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Petroleum Products Pricing Reform in Nigeria: Welfare Analysis from Household Budget Survey

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ABSTRACT: This paper examines welfare effects of energy reform particularly petroleum products pricing reform in Nigeria. The data for 5000 households were collected to estimate a demand system for PMS, AGO and DPK. The survey contains information on the occupation and income of the household members, as well as on household expenditure and consumption as well as on a wide range of demographic and socio-economic characteristics. This study use marginal social cost approach to evaluate equity and efficiency implications of petroleum products subsidy reform in Nigeria. The reduction or removal of subsidy on PMS will save largest amount from government budget. When there is distribution concern, the marginal social cost of reducing subsidies on AGO is lowest supporting the reform that have been carried out by removing subsidies on AGO. However, marginal social cost for all petroleum products are extremely low suggesting reduction of subsidies on all petroleum products in Nigeria. These findings revealed that equity argument for continue subsidization of household kerosene can no longer be justified since marginal social cost is low. The reality is that apart from the NNPC outlets, there is no other outlet anywhere in Nigeria where kerosene is sold at the subsidised price.

Keywords: petroleum products; subsidy reform; household's welfare; expenditure elasticities; marginal social cost approach; Nigeria
JEL Classifications: D12; Q4; Q41

1. Introduction

Petroleum products subsidies have long been features of the Nigerian economy since early 70s in form of implicit subsidies. The demand and supply situation is subjected to a subsidy and price fixing effect. Fuel demand and supply in Nigeria are inelastic. This means that it is very difficult for consumers to find an alternative to the use of gasoline, kerosene and diesel in their daily lives. The various taxes and subsidies further produce a dead weight loss to the economy. These subsidies have a number of perverse consequences. These include among others: they send false price signal that encourage overuse of resources, they inhibit the development of substitutes that are more environmentally friendly and divert scarce financial resources from other social purposes. Subsidies discourage private investors in refineries, place burden on state budget, persistent fuel shortage, smuggling and adulteration of products. Subsidies persist in most developing countries due to equity consideration. In some cases, subsidies still serve legitimate social goals benefiting poor or marginalized consumers while in others, government is reluctant to undertake the reform for fear that its removal may adversely affect competitiveness and employment in certain sectors. Thus, removing or at least reshaping subsidies could lead to substantial benefits in terms of economic efficiency, environmental preservation and social equity. Their redesign could also free resources to allocate to other urgent needs that are prevalent in developing countries. Energy price increases are usually announced with short notice, and with limited attempts at explaining the rationale behind the changes. Social unrest was a common response: violence and protests followed price rises in Egypt (1977), Morocco (1981, 1984), Tunisia (1984), Jordan (1989, 1996) and Ghana (2005).There have been many attempts to reduce subsidies on petroleum products in Nigeria, such attempts had at times, led to extensive public protests and policy reversal in the form of cancellation or reduction of the planned

price increases. This was what happened in January 2012 when Nigerian government increased the price of gasoline by 117 percent. This led to total a shutdown of the economy and the nation lost N300 billion in the five days strike of January, 2012.[1] However, in reaction to the protests by organized labour and civil society in major cities, the government agreed to a lower price of N97. The global practice today is the removal of fossil fuel subsidies to enhance fiscal stability. The equity and efficiency implications of petroleum products prices reform in Nigeria is the main thrust of this study.

Several studies have attempted to quantify the effect of price reform in an economy (Aldriamihaya and Vecchi, 2007; Pitt, 1985; Olivia and Gibson, 2008). Analysis of equity and efficiency of petroleum products subsidy removal on household is imperative in an economy such as Nigeria that is undergoing substantial reform in its petroleum sector. Previous studies emphasis on the macroeconomic effects of energy pricing. The key existing study on petroleum products pricing in Nigeria use computable general equilibrium approach (Adenikinju, 2000; Iwayemi and Adenikinju, 1996; Nwafor et al., 2006). Previous studies in Nigeria do not provide satisfactory explanation on the effect of the phenomenon of subsidy on household welfare. The macroeconomic benefit does not automatically transmit to household benefit. The study of this nature is essential in filling the gap in the literature on energy pricing in Nigeria

2. The Nigerian Economy and Petroleum Industry

Nigeria has proven reserve of crude oil of 37.2 billion barrels as at the end of 2010, the tenth largest in the world and the second largest in Africa behind Libya. Nigeria with a daily production averaging about 2.4 million barrels is the 8th largest exporter in the world and largest in Africa. This has generated billions of revenue, unlike other oil exporting countries like Venezuela, Saudi Arabia, Algeria and Ecuador with a better standard of living; this has not translated into an improved economy in Nigeria. Nigeria has been trapped in almost three decades of petroleum products shortage and importations. The situation is alarming in the last twelve years that she import over fifty percent of her oil products consume daily. The entire world is amazed at the Nigerian paradox: the world's 8th largest exporter of crude oil and at the same time, a major importer of refined petroleum products. Nigeria's four refineries (all producing below 40 per cent of installed capacity) and twenty two depots are in comatose for effective refining and distribution of her 2.4million bpd produces daily. This cannot be compared with Venezuela with 14 refineries refining 1.28 million bpd produces daily.

