PRIVATIZATION AND TRENDS OF AGGREGATE CONSUMPTION OF ELECTRICITY IN NIGERIA: AN EMPIRICAL ANALYSIS

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ABSTRACT

Electricity as a source of energy is vital to the growth and development of any economy. Its significance arises from the impact it has on infrastructure, a range of socio-economic activities and consequently on the country's standard of living. This means that transportation, communication, construction, and other facilities depend on electricity to function effectively. Electricity has continued to play a significant role in the development process. In the Nigerian situation the reverse appears to be the case because power outages have continued to affect the country's development. Some have argued that privatizing electricity supply through the unbundling of power generation arm of National Electric Power Authority (NEPA) now Power Holding Company of Nigeria (PHCN) will ensure its efficiency. Despite this reform, electricity supply is still rationed to the consumers in ways that are still grossly inadequate. This study shows with empirical evidence that privatizing the power sub-sector in Nigeria will significantly reduce the aggregate demand for electricity in the short-run.

Keywords: electricity consumption, privatization, Nigeria.

JEL classifications: E2, L33, Q41, Q43, Q48

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I. INTRODUCTION

In spite of Nigeria's huge resource endowment in energy and the enormous investment in the provision of energy infrastructure, the performance of the power sector has remained poor, in comparison with other developing economies. This assertion was confirmed by a World Bank (1993) assessment study conducted on energy development in Nigeria, which compared the performance of Nigeria's Power Sector with those of 20 other developing countries. The study reveals that the sector had the highest percentage of system losses at 33-41 percent; the lowest generating capacity factor at 20 percent; the lowest average revenue at US$1.56 KWH; the lowest rate of return at 8 percent; and the longest average accounts receivable period of 15 months. Perhaps, the worrisome picture depicted by this assessment and other negative considerations informed government's decision to embark on full privatization of the power sector and the proposal for increased foreign participation in it.

The privatization and commercialization Decree of 1988 recognized the need for NEPA to operate a tariff structure that would facilitate increased revenue generation which would reduce its dependence on government for funding, support its cost of operations and fund part of its annual investment plans. The performance agreement signed between Government Technical Committee on Privatization and Commercialization (TCPC) now the Bureau of Public Enterprises (BPE) and NEPA, now PHCN also recognized the need to remove the constraints imposed by NEPA's inappropriate tariff regimes over the years. Consequently, the agreement allowed NEPA to set its tariffs in collaboration with Utilities' Charges Commission, subject to government approval.

Despite the slow growth in economic activities in recent years, the demand for electricity in Nigeria has continued to increase. There is no doubt that expensive and unreliable power remains a major concern to Nigeria's industrial sector and household consumers alike. Multiple and unpredictable power cuts, which have become a daily occurrence in Nigeria, often result in equipment malfunctioning in all sectors of the economy and make it difficult to produce goods and provide services efficiently. As a result of this fundamental problem, industrial enterprises have been compelled to install their own electricity generation and transmission equipment, thereby adding considerably to their operating and capital costs. Enweze (2001) has estimated that about 25 percent of the total investments in machinery and equipment by small firms, and about 10 percent by large firms, were on privately installed infrastructure. Despite the attempts by some firms to supplement the power supply by NEPA, electricity demand by consumers, particularly domestic users, has continued to increase.

An empirical analysis of the impact of tariff, income and electricity generation on aggregate consumption of electricity in Nigeria with reference to

privatization was carried out. Compelling results showed the high level of electricity loss in the country and the peoples' responses to increase in tariff rates. The paper has four major sections, the literature on electricity consumption, the methodology of the study, and an empirical analysis; while the paper is concluded with suggestions for effective electricity distribution in the Country.

II. LITERATURE REVIEW

According to Accram (2005), about 928 million people live in slums all over the world and most of these people are in developing nations. The challenges are copious, as the slum world brings with it mass poverty, unemployment and degradation. The figures according to him are expected to rise in the next few years. There is another problem facing city managers in Africa, it is providing electricity to the poor in order to aid development, but there seems to be no concrete arrangement in this direction.

