

THE IMPACT OF SOLID MINERALS RESOURCES ON ECONOMIC GROWTH IN NIGERIA: AN OLS AND CAUSALITY APPROACH

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ABSTRACT

Over the past four decades, increasing emphasis has come to be placed on the potential importance of solid mineral resources to the Nigerian economy. A more common strand of research is those that tested the resource curse hypothesis to show empirically the actual relationship between natural resources and economic growth. Whereas, most of the studies have looked at various resource endowment, especially oil and metals, just a few have focused on solid mineral resources. This paper empirically tries to expose the potentiality in solid mineral resources as viable alternative to the petroleum sector, which production in Nigeria is unpredictable and the crisis in the region that produce the oil make unreliable as revenue-earning source for the country. Using various econometric tools of analysis, the variables for study were tested for stationarity and all variables became stationary at first difference. In the same vein, evidence revealed that series in the model exhibit long-run equilibrium relationship judging from the Johansen cointegration result. Major findings from the OLS output showed that, a billion naira increase in solid minerals development e.g. quarrying, bauxite, metal ores, iron ore, coal etc will contribute 0.26 billion naira to the GDP of Nigeria. This contribution, though negligible is commendable owing to the fact that successive administrations in Nigeria have paid scant attention to the development of the solid minerals sector. Nigeria over the decades was trapped in the web of the Netherlands affliction known as the Dutch disease where proceeds from crude oil sale led to almost complete neglect of the non-oil sector. The study recommended that in view of the importance of the solid minerals sector as part of the federal government policy on diversifying the economy away from oil revenue, the government must formulate an explicit export-promotion programme based on principles of comparative advantage in order to encourage the growth of the sector. The government should encourage private investment, both local and foreign, through adequate provision of infrastructures, and encouragement of macroeconomic stability such as low inflation rate, stable exchange rate and assurance of security such as reduction in attacks by herdsmen across the country, kidnapping, the Boko Haram insurgency etc, that has contributed greatly in stagnating exploration activities across such regions.

KEYWORD

Solid minerals, Economic Growth, Exports, Exchange Rate, OLS

1. BACKGROUND TO THE STUDY

Mining is one of the oldest economic activities in Nigeria, dating back to 340BC. Early mining activity involved the extraction of gold and metallic substances. Most states have identified extensive mineral resources. However, most of this is unquantified. Apart from oil and gas, which are obviously the most important mineral resources in the country, but have a more limited direct impact on people's livelihoods and day-to-day lives, other mineral resources are very important to a large share of the Nigerian population. The solid mineral sector is currently underexploited and a study of the sector forms part of a broader attempt by the World Bank to analyze key issues in

natural resource management, with emphasis on the economics and regulatory aspects of their utilization. Nigeria maintained a dominant economy in Sub-Saharan Africa after South Africa and the 10th largest producer of crude oil in the world with about 2.4 million barrels of crude oil per day (OPEC, 2017). Before the Arab-Israeli war of 1970s, Nigerian economy was basically an agriculturally-based economy and with some little commercial activities. Since then, oil sector have taken over the economy and more than half of the government's revenue and over 80% of export earnings were derived from oil sector. It should be noted that more than half of the population and 10% of gross domestic product GDP are derived from agricultural sector. Presently, the total population of over 180 million with a land mass of over 900,00km are endowed with abundant natural resources that cut across the length and breadth of the country. In fact, there is no state in the federation that is not blessed with one form of mineral resources or the other. The abundant mineral resources are metallic, non metallic and/or industrial are available in commercial quantities. But, since independence, there is lack of proper utilization of resources, while some of the resource remains untapped. This may be attributed to the lack of adequate capital to harness the resources (World Bank, 2007).

Apart from these, there are also problems of inadequate infrastructural facilities, technical competence and huge investment capital involved in the exploration of the resources. Currently, the country is exploiting a numbers of mineral resources to satisfy the socio-economic development needs of the nation starting from the common water to crude oil, bitumen, coal and gas reserves estimated at about 105 trillion cubic feet; all these are from the physical components of the physical environment which could be divided into renewable natural resources and non-renewable natural resources. The renewable natural resources include solid / liquid minerals, whose supply is finite and exhaustible. In 1999, the federal government of Nigeria created the Ministry of Solid Mineral Development, which has motivated a lot of interest in the sector and provide alternatives sources of foreign exchange to the country, coupled with the fact that petroleum products are unreliable, attributable largely to the crisis in Niger Delta region areas of the country (Central Bank of Nigeria, 2014)

