02111	0.23118*	0.02931*

R^2	0.1132	0.1421	0.2882	0.3171	0.3821

Source: Authors' Computation (2024)
* Significant at 5%

4.3 Hypothesis Testing and Discussion of Results

In this section, the study present the result of hypothesis testing and support the result with in-depth discussion. The study adopted non-directional approach in testing the hypothesis and statistical tool used is analysis of variance.

Hypothesis

H_0= There is no relationship between Energy Pricing Reform and Household Energy Stacking and Switching Behaviour

The model summary in Table 5 revealed correlation co-efficient R= 0.487 indicating linear relationship between energy price reform and fuel stacking and switching behaviour. It also indicates coefficient of determination $R^2\ value = 0.468$, which implies that 46.8 percent stacking behaviour is accounted for by energy pricing reform. The significance of the coefficient at 5 percent (0.000) indicating the model is statistically significant in prediction how energy pricing reform influences fuel stacking and switching behaviour of households in Odo-Otin Local Government of Osun State. The F-statistics value of 51.020 indicates the overall regression is significant. Therefore, null hypothesis is rejected. Alternative hypothesis which says there is a significant relationship between energy pricing reform and households fuel switching and stacking behaviour is thereby accepted. The coefficient result in Table 7 indicated that a unit increase in pricing reform results in 0.468 increase in household fuel stacking and switching behaviour. The t- value 7.143 indicates the regression is significant at 1 percent.

Table 5: Model Summary

Model	R	R.Square	Adjusted R square	Standard Error of the estimate
1	0.487	0.468	0.451	0.35211

a. Predictor: (constant): Energy Pricing Reform
b. Dependent Variable: Household Energy Stacking and Switching Behaviuor
Source: Authors' Computation 2024

Table 6: Anova

Model	Sum of Square	DF	Mean Square	Significance
Regression	11.689	1	11.696	0.0000
Residual	69.312	273	.229	
Total	81.001	274		

a. Predictor: (constant): Energy Pricing Reform
b. Dependent Variable: Household Energy Stacking and Switching Behaviuor
Source: Authors' Computation 2024

Table 7: Coefficient

Model	Unstandardised Coefficent		Standardise Coefficent	T	Sig.
	B	Std. Error	Beta		
Constant	0.798	.146	.	6.183	.000
Switching and Sacking	0.503	.070	.397	7.143	.000

Behaviour					

a. Dependent Variable: Household Energy Stacking and Switching Behaviuor
Source: Authors' Computation 2024

5. Conclusion

This study drew the following conclusions. In addition to prices of related goods, household expenditure, other household characteristics, such as family size, age and education level of household head were seen to be important variables in explaining fuel stacking behaviour of households in Odo-Otin Local Government of Osun State. The results also revealed that multiple fuel use are common; the fact that households in the Local Government consume a portfolio of energy sources spanning different points of the energy ladder does not fit easily with traditional energy ladder model. What we have are fuel substitution and fuel stacking.

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