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Econometric estimation of the petroleum products consumption in Nigeria: Assessing the premise for biofuels adoption

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ABSTRACT

The promotion and adoption of biofuels in Nigeria must be predicated on sufficient capacity for absorbing biofuels produced from the increasing investments in biofuels plantations, plants and processing facilities. This paper assesses the socioeconomic and related premises for biofuels development in Nigeria by conducting an econometric estimation of the petroleum products consumption. The paper first estimates aggregated petroleum product consumption, and then assess the response to specific petroleum products in terms of consumption, market (population), electricity generation, installed electricity generation capacity, and GDP. The result shows that all the petroleum products contribute significantly and about equally to aggregate petroleum consumption. The high proportion of petrol (about 44 percent) as a percentage of the aggregate petroleum product consumption validates the push for implementing the E10 petrol-ethanol blending for Nigeria. The consumption of diesel is also significant. Diesel is another petroleum product for which D20 biofuel blending policy has been proposed. The increase in population and GDP, coupled with the poor electricity situation, will keep driving the consumption of petroleum products. As the population increases, and the country continues to struggle to match electricity generation with population growth, the petrol-ethanol and diesel-biodiesel blending policy must be pursued tenaciously to ensure a reduction in carbon emission in Nigeria.

1. Introduction

Nigeria is a petroleum-endowed country with myriad energy challenges. Though the country is among the top ten exporters of crude oil globally, with a vast natural gas reserve, it still faces several crises related to the consumption of petroleum products. The challenges include the scarcity in supply of refined products, dependence on imports, the huge yearly subsidy budget which has been spiraling out of control, and increasing pollution, along with other socioeconomic burdens. Nigeria continues to struggle with meeting the energy demands of its growing economy. Per capita energy consumption in Nigeria is among the lowest in the world — and even in Africa, considering population size and the global ranking of the economy. A World Bank [1] report estimated the annual total energy consumption per capita at 713.6 kg of oil equivalent, lagging behind that of South Africa and Libya with smaller populations. The evident low level of penetration of energy consumption goes along with the inability to meet the demand for petroleum products through local refining.

Burdened with these challenges, Nigeria joined other nations in promoting the adoption and utilization of biofuels. The country in 2007 commenced the implementation of the automotive biofuels development and adoption program. The biofuels program aims (among other goals) to reduce the import of refine petroleum products, conserve oil reserves, improve the agricultural and allied sectors, create a biofuels economy and stimulate overall economic growth [2–4]. The Nigerian biofuels development program is currently at the second phase, which encompasses the development of domestic capacity for meeting targets of 10% ethanol in gasoline blends and between 10% and 20% biodiesel (in petroleum diesel blends) [3,5].

During the first phase, involving the seeding of the biofuels market, Nigeria relied on Brazil as the main supplier of the bioethanol required for attaining the E10 blending target [2]. To facilitate the domestic production of ethanol and biodiesel, the Nigerian biofuels policy included a number of incentives to attract investors into the sector, such as import waivers, tax incentives, and guaranteed loans. To be economically viable, biofuels production

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must be related to the consumption capacity for gasoline, diesel and other petroleum products. Some of these products are consumed as complementary goods, while others are petroleum substitutes in the transport, energy, manufacturing, and processing sectors.

Entering into the second phase, the Nigerian biofuels program still seems to be struggling to fully takeoff [3,6]. While biofuels adoption and promotion represent a laudable step toward solving the many energy-related challenges facing Nigeria, the promotion of these new fuels must be based on a clear analysis/assessment of the existing demand for fossil fuels.

This paper attempts to estimate the consumption of petroleum products, including some of which blending targets have been set, through an econometric estimation based on historical data and trends of petroleum products consumption. The aim is to better understand the relationship between aggregate and individual petroleum products consumption, in the context of socio-economic and other factors. This paper assesses the empirical argument for promoting investment in both the upstream and downstream sectors of biofuels in Nigeria.

2. Petroleum consumption as a premise for biofuels adoption

Biofuels production, and particularly ethanol, is not a new technology. However, the promotion of these alternative fuels gained global momentum only after governmental interventions started to drive intensive development and adoption. Various countries have promoted biofuels by enacting a compulsory blending rate with gasoline or diesel, and regional bodies around the world have also promoted their use. In EU, the renewable energy directive of 2008, published by the European Commission, proposed a mandatory target of 20 percent EU energy from renewable sources [7]. Toke [8] hinted that the directive to adopt the 20 percent renewable energy (which also includes transport fuels) was driven by pressure from the renewable energy industry as well as the European Parliament. Sorda et al. [9] provided an overview of government policies from across the world which energized the promotion of biofuels. In the United States, the July 2010 Renewable Fuel standard (RFS2) replaced an earlier policy document, the Energy Independence and Security Act of 2007. In 2007, Nigeria drafted the Biofuels Policy and Incentive, designed to ensure the implementation of biofuels utilization in transport and other sectors.