2.1 Petroleum Products Consumption in Nigeria

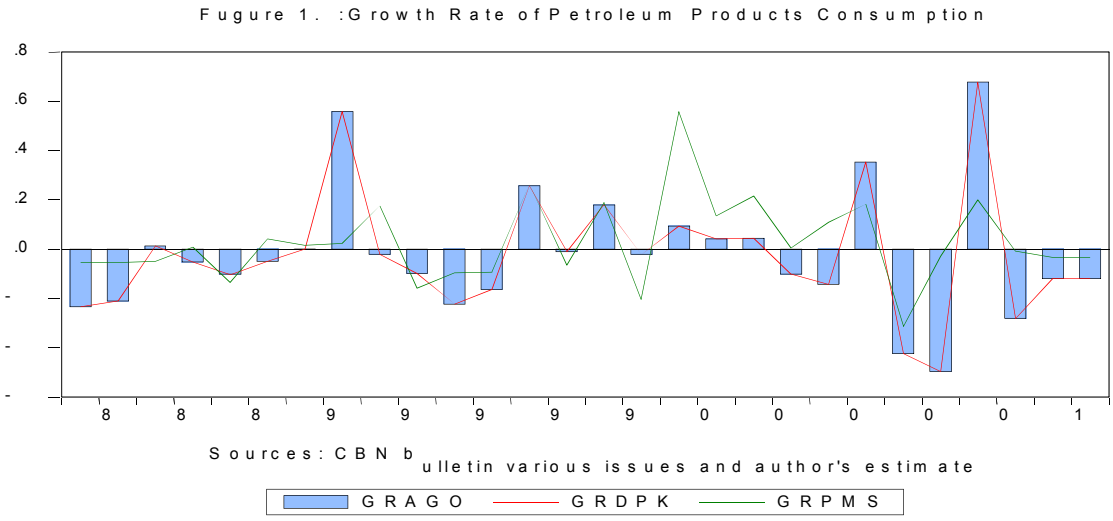
Consumption of petroleum products has been on the increase with economic growth. This trend has also been encouraged by the low prices of these products. As would be expected of other nations with similar economic and social characteristics like Nigeria, the bulk of consumption has been the Premium Motor Spirit (PMS) or gasoline, Automotive Gas Oil (AGO) or diesel and Dual Purpose Kerosene (DPK). Together, they account for more than 60% of the total of petroleum products. There are several characteristics of petroleum products consumption. First, its consumption cut across various sectors of the economy; therefore it is the most widely utilized fuel. Second, the elasticity of substitution of the products varies across sectors. It is low in transportation and very high in industry and residential. The low elasticity of substitutions in transportation makes the impact of pricing policies in the sector very extensive in reach and quite sensitive. PMS and AGO are the major fuels utilized in the road transportation sector and for small to medium sized electricity generation plants for power supply in homes and locations detached from PHCN, as well as industries. Specifically, PMS is used in vehicles, small generating plants, drives for compressors while AGO is used largely on heavier engines. Third, the political impact that pricing of petroleum products engender varies. It is based on level of development of a country, its economic philosophy, and whether it is a net oil exporter or net oil importer.

Several dimensions of the trends of petroleum products consumption at both aggregate and disaggregate levels are worth noting. The figure1 therefore provides information on the domestic consumption of the major petroleum products in Nigeria within 1977 and 2010. It is apparent from this figure that domestic aggregate petroleum product consumption showed an average increase of 29.8% from 1977 to 1981. This can be attributed to increase in per capital income. The key factors in this rapid growth in gasoline consumption were the rapid income expansion due to strong oil export

[1] Nigeria lost N300bn to strike-OkonjoIweala. See page 20 of The Punch Newspaper, Tuesday January 17, 2012.

performance. This increase in income which led to rapid acquisition of vehicles and generating plant in response to epileptic power supply from the Power Holding Company of Nigeria (PHCN).At 6.5 million tonnes in 1981, consumption of PMS rose by 2.0 percent to 6.7 million tonnes in 1982. The economic recession in the post-1982 period was accompanied by a decline in the level of demand culminating in the sharp fall from 4.2 million tonnes 1983 to 3.6 million tonnes in 1987, a decrease of 14.2 per cent. Similarly, AGO declined from 3 million tonnes to 1.7 million tonnes in the observed period. This coincided more or less with the economic depression consequent on the two-thirds fall in world crude oil prices. Consumption of gasoline increased from 3.3 million litres in 1991 to 3.9 million tonnes in 1992. It fluctuated downwards to 2.7 million tonnes in 1995. The consumption of DPK fell from 1.3 million tonnes in 1991 to 406.2 thousand tonnes in 2010. This can also be attributed to the non affordability and non accessibility of the products because of high cost of kerosene. The reality is that apart from the NNPC outlets, there is no other outlet anywhere in Nigeria where kerosene is sold at the subsidised price. The product sells for between N100 and N150/L depending on outlet and location. PMS consumption subsequently edged up to 3.2 million tonnes in 1997 and it maintained an upward trend of an average of 6.5 million tonnes between 1998 and 2005. The general growth in the economy may have been responsible for this trend in gasoline consumption, as there is usually a close relationship between energy use and economic development. The consumption of AGO decline from 2.2 million tonnes in 2002 to 722 thousand tonnes in 2010.This can be attributed to the deregulation of the price of diesel.The consumption of PMS declined from its peak of 8.6million tonnes in 2005 to 5.7 million tonnes in 2007. It increased to 6.8 million tonnes in 2008, but declined to 6.5million tonnes in 2010. Most of the demand for the products is supplied by the domestic refineries. However, because of the poor conditions of three of the four refineries problems of evacuation of products due to inadequate capacity of ports pipelines and depots, the present unconnected pipeline systems, irregular power supply of pumping stations, poorly maintained and inadequate rolling stock and truck fleet there have been shortages which have had to be augmented with importation from time to time.