With the establishment of the solid mineral resources ministry, the prospect in the sector became brighter with improvement in foreign exchange earnings from the sector which will improve with time. It should be noted however, that Nigeria is blessed with abundant solid mineral resources that could be beneficial to varieties of industries in the country. These solid mineral resources include Coal, Gold, Limestone, bitumen, tin, iron ore, salt among others. Research carried out further revealed that it cost much more in the exploitation of crude oil than prospecting for solid mineral resources. It is common knowledge that most of the Asian countries like Japan, Malaysia, South Korea etc that enjoy high growth rate and dominate exports are not oil driven and most of their earnings come from non-oil sector and yet, these countries cannot be compared with Nigeria that has vast solid mineral resources that could be used to propel development in the country. The problem that necessitated the study could be viewed from the fact that over the years Nigeria's government have been experiencing series of crisis in the oil producing areas of Niger-Delta Nigeria, coupled with the inherent shocks in the international oil market that has led to price upswings and downswings over the past three years. Moreso, the fact that U.S being the major buyer of Nigeria's Crude oil with other industrialized economies are already seriously working on alternative source of energy supply apart from crude oil makes it imperative for the country to look in the direction of an alternative source of revenue for the country. It has also been acknowledged that recurrent instability in revenue may distort economic planning and this has serious implications for economic development of Nigeria hence this study takes an empirical look at the impact of solid minerals resources on Economic Growth in Nigeria from 1980 – 2015. The specific objective is to examine the causal relationship between solid minerals resources and economic growth in Nigeria. The rest of this paper is divided into five parts; part II contains the conceptual framework and review of literature, Part III contains the methodological issues,

presentation and discussion of results is contained in Part IV while Part V is devoted to conclusion and policy recommendations.

2. LITERATURE REVIEW

In strict economic terms, growth implies increased output of an economy, which means positive growth rates; while development has consistently implied the sufficiency of an initial economy with a static condition for a long time which is used to generate and sustain the yearly growth in its Gross National Product at 5% to 7% or more. For growth to take place, the nation must invest in order to build up productive capacity. It is this capacity that determines the level of output of goods and services in the economy. An expansion of productive capacity requires an increase in the natural resources, human resources, capital and the net increase in the capital stock of the economy which leads to growth. Hence, there is a connection between capital accumulation and economic growth. It is assumed that over time, with efficient policies that allow more equal circulation of the fruits of economic growth amongst a progressively increase percentage of the population, economic development would follow.

In Nigeria, improved geological data revealed that the country is endowed with numerous and proven deposits of industrial, metallic and non-metallic mineral fuels. Anderson (1977) observed that deposits of minerals will have a big influence on the productive capacity of a country. He noted that the availability of mineral resources can affect the nature of industrial development and help raise standard of living. Development connotes an endless advancement in the living standards of the people inside a social composition. Any indication of growth must include the reduction in inequality, access to a wide variety of goods and services, provision of basic needs and positive changes in social institutions.

Ekpo (1992) viewed industrialization of a country as a developing process of the country's capacity in locating and mastering the borders, the entire industrial production process. This includes fabrication of tools/machines for manufacturing, production of intermediate products for other industries, production of raw materials, skills to operate, maintain and reconstruct the machines and tools, skills to manage factories and the production process. It would therefore be illusive for any country to achieve self-reliance, productivity and growth in the absence of both agricultural and industrial development. Agriculture alone, if not accompanied by industrial development can only give a temporary relief to the economy. It is in this light that Aboyade (1980) observed that in the early stages of economic growth of nations, the readily available mineral and other natural resources contributed directly to meeting the requirements for food, shelter, fuel and metals. He stresses that as the population grew and the markets widened, these resources made it possible to evolve complex and social organizations that supported increasing labour specialization and capital accumulation.

Furthermore, Raphael and Mordecai (1982) asserted that the existence of rich natural resources, particularly minerals, played a major part in the development of a nation's economy in the world. They remarked that at the time of Industrial Revolution, the confluence of energy and material availability was a determining factor in the location of major industrial activities. The emergence of Great Britain, Western Europe, the United States and Japan as major industrial powers is based upon a natural endowment of energy and material resources or access to ocean transportation to permit their acquisition relatively cheaply. They further pointed out that the emerging world now looks upon resources as a major means to facilitate their economic development. They asserted further that the Union of South Africa which has a disproportionate endowment of manganese, chrome and platinum group metals used these materials, plus gold and diamonds as a major source of its wealth.

Phillips (1980) noted that before the advent of manufacturing and other modern sector activities, mining has been a major employer of labour in Nigeria. He observed that the sector was competing favourably with the government departments and public enterprises (such as the Nigerian Railways). Obialo and Kogbe (1976) also observed that in addition to an enormous contribution of mining to the economic development of the Nigerian economy, the mining industry also serves as a medium of acquiring the much needed technological know-how.

