National Oil Industries and Economic Development: Transnational Econometrics Studies and Proposals for its Applications in Africa's Largest Economy/Oil Producing Country (Nigeria)

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Abstract

Nigeria's oil industry has been criticized for failing to adequately apply petroleum economics for understanding how to optimize the benefits that could accrue from the natural resource as well as minimize the constraints associate with it. Therefore, it is easy to reckon that such a failure would naturally be extended or applicable to the adoption of econometrics, which is an aspect of economics, itself the major discipline that makes up petroleum economics. The objective of this article is to examine applications of econometrics in Nigeria's oil industry. We review econometrics applications in the global oil industry to understand the extent to which the subfield has been valuable to the industry as a means of projecting how econometrics could be applied in specific aspects of Nigeria's oil industry, in particular. We find that econometrics applications in Nigeria's oil industry have been as scanty and rudimentary as has been petroleum economics, its wider field. We point out some of the many and nearly unlimited areas that the sub-field could be adopted to increase understanding of several aspects of Nigeria's oil industry.

Keywords: Nigeria, oil industry, econometrics, applications, petroleum, economics, projections

Introduction

The significance of petroleum oil to the Nigerian state, government and people could be best appreciated by considering the derogatory description of country's economic management culture as befitting petro-capitalism.

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The latter refers to a variation of what is known as the resource curse thesis, economic systems whereby a disproportionately large share of the national economy revolves around petroleum oil, its distribution, trade, earnings and management of the latter (Castree, Kitchin, Rogers, 2013). Similar characteristic dependence on other forms of natural resources are discussed under the "resource curse" thesis [1]. This is especially true of cases when such happen in abundance in many (not all cases) have tended to blunt capacities of the leaders and rulers of the state involved are non-democratic systems to apply prudent resource management skills to cost-effectively apply human resources (human capital) to harness the natural resources for improving social welfare. In Nigeria's case, petro-capitalism describes the state's over-reliance on petroleum oil and little else (agriculture, tourism, among other sources/sectors) matter except that most operations (in the political, economic, cultural, among other spheres of the life of the state/nation afflicted by the malaise –for that is what it really means- are undertaken under poor governance and justice systems, corruptly, inefficiently, and ineffectively.

Therefore, socio-economic and political sectors of the state and its people is adversely affected because disorder, despair, and frequently, dissenting views and movements are common. While not as much details of Nigeria's version of petro-capitalism has been documented apart from its listing together with that variety of petro-capitalism that conspicuously characterized that *Shar* of Iran in the 1970s (Gregory *et al.*, 2009), the Nigerian scenario could be discerned from a convergence of evidence matching the outlines of adversities painted in the foregoing. As already stated, a major feature of Nigeria's petro-capitalism expresses in over-reliance of the country's governments (federal, 36 states, federal capital territory mayoralty in Abuja, and 774 local governments/councils) on revenue earned from export of crude oil. The latter is over 90 per cent of the total revenue, as has been reported, such that revenue from other sectors has been much lower compared to the contribution from oil, and more recently natural gas. Thus, advocacy for diversification of the economy, away from oil-dependence has been vigorous since the 1970s, without evidence that considerable changes have occurred in that direction of increasing earnings from other sources.

Apart from the over-dependence of Nigeria's governments on oil/natural gas, overall planning including application of econometrics, petroleum economics, management skills/knowledge, among other tools usually employed for cost-effective decision making and management, have been mediocre in the same oil sector, irrespective of its significance to the national economy.

