TARIFF PRICING DISPARITY AND HOUSEHOLD ELECTRICITY PREPAID USERS' BEHAVIOUR IN SOUTHWEST, NIGERIA

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Abstract

In Nigeria, previous studies attributed energy wastage to poor pricing resulting from low electricity tariffs and awful human behaviour. By incorporating the practice theory approach, this study examined the disparity in electricity tariff pricing and household electricity prepaid users' behaviour in Southwest Nigeria. The study employed a survey method and gathered data from 286 respondents in purposively selected residential areas in Osogbo, Nigeria. The study was analysed using two approaches: descriptive and econometric. The study, however, showed that respondents were indifferent about the tariff pricing scheme in Nigeria, which was attributed to respondents understanding the concept of "Pay As You Go" pricing technique. The finding also revealed that the impact of efficient price on electricity consumption is 3% greater than the price disparity currently used in Nigeria and that consumers' behaviour towards electricity wastage was well-managed by prepaid metering. The findings of this study suggest the distribution of well-programmed energy-efficient technologies that will capture price disparity, coupled with well structured uniform tariff rate that will make prepaid metering relevant to energy saving.

Keywords: Price Disparity, Household Electricity Consumption, Prepaid Metering, Practice Theory, Behaviour

INTRODUCTION

Energy use which is the basic necessity for all human livelihood and development is in different forms and the most important form is electricity. Today, electricity has become an indispensable commodity that one cannot live without. In spite of its importance**,** Nigeria with over 200 million in population (Worldometer, 2022), is faced with many electricity problems spanning the electricity value chain; generation, transmission, distribution and marketing. The unpredictable conditions of the power sector are attributed to inappropriate funding of the industry, which was aggravated by excessive energy consumption, which resulted from inappropriate pricing and high subsidy (Folorunso & Olowu, 2014; Rapu, Adeniyi & Adenuga, 2015; Echeta, Nwadike & Emerenin, 2015; Ogaji, 2017). Experience shows that the electricity tariff pricing, and subsidies inclusive, which are also delivered through electricity pricing, can be a source of inefficiency in the sector in terms of low funding and the inability of revenue to cover costs (Adenikinju, 2008).

The role of prices in any market is to make information available about the relative scarcity of a certain good and its value to the society (Faruqui & George, 2006). In the electricity market, price is the most efficient way of communicating. A tariff pricing scheme for electricity is one in which the price of electricity changes with the level of consumption. Increment in tariff will bring about an increase in the price of electricity, reducing electricity consumption (Borenstein, 2008). Despite poor revenue generation, which resulted from inappropriate energy prices, there are disparities in electricity prices as regards consumption in the household sector. The residential sector which is classified under Life-Line (50kWh) consumers, Single and 3-phase meter users, LV Maximum Demand and HV Maximum Demand (11/33 KV) users are charged different electricity prices (NERC, 2015). A large proportion of 80%

Nigeria's electricity consumption is used by the residential sector (International Energy Agency, 2015). Therefore electricity pricing scheme should be carefully considered because energy is an intrinsic and valuable infrastructure for modern-day activities in all segments of life (International Energy Agency, 2005).

Despite the predominant electricity consumption by the residential sector, there is an erratic power supply whereby consumers' demand cannot be met (Sambo, 2008). This challenge deprives 55% of the users' access to electricity and modern energy services due to the unbeatable factor of population growth (International Energy Agency, 2014). Those that are privileged to be connected to the national grid are experiencing epileptic power supply that last for several hours daily (Etiosa, 2008). However, those privileged to access electricity were wasteful despite the power outages. Previous studies on households' electricity consumption attributed energy wastage to unconscious habits resulting from low electricity tariffs. In the study carried out by Ahmad and Othman (2014) that examined the behavioural pattern of the electricity consumption of Bruneian households, it was found that Bruneian households consumed a high amount of electricity due to low electricity tariffs. Asare (2008) viewed the attitude of Ghanaians towards the usage of electricity as one of Ghana's biggest challenges resulting from cheap electricity tariffs. In Nigeria, energy wastage is attributed to poor pricing resulting from low electricity tariffs (Folorunso & Olowu, 2014). In addition to inappropriate pricing, other factors contributing to energy wastage in Nigeria include inefficient technologies, low infrastructural development, and awful human behaviour (Etiosa, 2008).