2.1 SOME SOLID MINERAL RESOURCES IN NIGERIA

The absorptive capacity of the solid minerals sector could be better appreciated if an attempt is made to present an inventory of some of the mineral resources of Nigeria. According to Maduka (2014), the following solid mineral resources are found in different parts of Nigeria.

Tin

Tin Ore is one of Nigeria's major solid mineral endowment. The commercial mining of this mineral began in 1904, although it has been mined for use in the local economy long before the advent of colonial administration. The mineral was exported in ore form until 1962 when local smelting began. Thereafter, it was exported in the form of tin ingot. Since the mineral activity is export-oriented, tin has been subjected to fluctuations of the world market. These fluctuations have in recent years worsened into a speedy decline in market conditions. Trade in tin is conducted through the Penang and London Tin Exchanges. Tin is usually transported as metal rather than as concentrates. The institutional mechanism for looking after interest in the tin is the International Tin Council (ITC) which manages Tin prices by means of thorough buffer stocks. Tin (cassiterite) and its associated minerals have not had a better fortune because since 1981, the production of the mineral outstripped its market demand worldwide..

Phillips (1980) remarked that tin mining was responsible for the bulk (over 95% annually) of the employment in the metallic mining industry. One result of this is that mining employment in Nigeria is heavily concentrated in Jos, Plateau state. Kogbe and Obialo (1976) also observed the contribution made by tin mining to the Nigerian economy when they noted that export value of tin mining alone far exceeds the export value of all the other solid minerals put together.

Columbite

Columbite is used as an additive in strengthening steel and is produced as a by-product of heat-resisting alloys used in the manufacture of jet engines, turbines and similar products with Professor A. Phillips (1980) stating, Nigeria supplies to be over 80% of world requirements of columbite. Ifaturoti(1984) remarked that columbite was exported mainly to Europe until the early fifties (at the time of Korean Conflict) when the United States of America (USA) decided to stockpile columbite and other strategic minerals not produced in USA. As a strategic mineral, it is also subjected to fluctuations brought about by changing demand conditions in (and the inventory policies of) the developed countries, in particular, the USA. The fortunes of this mineral have been very similar to that of tin, with declining output, export and prices being the significant developments of the past years. Pyrochlore (a substitute) in Brazil and Canada suggests that a continued decline in columbite mining in Nigeria can be expected, unless of course another major world emergency gives a fillip to demand, the way the Korean crisis did in the early 1950s but for the moment, the industry is likely to remain in a depressed state.

Coal

Aiyedun, E. (1996) observed that coal has been an important solid mineral in Nigeria's economic development since 1940s. He noted that the first coal mines in Nigeria were opened in the Udi Hills, Enugu State in the 1940s. Since the 1970s, new mines have been opened in the Okaba area

of Benue State and Lafiagi-Obi in Kwara State. Available estimate put Nigerian coal reserves at 800 million metric tonnes out of which only 12,965.5 tonnes was to be mined in 1994. Coal mining is perhaps the only segment of the domestic-oriented mining activities to experience depressed conditions. The major consumers of coal were The Nigerian Railways and the Power Holdings Company of Nigeria, but have over the years increasingly changed to other energy sources such as diesel, gas, petroleum and water. Besides, coal has never been a popular domestic fuel. Moreover, Nigerian coal has never been suitable for cooking until recently when technological advancements made cooking possible by which time of course cheaper sources of energy had become available to Nigeria. Coal has been the only mineral that has all along been mined only by the government-owned Nigerian Coal Corporation (NCC).

2.2 THEORETICAL FRAMEWORK AND EMPIRICAL REVIEW

Recent studies assert that natural resources abundance particularly mineral resources have adverse effects for economic growth. To support this resource curse hypothesis, Sachs and Warner (1977) concluded in their findings that countries with abundant natural resources have tendency to grow slower in their economies than those countries without substantial natural resources. Their paper examined the trend for 20 years period of 1970-1990. They concluded that having controlled for many variables, mineral resources are found not to be important for economic growth i.e there is a negative relationship between resources abundance and economic growth. Early scholars including the sixteenth century political philosopher Jean Bodin, (1576, reprinted 1962) asserted as much, when he claimed that “men of a fat and fertile soil are most commonly effeminate and cowards; whereas contrariwise a barren country make men temperate by necessity and by consequences careful vigilant and industrious”. This further reinforced “resource curse” hypothesis that mineral resources cannot propel economic growth even in the surplus countries, hence countries should look beyond her resources.

