



Estimating petroleum products demand elasticities in Nigeria: A multivariate cointegration approach

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ABSTRACT

This paper formulates and estimates petroleum products demand functions in Nigeria at both aggregate and product level for the period 1977 to 2006 using multivariate cointegration approach. The estimated short and long-run price and income elasticities confirm conventional wisdom that energy consumption responds positively to changes in GDP and negatively to changes in energy price. However, the price and income elasticities of demand varied according to product type. Kerosene and gasoline have relatively high short-run income and price elasticities compared to diesel. Overall, the results show petroleum products to be price and income inelastic.

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1. Introduction

Energy demand modelling has focused on improving our understanding of the size and dynamics of consumer responses to changes in relative energy prices and the level of economic activity since the price of oil quadrupled in the early 1970s (Bohi and Zimmerman, 1984; Gately, 1993; Dahl, 1994; Liu, 2004). Nevertheless, the quest for more accurate estimates of key energy demand parameters such as short and long-run price and income elasticities derives from three factors. First is their critical importance in the projection of future energy demand in particular, and energy market trends in general. Second is the role of these parameters in the design of policies for dealing with the negative environment externalities of the energy sector. Third is the fact that understanding energy demand dynamics through improved and more robust estimates of energy demand parameters is essential for more informed and successful energy policy decision making and implementation. Often times and for various reasons, unduly strong assumptions have been made in the estimation of these elasticities in many developing countries. The implications of these strong assumptions are hardly alluded to in

drawing conclusions from the estimated results. In many cases, the estimated models are likely to have produced spurious parameter results. Obviously, policies based on such parameters are more likely to result in wrong policy actions.

The key objective of this paper therefore is to model and estimate petroleum products demand dynamics in Nigeria based on a multivariate cointegration approach with the aim of deriving improved and more robust estimates of price and income elasticities. In the process, we investigate whether there is a long-run relationship between petroleum product demand and its primary determinants, price and income. In this empirical exploration we attempt to fill an important gap in the empirical literature on developing countries. This study is the first rigorous econometric study of Nigeria's energy demand function at the aggregated level and by energy type. Also the paper examines the time-series properties of the data series with a view to minimizing spurious regression results associated with a less rigorous econometric approach. The data for the study covers the period 1977 to 2006.³

The structure of the paper is as follows. In Section 2 we present some stylized facts about petroleum products and the Nigerian economy. Section 3 presents a brief review of the literature. Section 4 discusses the analytical framework on which the model is predicated while Section 5 discusses estimation issues. The main empirical

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³ The choice of the period was guided by data availability considerations.

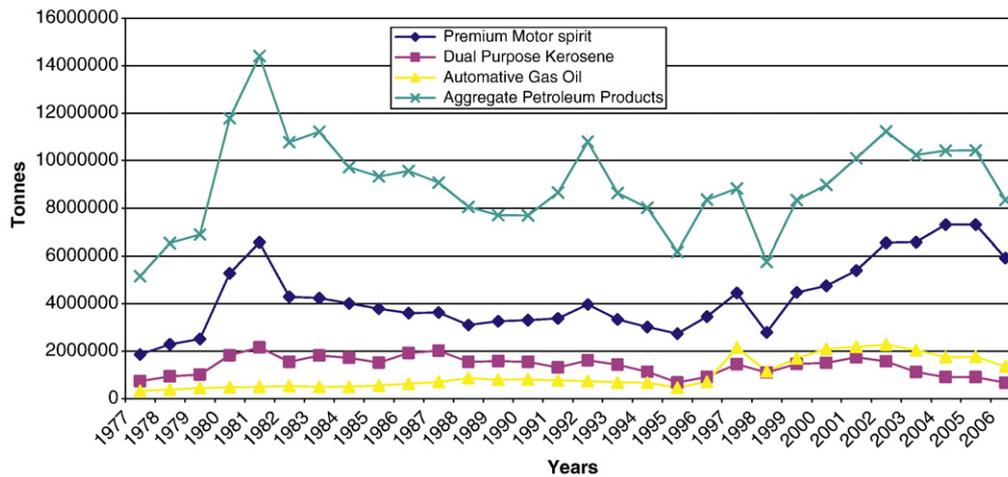


Fig. 1. Petroleum products consumption (1977–2006).

findings and their policy implications are discussed in Section 6. The conclusions and policy implications are presented in Section 7.

