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SUBSIDIES AND THE DEMAND FOR PETROLEUM PRODUCTS IN NIGERIA

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ABSTRACT

The study empirically examines the effect of subsidies on the consumption of petroleum products in Nigeria for the period of 1970 to 2007. The study employs Augmented-Dickey Fuller (ADF) test for unit root, Engle and Granger (1987) approach for cointegration and Error Correction Model (ECM) for correcting disequilibrium. The ADF test suggests that the variables are mean reverting series after first order difference. The results of the cointegration and ECM confirm that a stable, long-run relationship exists between the demand for petroleum products and their respective determinants: subsidies, real income, prices of the products, prices of substitutes and population. The empirical results show that the elasticity of own and substitutes' prices are negative, while the own price of diesel, subsidy, real income and population coefficients are positive. Meanwhile, the coefficient of subsidy on gas demand is negative. Hence, the removal of subsidy from petroleum products is not the problem, but the misapplication of the fund meant for the subsidy. This is due to the fact that the subsidy does not reflect in the prices of petroleum products in Nigeria. Therefore, the managers of the economy should ensure that subsidies are better used to achieve economic growth.

Keywords: Subsidy, Petroleum, Products, Demand, Price, Kerosene, Gas, Diesel.
JEL Classification Code: C32, Q41, Q48.

Contribution/ Originality

This study is the first to employ Error Correction Model (ECM) with Nigerian data. Furthermore, it is the first to estimate the demand for all the four petroleum products in Nigeria.

1. INTRODUCTION

Successive Nigerian governments in the past particularly the administrations from the period of oil glut have been subsidizing petroleum products. As a result of the above, the government has been paying part of the cost of every litre of oil that is consumed by any individual in Nigeria whether a foreigner or a citizen. This development has led to increase in government expenditure resulting in budget deficit over the years. As a result, the government became worried over the situation and eventually came out with the concept of oil subsidy removal so as to reduce cost of

running the government and use the accruing funds to provide essential and social amenities to the larger citizenry (Abutu, 2012).

However, Nigeria is a member of Organization of the Petroleum Exporting Countries (OPEC). It ranks as the largest producer of crude oil in Africa and sixth in the world. Yet, it has alarming short supply of petroleum product for domestic consumption. The high demand for petroleum products could be as a result of rising incomes, lower prices (influenced by a subsidy), a teeming population (of which Nigeria happens to be the most populous country in Africa), and various other factors that could affect demand. Nigeria is said to have an oil production of about 2.451million barrel per day (bpd), while it consumes about 310,000 bpd (World Fact Books, 2005; 2008). In 2006 alone, the level of consumption increased to 312,000 bpd with a production level of 2.352 million bpd. In 2007, it ranked 38th position in the world with respect to oil consumption. From these facts, it is quite obvious that Nigeria, despite the decrease in oil production in 2006, still has an increased oil consumption rate.

Hence, consumption of petroleum products in Nigeria grew tremendously from the middle 1980s reflecting the rapid growth rate in the number of automobiles, industries, households, intensified rural–urban migration, economic and political developments. The bulk of production has been the Premium motor spirit (fuel), Gasoil (Diesel), Dual purpose kerosene and Bitumen, which in all, accounts for 60% of the total consumption of petroleum products. Due to the fact that there is a rapid growth rate in automobiles as well as acquisition of generating plants, the consumption of fuel and diesel has been high (Onwioduokit and Adenuga, 2001). Furthermore, urbanization has also been a determinant in the demand for petroleum products. For instance, it is believed that since transportation is very high in urban than rural areas, the demand for petrol would be higher in such areas. Kerosene and Gas are used mainly for cooking and lighting purposes, and are used virtually in most households. As price of kerosene rose, people in the rural areas resorted to fuel wood, better known as "firewood". The current government has removed subsidies on petroleum products due to the increase of crude oil price in the international market. For example, subsidies on petroleum products increased from ₦70 billion in 2003 to ₦450 billion in 2006, while it rose further to over ₦1.5 trillion in 2008 which is equivalent to the capital budget for the entire economy and would continue to grow in tandem with increase in consumption as a result of the large dependence on petroleum products by industries, homes and the transport sector (Ogbuanu, 2008). However, subsidy removal would lead to higher prices which would in turn raise the poverty level in the country (Nwafor *et al.*, 2006). Nigeria exports crude oil and imports refined petroleum products. As a result, as prices of petroleum products increase in the international market, the imports become more expensive and domestic prices rise.

