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The Political Economy of Petrodollars in a Mono-product Economy (September 2006)

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Abstract *- Nigeria is a mono product economy because oil accounts for over 95 percent its export earnings. About 70 percent of government revenue is derived from oil and over 90 percent of new investments are associated with oil. The current evidence is that the Nigerian economy goes through a boom-and-burst as a result of variability in the price of oil. The policy makers in Nigeria have been accused of mismanagement and incompetence. Anifowose (1995) notes that foreign exchange budgeting is based on a crude linear extrapolation of OPEC's benchmark price for oil. The results in this paper reject the presence of linearity in oil price generating process. Therefore, policy makers need to devise a more sophisticated nonlinear forecasting mechanism in planning for economic growth and development.*

1. INTRODUCTION

A general description of the performance of oil exporters relative to resource-poor nations of the world is captured by the phrase, "paradox of plenty" Eifert et al. [9]. Many oil exporters are said to have performed worse than several resource-poor nations of the world. The capacity to engineer growth in these oil-rich nations has been hampered by the debilitating effect of volatility in export earnings [3]. There is no doubt that Nigeria has been negatively impacted by the fluctuations in its revenue from oil. In a previous attempt, Ayadi et al. [7], model the interrelationship among a variety of macroeconomic variables representing the financial as well as the energy sectors of the Nigerian economy. The results reveal that the energy sector exerts a significant influence on the Nigerian economy by acting as a prime mover.

The Nigerian economy is dominated by the public sector and the bulk of the aggregate output is accounted for by exports and government expenditures [5]. While analyzing the practice of foreign exchange budgeting in Nigeria, Anifowose [4] notes that the size of the budget depends crucially on expectations of crude oil production and price. The reason is that about 90 percent of Nigeria's export earnings are from the sale of petroleum. Given that Nigeria is a member of OPEC, its production output of petroleum is exogenous, because it is based on allocation to her by the OPEC cartel. Therefore, the reliability of Nigeria's revenue projection depends heavily on the ability of economic managers to project the price of oil. Anifowose [4] reports that oil price projection is made by a linear extrapolation of the OPEC benchmark price.

In a recent presentation, Okonjo-Iweala [19], the current minister of finance in Nigeria, posits that Nigeria goes through fiscal recklessness when oil price rises. She notes that past administrations in the country implement loose fiscal policy with its attendant flawed pattern of borrowing. The debt management strategies are classified as archaic and coupled with its fiscal policy, the economy goes through unnecessary boom-and-burst cycles. Moreover, Obadan [17] notes that the Nigerian foreign exchange management is, seriously flawed. The author concludes that exchange rate management is predicated on methods that fail to achieve desired goals. Shortly after Nigeria achieved independence, Wolfgang Stolper served as the head Nigeria's Economic Planning Unit and observed that the process of planning was undertaken without much data [23]. Adedipe [1] and Ayadi [6] document the failure of the Nigerian government to balance its budgets for several years. All these represent anecdotal evidence that Nigeria's planning apparatus is defective.

In order to begin a program of effective planning for economic development in Nigeria, there is need to understand the data generating process for the oil price series. Traditionally, most economic time series are modeled under the assumption of Gaussian distribution and linear random walks. Beginning with the work of Mandelbrot [15], it is now proven that several of these time series are non-linear. Therefore, the objective of this paper is to examine whether or not the oil price generating process contains linearity. The presence of nonlinear dynamics in Nigeria's oil price series becomes a useful tool in the search for a forecast model in planning for growth and development.

2. OIL AND THE NIGERIAN ECONOMY

Nigeria achieved independence from Britain in 1960, a time when oil had little or no role in management of the Nigerian macro-economy. Ayadi et al. [7] report that the discovery of oil in commercial quantities in Oloibiri, Nigeria's Niger Delta, occurred in 1956 but production did not start until 1958. Table 1, shows the relative significance of oil to the economy. In the early years of oil discovery, Madujibeya [14] catalogs its contributions to the Nigerian economy. These include employment opportunities, source of government revenues, supply of energy to industry,

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household and commerce, source of growth in GDP, and a source of foreign exchange reserves.

A cursory view of Table 1 shows that the relative significance of manufacturing increased from 4.8 percent in 1960 to 8.2 percent in 1990. However, in 2000 and 2002, this sector of the economy had taken a big hit. As for the petroleum sector, its relative significance had dominated the other sectors especially since 2000. Therefore, while the petroleum sector grew in importance over time, the industrial sector did not experience much growth.