Odumosu (2005) states that for a long time now most role-players in the power industry have agreed that the best way to rapid development is through adequate provision of electricity. However, across the African continent, there are differences in levels of power provided such that classification on the basis of sufficiency is complex. Hence the continent can be categorized into four on the basis of population and land mass. There are small countries with sufficient power such as Lesotho, big countries with sufficient power such as Ethiopia and South Africa, small countries with insufficient power such as Benin Republic and big countries with insufficient power such as Nigeria. It is therefore imperative for Africa to generate adequate power for development to take place.

Mwangi (2005) observed that illegal electricity connections are the bane of the Kenyan power utility's life. But it is a symptom of a greater scourge, in which the poor and the small businesses are badly affected. This may not be limited to Kenya alone, but to almost all the countries on the Continent. Ayodele (1998) pointed out that the electricity crisis in Nigeria makes many inhabitants especially the poor miserable. There have been great stress, tension, suspicion, and conflicts between electricity users and provider officials, and this encourages illegitimate activities such as illegal electricity connections either to the national grid or the existing residential/industrial electricity outfit, over/ under billing, and payment via unscrupulous business collusion, and vandalization of equipment resold in most cases to private electricity institutions. Despite the recent unbundling of the power sub-sector in Nigeria, the situations mentioned above remain the same. With the persistence of all these problems, the way forward according to Odumosu (2005) is to strengthen the capacity to recover debts through honest marketing strategies. To him, the need to have an incorruptible marketing sector in the power industry is to ensure efficient power self-sufficiency so that erratic power supply can be eliminated through diligent monitoring of breakdowns, replacement of obsolete pieces of equipment, and decentralization of power source.

Ezenwe (1988) however observed that privatization entails costs in terms of widening income gap, loss of jobs, price hike of the service, and upward implication for general price level. He called for selective privatization of social services to be pursued only when conditions are favorable to the economy, and at the same time ensuring that public interest is not jeopardized. It is further noted that efficiency to a great extent is determined not only by ownership structure but by competition of an industry. Onimode (1988) favored public enterprises provided they are operationally autonomous and at least break even to enhance efficiency. However, the Nigerian government will have to outline control measures to regulate the activities of the emerging private power providers so as to avoid unfair distribution of electricity services, inflation and associated problems.

Despite his criticism of privatization of public enterprises, Adejumobi (1997) argued that privatization eliminates demand for subsidized services, enhances efficiency to meet up customer's satisfaction as this is crucial in determining the firm's market share, production level, sales, and profit margin. Other arguments pointed out are that privatization stimulates choice making and creating new businesses by encouraging entrepreneurial development in the country. Therefore, the privatization processes are desirable for Nigeria given the numerous problems in her power sub-sector. Since the effects of these problems will generally lead to increase in cost of living, Holtedahl and Joutz (2004) showed electricity consumption in general as a function of the stock of electrical energy using equipment (K_t), and economic factor (X_t). Both variables can have independent and interdependent impacts on electricity demand or consumption. The capital stock of energy using equipment can be divided into two types. The first relates to the demand for daily energy services: lighting, refrigeration, cleaning, and entertainment. The second relates to seasonal weather patterns which can affect the demand for heating and cooling services. The dependence of capital stock on economic factors holds in the medium to long run. This is because in the long-run, the stock of appliance is flexible and can respond to changes in relevant prices. In the short-run, the demand for electricity will be constrained to changes in the utilization rates given the fixed stock of electricity using appliances.

In the contrast however, Fishers and Kaysen (1962) suggested a two – stage model where consumption in the short-run depends on two components: income (Y_t), and the price of electricity (PE_t). In the second stage, Fisher and Kaysan (1962) tried to explain the factors affecting capital stock. Their model used the growth rate in appliance stocks regressed on population, expected income, marriages, expected energy prices, and the number of wired households. Reinforcing Fisher and Kaysan's (1962) model, Taylor, Blattenburger and Rennhack (1984), and Silk and Joutz (1997) summarized the results from research using the two-stage framework and found that there was an improvement in the results relative to a static model. However, they noted that until data on

appliance stock improved, additional research would be hampered. The estimation problems associated with two-stage approach led scholars such as George (2004), De Vita, Endresen, and Hunt (2006); and Yuan, Zhao, Yu, and Ho (2007) as well as Zachariadis and Pashoutidou (2007) to develop an alternative procedure which avoids the use of equipment stock. In this alternative approach, a distinction is made between actual consumption and long-run equilibrium consumptions.