Objectives and Organisation

The general objective of this article is to highlight the potential and current value of econometrics to Nigeria's oil industry. In the rest of this article, we present materials relevant to the achievement of the specific objectives of this study. We begin by framing the study on suitable theoretical perspectives capable of enhancing understanding of the title and subject matters. We follow on by presenting a brief on Nigeria's oil sector and challenges that it has been facing. Afterwards, we review the literature focusing on transnational studies of econometrics in the global oil sectors of other countries outside Nigeria. Then drawing from the foregoing, we draw ideas on how some correlative links could be made in terms of the extent to which such studies could be replicated creatively or adaptively to similar challenges or situations in Nigeria's oil sector. Then we conclude by summarizing the main points of the study and recommend next steps for econometrics applications in Nigeria's oil sector.
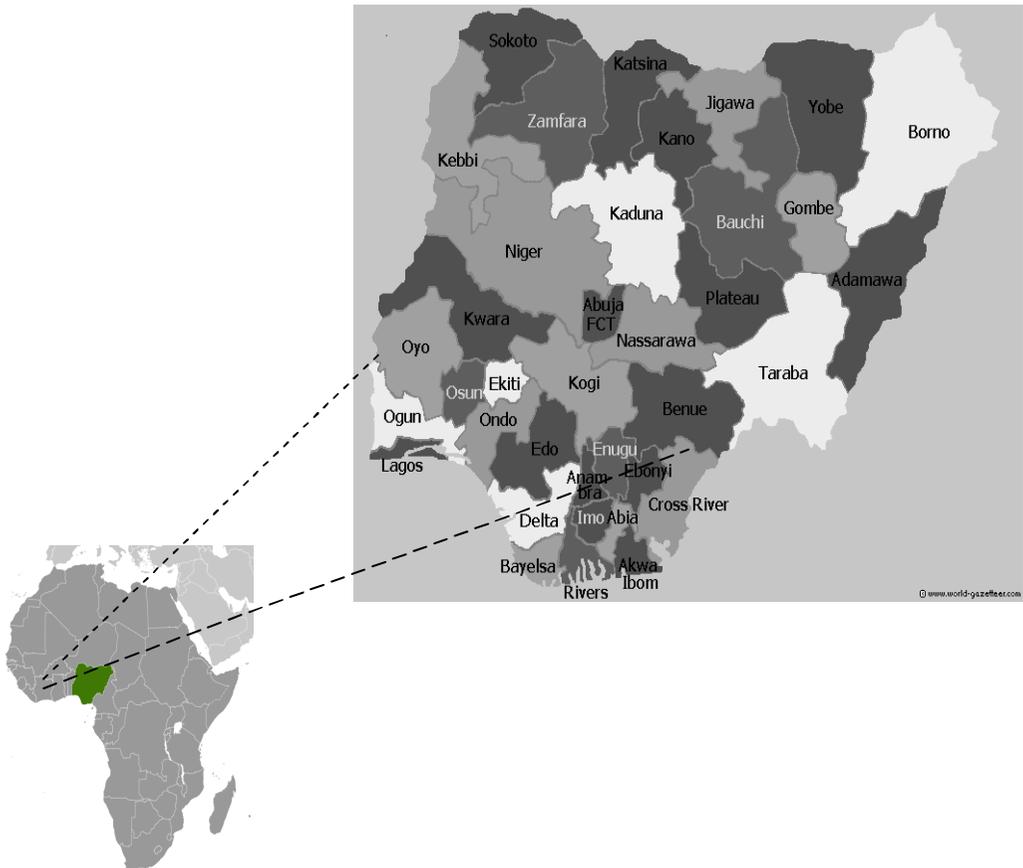
Methodology: Methods, Data, Data Sources

The hypothetico-deductive scientific methodology, accepted by the universal scientific community, was used for this study.

Descriptive Case Study Method

We used the method of description for implementing this study. Documentation by previous workers shows that this method is suitable for investigating issues focusing on relatively unpopular matters. The use of econometrics for investigating aspects of the oil industries of the economies of Developing Countries (DCs), especially those of Africa's largest economy (Nigeria)'s oil industry, could be classified under this category.

In our quest for understanding the relationship between oil industries, consumption, among other aspects of the national economies of Developing Countries, DCs, generally and of Africa, as a component of the former, we are only beginning to explore the value that econometrics, as one of many methods, could add our proposal to apply econometrics to Nigeria's economic growth from the perspective of fossil fuel consumption, as a component of a larger community represents a case study. This represents a combination of description and case study, thus described as descriptive case study method or approach.