But even in 1950s and 1960s, through Dutch disease model of 1970s and 1980s, there have been different shades of opinions regarding the reliability of natural resources in propelling the economic growth of a country. For example, Hirschman 1958, Seers 1964 and Balwin (1966) promoted the view that, “forward and backward linkages” from primary exports to the rest of the economy would be small. The essence is that emphasis should be placed on manufacturing sector as opposed to the natural resources production which would lead to more robust division of labour and hence to a higher standard of living. Dutch disease models demonstrated that the existence of sector dominated by natural resources have the tendency of affecting the distribution of employment in the entire economy and equally lead to the pulling of resources in and out of non traded sectors. This sectoral shift can affect long-term growth in the economy. Another line of argument was in the area of political economy. Accordingly, Gelb (1988) stressed that government typically earned most of her rents from natural resources exploration. Others even argued that natural resources abundance inevitably leads to greater corruption and inefficient bureaucracies, or that high rents from natural resources distract government from investing in the ability to produce growth supporting public goods such as infrastructure.

Lane and Tornell 1995, argue that a windfall coming from terms of trade improvement or a discovering of natural resources deposits can lead to a “feeding frenzy” in which competing factions fight for the natural resources rents and even end up inefficiently exhausting the public good. In the view of Gavin Wright and Czelusta (2003), it was opined that the hypothesis should be subjected to proper scrutiny and conclude that it is inappropriate to equate development of mineral resources with terms such as “windfall” and “bonus” and that mineral production cannot be regarded as mere depletion of a fixed natural endowment and they demonstrated that so called non-renewable resources have been progressively extended through exploration, technological progress and advances in appropriate knowledge as indeed solid mineral constitute a high-tech

knowledge industry in many countries. Investment in such knowledge should be seen as a legitimate component of a forward looking economic development programme.

The above submission was further reinforced in the work of David Romer 2006, using quantitative analysis to establish a relationship between growth rate mineral resources and land. He concluded that the growth path can be either positive or negative. If it is negative in the sense that resources and land limitation can cause output per worker to decline and that the declining in the resources and the land per worker are drags on growth but technological progress is a spur to growth. If the spur created by technological progress is larger than the drags exerted by resources and land, then there is sustainable growth in output per worker. In respect to Nigerian economy, a further line of argument is that resources per se are not the problem, it's just that they tend to have volatile world prices and volatility is the problem. The fact that natural resources, especially oil prices is more volatile than other mineral resource translates into greater ex-ante uncertainty for countries that relies on crude oil as major sources of exchange earnings.

Very few countries have established provisions for the distribution of funds beyond the national level. Among the recent studies on the impact of mining of the solid minerals is Roderick (2001), in his study of mining and economic sustainability, employing mainly qualitative analysis, he concluded that through appropriate responses to the challenges of mining and economic development, the benefits of mining can be sustained, even when a mine or a mining community inevitably declines as the ore runs out. Mineral wealth lives on, but in other forms such as in educated and healthy people, efficient and fair social institutions, and man-made physical capital but mining and minerals can be a curse if the challenges are not met.

Adeniyi, Adeleke & Olabode (2013), in their analysis on the legal regime for exploring solid minerals for economic growth in Nigeria, employing mainly qualitative analysis. The study revealed that the solid mineral sector remains crucial to economic development, wealth creation and poverty alleviation in any nation that is blessed with such mineral deposits and thus concluded that Nigeria government should adopt best practices and mechanisms that have been used by different countries to formalize and regulate mining explorations in order to attain sustainable development in the mining sector in Nigeria.

Akongwale, Ayodele & Udefuna (2013) in their analysis on the role of solid minerals on economic diversification in Nigeria, employed both qualitative and quantitative (descriptive) analysis, the study showed that the solid mineral sector in Nigeria has the potential to contribute immensely to the economy of Nigeria. Specifically, it reveals that the development of the solid mineral sector could help to combat poverty in Nigeria via job creation; especially, given its forward linkage with other sectors of the economy. Most importantly, it could help alleviate some of the problems associated with "enclave" nature of the Nigerian economy that has for too long been vulnerable to fluctuations in global oil prices.

Adekeye (2010) in his study on the impact of conflict on mining in Nigeria revealed that there is much more to be gained from the development of mining sector than is usually organized and there is very much to lose from the non-development of the sector.

Agba (2007) in his study on economic analysis of natural resources sustainability for the mining sector component in Nigeria, employed both qualitative and quantitative (descriptive) analysis, the study revealed that Nigeria stands to benefit from the development of solid minerals sector. He concluded that the government must provide enabling environment for the private sector investment in mining.

Finally, from the review of the literature above, almost all the studies employed mainly qualitative and descriptive analysis in their research work as against this current research which focus on a quantitative assessment, employing various econometric tools using time series data

analysis in assessing the contribution of solid minerals sector to the economic growth of the Nigerian economy.

3. STUDY METHODOLOGY

3.1 RESEARCH DESIGN

Primarily, this research examines the impact of solid minerals development on economic growth in Nigeria. In order to achieve the objectives, the study adopted quasi- experimental method to investigate this impact between 1981- 2015. Specifically, the study analysed the data to examine the relationship and impact of the independent variables on the dependent variables using Ordinary Least Square (OLS). Ordinary Least Square method seeks to understand and explain economic phenomenon by identifying possible relationship between or among variables.