III. DATA AND METHODOLOGY

Annual time series data had been used to examine the interactions between privatization and electricity consumption taking into account the non-stationarity of the data on electricity generation, per capita income, and price of electricity in other to capture the existence of potential co-integrating links between series. The data on electricity consumption, electricity generation, gross domestic product and population, from which per capita income was computed was extracted from the Central Bank of Nigeria statistical bulletin (2003). We obtained the data on price of electricity from the annual technical reports of NEPA (1970-2003). Per capita income was obtained by dividing the GDP by the population. All the variables are from 1970-2003.

The methodology adopted in this study follows the co-integration approach. A preliminary step in testing co-integration is to incorporate the unit root tests such as the Dickey fuller (DF) or the Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1981) to determine the degree of integration of the relevant variables. Such variables may drift apart in the short-run for several reasons, such as seasonal effects, price shocks etc, but in the long run, they should not diverge and should comform with the long-run behavior.

This study thus focuses on determining whether actual electricity demand function in Nigeria is a short-run or a long-run phenomenon. That is using utilization rates of electricity instead of stock of electricity, using appliances in Nigeria for instance is actually a short –run phenomenon. Hence, there will be no need for error correction mechanisms where the variables do not co-integrate.

A. **Model specification**

Our model specification follows Fishers and Kaysen (1962), Silk and Joutz (1997), and Zachariadis and Pashourtidou (2007) models except for the incorporation of electricity generation as explanatory variable and application of dummy variables on tariff or price to measure the effect of privatization/commercialization on electricity demand in Nigeria.

$$ECON_t = f (EGEN_t, PCI_t, PEt) \dots\dots\dots\dots\dots\dots\dots(1)$$

But technically, equation 1 can be specified as:

$$ECON_t = b_o + b_1 EGEN_t + b_2 PCI_t + b_3 PE_t + \mu_t \dots\dots\dots\dots (2)$$

Where :

$ECON_t$ = Electricity Consumption at time t (Million Kilowatt Hours)

$EGEN_t$ = Electricity Generation at time t (Million Kilowatt Hours)
PCI_t = Per Capita Income at time t in Naira
PEt = Price of Electricity at time t in Naira
μ_t = Stochastic error term at time t
b_0-b_3 = Parameters of the model representing the coefficient of the explanatory
   variables

The model for Augmented Dickey Fuller test is specified as:

$$\Delta X_t = a + b_t + \beta X_{t-1} + \Sigma\theta\{\Delta X_{t-1}\} + \mu_t \text{ ----------------------------(3)}$$

Where:

Δ = the first difference:

X_t = the variables under investigation at time t, and
μ_t = random error term at time t.

Applying a dummy variable, the model becomes:

$$ECON_t = b_o + b_1\ EGEN_t + b2PCI_t + b_3D_t + \mu_t \text{ -------------------------------(4)}$$

Where D_t is the dummy variable at time t. 'O' for period 1970-1989 (Pre-commercialization advantage) and '1' for period 1990-2003 (Post-Commercialization advantage) in Nigeria's electricity sector.   These periods according to CBN (2003) marked the increment of electricity price or tariff from 60kobo (1970-1989) to N4.00 (1990-2003).

B. Theoretical expectations

The theoretical expectations about the coefficients of equations (2) and (4) are as follows:

b1>0, b2 >0, b3<0

The amount of electricity generated is expected to have positive relationship with electricity consumption. Similarly the coefficient of per capita income should have positive sign, which means that as the per capita income goes up, electricity demand increases.   The coefficient of electricity price or tariff is however expected to have negative sign because as electricity tariff increases, demand or consumption of electricity decreases. The coefficient of the dummy variable is also expected to be negative sign because it is meant to explain the impact of electricity prices in our study.

IV. EMPIRICAL RESULTS

A. Pre-testing procedure

The first step involved a comprehensive pre-testing procedure to investigate the characteristics of the time series variables, before conducting Johansen's procedure for co-integration.

Table 1: Stationary Tests Using ADF Procedure

Variables	Levels	First Difference
ECON	-0.450780	-6.785399 **
EGEN	-0.827251	-3.070178**
PCI	-1.493474	-5.282640**
PE	-0.801713	-5.656854**
Mackinnon Critical value 5%	-2.9499	Note: ** denote rejection of the hypothesis of non-stationary at 5% significance

Source: Computed by the authors.