Figure 1. Growth Rate of Domestic Consumption of Petroleum Products



Note: GRAGO: Growth rate of AGO consumption
GRDPK: Growth rate of DPK consumption
GRPMS: Growth rate of PMS consumption

2.2 Petroleum Products Pricing and Subsidy in Nigeria

Petroleum prices in the domestic market have been under government control since 1973 when the government took it over from the private oil companies (Iwayemi, 1993). The prices of petroleum products in Nigeria should theoretically be derived from International Crude oil prices since the marginal supply (litres) comes from import, it should therefore reflect import price. In other words,

when the marginal unit of consumption is imported the economic price should be import parity price.[2] However, this has not always been the case for a number of reasons particularly socio-political ones. Iwayemi and Adenikinju (1996) identify three factors that have influenced government position. First, is the desire to protect the interest of the poor who could be hurt from higher prices? The second is the need to reduce industrial cost as energy products are seen as critical inputs in production processes. The third factor relates to the potential inflationary impact of higher energy prices. Government of both oil producing and consuming countries invariably intervene in the market to influence product price. The extent of such intervention depends on the specific needs of the country and importance of the product in question. It has also been noted that crude oil cost is not the only cost incurred in the supply and distribution of petroleum products as other costs such as refining costs, transportation and distribution costs are involved.

The trends in petroleum products pricing in Nigeria has a long history. The Military Head of State of General Gowon increased fuel price from 6 kobo to 8.45 kobo. It was raised to 9kobo in 1976 by Late General Muritala Administration. On October 1, 1978, the then military government of Obasanjo increased the pump price of petrol from 9kobo to 15.37kobo.There was another hike on April 20, 1982, when price was marked to 20kobo.On March 31, 1986, General Ibrahim Babangida increased pump price of fuel to 39.5kobo.On April 10, 1988, it was increased to 42 kobo per litre. On January 1, 1989, it was announced another increase whereby private car were to pay 60 kobo per litre while commercial cars continue paying 42 kobo.

Table 1. Changes in Fuel Prices in Nigeria

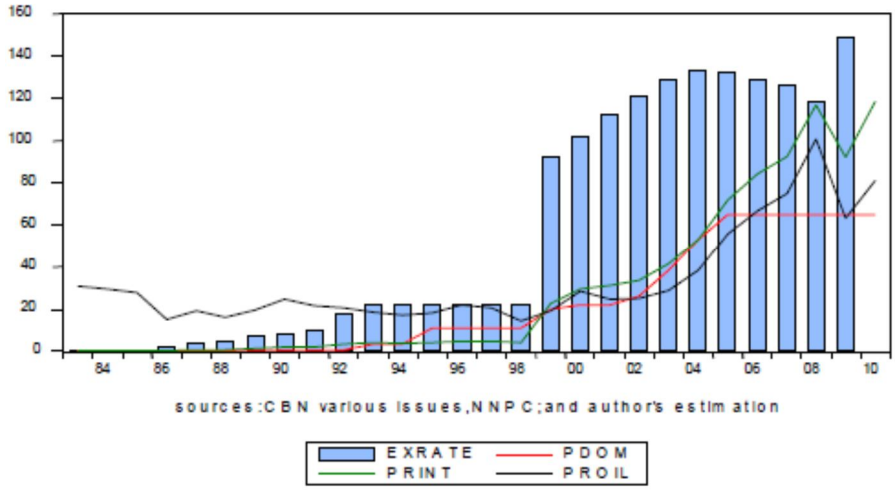
Date	Prices per litre	Change%
Jan, 1973	0.095	_
Sept, 1978	8.5 kobo	8447.2-
Oct, 1978	15.5 kobo	73.9
Apr 20, 1982	20 kobo	31.0
Mar 31, 1986	39.5 kobo	97.5
Apr 10, 1988	42 kobo	6.0
Jan 1, 1989	40 kobo for commercial	43.0
Dec 19, 1989	60kobo for all vehicles	43.0
Mar 6, 1991	70kobo	16.6
Nov 8,1993	N5.00	614.0
Nov 22, 1993	N3.25	-35.0
Oct 2, 1994	N15.00	361.5
Oct 4, 1994	N11.00	-26.67
Dec 20,1998	N25.00	127.0
Jan 6, 1999	N20.00	-20.00
Jun 1, 2000	N30.00	50
Jun 8, 2000	N25.00	-16.67
Jun 13, 2000	N22.00	-12.0
Jan 1, 2002	N26.00	18.2
Jun 20, 2003	N40.00	53.0
Jul 9, 2003	N34.00	-2.40
Oct 1, 2003	N38.50 and N42.00	23.53
May 29, 2004	N49.90	16.67
Sept, 2004	N53.00	8.16
Sept, 2005	N65.00	22.64
27th,May 2007	N70.00	7.6
June 2007	N65.00	-7.6
Jan 1,2012	N141.00	116.9
Jan 8,2012	N97,00	-31.2

Source: Own Compilation

[2] For theoretical exposition, see Iwayemi (2011) Solving Nigeria's Energy Puzzle: Why Economic Analysis Matters. .Presidential Address Delivered at The Fourth Annual Conference of The Nigeria Association For Energy Economics, Abuja. April 28. Pg 21.

The failure of price discrimination policy led to the announcement of a uniform price of 60 kobo per litre on December 19, 1989. In March 1991, the retail price of gasoline was increased from N0.60 to N0.70 per litre. In November 1993, the pump price was further increased to N3.25 per litre and in November 1994 it was raised again to N11.00 per litre. Prices of other petroleum products such as liquefied petroleum gas (LPG), bitumen, waxes, lubricating oil, base oils etc were however uncontrolled and therefore fluctuated essentially in response to demand and supply conditions. According to the formula introduced in December 1994, oil marketers earn 65kobo per litre, transport owner a maximum of 40 kobo per litre (depending on the transport zone), while 20 kobo per litre goes to the service station. On December 20, 1998, it was increased to N30 and again reduced to N25.The price was further reduced to N22 per litres on June 2000.The changes in fuel prices is shown in table 1. On January1, 2002.it was again hiked to N26 per litre from N22.It was increased to N40 per litre on June 23, 2003. There was another increase in price on 29th May, 2004 to N50. This was later increased to N65 on August of the same Year. It was hiked to N75 per litre on 27th May, 2007.But following people's protest; it was reduced to N65 per litre on June 2007. This was sustained till January 1, 2012, when the price was increased to N141 per litre. It was later reduced to N97 per litre.