3.2 VARIABLES USED AND SOURCES

Sachs and Warner (1977) concluded in their findings that countries with abundant natural resources have tendency to grow slower in their economies than those countries without substantial natural resources. Their paper examined the trend for 20 years period of 1970-1990. They concluded that mineral resources are found not to be important for economic growth i.e there is a negative relationship between resources abundance and economic growth. This paper taking a lead from their works seeks to examine the impact of solid mineral resources on Nigeria's Economic Growth so as to see the nature of relationship between solid minerals and the nation's gross domestic product. To undertake this study, a number of variables have been taken into consideration. These variables are:

Gross Domestic Product (GDP) which is a proxy for economic growth. This is usually employed to denote market size, which is indicative of the level of economic activity. A large market size is suggestive of a prosperous business climate, hence serves as a factor attracting foreign investors on one hand, and a means of measuring the impact of foreign investment in the host countries on the other hand.

Solid Minerals (S_MIN): These are mineral deposits found in the different states of the federation. They include tin, columbite, coal, iron ore, bitumen, gold, kaolin etc.

Gross Fix Capital Formation (GFCF) which is an indicator of government's investment in the sector is included as a control variable. Moreover, the inclusion of this variable eliminates the problem of spurious causal effects due to the omission of important variables from the investigated relationship Aziz (2000).

Exchange Rate (EXCR) This refers to the price at which a country's currency is expressed in terms of other currencies. In Nigeria today, the demand for other country's currency such as Pound Sterling, Dollar, Japanese yen etc is very high. So our importers have to pay higher prices for whatever they buy from abroad.

International trade theory posits that currency depreciation or devaluation could be favourable to export in the long run. The rational is that with increase in exchange rate (i. e. currency devaluation or depreciation), a country's export becomes cheaper in the foreign markets while its import becomes more expensive in the domestic market. However, the theoretical effect of currency depreciation on export and import depends on the elasticity of demand for the country's export in the foreign market as well as the elasticity of demand for import in the domestic market. If the demand for a country's export commodities in the foreign market is inelastic, currency depreciation may not have any significant effect on the performance of the country's export.

Similarly, if the country's demand for import is inelastic, the ability of currency depreciation to reduce import will be undermined.

The research data employed for this study were secondary data. The secondary sources of the data are useful relying on the efficiency of validated model built by economic experts in this field to analyze such data. Essentially, time series data for this study from 1981 to 2015 were sourced from Central Bank of Nigeria (CBN) statistical bulletin for various issues. The choice of this type of analysis is borne out of the claims in econometrics that information about the behavior of variables is contained in their historical time series data.

3.3 Method of Data Analysis

To empirically examine the impact of solid minerals development on Economic Growth in Nigeria the study adopts Unit Root test, Cointegration test, Granger Causality testing and Ordinary Least Squares Regression. Essentially, for the reason of uniformity in measurement, and clarity in the interpretation of findings, the variables were transformed to their natural logarithms to eliminate any serial correlation that might be present.

3.4 Model specification

Based on earlier works done on the subject, a model was drawn up for the purpose of this study. The model will help to verify the impact of solid minerals development on the GDP of the nation for the period under consideration. According to the model and for the purpose of this study, the GDP of the nation depends on the receipts from solid minerals, investment in the solid minerals sector and the exchange rate regime.

The functional form of the model is:

$$GDP = f(S_MIN, GFCF, EXCR) \quad 4.1$$

The mathematical form of this model can be specified as follows:

$$GDP = f(S_MIN + GFCF + EXCR) \quad 4.2$$

In order to allow for the inexact relationship among the variables as in the case of most economic variables, a stochastic error term ' μ_t ' is added to the equation. Thus, we can express the econometrics form of the model in its log (linear) form as:

$$\text{LnGDP} = \alpha_0 + \alpha_1 \text{LnS_MIN} + \alpha_2 \text{LnGFCF} + \alpha_3 \text{LnEXCR} + U_t \quad 4.3$$

Where: $\alpha_0, \alpha_1, \alpha_2, \alpha_3$ are intercepts (constant term) and regression coefficients respectively with u_t as the error term, which is a random variable.

$$a_1 > 0, a_2 > 0, a_3 > 0$$

Where

GDP	=	Gross Domestic Product
S_MIN	=	Solid Minerals Development
GFCF	=	Gross Fix Capital Formation
EXCR	=	Exchange Rate
Log	=	Logarithms
U_t	=	Stochastic error term

3.5 A PRIORI EXPECTATION:

Ordinarily, *a priori* expectation is that all parameters will be positive, but considering the fact that the Nigerian solid minerals development is at its infant stage; exchange rate here can have positive or negative impact on growth.