However, human behaviour towards electricity wastage, according to literature, had been appropriately managed by energy-efficient technologies such as consumers accessing information and feedback on their electricity consumption combined with high energy prices, which incidentally impacted the behaviour of electricity users towards not having option than to bid for energy efficient technologies (Matsukawa, 2004; Wang, 2011; Klopfert & Wallenborn, 2011). Pre-payment metering was a mechanism that was proposed in electricity as an innovative solution purposely for managing awful human behaviour towards electricity usage. It is designed in a way that helps households change their electricity behaviour pattern. It positively impacts the users by reducing electricity consumption (Adenikinju & Oluwayemisi, 2013). Prepaid metering does not only impact behaviour in using electricity wisely alone; it does when it is coupled with high electricity prices (Wang, 2011). The study by Ahmad and Othman (2014) revealed that energy conservation is less significant for many Bruneians with a relatively low tariff. Most Bruneian households could not reduce electricity consumption and are not aware of how to efficiently use electricity as there are no financial incentives to do so.

With a great deployment of prepaid metering in Nigeria and as it has been made mandatory by the government for every consumer of electricity to install a prepaid meter, the ongoing review of existing tariffs should be carefully structured or modified in a way that will encourage energy efficiency as well as sustaining energy sector in operating consistently. To avoid unnecessary billing impacts, we should learn from the huge success greatly achieved in the telecommunication industry. After all, it was the sector that first introduced the "Pay As You Go" technique in Nigeria. Their services are more efficient with better quality, not because they are considering the categories of income earners or the types of handsets used, but because the users of handsets recharge their sets based on the affordability of individuals.

As earlier mentioned, the rate charged within the household sector differs in Nigeria. This makes pre-payment metering have little or no effect! Irrespective of the rate charged, the prepaid payment method makes electricity consumption of the individuals differ; households with similar equipment exhibited a difference in actual energy use. Prepaid metering determines how consumers behave regarding energy consumption, which largely depends on adequately structured tariff pricing. The number of studies evaluating the impact of information provision programs through prepaid metering and in-home displays (IHDs) on consumers' electricity consumption has increased in recent years (Matsukawa, 2004; Faruqui et al., 2009; Adenikinju & Oluwayemisi, 2013). However, literature examining the impact of electricity pricing programs on prepaid users'

electricity consumption behaviour, especially in Nigeria, has been rare. Therefore, this study examined the disparity in electricity tariff pricing and consumption pattern of household electricity prepaid users' behaviour. It also investigated the knowledge of consumers about electricity tariff pricing charges in Southwest, Nigeria.

LITERATURE REVIEW

Theoretical Background

The underlying theory of consumer demand is based on the behaviour of individual agents, and the microeconomic basis for consumer energy demand relies on consumers' utility maximisation principles. Such an analysis assumes that consumers know their preference sets and order of preferences and will always choose the most preferred bundle from the set of feasible alternatives (Subhes & Govinda, 2009). However, the theory guiding pre-paid electricity consumption behaviour is based on economic and psychological theories. Sarah (2010) observed four theoretical approaches that can be used in assessing the behavioural change of the consumers towards the usage of electricity in the short or long term; sociologically, economically, psychologically and educationally. However, it was observed that only economics, psychology and education apply to the smart card metering programme.

According to Yueming, Xing & Wang (2017), there are four basic economic theories through which a reduction in electricity consumption can be achieved by adopting a pre-paid plan for households. They are nudging, price effects, information provision, and costs of being disconnected which can be explained via simple models based on consumer theory. In recent years, the practice theory approach has gained ground in consumer studies formulated by Schatzki (1996) and further elabourated by Reckwitz (2002). The practice theory approach that has been termed the "A-Bc model" (Attitude-Behaviour connection) by Hargreaves, Nye, & Burgess (2008) or the "ABC paradigm" (Attitude, Behaviour, and Choice) by Shove (2010), emphasises on energy saving in the context of behaviour and practice. It is an approach that better includes unconscious habits and technological structures of household energy consumption. More recently, many researchers have started to use a theoretical practice approach as an alternative for understanding energy consumption in everyday life from a social-science perspective (Shove, 2010; Gram-Hanssen, 2010; Hargreaves et-al, 2011).