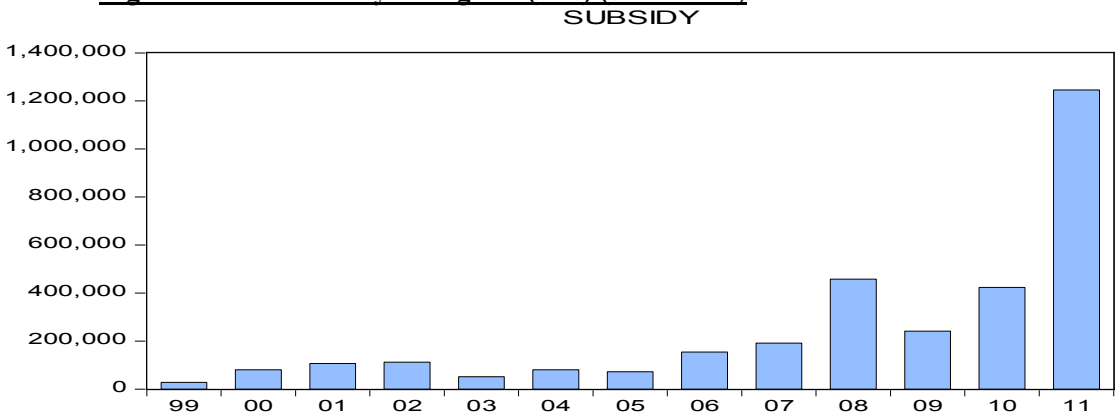
Figure 2. Exchange Rate, Crude Oil Price, International Minimum Benchmark Price and Retail Price of Gasoline



The domestic petroleum products prices have been set administratively in Nigeria since 1973, as in most oil exporting countries. They were set at a level to cover substantial part of production costs and have been changed occasionally. This worked well when the international oil prices were relatively stable and low, and close to production costs. However, when international prices began to rise in 2004, low domestic petroleum product prices became increasingly out of line with the market value of oil. Oil prices have increased dramatically since beginning of 2003,From $28.77 a barrel in 2003,the price of crude oil peak in August 2010 at $100.60, and closed at $81.07 in December2010.In addition, high domestic inflation and exchange rate deregulation contributed further to erode domestic petroleum prices vis –a-vis international benchmarks as shown in figure 2. The deregulation of exchange rate in 1999 and the resulting naira depreciation also accentuated a growing disparity between domestic and international petroleum product prices. By 2011, few people could dispute the need to reform Nigeria's domestic petroleum products prices. As international oil prices approached US $110 per barrel and f.o.b. gasoline prices hovered $1 per litre, Nigeria's domestic price of US$0.59 per litre of gasoline was clearly out of touch with reality, unsustainable, and unjustifiable by any economic theory. Gasoline accounts for the largest share of petroleum products consumption and also receives largest rate of subsidy. The subsidy level in 2008 alone was 150% of capital expenditure of the Federal Government in that year. In 2006, subsidy payment on fuel products was 50% of the size of Federal Government expenditure. The estimated subsidy payment is about 400% of the budgeted capital expenditures for Human Capital Development. The landing cost of petrol plus margin as at May 2012 is 169.13 naira. With this, it means the Federal Government is subsidizing petrol at the rate of 72.37 naira per litre given the fact that the product is sold for 97 naira per litre to the people. As at December 31, 2011 before the partial withdrawal of subsidy, it stood at 76 naira per litre but was

reduced to 44 naira when the official price of petrol was pegged at 97 naira per litre. Oil subsidy has moved from being implicit to explicit from 1999. The subsidy payment in 2010 was amounted 1.25 billion. Nigeria spent 19 percent of her budget on subsidy payment in 2011. In addition, N656.3 billion allocated to subsidy is the second largest allocation in 2012. It came behind security which has the largest allocation of N921.91 billion. Also, provision of N231.8 billion was made for the payment of the 2011 subsidy arrears. These figures exceed total allocation to priority sectors of our economy. The recent development has revealed that most of the claims and payments are frauds.[3] Some of the importers collected subsidy payments without importing products. Corruption accounts for the substantial part of the increase in the amount of fuel subsidy. That shows Nigeria is subsidizing inefficiencies, fraud and racketeering in the production and distribution chain.

Figure 3. PMS Subsidy in Nigeria (Nm) (1999-2011)



Source: NNPC, CBN various issues, Author's estimate.

3. Literature Review

3.1 Conceptual Issues

Energy subsidies and specifically fuel subsidies, which are the subject of this review, have a long history and have been applied in different forms. Two major classes of subsidies exist: production subsidies mainly a feature of developed economies and consumer subsidies which are found mainly in developing countries. A subsidy can be categorized into implicit, explicit and cross subsidies. Explicit subsidies are transfers from the government budget to the producer or consumer while implicit subsidy refers to the difference between opportunity costs of an asset and present selling price. Cross subsidies involve a group of consumers paying more than the general cost of supply and the surplus is used to subsidize the provision to the other group at a price that is lower than the cost of supply to subsidized group (World Bank, 2010).

