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SOLID MINERAL RESOURCES AND ECONOMIC GROWTH IN NIGERIA

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ABSTRACT

The mono-dependent economy over the years has placed Nigerians to tremor stemming from the alteration of the international oil market. This, however, have drawn the attention of researchers and policymakers towards diversification of the economy. It is on this premise that this study examined the nexus between solid mineral resources and Nigeria's economic growth by adopting time series data spanning 1982 to 2021. Autoregressive distributive lag model was adopted to analyze data on solid mineral resources and Nigeria's real gross domestic product growth. The model variables are: Real GDP growth (RGDPR), Coal(COL), Metal Ore (ORE), Quarrying and other Solid Minerals (QOD), Gross Capital Formation(GCF), Foreign Direct Investment (FDI), and Population Growth Rate (PUPGR). Results obtained from the ARDL estimation showed that solid mineral resources impacted significantly and positively on Nigeria's economic growth rate both in the short-run and long-run in the study period. In other words, a rise in the production of solid minerals will transform to an upsurge in Nigeria economic growth. Furthermore, the empirical result showed that there is a long-run relationship between solid mineral resources and real gross domestic product growth, and that causality runs from solid mineral resources to Nigeria's economic growth. The error correction term (ECT) which explains short-run dynamics of the adopted model indicates that the model is well specified and significant to Nigeria economic growth. The study concludes that the solid mineral sector if properly positioned will provide the needed country's foreign exchange earnings, and absorb the growing population; which will reduce unemployment, reduce illegal mining, and be a catalyst for economic growth and development. Therefore, this study recommends among other things; increase investment in the solid minerals sub-sector, an increase in capital formation of the nation, and the provision of a conducive environment for private sector investment in the solid minerals sub-sector.

KEYWORDS: Solid Mineral Resources, Economic Growth, Nigeria, ARDL Model, Gross Fixed Capital Formation.

1. INTRODUCTION

The abundant natural and mineral resources in Nigeria are extensively dispersed virtually across the different states of the country, with more than forty (40) different types of natural resources which include; coal, marble, gypsum, lithium, silver, granite, gold, gemstones, bentonite, iron ore, laterite, limestone talc etc. (National Bureau of Statistics 2021). There are enormous reserves of solid mineral resources in Nigeria, namely: bitumen, topaz, lignite, coal, tin, columbite, iron ore, gypsum, barite talc, etc. There is no part of the country without at least six solid mineral resources. Kayode and Onwurah (2016) observed that over 40 million metric tons of talc deposits are spread across the six different Geo-political zones and over a billion metric tons of gypsum deposits across the nation's soil. Nigeria is recorded to have the second-largest deposits of bitumen in the world. Nigeria is blessed with more than 1 trillion metric tons of coal resources (limestone) which yearly national demand is about 18 million metric tons. They also noted that there are over 44 known natural resources in commercial quantities in Nigeria's natural resource portfolio assets which are yet to be harnessed.

Mining activities in Nigeria are largely informal and are strenuous in specific part of the nation: Metallic extraction is carried out majorly in the middle belt, whereas, coal mining is predominantly carried out in the South East and Middle Belt, while bitumen mining is primarily carried out in the South West, crude oil and natural gas extraction are largely concentrated in the south-south area of the nation.

There are over 37 billion barrels of proven reserves of crude petroleum in Nigeria, and over 187 trillion standard cubic feet of natural gas reserve (Olumide, Akongwale, and Udefune 2013). The structure of mineral endowment in Nigeria facilitates inter-regional trade within the nation. This inter-trade within the nation made it a viable source of raw materials for European industries, particularly the Britain during the colonial era. Prior to the discovery, and oil boom era of the 1970s and 1980s, Solid mineral resources contributed largely to Nigeria's economic growth before the independence in 1960. Throughout the period, Nigeria was known for coal production and its use as a source of energy for electricity generation, construction of railways, and also for export earnings. Tin, Columbite, Lead, and Zinc were some of the major commodities exported by Nigeria during this era. Olumide, et al. (2013), noted that Nigeria was once the largest producer and exporter of columbite before the discovery of oil, and the proceeds from these solid minerals then was used to construct roads, build hospitals, fund education, and in fact in the development of the petroleum sector. Adekeye (1999) cited in Dateer (2017), also noted that Coal and Tin were Nigeria's highest generating foreign exchange earnings throughout the Colonial era and subsequently after the country's independence in the 1960.