2. Petroleum and the economy in Nigeria: Stylized facts

Nigeria is the largest oil producer in Africa, the world's eighth largest exporter of crude oil and a member of the Organization of Petroleum Exporting Countries (OPEC). Several dimensions of the trends of petroleum product consumption and prices at both aggregative and disaggregative levels are worth noting. The development from 1977 to 1981 showed a rapid increase in aggregate products consumption (Fig. 1), increasing by 31.28% on the average. Between 1981 and up to 1985 the strong growth in the aggregate petroleum product demand began to slow down markedly. Notwithstanding the temporary reversal in 1986, the significance decline in consumption resurfaced again in 1987 and continued until 1990. However, there was demand recovery between 1990 and 1992. A fall in consumption was recorded again between 1993 and 1995 as well as in 1998 which could be largely attributed to the political situation in the country. However, between 1999 and 2002, aggregate product consumption was on the rise again and recorded an average growth of about 19.05%. The trend for the various groups of petroleum products was broadly similar to the aggregate demand pattern.

The price development over this period partly provides an answer to the consumption pattern observed above. Until recent times, the prices of oil products as well as energy products were repressed by the government to achieve certain national objectives. However, the emergence of persistent macroeconomic maladjustments and protracted economic downturn which culminated in the adoption of the structural adjustment programme (SAP) in 1986, resulted in a radical change in energy policy.⁴

Another explanation for the trend observed in consumption relates to developments in real per capita national income proxy by real GDP per capita. Per capita income (PCI) recorded negative mean growth rates of 4% between 1977 and 1981 and 3.23% between 1982 and 1985 (Fig. 4). For the adjustment period, the growth rate which was 1.63% declined by -0.86% . The income growth trend therefore seemed to have reinforced the price factor. Thus, the combination of declining

⁴ A major aspect of the energy policy reform was targeted at the elimination of subsidies on petroleum and other energy products. As a consequence, nominal petroleum product prices have risen sharply and more frequently since the onset of the SAP economic reforms. The year 1993 remains a major turning point when the price of petrol products witnessed astronomical increases. The price of petrol was increased from 70 kobo to N3.25 kobo (an increase of over 364%), kerosene was increased from 50 kobo to N2.75 kobo (an increase of 450%); while diesel was increased from 55 kobo to N3.00 kobo (an increase of 445%).

prices and rising income jointly account for the increasing trend in oil demand between 1977 and 1985, but the reverse in these two key determinants of demand seemed to have contributed to the adjustment in demand during the post-SAP period. However, in spite of the fall in per capita income, it seems that the effect of prices has dominated resulting in the overall positive growth in oil demand.

Another important development concerns the pattern to domestic petroleum demand in Nigeria. Gasoline continues to dominate the composition of total demand. Its share increased from 36.03% in 1977 to 50.51% in 1997 and 71.03% in 2006. The share of diesel also increased from 6.50% in 1977 to 10.51% in 1990 and 16.31% in 2006 (CBN, 2006).⁵ This development reflects the impact of rising prosperity of the oil boom period on the rapid acquisition of vehicles and private electric generators as back up in response to the epileptic power supply from the state-owned monopoly Power Holding Company of Nigeria (PHCN). The economic recession that set in after 1983 contributed to switching demand from largely new vehicles to imported used and old vehicles that are largely fuel inefficient. Kerosene on the other hand recorded a decline from 14.24% to 8.07% in 2006. This performance can be largely attributed to the rising profile of Liquefied Petroleum Gas (LPG) and electricity in domestic use. This is in line with the Engel's Law that consumers move away from inferior goods to high quality ones as the level of per capita income rises. Another possible explanation includes a substitution away from kerosene to traditional fuels like charcoal, fuelwood, sawdust due to sharp fall in real income among the lower class of consumers in the aftermath of SAP and the general unreliable supply of kerosene in the country.

3. Review of empirical literature

A diversity of approaches to the estimation of energy demand can be found in the literature, ranging from aggregative analysis of the relationship between energy demand, income and prices (Hunt and Manning, 1989; Gately and Streifel, 1997; Gately and Huntington, 2001; Liu, 2004), to more detailed disaggregated analysis (Baker et al., 1987; Baker and Blundell, 1991; Espey, 1996; De Vita et al., 2005) based on simultaneous model structure.

There is a paucity of research on energy demand in developing countries and only a few of the studies accounted for the time-series properties of the response of energy consumption to changes in income and relevant prices. In addition, most of the studies on energy demand functions have focused on Asia (Brenton, 1997; Pesaran et al.,

⁵ Authors' calculation from statistics obtained from CBN (2006) bulletin.

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