3.6 TIME SERIES PROPERTIES

The time series econometric procedures were used in order to examine the impacts of solid minerals development on economic growth in Nigeria. There are four steps involved in estimating the relationships. The first step is to test the stationarity of the time series data using the method of the Augmented Dickey-Fuller and Phillip-Perron unit root test. The principle behind the diagnostic test of stationarity and others is to ensure that the results of the regression analysis are not spurious. After establishing their orders of integration, we proceed to an examination of the time series data for the presence of a long-run relationship among all variables in the model. However, the long run coefficients are estimated using the associated cointegration model, proposed by Johansen (1991). Decisions about the presence of cointegration will be done using the trace test and the maximum eigenvalues tests. Once the cointegration is confirmed in the model, an OLS technique is estimated to examine the impact of solid minerals on economic growth. Lastly, the causality relationship between solid minerals resources, gross fix capital formation, exchange rate and economic growth was analyzed using the Granger causality technique. This technique follows the F-distribution, as the variables will be lagged at lag 2.4.

RESULTS / DISCUSSION

The table below shows the dependent and independent variables used in the model

Table 1

	GDP	S_MDN	GFCF	EXCR
1981	6.11E+10	1.648212	2.15E+10	0.617708
1982	5.14E+10	1.871872	1.64E+10	0.673461
1983	3.55E+10	1.550250	8.16E+09	0.724410
1984	2.85E+10	1.474162	4.05E+09	0.766527
1985	2.89E+10	0.916832	3.45E+09	0.893774
1986	2.07E+10	0.659018	3.14E+09	1.754523
1987	2.41E+10	0.762144	3.28E+09	4.016037
1988	2.33E+10	0.863575	2.76E+09	4.536967
1989	2.42E+10	1.595659	2.85E+09	7.364735
1990	3.08E+10	0.941333	4.38E+09	8.038285
1991	2.74E+10	2.023247	3.76E+09	9.909492
1992	2.93E+10	2.259225	3.74E+09	17.29843
1993	1.58E+10	2.589613	2.14E+09	22.06540
1994	1.81E+10	2.981415	2.02E+09	21.99600
1995	2.85E+10	3.513494	2.02E+09	21.89526
1996	3.50E+10	3.871888	2.55E+09	21.88443
1997	3.58E+10	4.297601	2.99E+09	21.88605
1998	3.20E+10	5.211835	2.75E+09	21.88600
1999	3.59E+10	5.627785	2.51E+09	92.33810
2000	4.64E+10	6.114122	3.26E+09	101.6973
2001	4.41E+10	7.523332	3.35E+09	111.2313
2002	5.91E+10	8.616198	4.14E+09	120.5782
2003	6.77E+10	9.981948	6.70E+09	129.2224
2004	8.78E+10	13.05133	6.49E+09	132.8880
2005	1.12E+11	17.29669	6.13E+09	131.2743
2006	1.45E+11	27.28396	1.20E+10	128.6517
2007	1.66E+11	31.45441	1.54E+10	125.8081
2008	2.08E+11	36.19011	1.73E+10	118.5460
2009	1.69E+11	40.61278	2.05E+10	148.9017
2010	3.69E+11	45.73159	6.11E+10	150.2980
2011	4.12E+11	52.45821	6.40E+10	153.8616
2012	4.61E+11	59.38875	6.53E+10	157.4994
2013	5.15E+11	68.17702	7.30E+10	157.3112
2014	5.68E+11	100.2700	8.57E+10	158.5526
2015	4.81E+11	105.6500	7.13E+10	192.4405

Source: Central Bank of Nigeria Statistical Bulletin (various issues)

4.1 ADF AND PHILLIPS-PERRON (PP) UNIT ROOTS TESTS

The Augmented Dickey Fuller (ADF) and the Phillips Perron (PP) tests of stationarity will be employed to determine the underlying properties of the time series data, that is, whether the variables of interest have unit root or not to avoid the generation of spurious results. The unit root test below shows the result of stationarity for Gross Domestic Product (GDP), Solid Minerals (S_MIN), Gross Fix Capital Formation (GFCF) and Exchange Rate (EXCR) respectively. For clarity and ease of understanding the results from the ADF and PP unit root tests are hereunder tabulated:

Table 2(a): Augmented Dickey Fuller Unit Root Test at Level and 1st Difference

Variable	Level	1 st Difference	5% Critical Value	Order of Integration
LOG(GDP)	Non-Stationary	-5.332256	-2.954021**	I(1)
LOG(S_MIN)	Non-Stationary	-2.954021	-2.625121***	I(1)
LOG(GFCF)	Non-Stationary	-4.024022	-2.954021**	I(1)
LOG(EXCR)	Non-Stationary	-4.959554	-2.954021**	I(1)