Figure 1: Nigeria's 36 states and Federal Capital Territory projected from Africa

Sources: (1) http://www.worldofcultures.org/1024/africa/AfricaMaps/nigeria.gif; (2) http://www.world-gazatteer.com.

The methods of descriptive case studies emphasize the introduction of new issues deserving the attention of the academic community and minimal demands for sophisticated quantification, except for some rudimentary statistical (averaging tools), description has served creditably for purposes of the kind undertaken presently. Therefore, our adoption of the case study approach is justified (Ogunniyi 1992).

Data

We gathered data from a combination of primary and secondary sources. Data was obtained through desk research and/or review of the literature on applications of econometrics in the global oil industries of nations, as a means of clarifying the situation of oil industry and economic growth in Nigeria.

Background on Nigeria's Economy, Oil and Gas

Recent estimates of Nigeria's proved petroleum (oil) reserve was put at 37.2 billion barrels of oil in -as at January 2012 (Iledare, 2013), rising from a low point at the time of initiation of the industry of 0.184 billion in 1958. This was when the first oil shipment of oil out of the country was undertaken (Dosunmu, 2013: 23). The estimate of Nigeria's oil in the mid-2000s to have been 4,635 million metric tons of oil equivalent *(mtoe)* of petroleum oil, was put at nearly half of the total reserves in all of the world's low-income states. Ruefully, despite that immensity of oil wealth, it was lamented that the country remained in the poorest 10% of all countries in terms of GDI per capita (Resources for the Future, 2003). More recent rankings place Nigeria as the sixth largest oil exporter in the Organisation of Oil Exporting Countries, OPEC, and eleventh largest worldwide. It is worth mentioning briefly the size of a closely associated fossil fuel natural gas, which frequently occurs in association with oil. With a proven **natural gas** reserve increasing from 2,260 billion cubic feet in 1958 to 187 trillion cubic feet in 2013, Nigeria's position was 10th worldwide (Dosunmu, 2013: 23; Heritage Foundation, no year/date).

Nigeria's oil industry has, from inception up to the present, been dominated by international oil companies (IOCs), which control disproportionately large shares of the world's oil reserves and wealth for their profit making purposes and associated lust for amassing and applying structural power frequently involving the subversion of policies of governments of sovereign states including those of Nigeria's at the federal, states and local levels. The dynamics of structure of operation or share ownership of Nigeria's oil industry by IOCs is interesting. Although, Nigeria's Government own all petroleum, like other minerals, the recent Joint Venture agreement comprises Nigeria's Federal Government (NNPC) (55%), Shell Petroleum Development Company of Nigeria, SPDC (30%), TotalFinaElf (10%), and Agip (5%).

The accurate information on how much oil is currently controlled by other IOCs (ExxonMobil, Chevron) is not available (Human Rights Watch, 1999). In the 1989 Fifth participation agreement for Nigeria's oil industry operation had the following proportions, in per cent stood: Nigerian National Petroleum Company (NNPC) (60), representing the Federal Republic of Nigeria, while the IOCs' were awarded as follows; SPDC (30), Elf (5), and Agip (5). In the same year came on stream Elf's Obudu blend, offshore OML 100 (Dosunmu, 2013: 58).

Recently, Nigeria's oil industry has been experiencing divestment of the oil Majors from onshore operational fields towards oil deposits located in offshore in phenomenal ways that public analysts' fears have had to be allayed by government and experts who claim that there is no cause for exercising fears since the latter investments have been increasing steadily (The Guardian, 2014). Recent rankings place Nigeria as the sixth largest oil exporter in OPEC fold, 11th worldwide.