Three methods of quantifying the magnitude of subsidies are in the literature (Koplow, 2009). These are price gap approach, the program-specific approach and the measure of producer or consumer subsidy equivalent. The price gap approach constitutes a measure of the difference between observed prices and reference price that would prevail in a competitive (efficient) market with no price intervention. The price gap approach assesses the wedge between the actual and a reference price. The reference price for goods that are traded (like oil) is usually the international or border price adjusted for market exchange rates, transport and distribution costs, and country specific taxes. For economies that export a given fossil-energy product but charge less for it in the domestic markets, the domestic subsidies are implicit; they have no direct budgetary impact so long as the price covers the cost of production. The subsidy, in this case, is the opportunity cost of pricing domestic energy below international market levels, *i.e.* the rent that could be recovered if consumers paid world prices, adjusting for differences in variables such as transportation costs. For net importers, subsidies measured via the price-gap approach may be explicit, representing budget expenditures arising from the domestic sale of imported energy at subsidized prices, or may sometimes be implicit. Subsidy estimates in Nigeria represent a combination of opportunity cost and direct expenditures. The program-specific approach attempt to measure the value transferred to stakeholders from a particular

[3] See Nigeria assembly and fuel subsidy report, 19 June 2012. Retrieved from newsofafricapress.org

government intervention. The producer or consumer subsidy equivalent combines feature of price gap approach and program specific approach. This approach attempts to capture both net budgetary and net market transfers. These were known as producer subsidy equivalent and consumer subsidy equivalent until 1999(OECD, 2000). The use of this approach has been limited in the energy sector to date (the few studies that adopted this method are Steenblik and Wigley, 1990; Cox and Schmidt, 2002).

3.2 Theoretical and Empirical Issues

Economic theory suggests that subsidies are inefficient because, in the absence of market imperfections and with convex indifference curves, the value of the subsidy to the consumer will be less than its cost to the government (Katz and Rosen, 1994). In other words, consumers do not use resources optimally. If prices were increased to reflect commercial costs and subsidy was returned to consumers in cash, they would be on a higher indifference curve, would be consuming less petroleum products (because relative prices have changed) and more of other normal goods. Economists argue that income transfers are superior to subsidies and reduce inefficiencies, as the former do not create the deadweight loss associated with subsidies and maximize welfare. Economic theory says that social welfare is maximized when the price of each good and service is determined by the intersection of producers' willingness to supply and consumers' willingness to pay. When the price deviates from this point of static equilibrium, resource allocation is inefficient since the benefit to consumers from the last unit of energy consumed are smaller than the costs involved in supplying the energy service (Manzoor et al., 2009).

There have been studies on subsidies and economy, and many researchers have directed the focus of their studies on subsidies as well as household both within and outside Nigeria. Several findings emanate from various empirical investigations on energy price reform and petroleum products subsidy in particular and its effect of removal on household welfare. Adriamihaja and Vecchi (2007) employed Price –Shifting Model to assess the distributional impact of higher energy price in Madagascar on households' real expenditure. The study concludes that the benefit of introducing price subsidies would be progressive; that is, in percentage terms, subsidy would benefit poor households' more than rich household. However, subsidising would involve substantial leakage in favour of high income households. Freund and Wallach (2000) conducted a study of energy price reform in Poland, which results in 80 percent increase in price. For one case, they assumed a zero elasticity of demand and found that welfare decline would be greater for the richest quintile than for poorest quintile. Oktaviani et al. (2007) use a GCE model to analyze the elimination of fuel subsidies in Indonesia, which occurred in three stages over the period 2000-2005(prices were increased by 21% in 2000, 30% in 2001 and 29% in 2005). They conclude that the short to medium –term macroeconomic performance of the economy was impaired by the removal of the subsidies, due to reduction in household incomes and increase in domestic prices. Furthermore, the reduction of fuel subsidies increased overall impact of poverty in Indonesian economy from 8.9% to 12.9% of population, with rural areas worst affected. On the other hand, the authors note that there is little difference in term of inequality over the period; declines in household incomes were fairly across the group. Kpodar (2006) concludes that high oil price impact negatively on poorest household in Mali.

Coady et al. (2006) simulated both direct and indirect effects of fossil –fuel subsidy reform in Bolivia, Ghana, Jordan, Mali and Sri Lanka. They found that the direct effects of increased fossil-fuel prices on aggregate real income ranged from 0.9 per cent in Mali to 2.0 per cent in Bolivia. However in Ghana, Jordan and Sri Lanka they were regressive affecting the lowest income more than the highest. Indirect effect resulting from increases in the prices of other goods and services were higher, ranging from 1.1 per cent to 6.7 per cent but tended to be equally distributed across income quintiles. This reflects the higher proportion of their budgets that lower income quintiles must devote to energy as opposed to other goods and services.

Gibson and Olivia (2008) used the marginal social cost approach to evaluate the equity and efficiency of subsidy reform in Indonesia. The study concludes that the large subsidies on kerosene should be reduced. The study concludes that the large subsidies on kerosene should be reduced. Iwayemi and Adenikinju (1996) in their computable general study of the macroeconomic implication of higher energy prices in Nigeria found that higher energy prices increases production costs, which increases prices in other sectors, particularly in energy intensive sectors such as utilities, construction,

mining and quarrying, which in turn in reduces overall consumer demand. Nwafor et al. (2006) examines the impact of removal of petroleum products subsidies on poverty in Nigeria. The study concludes that Subsidy removal, without spending of the associated savings, would increase the national poverty level. This is due to the consequent rise in inputs' costs which is higher than the rise in selling prices of most firms and farms. The key sectors which experience increased nominal output are the refined petroleum products which provide income for an extremely low number of households. The paper offers a similar contribution to the literature but deviates from the previous studies by using different methodology which is marginal social cost approach and household budget survey from Nigeria. Summary of previous studies are provided in Table 2.