From the economic approach, the study examined household electricity consumption in the context of household production theory which was developed essentially by Becker (1965), Lancaster (1966), and Muth (1966), and which can be better understood by the use of micro-oriented models. Household production theory captures the behaviour of individual agents, which can be examined through the survey method to gather data for each household. In the context of household production theory, energy is not regarded as consumption good for the household but rather as a factor input into the production of the household services provided (Reinhard, 1996). In other words, the residential demand for electricity is derived from the demand for a well-lit house, cooked food, hot water, etc. The great advantage of the household production theory is its treatment of energy and the energy-using appliance stock as a means to provide utility-creating services. Consequently, models can be placed within a utility-maximising framework (Reinhard, 1996). From the psychological perspective, practice theory was introduced as an approach that better includes unconscious habits and technological structures. Energy consumption is not a practice in itself, but different things people do at home every day which consume energy, such as cooking, washing, turning the light on, etc., are practices (Gram-Hanssen, 2010).

Empirical Consideration

Many researchers have conducted various studies examining consumer behaviour and how it relates to energy use, especially within households. It was gathered that the complexity of human behaviour could not be explained fully by existing theories (Wang, 2016). However, when it comes to the erratic behaviour of energy consumers, the behaviour exhibited by individuals differs in the same household. According to Desmedt, Vekemans & Maes (2009), households with similar equipment exhibited about a 40% difference in actual energy use. Similarly, there is an information deficiency in energy units used within the households. Tang & Bhamra (2008) revealed in their study that there is a lack of consumer awareness of the connection between personal

behaviour and the direct impact on the environment and energy use. Di Maria, Ferreira and Lazarova (2009) found that over 50% of their respondents failed to install energy-efficient measures because they were unaware of the benefits of energy-saving measures in their homes. Consumers assume that electricity product is efficient enough by themselves and that there is no need for them to consciously improve the overall energy performance (Tang, & Bhamra, 2008).

In addition, adopting behavioural insights into practice has been a challenge (Allcott & Mullainathan, 2010). According to Vandenbergh, Stern, Gardner, Dietz & Gilligan (2010), the result of residential energy efficiency will be enormous if there is an effective use of behavioural insights in technologies like smart meters. In recent years, the various studies carried out to examine the behavioural pattern of energy consumption in relation to the impact of information as regards prepaid metering have improved. It has been proven that energy saving can be gained by providing information and feedback through electricity bills and energy display meters. When people are aware of their situation, they will take action on how to curtail their consumption (Environmental Change Institute, 2005 cited in Tang & Bhamra, 2008)

Prepaid metering technology is a platform that addresses the challenge of energy conservation by providing accessible information to improve the behaviour of consumers. Fewer studies have been conducted to examine prepaid users' behaviour. It has been observed that residential consumers decrease energy consumption when provided with information and feedback on how much they consume. Matsukawa (2004), Faruqui, Sanem and Ahmed (2009), Sarah and Clive (2009), Amann & Friedrich (2010), Wang (2011), Adenikinju and Oluwayemisi (2013), among others, carried out studies on the impacts of prepaid metering on the electricity consumption of households. Coupled with prepaid metering is also the energy price. Energy price also plays an important role in determining how consumers behave regarding energy consumption. The significant impact of prepaid metering on the behaviour of consumer largely depends on adequately structured energy pricing. Price is a signal that has a direct effect on the consumers' goods. The demand for a particular commodity solely depends on its price, irrespective of the buyer's income, and it should be acknowledged that the motive behind pre-payment metering is to manage electricity efficiently.