However, the downturn in the Nigerian solid minerals sub-sector begins with the exploration of crude oil to the point that Nigeria became a mono-product economy, susceptible to international oil policies. Ever since the exploration of crude oil in 1956, and the oil glut of the 1970s and early 1980s, the Nigerian economy has been depended on crude oil exports as the main source of revenue. The resultant effect of the oil boom of the 1970s caused the Nigerian economy to be dominated by an oil-dependent growth economy. With the prevalent instability in the international oil price and often volatility in the economic growth, Nigeria has wasted a lot of opportunity to alienate from under-development with its enormous natural and human resources endowments. Dateer (2017), noted that Nigeria irrespective of its abundant natural and human resources has depended solely on the abundant of crude oil resources as the principal sources of revenue, thereby operating a mono-economy over the years. This neglect in the solid minerals industry in Nigeria caused a disorder in the mines-field with strong interference from illegal miners whose operations are described as in-efficient mining, illegal mining, and ecological degradation, thereby spreading diseases, causing economic sabotage and huge revenue loss to the Nigeria's government, OSGF (2023).

Statement of the problem

The volatility and instability of crude oil price in the international oil market and the dwindling economic growth coupled with global economic recession have prompted the need to diversify the Nigerian economy. This attempt led to the establishment of the Ministry of Solid Minerals Development in 1995. Prior to the establishment of this ministry, several efforts have been made by the previous administrations towards the development of the solid mineral sub-sector. These includes the enactment of the Minerals and Mining Act of 2007, the Minerals and Mining Regulations of 2011, the establishment of the presidential retreat on solid minerals in August 2013, and the National Council for Mining and Mineral Resources Development (NCMMRD) in 2017(Iduh, 2012; Omoh, 2015; Fowove, 2018). These policies and programs of the government to diversify the Nigeria's economy from the mono-product economy of crude oil to non-oil resources have not been successful.

Over the years, despite the establishment of these ministries by the government, no administration in Nigeria has given solid minerals exploration the needed attention. It has been observed that solid mineral endowment is comparably greater than crude oil and gas endowment in Nigeria, yet no government seems to be interested in paying adequate attention to the exploration and utilization of solid minerals for the country's economic growth and development. This avoidable backdrop has raised serious concern for researchers, entrepreneurs, and even the international community. Whereas other countries like South Africa, Egypt Ghana, etc, are exploring and utilizing their solid mineral resources for the benefit of their economy, Nigeria seems to be confused about what to do with its solid mineral resources and no research seems to have adequately addressed this concern. This study observed this neglect as retrogressive and injurious to economic growth. It is against this backdrop that this study tried to find out the impact of solid mineral resources on Nigeria economic growth (1982 –2021). In view of the above problem, the following research questions were raised to guide or direct the study:

i. to what extent have solid mineral deposits impacted on the growth of Nigeria's economy?
ii. what is the direction of causality between solid mineral resources and economic growth in Nigeria?

Research hypotheses

Based on the above research questions, the null hypotheses of the study are:

1. Solid minerals does not impact significantly on Nigeria's economic growth
2. There is no directional causality between solid mineral resources and Nigeria economic growth.

2. LITERATURE REVIEW

Theory of Natural Resources

Theory of natural resources can be traced to the classical thesis by Lewis C. Gray (1914) and Harold and Hotelling (1931). Gray (1914) explained that the supply behaviour of a single extractor over time would forestall rise in prices in other to maximize discount profit. On the issue mode of utilizing non-renewable resources Gray emphasize the essential need to take into account the present level of consumption while estimating future level of consumption of non-renewable resources (Stephen 1995).

Gray further opined that, as certain mineral resources stock remains fixed, and their constant extraction will surely prevent future production. Therefore, certain specific mineral deposits will only be extracted in the future if they are not presently extracted. Their deferment for future extraction means that there is excess marginal revenue above marginal cost. Gray inculcated discount rate as a critical factor for the extraction of non-renewable mineral resources. Hence, the introduction of a discount rate in the current extraction of an extra unit of output will result to postponement to a future period if the current value of the difference between revenue and costs for an additional unit in the future than that of the current value. Thus, he further harangued that a rise in the price of mines products, all things being equal, will translate to an increase in output. Thus, the current prices reflect future scarcity. So, any mines that cannot earn royalty cannot fetch rent and, therefore, does not have capitalized value.

Solow's Theory of Natural Resources

Solow while dealing with the issue of natural resources based on royalty and interest rate explained that general price will increase over time at a rate that is equivalent to that of the interest rate. Thus, if the price level continues to increase over time, a time will come when people will be left with no other option than to switch to the alternative mineral resources in order to meet their increasing demand, which will usher in a new era where such minerals would go into extinction. Consequently, Solow asserted that, if the interest received by the owners of non-renewable resources is higher than that of social discount rate, the owners of such resources will extract more swiftly than that of socially optimal path which would eventually left a lesser stock of such non-renewable resources for the future. This, therefore, suggest an orderly progression in exploitation of mineral resources from the highest quality resources to the lesser quality resources. Hence, as exhaustion of higher quality minerals approaches, prices are hiked and lesser-quality resources are brought into production. The theory also suggests that, even though lower quality resources are brought into production as a result of exhaustion in quantity of higher mines, the market price may fall if the effect of technology is higher than the effect of the declining natural resource.