Table 2. Summary of Some Empirical Findings

Author /Year	Study Area	Methodology	Conclusion
Abouleinein et al. (2009)	Egypt	CGE Model	Household welfare across all distribution is depressed, but rural households suffer the largest impact.
Kpodar,K(2006)	Mali	Price –Shifting Model	High oil price impact negatively on household welfare
Oliver and Gibson(2008)	Indonesia	Marginal Social Cost Approach	There is need to reduce large subsidies on kerosene
Hope and Singh(1995)	6 developing countries	CGE Model	There was no large change in the consumer price index during the period of energy reform in all six countries
Coady et al. (2006)	5 developing countries	Micro simulation approach	The impact is progressive in Mali and Bolivia while regressive in Ghana, Jordan and Sri Lanka
Manzoor et al. (2009)	Iran	CGE	The price of energy products should be increased on both equity and efficiency grounds
Adenikinju 2000)	Nigeria	CGE	The recessionary impact of efficient energy pricing is limited.
Oktaviani et al. (2007)	Indonesia	A Recursive Dynamic GCE model	The short to medium term macroeconomic performance of the economy was impaired by the removal of subsidies.

Sources: Author's Compilation

4. Methodology and Data

4.1 Theoretical framework and Methodology

The method employed in this study is based on the theory of marginal tax reform and normative optimal taxation theory. The marginal social cost approach originated with Ahmed and Stern (1984) and in this method, a set of price reforms are judged based on their distributional impact within a utilitarian social welfare framework. Two aspects of a change in price are being assessed. First, the redistributive effect of the reform is gauged through the calculation of the distributional characteristics for asset of disaggregate goods. Second, the overall impact of the price change on social welfare is assessed.

Following the approach of Decoster and Schokkaert (1989), It is assume that there are H households in the economy and denote by X_i^h (q), the quantity of commodity i purchase by household h. Subsidy reduction increases the consumer prices.

$$p_i=q_i+s_i \quad (1)$$

Aggregate consumption is then given by $X_i=\sum_h x_i^h i=1 \ldots . \quad N$ (2)

The government realised certain amount of revenue through subsidy reform.

$$R=\sum_i sixi \quad (3)$$

The starting point is the social welfare function, which aggregates individual welfare levels. Define the social welfare function over h=1. . . H households

$$W=W(U^1, \ldots ,U^H)=W(V^1(e^1, p) , \ldots ,V^H(e^H , p)) , \quad (4)$$

Where for household h, U^h is the direct utility and is equivalent to the indirect utility function $V^h(e^h, p)$,which is a function of household expenditures, e^h and a vector of prices.

Let we consider the consequences of a marginal change in the subsidy. This change will affect government revenue.

$$\frac{\partial R}{\partial si} = X_i + \sum_k s_k \frac{\partial Xk}{\partial pi} \quad (5)$$

It will also have an effect on social welfare:

$$\frac{\partial w}{\partial si} = W^*(V^1(e^1,p), \ldots, V^H(e^H,p)) - W(V^I(e^1,q), V^H(e^H,q))/\Delta Pi = \sum_h \frac{\partial w}{\partial vh}\frac{\partial vh}{\partial qi} = -\sum_h \beta^h x_i^h \quad (6)$$

Where W* is social welfare at the changed price and W is social welfare at the original price. The first step in examining the welfare impact of a price change, such as one resulting from removal of petroleum products subsidy, is to approximate the effect in equation (6)

$$\beta^h = \frac{dW}{dVh}\alpha^h \quad (7)$$

$$\alpha^h = \frac{dw}{dvh} \times \frac{dvh}{dmh}$$

m^h being the lump-sum income of the household h. The parameter α^h therefore gives the marginal social valuation of one unit of income accruing to household h. It is also known as the private marginal utility of expenditure (or income). The value of β^h is the social weight or the social marginal utility of household h receiving an additional unit of expenditure (Newberry 1995) and therefore combines the weighting policy maker and social planner $\frac{dw}{dvh}$ with that of private individual. To gauge the distributional consequence of petroleum products reform, the distributional characteristics computed. The distributional characteristics, d_i for i^{th} good is

$$d_i \equiv \frac{\sum_h^H \beta h pih}{\varpi Xi} \quad (8)$$

Where $\varpi \equiv \frac{1}{H}\sum_h^H \beta^h$ is the average of social utility weighs over all households and $X_i \equiv \sum_h^H x_i^h$ is the aggregate consumption of the i^{th} good. In money terms, household h is worse off by the quantity consumed, x_i^h, or in utility terms is worse off by $\alpha^h x_i^h$. Using Roy's identity the change in household utility from a price change as result of removal of subsidy is given by

$$\frac{\partial vh}{\partial pi} = -\alpha^h x_i^h \quad (9)$$

The change in social utility for a small change in price (e.g., a tax or subsidy on quantities) in equation 6 can be approximated to provide a numerical measure of change in social welfare.

And using (5) and (6)

$$msc_i = -\sum_h \beta^h x_i^h / (X_i + \sum_k s_k \frac{\partial Xk}{\partial pi}) \quad (10)$$

Multiply numerator and denominator of equation (10) by price q_i leads to an expression which can be operationalised easily:

$$msc_i = \sum_h \beta^h (pix_i^h) / [p_i X_I + \sum_k \varepsilon_{ki} s_k^* (p_k X_k)] \quad (11)$$

Where ε_{ki} refers to the uncompensated price elasticity $(\frac{\partial Xk}{Xk} / \frac{\partial pi}{pi})$ and $s_k^* = t^*/p_k$, the subsidy reduction rate as a fraction of consumer price. The equation (11) is the combination of subsidy factor and cross elasticities.

$$msc_i = \sum_h \beta h\ (pixih) \Big/ [1 + \frac{si}{1+si}(\frac{\varepsilon ii}{Xi} - 1) + \sum_{k \neq i} \frac{sk}{1+sk}\frac{\varepsilon ki}{Xi}] \quad (12)$$