** : Stationarity at 5% significance level

*** : Stationarity at 10% significance level

Source: Author's Computation using E-views

Table 2(b): Phillip-Perron Unit Root Test at Level and 1st Difference

Variable	Level	1 st Difference	5% Critical Value	Order of Integration
LOG(GDP)	Non-Stationary	-5.322900	-2.954021**	I(1)
LOG(S_MIN)	Non-Stationary	-6.313375	-2.954021**	I(1)
LOG(GFCF)	Non-Stationary	-4.024022	-2.954021**	I(1)
LOG(EXCR)	Non-Stationary	-4.959554	-2.954021**	I(1)

** : Stationarity at 5% significance level

Source: Author's Computation using E-views

The result above showed that all the time series variables for ADF and PP tests are integrated at first difference with trend. Stationarity occurs where the absolute value of the t -statistic at either level of 1st difference as the case may be is greater than the 5% critical value. This condition existed in all the time series variables except for ADF test for solid minerals where stationarity was attained at the 10% significance level. Having established this, we proceed to determine if the time variables could be used for long run prediction. The result of the Johansen cointegration test is presented in Table 3 below:

Table 3(a) Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.824624	93.54133	47.85613	0.0000
At most 1 *	0.488240	36.09423	29.79707	0.0082
At most 2	0.342930	13.98753	15.49471	0.0833
At most 3	0.003892	0.128683	3.841466	0.7198

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Table 3(b) Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.824624	57.44710	27.58434	0.0000
At most 1 *	0.488240	22.10671	21.13162	0.0364
At most 2	0.342930	13.85884	14.26460	0.0579
At most 3	0.003892	0.128683	3.841466	0.7198

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Source: Author's Computation using E-views

The table above indicates the existence of two cointegration equations at those ranks where the values of the trace statistics exceed the 5% critical values. This occurred in two places in the table. In addition, this was confirmed by the results of the maximum eigenvalues where cointegration exists at ranks where the value of eigenvalues is at least 0.5. The discovery here is that both the trace statistic and maximum eigenvalues result yielded two cointegration equations. Though theory agrees that cointegration exists where there is at least one cointegration, in this study two cointegrating equations are obtained giving credence to the fact that there exist a unique long-run relationship between the series: gross domestic product, solid minerals, gross fix capital formation and exchange rate respectively.

4.2 ORDINARY LEAST SQUARES REGRESSION OUTPUT

The result obtained using the Ordinary Least Square (OLS) estimation technique is as tabulated below:

Table 4: OLS Output

Dependent Variable: LOG(GDP)
 Method: Least Squares
 Date: 02/21/17 Time: 02:08
 Sample: 1981 2015
 Included observations: 35

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	11.46695	1.313960	8.727014	0.0000
LOG(S_MIN)	0.258012	0.079274	3.254706	0.0027
LOG(GFCF)	0.561772	0.058735	9.564548	0.0000
LOG(EXCR)	0.055700	0.043576	1.278233	0.2107
R-squared	0.980354	Mean dependent var	24.91434	
Adjusted R-squared	0.978452	S.D. dependent var	1.106783	
S.E. of regression	0.162466	Akaike info criterion	-0.689491	
Sum squared resid	0.818247	Schwarz criterion	-0.511737	
Log likelihood	16.06609	Hannan-Quinn criter.	-0.628130	
F-statistic	515.6358	Durbin-Watson stat	1.191101	
Prob(F-statistic)	0.000000			

Source: Author's Computation using E-views

4.3 EMPIRICAL OLS REGRESSION OUTPUT:

From the result, the entire regression coefficient has the expected sign of hypothesis. It is revealed that the exogenous variables are in conformity with their '*a priori*' expected signs.

Economic Growth vs other Variables outside the Model

The result indicates that the constant (α_0) has a positive sign which implies that holding all other explanatory variables constant, economic growth will increase by at 11.46695. Other variables outside the model could serve to grow the economy notwithstanding the contribution of S_MIN, GFCF and EXCR.

Solid Minerals and Economic Growth

Solid Minerals development is positively related with economic growth in line with economic theory. From the OLS output above, a billion naira increase in solid minerals development e.g. quarrying, bauxite, metal ores, iron ore, coal etc will contribute 0.26 billion naira to the GDP of Nigeria. This contribution though negligible, is however commendable owing to the fact that successive administrations in Nigeria has paid scant attention to the development of the solid minerals sector. Nigeria over the decades was trapped in the web of the Netherlands affliction known as the Dutch disease where proceeds from crude oil sale led to almost complete neglect of the non-oil sector of which solid minerals is one. The coefficient is statistically significant in explaining GDP judging from its t-statistic value of 3.3 and a low probability value of 0.0027.