Oil production reached one of its highest points over its history of over 50-year history when it reached 2,523, 000 barrels/day, in 2010, rising from 2,087, 000 barrels/day), in 2002 (BP, 2013). Proven reserves ('000 MBPD), at years end, were: 21.0 (1992), 34.3 (2002), 37.2 (2012, being 2.2% share of the total (BP, 2013). From the 1980s to early 2010s, dictators abandoned the state-owned oil refining enterprises located in the south-central city of Port Harcourt (two plants), one in the other south-central city (Warri), and another in the north-central city of Kaduna. It was only in the early 2010s that the pioneer Niger Delta-native, President Goodluck Jonathan, undertook to resuscitate the ailing refineries. Nigeria's national oil company reports that the country's reserve-production ratio (R/P) has increased from 17:9 (1961) to 25:7 in 1997 (NNPC, no year/date).

However, with about 184.7 million cubic feet of natural gas, only a fewer countries of the world can compete with Nigeria if its economic managers had applied superior resource (including petroleum oil, natural gas) economics and management skills to take aims at optimizing the use –including domestic and foreign consumption- of this alternative but related fossil fuel. Exploration of natural gas deposits in the country has never been seriously undertaken. Rather than embarking on surveys aiming towards discovering the commercial viability of the fuels deposits, available knowledge of gas remains rudimentary, obtained through accidents arising from its association with oil during explorations designed specially to find the latter.

Most uses of oil extracted in Nigeria, in form of crude, has been exported due to the failure of the country's refineries. In early 2000s, Nigeria's oil export rose from 2.2 million barrels/day (MBPD) while refining capacity, of state-owned-refining enterprises, supported only 44,500 MBPD (Kennedy-Darling, *et al.*, 2008: 7; Nigeria, 2003). Nigeria's energy consumption was 8,771,863 *toe* (i.e. 180,000 BPD) in 1985 (CBN, 1985). Of this amount of energy consumed, oil constituted a substantial proportion of the total. Energy consumption dynamics has been experienced in Nigeria afterwards ??. This involved ???

Challenges Faced by Nigeria's Oil Sector

A major challenge facing Nigeria's oil industry concerns dwindling exploration aimed at increasing reserves. A comparison among oil producing/exporting countries shows that Nigeria's proven oil reserves have not increased at paces achieved by its counterparts, even among African states such as Angola. While, it might be trues, as government claims that oil majors' divestment offshore ensures that Nigeria's oil production levels remains stable, in future, fears have been expressed by monitors of the country's oil industry concerning the declining reserves over the years.

Econometrics Defined

The history of econometrics has been traced to the work of R. Frish in the second decade of the Twentieth Century, specifically in 1926. The theme of this sub-field of economics was the application of rigorous quantitative analyses to focusing on increasing understanding of real life challenges and phenomena.

This variety of mathematisation of real life economic problems frequently involves deployment of linear algebra, among other aspects of mathematics such as statistics, probability theory, and general analyses (Frish, 2014: 1168). Environmental and natural resource economist, C-Y Lin suggests that econometrics comprises techniques and tools that facilitate confrontation among two major dimensions of myriad challenges. The first challenge is statistics, especially those posed by profusion and complication represented by barrages of data. The second pertains to problems arising from efforts related to proper identification of difficulties in the nexus using data analyses for empirically validating theoretical perspectives espoused for enhancing understanding (Lin, 2011; Manski, 1995).

The invention of econometrics could be related to one concern by economists. The employment of suitable quantitative analytical tools namely simultaneous equation by economists was driven by their quest to elucidate on the characteristics of competitive markets through estimation and identification of variables involved (Lin, 2011).

Challenges Associated with Econometrics

Apart from challenges arising from the sub-field's newness include scarcity of textbooks (currently estimated at only 40 published as at 2014), they remain characterized by diversification of content and style while manuals or guidebooks for exercises are virtually absent. Scholars involved in its practice or applications acknowledge that it (like the associated quantitative analytical techniques of statistics) frequently borrowed to extend its boundaries has been encumbered by complicated calculations that beckon for the deployment of electronic computers and software packages. To resolve these problems, two suggestions have been proposed to econometrics students in terms of skills that they need to obtain. The first concerns rapid selection of the most appropriate, from a set of formulae and alternative data set. The second relates to the making of appropriate economic forecasts and conclusions (Kapustina, Popyrin, Savina, 2014: 1168).