The first term of the denominator in equation (12) measures the own –price distortionary effect of the subsidy. If it is large and positive, as would be the case for a heavily subsidised and price elastic good, the term will contribute to a small marginal social cost (msc_i) and would indicate the low cost of saving fiscal expenditures from decrease in the subsidy on this good. The last term is the sum of the subsidy factors multiplied by cross price elasticities, and captures the effects on other goods(and resulting revenue changes) from subsidy reform on good i (Oliver and Gibson 2008).The use of the complete expression in equation (12) integrates equity and efficiency consideration. To illustrate the trade- off between efficiency and equity, it seems interesting to rewrite (12) as:

$$msc_{\mathrm{I}}=\sum_h \beta \mathrm{h}\ (\frac{xih}{Xi}) \Big/ [1+\frac{si}{1+si}(\frac{\varepsilon ii}{Xi}-1)+\sum_{k\neq i}\frac{sk}{1+sk}\frac{\varepsilon \mathrm{ki}}{Xi}] \quad (13)$$

Let us first consider the case where we would neglect all changes in consumption pattern. If the assume that $\varepsilon_{\mathrm{ki}}= 0\forall\ k, i$.Equation (13) then reduce to

$$msc_{\mathrm{I}}= \sum_h \beta^{\mathrm{h}} x_{\mathrm{i}}^{\mathrm{h}}/X_{\mathrm{i}} \quad (14)$$

The marginal welfare cost of subsidy reform for any commodity, then coincides with the distributional characteristics of that commodity. This concept summarizes the variation of consumption pattern across income classes by weighting the market shares of the different households in the consumption of commodity i, using the β^{h}'s as weights.

If equity does not matter at all, in that case equation (14) reduces to

$$msc_{\mathrm{I}}= 1 \Big/ [1+\frac{si}{1+si}(\frac{\varepsilon ii}{Xi}-1)+\sum_{k\neq i}\frac{sk}{1+sk}\frac{\varepsilon \mathrm{ki}}{Xi}] \quad (15)$$

Equation (15) concentrates on efficiency aspects of the reform.

4.2 Data and Estimation Techniques

The data for 5000 households were collected to estimate a demand system for PMS, AGO and DPK. The survey contains information on the occupation and income of the household members, as well as on household expenditure and consumption as well as on a wide range of demographic and socio-economic characteristics. The empirical model applied in this study to get price responses needed for the marginal reform calculation in equation (12) is almost ideal demand systems (AIDS) model. AIDS allows household utility maximization framework with regularity conditions of adding up, homogeneity and symmetry. The AIDS Model for petroleum products demand can be expressed as

$$W_{\mathrm{it}}= \alpha_{\mathrm{i}}+\sum \gamma_{\mathrm{it}} lnp_{\mathrm{ik}}+B_{\mathrm{i}}\ln(m_{\mathrm{t}}/p_{\mathrm{k}})+\sum_{\gamma i} H\ +u_{\mathrm{it}}\mathrm{i}=1,\ldots\ldots..,\mathrm{n} \quad (16)$$

and where in observation t

w_{it} is the budget (expenditure) share of the i[th]product;

p_{kt} is the nominal price of the k[th]product;

$ln\ m_{\mathrm{t}}$ is total expenditure;

H is Household characteristics

u_{it} is the random error term

ln_{t} is the translog price index defined by;

$$lnp_{\mathrm{t}}=\alpha_0+\sum \alpha_{\mathrm{k}}\, lnp_{\mathrm{k}}+\frac{1}{2}\sum_i^n\sum_k^n \gamma_{\mathrm{it}}\, lnp_{\mathrm{it}}p_{\mathrm{kt}} \qquad \mathrm{t}=1\ldots\ \mathrm{T} \quad (17)$$

Compensated and uncompensated elasticities will be calculated using the formulas.

$$\varepsilon ii=\mathrm{e}_{\mathrm{it}}+w+\beta(\mathrm{w_k}/\mathrm{w_i})=-\delta+(\frac{\gamma it}{wt})+wj \qquad \mathrm{I,j}=1,2,\ldots\ldots.,\mathrm{N}. \quad (18)$$

$$\varepsilon ki=-\delta+(\gamma_{\mathrm{it}}/\mathrm{w})-\beta_{\mathrm{t}}(\mathrm{w_k}/\mathrm{w_i}) \quad (19)$$

Where $\delta = 1\ \ for\ i=j\ and\ \delta=0$ otherwise. The average expenditure shares are represented by $\mathrm{w_t}$ whereas, β_{t} and γ_{it} are RSUR parameter estimates for the LA/AIDS model.

5. Empirical Results

Table 3 presents Petroleum products share in total expenditures, share of petroleum products types in petroleum products expenditures and proportion of household and types in the sample. The consumption survey indicates petroleum products consumption take less than 10 percent of household's total expenditure, an overwhelming households do not have access to petroleum products at government subsidized price. On other hand, majority of household in rural area use traditional biomass for cooking, heating and lighting. Petroleum products subsidies are inherently biased towards the urban households. In spite of subsidies for many decades they have failed to shift fuel consumption away from traditional biomass in rural area.

Table 4 presents expenditure elasticity. The coefficient for AGO and PMS are positive indicating luxury goods whose budget share rise more than proportionally as household expenditure rises.10 percent increases in total expenditure leads to 2.3 percent increases in budget share for PMS.