The country became a member of the Organization of Petroleum Exporting Countries (OPEC) in 1971. In 2003, it was the fifth largest supplier of crude oil to the United States. It is the seventh largest producer of oil in the world. The economy of Nigeria is heavily dependent on oil because it accounts for over 90 percent of export revenues and over 90 percent of foreign exchange earnings. Over 80 percent of government revenue comes from this source. In 2003, Nigeria produced an average of 2.1 million barrels of oil per day. However, in 2004, OPEC raised Nigeria's production quota to 2.14 million barrels per day.

Table 1. Sectoral Contribution to Gross Domestic Product in Nigeria, 1960 – 2002

Year	Agriculture %	Manufacturing %	Crude Oil %	Others %
1960	64.1	4.8	0.3	30.0
1970	47.6	8.2	7.1	37.1
1980	30.8	8.1	22.0	39.1
1990	39.0	8.2	12.8	40.0
2000	35.7	3.4	47.5	13.4
2002	28.4	5.5	40.6	25.6

Source: Adedipe (2004), [1].

According to Soremekun and Obi [22], since the time of discovery, oil has become inextricably linked with the national question. The U.S. Department of Energy estimates Nigeria's current proven oil reserves at 25 to 35.2 billion barrels. There are about 200 known oil fields whose reserves have not been ascertained. Nigeria exports Bonny Light and Forcados, which are sweet because of their low sulfur content.

It is ironic that the discovery of oil in Nigeria has not been associated with economic development. Soremekun and Obi [22] note that the emergence of oil as a mono-cultural base of the Nigerian economy has magnified the country's economic contradictions. The total impact of these contradictions is the "near permanent situation of national crisis," in which the nationalities of some parts of the country nurture feelings stymied by the other parts and thus are in search of reparation. Ross [21] also notes that the discovery of oil in Nigeria had neither raised Nigerian income nor reduced poverty. According to Ross [21], between 1970 and 1999, oil generated about $231 billion in rents for the Nigerian economy when valued in constant 1999 dollars. Relative to GDP, rents from oil accounts for between 21 percent and 48 percent of GDP since 1974. At the same time, per capita income in Nigeria has been declining at a rate of about 4 percent per year.

In the same sentiment, Forrest [10] observes that the large windfall from oil had a number of unforeseen and unintended consequences. These include the power of government to bypass taxpayers in expending funds on unproductive "white elephant" projects. Moreover, there is a lack of public accountability in governance, neglect of non-oil tax revenue, an unnecessary expansion of state resources and a loss of control and discipline by those in positions of authority.

Aiyegoro [2] enumerates the outcomes associated with oil discovery in Nigeria to include over-bloated public sector, ambitious public projects, depreciating currency, badly implemented price and wage control, and the distortion of financial markets through bad public policy. Omotoye [20] and Ojo and Ayadi [18] support this viewpoint by also noting that the demise of agricultural sector is associated with oil discovery in Nigeria.

Table 2. Five Most Oil-Dependent Countries of the World in 2000

Country	Fuel Export as a Percentage of Total Exports
Nigeria	99.6
Algeria	97.2
Saudi Arabia	92.1
Iran	88.5
Venezuela	86.1

Source: Ross (2003), [21].

Table 2 shows that Nigeria is the most oil-dependent country in the world in 2000. According to Ross [21], the volatility in the oil sector will lead to volatility in government revenues as the dependence on oil increases. This situation in significant, because the revenue generated by positive shocks, are usually squandered, thereby producing unhealthy rates of expansion in the size of the government. Moreover, Ross notes that positive shocks lead to a decline in the quality of public investments. These observations are consistent with those of Okonjo-Iweala [19].

It is important for a country to experience a growth in investment. However, it is harmful for the quality of investment of fall. What Ross reports in his study of Nigeria is that the government relaxes its standards for selecting investment projects when it experiences an increase in oil revenue. This happens because of the desire to speed up economic growth or the pressure from rent-seeking politicians. Consequently, the desire to increase the quantity of investments had led to a decline in economic development. Therefore, it is imperative that government needs to institute a mechanism for planning and projecting oil windfalls. The starting point for such an effort is to identify the nature of the probability distribution of oil price series.

3. METHODOLOGY

The data employed in this study is the weekly price of Nigeria's reference crude oil, the Bonny Light as reported by the United States Department of Energy from January 1997 through December 2004. In order to test for the presence on nonlinearity in oil price series, the autocorrelation and partial autocorrelation functions are analyzed using the Box-Pierce Q statistics [24]. The next approach is to employ the BDS test.