Applications of Econometrics in General Situations

We shall discuss this following the different purposes that the sub-field and method has been used. Since we are interested in econometric applications in the oil industry here, we shall distinguish applications in the oil industry from others (i.e. non-oil industry) uses of it.

Major Questions that Use of Econometrics Has Emphasized

It has been suggested that some empirical studies that have applied econometrics have involved drawing from observations of equilibrium prices and quantities to make inferences on demand and supply in the market (Manski, 1995).

Modeling and/or Estimation

Modeling (involving estimation) the basic economic scenarios such as static competitive markets presenting transactions on commodities. Some examples of such econometric studies include: demand and supply of fish (Angrist, Graddy, Imbens, 2000) in an empirical analysis of daily labour supply of stadium vendors (Oettinger, 1999).

Oil industry Applications of Econometrics

Worried about the failure to (or mediocre scenario) of accurate modeling and explanation of historical data and prediction of the future regarding economic situations, an environmental and energy economist employed econometrics involving estimation of supply and demand in the world oil market (Lin, 2011).

Econometrics Application for Modeling National Economic Management (Including Planning)

Tara P. Bhusal (2010), supported Nepalese national economic management (including planning) tasks by applying econometrics for modelling oil consumption variables and economic growth. This involved testing the ECM model for examining causality between oil consumption and economic growth (represented by Gross Domestic Product (GDP)) in Nepal. It applied regression and co-integration tests for examining i.e. processing annual time series, long-run and short-run data (covering 1975-2009) based on the same order of integration. It is worth mentioning that prior to testing causality, two tests were conducted to examine unit roots and co-integration. These included the ADF test and the Johansen Maximum Likelihood test.

Philosophy for Econometrics of Oil and National/Regional Economic Growth Analysis

An important philosophical bases of this study was the thinking that for Nepal –an example of many Developing Countries exhibiting low domestic energy prices due to oil subsidy[2], which is frequently generous, the resulting challenge of inefficient oil usage (a.k.a. high oil intensity) in various end-user activities (manufacturing/industries, transportation, among others).

The quest to improve oil-use efficiency policy-making aiming towards resolving this problem beckons for the examination of direction of causality between energy consumption and economic growth. In an earlier study (Mehrara, 2007: 2940), an example of the use of the Granger causality test of directionality and inference, similar to that considered by Bhusal (2010) was illustrated as follows. It supposed that should unidirectional Granger causality run from income to energy, it would be inferred/implied that policies promoting (and concentrating on) energy conservation [3] result in negligible adverse effects on economic growth. In contrast, the implication of unidirectional causality run from energy consumption to income would be that policies aimed at reducing energy consumption[4] are capable of causing reduction in employment and income. This study's estimation result indicated that bi-directional short-run causality existed between oil consumption and economic growth bi-directional long-run causality existed between economic growth and oil consumption. It concluded that being an important factor in economic activities, reduction in oil supply and consumption was capable of causing declines in both industrial manufacturing, among other economic activities, as well as, employment (Bhusal, 2010).

Econometrics in Volatility in Fossil-Fuel Prices Futures in USA

Economists and finance specialist, Robert S. Pindyk, applied econometrics to analyse data on the volatility in the prices of crude-oil and natural gas futures in the USA covering 2 May 1990 through 26 February 2003 (Pindyk, 2004).

Kathleen King, Ai Deng and David Metz have also employed econometrics to analyse the impact of key factors on crude oil prices over four years (2006 - 2009) but concentrating on the two-year period (2007 -2008) when crude oil prices rose to over US$ 145. This analysis involved examination, separately, of individual factors (events) that were held responsible for determining day-to-day crude-oil price dynamics.

The latter study incorporated contributions made to crude-oil price dynamics arising from financial trading, physical supply factors and demand factors (represented by two key indicators of them covering decisions made by OPEC capable of influencing longer-term crude-oil price trends). Although the details of the study clarify the transparency of the factors considered, space constraints forbid their elaboration here (King, Deng and Metz, 2011).