The estimated energy impacts of various scenarios possibly reflect a smart metering program providing energy consumption information and real-time pricing. Such a program appears to increase energy consumption when the rebound effect and price elasticity are higher. This is especially true when energy prices are lower. The impact of energy prices on the possible realised energy savings from a smart metering program is evident in the subsequent years. During this time, energy savings from a smart metering program are realised, regardless of rebound effect reduction and price elasticity magnitudes. This suggests that electricity prices can significantly impact the realised energy savings from a smart metering program. Reducing consumer rebound effects and increasing their price elasticities alone will not necessarily realise energy savings. Such actions could increase energy consumption if energy prices remain low. Only when such information is provided and coupled with high energy prices, do significant energy savings result. Preliminary results suggest that implementing smart metering programs alone will not necessarily realise energy savings. Such programs could increase energy consumption if energy prices remain low. Significant energy savings result only when smart metering programs are coupled with high energy prices (Wang, 2011).

METHODOLOGY

Model Specification

Past research indicates that household energy use is related to socio-demographic variables such as income and household size (Gatersleben, Steg & Vlek, 2002) and psychological variables such as attitudes (Becker, Seligman, Fazio & Darley, 1981). To this end, the study used both the economic and psychological approaches.

From the economic perspective, composite energy commodity, which is given as S, according to Anna &Massimo (2011), can be written as:

$S = S(E, G, CS)$ ..... (1)

Where E is electricity, G is gas, and CS is the capital stock consisting of appliances. Energy services S enters the household's utility function

as an argument and aggregate consumption X. The utility function is influenced by household characteristics Zand the weather in the area where the household resides. We denote climate and weather variables as W. Formally,

U = U (S (E, G, CS), X; Z, W)……. (2)

The household maximises utility subject to a budget constraint,

Y – P_S.S – X = 0 …… (3)

Where Y is money income and P_S is the price of the composite energy commodity. The price of aggregate consumption X is assumed to be one. The solution to this optimisation problem yields demand functions for E, G, CS and X. This study employed household production theory which incorporates disposable income of the consumers, electricity price (tariff), size of the family and efficient price, which is proxied for a high price.

$$HEC = \beta_0 + \beta_1 HDI_1 + \beta_2 PEL_2 + \beta_3 SOF_3 + \beta_4 EPR_4 + \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

The household electricity consumption proxied for prepaid users' electricity consumption, denoted as HEC in this study, is a function of household disposable income, price of the electricity, size of the family and efficient price, which is represented as HDI, PEL, SOF and EPR respectively.

Qualitative interviews of electricity usage were captured using the practice theory approach. According to Gram-Hanssen (2010), in the practice theory approach, there are four elements holding practices together; embodied habits, institutionalised knowledge, engagements and technologies. Embodied habits are practices unconsciously in everyday life which consume energy. Institutionalised knowledge is a conscious decision that might influence practices as well, from information on energy conservation, for example. Engagement is the practice that means something to the people who perform them. A goal or a reason is guiding the practice. For instance, one of the energy conservation problems is that the goal is about the reason to perform the practice and thus mostly not about energy; when one is cooking, the aim is to serve a meal and not to save energy. Finally, it is obvious that technologies such as freezers and electric cookers influence practice, especially concerning energy-consuming practices. All four elements are important for understanding a practice or for understanding how to change practice.

Data sources

Since the underlying theory of consumer demand is based on the behaviour of individual agents, this study's primary data was sourced through a survey to enable us to understudy the consumer responses more closely and examine the variation in electricity consumption across the groups. The measure adopted in obtaining the data is a mixed method; questionnaire-interview.

RESULTS AND DISCUSSION OF FINDINGS

Table 1 show that, on average, efficient price (EPR) was 1.71, household disposable income (HDI) was 2.35, household electricity consumption (HEC) was 1.69, price of the electricity (PEL) was 1.31, and the size of the family (SOF) was 2.62. The maximum level of efficient price was recorded as 2 while the minimum was 0. The maximum level of household disposable income was 6, while the minimum was 1. The maximum level of household electricity consumption based on its measurement was 4, while the minimum was 1. The maximum price of the electricity was 2 while the minimum was 1. The maximum level of size of the family was recorded as 5, while the minimum was 1.