According to LeBaron [13], the BDS statistic is one of the key nonlinear diagnostics in the econometric literature because it has good power against many nonlinear alternatives. The BDS is a version of a statistical method of correlation dimension test for randomness against the general alternative of dependence in a series [16]. It is based on the concept of correlation integral used by Grassberger and Procaccia (1983) in tests of chaos and nonlinearity. Grabbe [11] gives an intuitive analysis of correlation dimension and correlation integral. Assume we have the time series of oil prices as $x_1, x_2, \ldots, x_m, x_{m+1}, \ldots, x_n$. One can compare each of these n prices with all the others such that we have n(n-1) possible comparisons.

The correlation integral is defined as the proportion of those pairs of prices whose absolute difference lies within a given constant number (say, ε). This implies that all pairs of prices are compared and those within a given distance of each other are counted and divided by n(n-1). As the length of the series (n) increases to infinity, the said ratio becomes the probability of finding that any two prices selected at random differ by less than a constant number (ε). The correlation integral can also be defined for a set of m successive observations. In this case the m is referred to as embedding dimension. If one plots the logarithm of correlation integral against the logarithm of ε on a graph, the slope of the curve is referred to as the correlation dimension.

When oil price series is identically and independently distributed, the true correlation integral for dimension m [C(m, n)] is related to the correlation integral for dimension 1 [C(1,n)] by the relation, $[C(m,n)] = [C(1,n)]^m$ for all m and ε. The correlation integral measures exactly the number of vector pairs which are not within ε of each other. According to Brock et al. [8], if price series is iid, the standardized difference between [C(m,n)] and $[C(1,n)]^m$ is asymptotically normally distributed. By using the aforementioned relationship, the BDS statistic is defined as a transformation of the correlation integral. The technical part of BDS test is shown in the appendix.

4. RESULTS

Table 3 presents the descriptive summary of weekly oil price series from 1997 through 2004. A cursory view of the table shows the time series is not normally distributed as depicted by the Jarque-Bera statistic. A kurtosis value of 3.324 is an indication of the presence of leptokurtosis in the probability distribution of the series. This means the presence of fat tails in the probability distribution of oil prices series in Nigeria.

The autocorrelation and partial autocorrelation structures provide a summary of the dynamics of oil price series. Table 4 shows a long lasting autocorrelation structure which suggests that the price process in nonlinear. Table 5 reports the results of the BDS test. With ε = 11.909 and m = {2, 3, 4, 5, 6}, we could not accept the null hypothesis of iid at the conventional level of statistical significance. The implication of this is that nonlinearity exists in oil price process.

Table 3. Descriptive Summary Statistics of Oil Price Series

Statistic	Value
Mean	24.349
Median	25.000
Maximum	51.140
Minimum	9.450
Standard Deviation	8.101
Skewness	0.433
Kurtosis	3.324
Jarque-Bera Statistic	14.809
Probability of Jarque-Bera	0.000

Table 4. Autocorrelation and Partial Autocorrelation of Oil Price Series

Lag	Autocorrelation	Partial Auto.	Q-Statistic	Probability
1	0.980	0.980	401.84	0.00
5	0.898	0.064	1856.30	0.00
10	0.822	-0.053	3396.50	0.00
15	0.736	-0.004	4674.90	0.00
20	0.672	0.054	5732.10	0.00
25	0.608	-0.014	6622.00	0.00
30	0.548	0.012	7351.00	0.00
32	0.524	-0.029	7605.00	0.00
34	0.497	0.022	7835.30	0.00
36	0.476	-0.010	8046.50	0.00

Table 5. BDS Test Results (with Bootstrapped Critical Values)

Dimension	BDS Stat.	Std. Error	z-Statistic	Probability
2	0.1798	0.0035	51.575	0.00
3	0.3036	0.0055	54.972	0.00
4	0.3894	0.0066	59.403	0.00
5	0.4445	0.0068	65.268	0.00
6	0.4807	0.0065	73.448	0.00

Raw Epsilon (ε)	11.909		
Pairs Within Epsilon (ε)	121019.0	V-Statistic	0.7027
Triples Within Epsilon (ε)	37825415.0	V-Statistic	0.5292

Dimension	C(m, n)	C(1, n-m+1)	$C(1, n-m+1)^m$
2	0.6757	0.7042	0.4960
3	0.6552	0.7058	0.3516
4	0.6380	0.7061	0.2486
5	0.6233	0.7087	0.1788
6	0.6105	0.7115	0.1298