Gross Fix Capital Formation (Investment) vs Economic Growth

The second independent variable known as GFCF has a positive sign which conforms to the a priori expectation. The coefficient is equally statistically significant owing to its high t-statistics a p-value of 0.0000. From the result presented above it can be deduced that a one billion naira increase in investment in the sector contributes 0.56 billion naira to the nation's economy. This reveals the modest investment the government have made over the years to facilitate the exploitation of the various mineral deposits across the thirty-six states of the federation.

Exchange Rate and Economic Growth

Exchange rate has a positive but insignificant relationship with economic growth at 21%, indicating that a 1% increase in exchange rate will increase economic growth by 0.055700%. This implies that exchange rate appreciation has robust effect on non-oil export and by implication solid minerals development in Nigeria. The implication of this result is that, a percentage appreciation in effective exchange rate leads to a 5% percent increase in solid minerals export in Nigeria within the period of study. This finding is in line with theory.

4.4 GRANGER CAUSALITY TEST

To be able to realize one of the objective for this study which is to examine the causal relationship between solid minerals resources and economic growth in Nigeria, the Pairwise Granger causality test was employed. Below is an extract from the Pairwise Granger Causality Test.

Table 5: Pairwise Granger Causality Test

Null Hypothesis	F-Statistic	Testing Hypothesis
S_MIN does not Granger Cause GDP	20.3240	Reject Ho
GDP does not Granger Cause S_MIN	1.25337	Accept Ho

Source: Author’s computation using E-Views 8.0

The Pairwise granger causality tests above with a maximum lag of 2 shows that causality runs unidirectionally from solid mineral resources to gross domestic product. Conversely, the second row indicates that GDP is not causing S_MIN. The implication of this outcome is in conformity with our earlier regression result which revealed a positive contribution from solid mineral resources to economic growth in Nigeria. Meanwhile, the non-causality from gross domestic product to solid mineral resources is a further confirmation of the fact that successive administrations in Nigeria have not done enough to build the solid minerals sector, hence the lack of causality from economic growth to solid minerals development.

4.5 MODEL APPROPRIATENESS

The coefficient of determination (R^2) for the estimated model indicates that about 98 percent of the variation in the gross domestic product growth is explained by the model, while the remaining 2% is explained by other variables which was not captured by the model and are included in the disturbance variable. On the basis of this, we may conclude that the estimated model has a good fit. The overall performance of the model as evidenced in the probability (0.00000) of the F-statistics is good.

4.6 ROBUSTNESS CHECKS

Certain diagnostic tests like heteroscedasticity, autocorrelation and CUSUM/CUSUM of Squares test were performed to ensure that our models yield robust estimates. These results are presented in the Appendix section. Based on the diagnostic tests, we can conclude that the modelling and results of all our models, including the OLS are robust and as such, we can make inference with greater certainty.

5. CONCLUSION / POLICY RECOMMENDATIONS

This study investigated the impact of the solid minerals development on the performance of the Nigerian economy between 1981 – 2015, using the Ordinary Least Square (OLS), Co-integration and Granger Causality test. With the result from the findings, we can infer that owing to lack of diversification of the Nigerian economy from oil to non-oil, solid minerals export was found to have performed below expectation and thus brought in little into the economy. Similarly, result obtained from the causality tests indicated that there exists a one-way causality from solid minerals resources to economic growth in Nigeria. The implication of this outcome is that while the solid minerals sector contributes to the gross domestic product, the reverse is the case as gross domestic product is seen not to be contributing to the sector. This is as a result of clear negligence by successive administrations which need to be urgently addressed for more robust output from the solid minerals sector.

Furthermore, the study revealed that the impact of solid mineral resources has the potential to bring about economic growth as indicated by its positive value; however, as a result of macroeconomic mismanagement in the Nigerian economy over the years, this effect is still yet to be substantially or significantly felt. Deriving from the foregoing conclusions, it is recommended thus:

In view of the importance of the solid minerals sector as part of the federal government policy on diversifying the economy away from oil revenue, the government must formulate an explicit export promotion programme based on principles of comparative advantage in order to encourage the growth of the sector. Also the encouragement of production and exportation of value added commodities should be propagated because of its relatively high price and income elasticity of demand over primary products. The government should encourage private investment, both local and foreign, through adequate provision of infrastructures, and encouragement of macroeconomic stability such as low inflation rate, stable exchange rate and political stability such as reduction in attacks by herdsmen across the country, kidnapping and the Boko Haram insurgency that has contributed greatly in stagnating exploration activities across such regions. The export base should be diversified in favour of non-oil commodities not only to increase their contribution to GDP but also to help cushion the effect of price shocks in the international oil market.

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