Skewness which measures the asymmetry of a distribution around its mean, showed that the efficient price and size of the family were negatively skewed at the value of -1.45 and -0.25, respectively, meaning that the efficient price and size of the family have been fluctuating over the period under study, more so it indicates increase at a low rate. Household disposable income, household electricity consumption and price of electricity were stable during the study period. The kurtosis measures the flatness and peakedness of the distribution of the series. A normal distribution has a kurtosis value of 3 (leptokurtic), while platykurtic distribution has a kurtosis value of less than 3. The price of the electricity and size of the family showed a platykurtic distribution of kurtosis value which is less than 3, meaning that the data has a lighter tail than a normal distribution. Efficient price, household disposable income and electricity consumption showed a peak (leptokurtic) distribution relative to the normal

distribution. The Jarque Bera test had the null hypothesis of normally distributed residual.

Standard deviation showed the measurement of dispersion around the mean series. It is often interpreted in relative terms by comparing the deviation of two different distributions. The distribution with a smaller standard deviation exhibits less dispersion, while the larger standard deviation shows higher dispersion. All the variables exhibit a less dispersed series of 0.497324, 1.378191, 0.746743, 0.465204 and 0.860878 for EPR, HDI, HEC, PEL and SOF, respectively.

Table 1: Descriptive Statistics

	EPR	HDI	HEC	PEL	SOF
Mean	1.713287	2.353147	1.692308	1.314685	2.622378
Median	2.000000	2.000000	2.000000	1.000000	3.000000
Maximum	2.000000	6.000000	4.000000	2.000000	5.000000
Minimum	0.000000	1.000000	1.000000	1.000000	1.000000
Std. Dev.	0.497324	1.378191	0.746743	0.465204	0.860878
Skewness	-1.446740	1.048527	1.224219	0.798099	-0.249671
Kurtosis	4.100347	3.385073	4.842720	1.636961	2.750313
Jarque-Bera	114.1973	54.17221	111.9031	52.50150	3.714268
Probability	0.000000	0.000000	0.000000	0.000000	0.156119
Sum	490.0000	673.0000	484.0000	376.0000	750.0000
Sum Sq. Dev.	70.48951	541.3322	158.9231	61.67832	211.2168
Observations	286	286	286	286	286

Source: Authors' Computation

Table 2 presents the result disparity in electricity tariff pricing and household electricity prepaid users' behaviour in Southwest, Nigeria. In this analysis, household disposable income and size of the family have a significant positive effect on household electricity consumption of prepaid users at a 5% significance level. This implies that an increase in household disposable income and family size results in an increase in electricity consumption. This finding of household disposable income conforms to the study by Louw, Conradie, Howells & Dekenah (2008) and Narayan & Smyth (2005). Alternatively, efficient price and price of the electricity have a reduced impact on the electricity consumption of prepaid users at a 5% significance level, which implies an increase in price tariff and efficient price brings about a decrease in electricity consumption. The impact of efficient price on the electricity consumption of prepaid users is 3% greater when compared to the current electricity price of prepaid metering users. This finding conforms to the study by Wang (2011). All the relationship results were consistent in theory on the ground of a priori expectation as all the coefficients have the expected signs.

Table 2: Household Electricity Consumption (HEC)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.825996	0.205330	8.892989	0.0000
HDI	0.184555	0.027130	6.802689	0.0000
PEL	-0.358230	0.076719	-4.669374	0.0000
EPR	-0.389891	0.072190	-5.400896	0.0000
SOF	0.217734	0.039497	5.512711	0.0000
R-squared	0.478366	Mean dependent var		1.692308
Adjusted R-squared	0.470941			
F-statistic	64.42310	S.D. dependent var		0.746743
Prob(F-statistic)	0.000000	Durbin-Watson stat		1.744393

Source: Authors' Computation

The study shows no evidence of serial correlation as Durbin-Watson value of 1.74 is greater than Durbin-Watson table value upper limit. The R^2 value of 48 percent is low. However, a low R^2 value does not mean the model is necessarily bad (Gujarati, 2003). In regression analysis, our objective is not to obtain a high R^2 but to obtain dependable estimates of the true population regression coefficients and draw statistical inferences about them. The adjusted R^2 indicates that, after considering the number of regressors, the model explains only about 47 percent of the variation in electricity consumption of prepaid users. F-statistic 64.42 and Prob (F-statistic) 0.0000 are statistically significant at 5 percent levels of significance. By implications, efficient price, household disposable income, price of the electricity, and size of the family impact the household electricity consumption of prepaid users in Osogbo, Southwest Nigeria.