Some national biofuels policies have been questioned, based on several arguments: biofuels impact the availability of crops meant for food; biofuels production are not profitable; they impact the environment negatively, yielding little or no benefit to curbing climate change, etc. [9–12]. Nevertheless, the promotion and utilization of these fuels continue to advance around the world.

The factors driving the development and promotion of biofuels as reliable alternatives to petroleum products vary, but they include economic, ecological, and social drivers. Not every country faces the same energy challenge, particularly in relation to the supply and consumption of petroleum products. While some of the key challenges are global in nature, including pollution and emission of greenhouse gases (GHGs), each country also has specific challenges that give impetus to their biofuels policies, laws and regulations. However, there is an overarching theme — a global challenge regarding the supply and utilization of fossil fuels. The most fundamental case for biofuels adoption is the fact that fossil fuel resources are finite, with limited recovery time frame, even when the cost of petroleum prospecting is decreasing. By the current estimate of the World Energy Council [13], global petroleum reserves stand at 223,454 metric tons of crude oil, with an overall R/P ratio of barely 56 years.

Nigeria is a petroleum resource-rich nation with recoverable crude oil and natural gas deposits of about 37,200 million barrels and an R/P ratio of 42 years [13]. However, such huge petroleum resources do not translate into availability, affordability, and accessibility of refined petroleum products to meet the criteria for Nigerian energy security. Due to the poor performance of its four refineries [14], Nigeria relies on import for much of the refined petroleum products consumed in the country. The need to solve the challenge of energy security led to the drafting of the Nigeria automotive biofuel program, which later resulted in the Nigerian Biofuel Policy and Incentives. Nigeria is pursuing biofuel development and adoption as a means of solving the energy crisis, boosting its agricultural sector, and addressing its socio-economic challenges [4]. Adopting biofuels may also allow Nigeria to pursue green economic growth.

3. Review of historical consumption trends for the various petroleum products

Nigeria is a major exporter of crude oil and a minor consumer of refined petroleum products. From the available historical data, it is clear that consumption of petroleum products has not matched the pace of population growth, in spite of the relevant economic goals and policies of administrations over the last five decades. A series of development plans, agendas, and programs have been put in place, designed to open up the economy and increase the consumption of key petroleum products, targeted particularly to those whose limited consumption reflects substandard living conditions. Since 1960, when data on energy consumption started being recorded for Nigeria, the consumption of petroleum products such as liquid petroleum gas (LPG) has remained very low; a high proportion of the population depends on primary biomass, such as fuel wood, charcoal, agricultural waste, and even dung, for cooking, lighting, and food processing [5].

The consumption of petroleum products varies from state to state across Nigeria. While Lagos, Oyo, Ogun, Kaduna, Edo, Rivers, Delta, Kano, Abuja, and Imo have been leading consumers of gasoline [15], other states with limited commercial activities still have very low consumption. Low penetration and variable consumption apply to virtually all petroleum products. Kerosene and LNG, which ought to be basic household commodities, still record very low consumption in most states, where the alternative primary energy options are preferred and more affordable.

The historical trends for petroleum products consumption in Nigeria are shown in Fig. 1. The products include kerosene, diesel, motor gasoline (petrol), jet-fuel (aviation fuel), liquid petroleum gas (LPG), residual fuel oil (heavy oils), and other refined petroleum products. Total petroleum products consumption increased over the two decades, with drops in 1987, 1990, and 1998. From 2001 to 2004, the country experienced an average drop of 3.73% in total petroleum product consumption.

Iwayemi et al. [16] posited that the trend in total petroleum product consumption can be explained in terms of real per capita national income (PCI) as well as the introduction of the structural adjustment program (SAP) in 1986. However, GDP (a proxy for PCI) only shows a drop in 1987, and not in other years when aggregated petroleum products consumption show negative growth. The historical data for prices of petroleum products over the period also indicate that the change in prices of key petroleum products (gasoline, distillate, and kerosene) did not correspond with the drop in consumption. These periodic drops in consumption can be explained by the supply constraints as the nation increasingly depended on import of refined products as the local refining capacity declined [14]. The increasing dependence on import of refined products leads to occasional supply chain and