Based on the Augmented Dickey Fuller (ADF) test, the assumption of non-stationarity cannot be rejected for the levels of all the variables at 5 percent significant levels.   That is, all the variables were non-stationary at levels. However, the non-stationary variables became stationary at first differenced operation. The absolute value of the ADF statistics are higher than the 5% significance level of the Mackinnon critical value as provided by the E-VIEWS package, which means that we reject the null hypothesis of non-stationarity of the variables.

B. Co-integration tests

We have shown that electricity consumption trend proceeds in an error correction form and this can only be the case if there is evidence of co-integrating vectors. Consequently co-integration tests were carried out. We adopted the Johansen co-integration multivariate test. The results are presented in Table 2.

Table 2: Johansen Co-integration Test Results

Hypothesis		Maximum	Eigen Value	Trace Test Statistics	
Null	Alternative	Statistics	Critical Value at 5%	Statistics	Critical value at 5%
R = 0	r =1	17.66191	27.07	34.45746	47.21
R ≤ 1	r =2	13.35769	20.97	16.79555	29.68
R ≤ 2	r =3	3.424375	14.07	3.437860	15.41
R ≤ 3	r =4	0.013485	3.76	0.013485	3.76

 Source: Computed by the authors

Both maximum Eigen value and Trace tests indicate no co-integration relationship exist in the model. Hence the model is best explained by short-run movements in the variables.

Table 3: Multiple Regression

Variable	Coefficient	T-Statistics	Prob.	R^2 = 0.970334
b_0	-587.165	-0.678821	0.5025	$AdjR^2$ = 0.967367
EGEN	0.629370	16.59279	0.0000	S. E = 567.4996
PCI	1.274586	1.548975	0.1319	F- stat =327.0863
PE	-350.7265	-2.461456	0.0198	D.W Stat = 1.640015

Source: Computed by the Authors

Table 4: Multiple Regression with Dummy of Electricity Price

Variable	Coefficient	T-Statistics	Prob.	R^2 = 0.970334
b_0	-797.5849	-0.859905	0.3967	AdR^2 = 0.967367
EGEN	0.629369	16.59256	0.000	S.E = 567.5066
PCI	1.274575	1.548942	0.1319	F –Stat = 327.0781
DUMMY	-1192.469	-2.461421	0.0198	D.W Stat = 1.640014

Source: Computed by the Authors

The short-run regression coefficients are all in consonance with the theoretical expectations. It was only the coefficients of electricity generation and price of electricity that were significant at 5% level. The significance of the dummy coefficients indicates that commercialization and privatization of Nigeria's electricity sector has the capacity of impacting negatively on the trend of electricity consumption in the country. The diagnostic statistics of the model in the form of R^2, DW and F tests are all within acceptable bounds as revealed in Tables 3 and 4 above.

V. CONCLUSION

The paper examined the trend of aggregate electricity consumption in line with privatization program in Nigeria. The validity of the explanatory variables as short-run variables was examined by conducting a co-integration test and our results confirmed that such variables as electricity generation, income and electricity tariff are short-run analysis variables. In order to avoid loss of information and to explain long-run trend of electricity consumption, Nigeria has to improve her database in order to provide accurate data on capital stock of electrical appliances. This submission is in line with Taylor, Blattenburger and Rennhack (1984), Silk and Joutz (1997), and Zachariadis and Pashourtidou (2007) recommendations.

Importantly, increment in price of electricity due to privatization and commercialization will largely reduce electricity consumption. Therefore, government

will need to regulate the price of electricity when the private providers finally take over since the amenity is essential to socio-economic development.

It is also essential to further ensure consumer protection apart from regulating the price by the government. Hence, issuance of licenses to private providers of electricity should include among other requirements the fulfillment of providing alternative source of power generation such as solar system. This will ensure uninterruptible electricity supply and the purpose of privatization in the first instance will not be defeated. As a follow up to meeting this requirement, there must be adequate security in place to protect the providers' equipment from being vandalized and pilfered by the undesirable elements in the country.

In all, the inclusion of electricity generation in short-run analysis of electricity consumption is not problematic as the model is overall significant and well fit. Government will therefore need to hasten the privatization process so that more electricity can be generated given the available numerous natural resources in the country.

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