Table 3: Practice theory approach result

	Electricity usage/management		**Tariff scheme**		**Consistency of Electricity expenditure**		**Management of appliances**	
	Yes	No	Yes	No	Yes	No	Yes	No
Respondents	118	21	17	122	128	11	107	32
Percentage (%)	84.9	15.1	12.2	87.8	92.1	7.9	77	23

Source: Authors' Computation

Interviews were conducted with 139 participants randomly selected from the population that were administered questionnaires. The interview captured only households with prepaid meters. The primary objective of the study was to examine the relevance of practice theory to energy conservation. Awful human behaviour has been considered one of the primary causes of inefficient energy consumption, while prepaid metering (In-Home Display (IHD)) feedback has helped reduce energy consumption. Regardless of energy price, respondents were questioned to ascertain the effect of prepaid metering on human behaviour towards electricity management. The questions are, does prepaid metering affect your consciousness of electricity usage? Does it change your habits towards electricity usage? The result revealed approximately 85% of respondents responded positively to changing electricity consumption habits. The finding conforms to the study by Faruqui, Sanem and Ahmed (2009).

As earlier mentioned, the rate charged within the household sector differs in Nigeria. A question was asked to ascertain the consumer's awareness of the rate at which they are charged per kWh – are you aware of any tariff scheme in Nigeria, and how it affects their energy behaviour? Approximately 88% of the respondents are not well informed of the rate they are charged per kWh. They only understand how the prepaid meter works; once the credit bought is exhausted, they are disconnected from the prepaid meter. The study conforms to the study by Kempton& Layne (1994), who clarified that kWh is useful for the utility but irrelevant to the buyer. From Table 3, two other questions that were asked to capture practice theory approach are: Is your monthly electricity expenditure consistent? Do you use to switch off all the appliances when not needed or when not at home? The share of energy expenditure in the average monthly expenditure per disposable income is consistent for approximately 92% of the respondents. While approximately 77% of respondents are fully conscious of energy conservation when using prepaid metering.

CONCLUSION AND RECOMMENDATIONS

The study examined the disparity in electricity tariff pricing and consumption pattern of household electricity prepaid users' behaviour. It also investigated the knowledge of consumers about electricity tariff pricing charges in Southwest, Nigeria. The study adopted both economic and psychological approach. From psychological perspective, the study used practice theory approach to investigate the disparity in electricity tariff pricing and household electricity prepaid users' behaviour in Southwest, Nigeria, using Osogbo as a case study. The study employed a survey method and gathered data from 286 respondents in 139 respondents to capture the practice theory approach. The study purposely selected households with prepaid metering and was

analysed using descriptive and econometric approaches. The result showed that respondents were indifferent to tariff pricing scheme in Nigeria. Approximately 88% of the respondents are not well informed of the rate they are charged per kWh. The only language the respondents understand is the "Pay As You Go" study was buttressed by Kempton & Layne (1994), who made it clear that kWh is useful for the utility but irrelevant to the buyer. Consumers are more interested in how to buy credit onto the meter and the usage until the credit is exhausted.

From economic approach, the empirical analysis showed that the impact of efficient price on the electricity consumption of prepaid users is 3% greater when compared to the current electricity price of prepaid metering users. The finding conforms to the study by Wang (2011) that significant energy savings result only when smart metering programs are coupled with high energy prices. The consumers' behaviour towards electricity wastage was well-managed by prepaid metering. All the relationship results were consistent with theory on the ground of a priori expectation as all the coefficients have the expected signs. Therefore, the findings of this study suggest to policy makers to carefully review energy pricing scheme for prepaid metering that will capture price disparity among residential sector. Also, government should support the distribution companies in distributing well-programmed energy-efficient technologies with well structured uniform tariff rate that will make prepaid metering relevant to energy saving.

In conclusion, recommendation of uniform tariff structure may not be implemented until a study is carried out to ascertain its usefulness on prepaid users' behaviour. Future studies can look into this area.

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