Furthermore, as the number of households in Nigeria increases virtually every year, the demand for basic petroleum products increases. This increase in the consumption level should be followed by an increase in domestic refinery production capacities to reduce the dependency from expensive mineral oil imports, but as statistics has it, there was a decrease in the domestic production of crude oil from 919,285.6 barrels in 2005 to 813,950.0 barrels in 2006 with consumption given as 73,105.9 barrels and 164,200 barrels respectively (Central Bank of Nigeria,

2006). From the figures above, it is observed that, despite the decrease in production, consumption still increased by 44%. This increase in consumption could be attributed to the presence of subsidy on these products. Demand for these products could also be high owing to the fact that they are part of the basic resources used in the day to day activities. As such, there is a possibility that a subsidy removal may not affect the demand for these products. A subsidy in actual sense is supposed to mean lower prices, but in Nigeria where refined petroleum is imported, international prices often affect the domestic prices despite the subsidies on them. This research however, is carried out to know the effect of a subsidy on the demand for petroleum products in Nigeria.

This study departs from previous studies in Nigeria with the inclusion of prices and the use of the four main petroleum products; PMS, AGO, DPK and LPG. The price variable is an important factor that affects the demand of a product. Thus, the objectives of this study are: first, to investigate the impact of subsidy on petroleum products; second, to determine whether an increase in income results to a corresponding increase in the consumption of petroleum products in Nigeria; third, to determine whether an increase in population results to an increase in the demand for petroleum products in Nigeria; fourth, to determine whether the increase in price of a substitute commodity results to an increase in the demand for a particular petroleum product in Nigeria.

2. LITERATURE REVIEW

Isfahani (1996) investigated government subsidies and the demand for petroleum products in Iran. The results suggest that price elasticities of demand are larger than previously thought. The results also indicate that price increases can stem the rise in consumption in Iran. In another study, Bacon and Kojima (2006) reported that subsidies have had unintended consequences in the thirty eight developing countries studied, such as fuel adulteration, smuggling, and benefits that go mostly to the better-off. Amegashie (2006) argued that removal of subsidies on petroleum products as prescribed by the World Bank to developing countries would have adverse effects on the poor in these countries, while Baig *et al.* (2007) investigated recent developments in the pass-through of international to domestic petroleum product prices in the different fuel pricing regimes, and in fuel subsidies in developing economies. They argued that there is limited price pass-through in many countries and the consequent increase in fuel subsidies.

There are few studies conducted on Nigerian economy. These studies employed different methodologies, data frequencies, and time periods. For example, Onwioduokit and Adenuga (2001) examined the demand for petroleum products in Nigeria from the period of 1970-1996. They reported that cooking gas and petrol consumption are urbanization elastic with values 1.903 and 0.664 respectively. The elasticity of agricultural contribution to income is negative. Thus, as agricultural contribution to income increases, petrol consumption decreases, while the contribution of the manufacturing sector to income is positive elastic. And the kerosene displayed negative urbanization elasticity as a result; kerosene is used mainly by rural and low income urban households for lighting and cooking. Meanwhile, Hossain (2003) used three products

(Gasoline, Diesel and Kerosene) to estimate the prices and economic subsidies of petroleum products in Nigeria. The results suggest that the prices in Nigeria were still much below their international prices implying that they were heavily subsidized. The limits to kerosene subsidy according to the study are set by the price of diesel which is regarded as a close substitute for kerosene. In contrast, Ukah (2007) reported that the consumption of Premium Motor Spirit (PMS) is not affected by its price. Thus, the withdrawal of subsidy has no significant impact on the domestic consumption of PMS in Nigeria.

However, Nwafor *et al.* (2006) argued that subsidy removal without spending the associated savings would increase the national poverty level due to cost of inputs relative to the prices of outputs by domestic firms. Hence, Salisu and Uduak (2012) are of the opinion that subsidy removal has significant benefits for the Nigerian economy. This is due to the fact that it will increase the revenues accruing to the government and enhance government capacity to undertake its economic programmes. Similarly, Abutu (2012) reported that the full removal of the subsidy on petrol would help the government to use the saved fund for other developmental projects. Such as, electricity power generation, mechanized agriculture, rehabilitation of railways and creation of inner waterway transportation, rehabilitation of bridge, improving of education, tackling security challenges and building of more refineries. Meanwhile, Onyisi *et al.* (2012) examined the domestic and international implications of fuel subsidy removal crisis in Nigeria. They argued that the removal of subsidy would lead to selling of fuel in the "black market" which would lead to higher prices. They further recommended that government at all levels should cut down the cost of running government so that more revenue would be used for capital expenditure. Adenikinju and Falobi (2006) investigated the causes of shortage in domestic oil supply in Nigeria. The study employed computable general equilibrium (CGE) model. The results suggest that oil supply shocks results in lower real GDP, higher average prices and greater balance of payment deficits. Similarly, Aigbedion and Iyayi (2007) argued that unless Nigeria deepens its economic reforms initiatives to include effective diversification of the petroleum sector, performance of the economy will continue its unimpressive trend of dependence on crude oil, while Adebimpe and Ibraheen (2008) studied coal demand in Nigeria. The results suggest that coal demand would continue to increase in Nigeria, but not in appreciable quantity.