Classical Theory of Exploitation of Exhaustible Minerals Resources

The classical theory of exploitation of non-renewable mineral resources championed by Adam Smith proffers a holistic explanation on the mining industries, where he opined that under fixed conditions high quality mines will yield normal profits, and under dynamic circumstance, the discovery of low-cost mines will lead to the abandonment of expensive resources. While the new and relatively low-cost resources (mines) have a critical part in determining price level.

The Theory of Balance Growth

This theory harangued that for growth to take place it is necessary for an instantaneous and simultaneous development in various sectors of the economy such that all the sectors grow in union. Thus, the balance growth theory states that the demand and supply sides of the economy should grow together. The supply side of the theory is accentuated on rising incomes, which will in turn increase the demand for goods and services. While the demand side also emphasized on the complementary industries, as well as the consumer goods industries, most especially agriculture and manufacturing industries. Hence, as all these industries are concurrently set up, a large number of people will be employed, which will in turn create inter-industrial demand for each other's goods and services.

Empirical literature

Olumide, Akongwale, and Udefuna (2013) carried out a study on diversification of the Nigerian economy; a role for solid mineral development. The authors adopted qualitative technique of data analysis. Their work revealed that the solid mineral sector has capacity to support Nigerian economy positively. Their study also asserted that the growth in solid mineral sector will aid in curbing the high level of poverty in Nigeria, especially, giving the forward linkages with other sectors of the economy. More prominently, it could be a better alternative to overcome the challenges of over-dependency on crude oil which has plagued the structure of Nigerian economy. Nigerian economy has suffered greatly from the fluctuations in the global oil market. Thus, their study

recommended that government should provide enabling environment for the private sector to participate in the solid mineral sub-sector.

Charles and Osuala (2015), investigate the socioeconomic effect of colonial Tin mining in Jos-Plateau state, 1904 – 1960. The study adopted a historical approach in its analysis. Their study revealed that Tin-ore was mined mainly in local streams, and was used by smiths for different metal works on brass and bronze and was used for the production of luxury items. However, with the arrival of British rule, the sector witnessed a new pattern of appropriating people's land either by direct force or by cunningly influencing their leaders. Hence, the mining industry was a source of revenue for the Nation's economy. They also found, that there was negative impact in terms of land degradation, health hazards, and loss of cultural heritage, and farmlands. However, they concluded that there were positive effects of Tin to the socio-economic wellbeing of the people of Jos in terms of rising income, job creation, population growth, etc.

Onwuka, Duluora, and Okoye (2013) carried out a study on the Socio-Economic Impacts of Tin Mining in Jos, Plateau State, Nigeria, using Analysis of Variance (ANOVA) in their analysis and they found that there is a substantial difference between the social components and tin mining in Jos. The study also found a positive effect amongst the economic variables and tin mining activities in Plateau State. Their work further revealed that tin mining venture has a significant negative effect on the environment, and adverse effect on socio-economic activities of Nigerians. The paper suggested the need for government to pay critical attention to environmental matters. Inuwa (2019) investigate the relationship between coal consumption and Nigeria's economic growth from 1980-2010, by adopting a two-step residual based method of co-integration and the Granger causality test. The author observed co-integration between Nigeria's economic growth and coal consumption in Nigeria in the long run while in the short run uni-directional relationship was observed between economic growth and coal consumption.

Nwogwugwu, Ebele, and Ebenebe (2021), searched the relationship between solid mineral Development and Nigeria Economic Growth from 1980 to 2020 using canonical co-integrating regression (CCR) technique. The result obtained from their analysis show that solid mineral production had substantial positive impact on Nigeria's economic growth. In other words, solid mineral production will translate to increase in investment of intermediate and capital goods, which engender increased aggregate demand. They concluded that solid mineral export is very crucial to economic growth. The paper recommends that; government should increase funding in the solid mineral sector, support research and development that will not only enhance production of solid minerals but also engender development of non-renewable resources.

Ajie, Okoh, and Ojiya (2019) study the significant of solid mineral resources on Nigeria economy, using OLS and causality approaches. They examined the possibility of solid mineral resources production as a viable alternative to the crude oil production in Nigeria, considering the fluctuations in production, coupled with the incessant crises in the oil-producing region that make it defective as a revenue source for the nation. The authors conduct unit root test on their variables, which show that the variables were stationary at first difference 1(1). Their major finding was that a billion-naira worth of investment in solid minerals sub-sector would generate 0.26 billion naira to Nigerian GDP. Their study among other things recommends that; government should formulate a clear export-promotion program premised on the principles of comparative advantage to stimulate economic growth. Government should also encourage private sector investment, both local and foreign, provide stable exchange rates and assurances of security of lives and property so that attacks by herdsmen, Boko Haram, unknown gunmen, kidnapping, insurgency, etc., across the country will stop. These security challenges have greatly affected the exploration of solid minerals activities across regions in Nigeria. It is important to emphasize that this research work adopted Auto Regressive Distributed Lag model estimation technique to analyze data for the model variables.