5. CONCLUSION AND IMPLICATIONS

The preponderance of empirical evidence on the relationship between oil price shocks and output in many economies of the world is negative. In other words, an oil price shock leads to a decline in the growth of gross domestic product. This result is more pronounced in the case of oil-importing countries of the world. The logical extension of this result is that an increase in oil price would cause an increase in output in oil-exporting countries. The financial economics literature indicates that this is not the case. Adedipe [1] argues that the formulation of a sound economic program of development depends critically on the quality of data used in the policy formulation. More specifically, the author notes that the development in the crude oil market should be anticipated by policy makers in Nigeria.

The results reported in this paper, indicates that policy makers in Nigeria erroneously employ a linear model to predict oil price. The results from the Jarque-Bera test, Box-

Pierce Q test and the BDS tests indicate that oil price series is not generated by a linear process. On the contrary, there are nonlinearities in the price generating process. The direct implication of these results is that Nigeria should revamp her policy-making mechanism. The results reported in this paper are consistent with a comment credited to Okonjo-Iweala [19]. She noted the inability or unwillingness of policy makers to manage Nigeria's oil resources well [1].

It is important for Nigerian policy makers to focus on the management of oil revenues and pay particular attention to measures that will ensure transparency in its activities. More importantly, the government should pursue vigorously the independence of the Central Bank of Nigeria (CBN) and allow the institution to be directly involved in the management of oil revenues. It is not very clear at the moment if the CBN is practically independent of government. CBN independence is crucial when it is necessary for it to neutralize the effect of the government fiscal recklessness. Nigeria should emulate the examples of Botswana and Norway and set up a Petroleum Fund to be managed by the Central Bank of Nigeria. The objective is to allow the Fund to serve as a buffer to smooth fluctuations in oil revenues and to help address the future needs of the country.

The government of Nigeria should emulate the examples of Indonesia and Malaysia where patronage is used in ways the benefit the poor [21]. The nature of oil and gas industries is such that they are nit pro-poor because they typically employ a few unskilled workers. To make these industries pro-poor, government should improve rural infrastructure as well as health and education facilities for rural dwellers. In the mid-1960s, Ross notes that Nigeria and Indonesia had the same level of GDP per capita. Three decades later, real incomes remained stagnant in Nigeria while they quadrupled in Indonesia.

It is also important for Nigeria to focus on its endowment of gas resources in order to diversify its revenue base. The current practice of flaring gas during oil extraction should be discontinued. The country has a huge deposit of gas which it could harness to generate electricity and thus promote industrialization. Nigeria is currently not aggressive enough in marketing its gas deposits. Finally, it is critical that manufacturing activities should be promoted by government. This can be done through several incentives to corporate entities as well as create conducive atmosphere for these activities. The 2004 government revenue is based on US$25 per barrel and with the current price exceeding US$60 per barrel, the groundwork is provided for the country to manage its excess revenue in a way that benefits the citizenry.

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APPENDIX

The BDS Test

The BDS test is developed by Brock et al. [8]. According to Kanzler [12], on a sample of n observations of oil price series (X), the correlation integral ($C_{m,n}$) for dimension m is calculated as the average of all available products of m-histories. That is,

$$C_{m,n}(\varepsilon) \equiv \frac{2}{(n-m+1)(n-m)} \sum_{s=m}^{n} \sum_{t=s+1}^{n} \prod_{j=0}^{m-1} I_{\varepsilon}(X_{s-j}, X_{t-j}) \quad (1)$$

The BDS statistic for embedding dimension (m) and dimensional distance (ε) is estimated as:

$$W_{m,n}(\varepsilon) = [n-m+1]^{0.5} \frac{C_{m,n}(\varepsilon) - C_{1,n-m+1}(\varepsilon)^m}{\sigma_{m,n}(\varepsilon)} \quad (2)$$

Brock et al. [8] show that the BDS statistic has a standard normal distribution asymptotically. The null hypothesis is that the time series under examination is independent and identically distributed. If this is the case, then for any given ε and m > 1:

$$\frac{C_{m,n}(\varepsilon) - C_{1,n-m+1}(\varepsilon)^m}{\sigma_{m,n}(\varepsilon)} = 0 \quad (3)$$

A sufficiently large value of the BDS statistic is an indication of nonlinear structure in the time series. The details of the BDS statistic are available in Kanzler [12]. In this paper we follow the small sample properties recommended by Kanzler [12].