3. THE MODEL

The model used for this study captures the most important factors namely: price of the product, price of substitutes, income and population. Four models shall be estimated for the four main petroleum products in Nigeria (Fuel, Gas, Kerosene and Diesel).

The models are specified as:

$$\ln Q^{F} = \alpha_0 + \alpha_1 \ln RGDP + \alpha_2 P_f + \alpha_3 P_d + \alpha_4 \ln POP + \alpha_5 \ln Q^{F}_{-1} + D_i + \mu_t \quad \text{.....(1)}$$

$$\ln Q^{D} = \alpha_0 + \alpha_1 \ln RGDP + \alpha_2 P_d + \alpha_3 P_f + \alpha_4 \ln POP + \alpha_5 \ln Q^{D}_{-1} + D_i + \mu_t \quad \text{.....(2)}$$

$$\ln Q^K = \alpha_0 + \alpha_1 \ln RGDP + \alpha_2 P_k + \alpha_3 P_g + \alpha_4 \ln POP + \alpha_5 \ln Q^K{}_{-1} + D_i + \mu_t \quad \ldots\ldots\ldots(3)$$

$$\ln Q^G = \alpha_0 + \alpha_1 \ln RGDP + \alpha_2 P_g + \alpha_3 P_k + \alpha_4 \ln POP + \alpha_5 \ln Q^G{}_{-1} + D_i + \mu_t \quad \ldots\ldots\ldots(4)$$

where Q^F, Q^D, Q^K and Q^G = Quantity demanded of fuel, diesel, kerosene and gas

P_f, P_d, P_k and P_g = prices of fuel, diesel, kerosene and gas, μ = Error term

$Q^F{}_{-1}$, $Q^D{}_{-1}$, $Q^k{}_{-1}$ and $Q^G{}_{-1}$ = lag quantities of fuel, diesel, kerosene and gas

RGDP = Real per capita income

POP = Population

D_i = Dummy variable for Government policy on subsidy (1 for periods of subsidy and 0 for periods of no subsidy).

4. EMPIRICAL RESULTS

First, we performed unit root test on the variables using Augmented Dickey-Fuller (ADF). The results reported in table 1 below, indicate that all variables became stationary after first difference, except lnRGDP. However, in order to make lnRGDP I(1) we differenced it twice. Given the unit-root properties of the variables, we proceed to Engle and Granger (1987) cointegration test to establish whether a long-run relationship exists amongst the model variables. The unit root test results are presented in table 1, while cointegration test is reported in table 2.

4.1. Unit Root Test

Table-1. ADF Unit Root Test Results

Variables	Fisrt order difference	Second order difference
Log(Q^F)	-4.689*	
Log(Q^D)	-5.443*	
Log(Q^K)	-5.067*	
Log(Q^G)	-5.508*	
Log(RGDP)	-	-5.609*
Log(POP)	-4.255*	
Log(P_F)	-3.782*	
Log(P_D)	-4.255*	
Log(P_K)	-4.647*	
Log(P_G)	-3.945*	

Note: * indicates significant at 5%. Mckinnon critical Value for rejection of hypothesis of a unit root is 5% (-3.543).

4.2. Cointegartin Test

This test is employed to establish whether the variables have a long – term stable equilibrium relationship between them. The Engle and Granger (1987) two – step approach shall be used. First, the residuals are generated, then, using the ADF technique, we test for the stationarity of

the generated residuals. If found stationary, then we conclude that there is cointegration and thus specify the error correction model (ECM)

Table-2. Engle and Granger (1987) Cointegration Test Results (for equations1, 2, 3 and 4 above)

Variables	T-ADF	5% Critical Values
D(Residual)	-3.134	-1.9504
D(Residual)	-3.492	-1.9504
D(Residual)	-3.318	-1.9504
D(Residual)	-3.685	-1.9504

The results of the cointegration tests are reported in table 2. Based on the ADF statistics, we reject the null hypothesis of no cointegration between quantity demand of crude oil products (fuel, diesel, kerosene and gas) and their economic determinants at the 5% level of significance. Thus, at 5% level of significance, cointegration is established.