Table 3. Distribution of Petroleum Products by Households Types

	Petroleum products share in total exp.	PMS	DPK	AGO	Other petroleum products	Percentage of Household
Income's source						
Wages/salary	**7.1**	**42**	**49**	**4**	**5**	**33.4**
Profit	**7.9**	**47**	**42**	**8**	**3**	**48.1**
Pension/gratuity	**3.2**	**49**	**41**	**2**	**8**	**14.3**
Others	**6.1**	**43**	**51**	**5**	**1**	**10**
HH Size						
Single	**5.1**	**27.1**	**51.3**	**2.1**	**19.5**	**20.8**
2 to 4 Members	**7.6**	**37.8**	**40.1**	**10.6**	**10.5**	**46.6**
Over 4 Members	**8.7**	**40.1**	**46.1**	**11.8**	**2.0**	**32.6**
Residence Status						
Not owned	**6.8**	**43.2**	**47.6**	**4.3**	**4.9**	**63.3**
Owned	**7.3**	**41.7**	**48.1**	**3.9**	**6.3**	**36.7**
Settlement types						
Rural	**1.1**	**20.1**	70.1	**6.1**	**3.8**	**11.1**
Urban	**7.3**	**42.7**	48.1	**5.6**	**3.6**	**89.9**

Source: Own computation

Table 4. Expenditure Elasticity

PRODUCTS	COEFFICIENT	STANDARD ERROR
PMS	0.2361	0.0021
AGO	0.0241	0.069
DPK	-0.3125	0.0131
OTHER CONSUMPTION	0.3061	0.0121

Source: Own computation

Also, 10 percent increase in total expenditure brings about 0.2 percent increase in budget share for AGO. The total expenditure elasticity for DPK is -0.31 indicating that kerosene is a necessity. This implies households in Nigeria have larger proportional increases in demand for this product as their income rises. Table 5 contains the estimate own-and cross-price elasticities. The own-price as well as cross – price effects are well determined. All estimated own price elasticities are negative as they should be. The estimated own price elasticity of demand for PMS found to be -0.2110.

Table 5. Own –Price and Cross Price Elasticities

Products	PPMS	PAGO	PDPK	R^2 ADJUSTED
PMS	-0.2110 (0.0121)	-0.0091 (0.0034)	-0.0023 (0.0011)	0.21
AGO	0.0791 (0.0016)	-1.1214 (0.0211)	0.0621 (0.0124)	0.13
DPK	-0.0214 (0.0021)	0.0216 (0.0312)	-0.9093 (0.1201)	0.29

Source: Own computation

Specifically, 10 percent increase in price of PMS will bring about 2.1 percent decline in the quantity consume by the Nigerian household. This suggests that on efficiency ground, the subsidy on PMS should be reduced. The own price elasticities are large for diesel and kerosene, justified the removal of subsidy on AGO and high price of DPK caused a lot of substitution into these products.

Table 6 shows the efficiency effects of subsidy reduction on each of the petroleum products, distinguishing between the terms in the denominator of marginal social cost formula. The first column indicate subsidy factor (difference between world and domestic price), while the second column shows the own price elasticities of quantity and quality together. The products of the first and second

columns which is shown as the third column, gives own contribution of price distortion that would be caused by a marginal increase in price.

Table 6. Efficiency of petroleum products price reform in Nigeria

Commodities	$\frac{1}{1+si}$	$\frac{\varepsilon ii}{xi}-1$	Own effect
Agg. Petrol. Products	-1.32	-1.62	2.138
PMS	-1.89	-1.95	3.685
AGO	-1.61	-1.4	0.835
DPK	-1.74	-1.62	2.818

Sources: Own computation

As it can be seen from this table, the own effects of all energy products are large with the exception of DPK. The reduction or removal of energy subsidy on PMS would save the largest amount from government budget.

Table 7. Equity Effects of Petroleum Products pricing reforms in Nigeria ($\varepsilon = 0$)

Commodities	$\frac{\omega\varepsilon}{\omega}$	λ
Agg. Petrol. Products	1.00	0.21
PMS	1.00	0.10
AGO	1.00	0.01
DPK	1.00	0.31

Source: Own computation

The table 7 presents equity effects when coefficient of equality aversion is zero ($\varepsilon = 0$). That is, when there is no distribution concern, the marginal social cost of reducing subsidies on AGO is lowest. AGO has lowest marginal social cost among petroleum products. However, marginal social cost for all energy products are extremely low suggesting reduction of subsidies on all petroleum products.

The larger coefficient of inequality aversion attached larger value to the product often consumed by the poor and a relatively smaller value to those consumed by household that are better off. For $\varepsilon = 2$, the lower social cost of reduced government expenditure (or equivalent additional revenue) would come from removing subsidies on AGO followed by aggregate petroleum products price (table 8). Government will incur low social cost if prices of PMS and DPK were raised. It is advisable that subsidy on household kerosene and gasoline should be reduced.

Table 8. Presents situation of high inequality aversion

Commodities	$\frac{\omega\varepsilon}{\omega}$	λ
Agg. Petrol. Products	0.81	0.07
PMS	0.72	0.09
AGO	0.86	0.04
DPK	1.21	0.19

6. Conclusions

This paper examines welfare effects of energy reform particularly petroleum products pricing reform in Nigeria. The data for 5000 households were collected to estimate a demand system for PMS, AGO and DPK. The survey contains information on the occupation and income of the household members, as well as on household expenditure and consumption as well as on a wide range of demographic and socio-economic characteristics. The marginal social cost approach was adopted to

evaluate equity and efficiency of petroleum products pricing reform in Nigeria. The study concludes that reduction or removal of subsidy on PMS will save largest amount from government budget. Where there is distribution concern, the marginal social cost of reducing subsidies on AGO is lowest. AGO has lowest marginal social cost among petroleum products. This result is in support of the reform of removal of subsidies on AGO in 2006. However, marginal social cost for all petroleum products are extremely low suggesting reduction of subsidies on all petroleum products in Nigeria. To check the appropriateness of this approach and statistical validation of the estimates are the directions for further research.

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