Proposing Some Applications of Econometrics to Nigeria's oil Industry from Reviews of Transnational Cases

From the trans-national case studies reviewed in the foregoing, some proposals could be made for investigations of Nigeria's oil industry using the methods of econometrics. For example, drawing from Bhusal's study of national economic management in Nepal, a research concentrating on modeling the relationship between oil consumption (including oil subsidy) and economic growth (also represented by GDP) in Nigeria could be proposed as urgent and imperative for understanding these issues in Africa's largest economy.

There are many other areas of Nigeria's oil industry that econometrics could be applied. A few of such aspects, already reviewed in this article include the following. As was reported of the work of energy economist employing econometrics for estimating supply and demand in the world oil market (Lin, 2011), the current poor understanding of the nature, magnitude of supply and demand of oil in Nigeria over many decades beckon for both estimation as well as historical analyses.

There is scope for adapting Robert S. Pindyk's application of econometrics to analyzing data on the volatility in the prices of crude-oil and natural gas futures between May 1990 and 26 February 2003 in the USA (Pindyk, 2004) for studying similar variables in Nigeria's oil industry. We can also draw from the foregoing review of the employment of econometrics for analyzing the impact of key factors on crude oil prices over four years (2006 - 2009) but concentrating on the two-year period (2007 -2008) when crude oil prices rose to over US$ 145, to propose econometrics of Nigeria's oil industry. In so doing, we note that the analysis referred to, involved examination, separately, of individual factors (events) that were held responsible for determining day-to-day crude-oil price dynamics.

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Without repeating ourselves, econometric analyses adapting from the foregoing study could focus on variables of Nigeria's oil industry.

Conclusion

This study has involved a review of transnational cases of applications of econometrics, a quantitative analyses-intensive sub-field of economics, for understanding the relationship between national oil industries and oil consumption. While such investigations have been conducted for other countries e.g. Nepal, among others, how such relationships exist or do not in Africa's largest economy (Nigeria) remains, by and large, poorly understood.

We acknowledge the valuable insights offered by results obtained from applications of econometrics in examinations of relationships between oil consumption and economic growth at global scales including case studies of Nepal, among others. Therefore, we propose that to better understand relationships among the national oil industry and economic growth in Nigeria, econometrics promises to facilitate such clarifications. Consequently, we recommend that rigorous econometric analyses be undertaken by scholars concerned with national economies exhibiting considerable characteristics of substantial consumption of oil as input for national economic activities (industrial manufacturing, agriculture, tourism, among others).

Limitations of this Study

We have conveniently concentrated on a brief review of transnational cases of econometrics applications in some countries to propose applications of the sub-field to Nigeria's oil industry. This does not suggest, in any way, that other applications of econometrics to the country's oil industry are either excluded or impossible. It is possible to undertake various sorts of research projects using econometrics as the generic approach of analysis.

Other Viable Investigations Requiring Econometrics

The research-derived information describing trends in the relationship between gross domestic product (GDP) growth rate declines over a bracket of between 0.05 to 0.1 per cent for each 10 per cent increase in oil price (Dosunmu, 2013: 12) could be modeled.

This could be tested by gathering and processing data concerning Nigeria. This project could be justified by several factors including the series of increases in the pump-price of oil as well as the steady decline in standard of living of Nigerians over the decades since the 1980s. As usual, this research should involve definition and clarification of various terms associated with the variables.

Acknowledgement

Notes

1. Resource curse thesis is concerned about the observation that many countries that are well endowed with natural resources through poor management, corruption, ineptitude, among other combination of factors, present weak economic conditions compared to their resource-poor counterparts.
2. Oil subsidy is a policy implemented in numerous countries where governments have been striving towards facilitating the availability of oil as a valuable input for productive activities.
3. Policies promoting energy conservation typically strive towards limiting energy consumption in the country or region where policy is applied. Two of them include total phasing out of subsidies or reducing them, and energy price distortion elimination policies.
4. Some examples of policies taking aim at reducing energy consumption are those that strive to align energy prices with those (prices) of the market.

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