4.3. Error Correction Models (ECM)

This is employed to estimate the speed of adjustment between the long-run and short-run dynamic in the model.

Table-3. ECM Results

Dependent Variables	Independent Variables (for equations 1, 2, 3 and 4)							
	Constant	$D(P_F)$	D(POP)	$D(P_D)$	$D(P_G)$	$D(P_K)$	DUMMY	ECT(-1)
Demand for Fuel	-165165.3 (-0.56178)	-8514.867 (-0.15094)	50613.76 (1.634312)	130509.8 (2.362931)*			234042.4 (0.671591)	-0.726779 (-3.92459)*
Demand for Diesel	-95855.10 (-0.94)	27327.96 (1.3622)	13648.68 (1.2635)	-55408.83 (2.909)*			145598.4 (1.164)	-1.509398 (-7.0786)*
Demand for Kerosene	-51853.33 (-0.432)		20365.91 (1.57525)		-9386.2 (-0.3728)	11752.24 (0.5226)		-0.980011 (-3.70795)*
Demand for Gas	-14789.83 (-1.67015)		373.5250 (0.407576)		-500.35 (-0.271)	2781.718 (1.6324)	21031.56 (1.926985)	-1.462519 (-6.70653)*

Note: t-statistic are in parenthesis and * indicates significant at 5%. The variables are estimated in first order differenced level.

The coefficient of Error Correction Term (ECT) for fuel is about (-0.728). It suggests that if there is 1 percent shock in the previous period, the demand for fuel is adjusted to reduce 0.728 percent of the shock and moves to the new equilibrium. Statistically, the equilibrium error term is different from zero, suggesting that demand for fuel adjusts to changes in price of fuel, population, and price of diesel in different time periods. As shown in table 3, short-run changes in price for fuel have a negative impact on the short-run changes in demand for fuel. Whereas, short-run changes in population and price of diesel have positive impact on the short-run changes in demand for fuel. However, price of fuel and population do not appear to have significant short term effects on demand for fuel. Similarly, the coefficient of error correction term for diesel is about (-1.509), the highest among the four. It implies that if there is 1 percent shock in the previous period, the demand for diesel is adjusted to reduce 1.509 percent of the shock and moves to the new equilibrium. The coefficient of the equilibrium error term shows that demand for diesel adjusts to changes in price of diesel, population and price of fuel in different time periods. As shown in table 3, short-run changes in price of diesel have a negative impact on the short-run

changes in demand for diesel. However, short-run changes in population and price of fuel have positive impact on the short-run changes in demand for fuel. As shown in table 3, the equilibrium error correction term is different from zero, showing that demand for kerosene adjusts to changes in price of kerosene, population, and price of gas. The coefficient of the error term suggests that if there is 1 percent shock in the previous period, the demand for kerosene is adjusted to reduce to 0.980 percent of the shock and moves to the new equilibrium. Furthermore, short-run changes in price of kerosene and population have a positive impact on the short-run changes in demand for kerosene. Whereas, short-run changes in price of gas have negative impact on the short-run changes in demand for kerosene. Similarly, in table 3 the coefficient of the error correction term for gas is about (-1.463), the second to the highest in among the four. The result implies that if there is 1 percent shock in the previous period, the demand for gas is adjusted to reduce to 1.463 percent of the shock and moves to the new equilibrium. The equilibrium error term further suggests that demand for gas adjusts to changes in price of gas, population and price of kerosene in different time periods. The results show that short-run changes in price of gas have a negative impact on the short-run changes in demand for gas. However, short-run changes in population and price of kerosene have positive impact on the short-run changes in demand for gas.

4.4. General Models

Table-4. Model 1

$Ln(Q^F) = -3.1888659 + 0.313\ln RGDP - 0.022P_F + 0.018P_d + 1.956\ln POP + 0.973\ln Q^F_{-1} +$
(-1.070) (1.224) (-0.930) (0.821) (1.956)* (11.503)*0.104D_i - 0.312RES(-1) (1.419) (-1.691)
$R^2 = 0.926$, DW= 2.136, F-stat. 51.853

Table-5. Model 2

$Ln(Q^D) = 1.936 + 0.082\ln RGDP + 0.001P_d - 0.007P_F + 1.358\ln POP +$ (0.292) (0.212)
(0.204) (-0.468) (1.625) 0.303ln Q^D_{-1} + 0.103Di – 0.219RES(-1) (1.815) (1.082) (-1.449)
$R^2 = 0.922$, DW = 2.061, F-stat. = 41. 450

Table-6. Model 3

$Ln(Q^K) = 11.998 - 0.548\ln RGDP - 0.003P_K - 0.021P_G + 0.011\ln POP +$ (2.722)* (-1.807) (-
0.150) (-1.271) (2.097)* 0.496ln Q^K_{-1} + 0.220Di – 0.027RES(-1) (3.961)* (2.374)* (-0.179)
$R^2 = 0.765$, DW = 2.112, F-stat. = 11.409

Table-7. Model 4

$Ln(Q^G) = -6.337 + 0.171\ln RGDP - 0.002P_G - 0.015P_K + 2.646\ln POP +$ (-0.455) (0.212) (-
0.462) (-0.462) (1.461) 0.388ln Q^G_{-1} - 0.114Di – 0.08RES(-1) (2.125)* (-0.565) (-0.036)
$R^2 = 0.552$, DW = 1.975, F-stat. = 4.313

The signs of all the variables in tables 4, 5, 6 and 7 are in line with a priori expectation, except the own-price of diesel and real income in tables 5 and 6 and prices of gas and kerosene in tables 6 and 7 respectively. Some of the variables were also taken in their logarithmic forms in

order to consider their direct elasticities. The results in tables 4, 5 and 7 show a positive, but non statistically significant relationship between demand for petroleum products and real income respectively. The results suggest that the major factors that significantly influence the quantity demand of fuel and kerosene in Nigeria are population respectively and subsidy for kerosene alone, but not own-prices. The results in tables 6 and 7 further show that kerosene and gas are not close substitutes in Nigeria as their prices are negatively related. The respective prices of the products suggest that an increase in the own-prices of the products leads to a decrease in their quantity demand, except that of diesel. This suggests that the own-price of diesel does not influence its demand in Nigeria. An increase in population leads to an increase in the quantity demand of the products. Furthermore, an increase in subsidy for petroleum products leads to a significant increase in the quantity demand of kerosene in Nigeria during the study period. Meanwhile, subsidy does not significantly impact on fuel, diesel and gas demand respectively. This result is consistent with Ukah (2007) for Nigeria for the period from 1987 to 1997. The lagged error correction terms (ECT_{-1}) have the expected negative sign. Similar results were reported by Hossain (2003) and Abiodun (2003) for Nigeria.

5. CONCLUSION AND POLICY IMPLICATIONS

The study shows that subsidy has positive impact on the consumption of kerosene, fuel and diesel in Nigeria. However, the impact of subsidy is only significant on the demand for kerosene. The empirical findings suggest that the demand for these products would continue to increase in future as a result of population growth. The results also show that prices only have little effect on the quantity demand of petroleum products as can be seen in their various coefficients. For instance, Fuel demand has a negative price elasticity of -0.022 while, Kerosene and Gas demand have negative price elasticities of about -0.003 and -0.002 respectively. On the other hand, the price of diesel shows a positive relationship with the demand of diesel. Real income has a positive coefficient in the models with moderate responsiveness to demand. Further, the cointegration results show that long-run relationships exist between the demand for petroleum products and their respective determinants.

Given the little responsiveness of subsidy to the demand of petroleum products, removal of subsidy would not significantly influence the demand for fuel, gas and diesel respectively. This is the case because the products have no close substitutes. However, due to the fact that subsidy significantly impact on the demand for kerosene, its removal would affect its consumption. Thus, the vast majority of the poor who dominate the rural enclaves would resort to firewood. Whereas urban dwellers would resort to firewood and charcoal and this would increase their prices. Consequently, this would result to deforestation and climate change in Nigeria. Similar outcome is reported by Hossain (2003) and Abiodun (2003) for Nigeria.

According to Hossain (2003), based on Nigerian household expenditure data, fuel and lighting expenditure make up about 6 percent of household expenditure in both urban and rural areas, while the kerosene (used for cooking and lighting) alone takes up the bulk of this expenditure - 2.4 percent of total expenditure in urban areas and 1.9 percent in rural areas.

Firewood makes up only about 1.2 percent of total expenditure in urban areas, but 3.2 percent of expenditure in rural areas.

The results suggest that the acclaimed subsidy by the government on petroleum products does not have any significant effect on fuel, diesel and gas demand in Nigeria. The prices of fuel, kerosene, gas and diesel have been on the increase over the years despite the subsidy. Thus, government should ensure that the four refineries are made functional in order to cut the costs incurred on importation of refined petroleum products from abroad. This importation contributes to rising prices of petroleum products and government subsidy may not necessarily translate to lower prices. If the production capacity of the four refineries is increased, prices would be reduced and employment opportunities would be created. Hence, the removal of subsidy from petroleum products is not the solution, but the misappropriation of the fund meant for the subsidy. This is due to the fact that the subsidy does not reduce the prices of petroleum products in Nigeria.

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