Theoretical Framework

Neo-Classical Economic Growth Theory

The study model was drawn from neoclassical growth theory by Meade (1960). According to J.E Meade, the total output produced in an economy depends upon 4 factors:

i. Total stock of capital available in the form of machines,
ii. Number of the available labour force,
iii. Availability of land and natural resources, and
iv. The state of technical knowledge which continues to improve over time.

This production combination is presented as:
Y = F (K, L, N, t) Jhingan (2010). According to Chambers and Guo (2013) cited from Nwogwugwu et al. (2021)
Y = F (K, L, R, t)
Where: R= renewable natural resources.
Y = total output or total national income, K= labour force, N = land and natural resources, and
t = time (technical progress).
If natural resource is fixed, total output can be raised in any period with the increase in K, L, and t. Thus:
$\Delta Y = V\Delta K + W\Delta L + \Delta Y1$ …… (1)
Δ represents an increase,
V represents marginal product of capital,
W represent marginal product of labour and
Y1 is used in place of t.
Equation one, simply means that an increase in total output over the years (ΔY) will be equal to increase in the stock of machinery (ΔK) multiplied by its marginal products (V) plus increase in the number of labour (ΔL) multiplied by its marginal products (W) plus increase in the rate of annual output due to technical progress (ΔY1). This, therefore, means that investment in the solid minerals sector proxied by solid minerals production will generate significant increase in the economy growth rate.

3. METHODOLOGY

Model Specification and Justification

The autoregressive distributive lag model(ARDL) is a least square model that includes lags of both the explained variable and the explanatory variables. It is a method of explaining co-integrating relationships between variables. The autoregressive distributive lag model was initially introduced by Pesaran and Shin (1999) and later expanded by Pesaran, (Shin, and Smith 2001). The ARDL technique was employed in this study because of its applicability to estimate the chosen variables that have different levels of integration. The uniqueness of our model is proven by its applicability in estimating variables that are integrated at different order [that is 1(0), 1(1), and not 1(2)], and also its ability to estimate both short-run and long-run coefficients instantaneously. The ARDL model in this study is specified in the following form:

$\Delta RGDPR_t = a_0\sum_{t=1}^{n} a_1\Delta RGDPR_{t-i} + \sum_{t=1}^{n} a_2\Delta COL_{t-i} + \sum_{t=1}^{n} a_3\Delta ORE_{t-i} + \sum_{t=1}^{n} a_4\Delta QOD_{t-i} + \sum_{t=1}^{n} a_5\Delta GCF_{t-i} + \sum_{t=1}^{n} a_6\Delta FDI_{t-i} + \sum_{t=1}^{n} a_7\Delta POPGR_{t-i} + \varepsilon_t$ …… (2)

$\Delta RGDPR_t = a_0\sum_{t=1}^{n} a_1RGDPR_{t-i} + \sum_{t=1}^{n} a_2COL_{t-i} + \sum_{t=1}^{n} a_3ORE_{t-i} + \sum_{t=1}^{n} a_4QOD_{t-i} + \sum_{t=1}^{n} a_5GCF_{t-i} + \sum_{t=1}^{n} a_6FDI_{t-i} + \sum_{t=1}^{n} a_7POPGR_{t-i} + \lambda ECT_{t-i}$…….... (3)

Equation 1 represents the short-run (ARDL) Model while equation 2 is the error correction model (ECM).
Combining equation 1 and 2 we have

$\Delta RGDPR_t = a_0\sum_{t=1}^{n} a_1\Delta RGDPR_{t-i} + \sum_{t=1}^{n} a_2\Delta COL_{t-i} + \sum_{t=1}^{n} a_3\Delta ORE_{t-i} + \sum_{t=1}^{n} a_4\Delta QOD_{t-i} + \sum_{t=1}^{n} a_5\Delta GCF_{t-i} + \sum_{t=1}^{n} a_6\Delta FDI_{t-i} + \sum_{t=1}^{n} a_7\Delta POPGR_{t-I} + a_8RGDPR_{t-1} + a_9COL_{t-1} + a_{10}ORE_{t-1} + a_{11}QOD_{t-1} + a_{12}GCF_{t-1} + a_{13}FDI_{t-1} + a_{14}POPGR_{t-1} + \lambda ECT_{t-1}$ ……(3)

Where:
RGDPR = Real Gross Domestic product rate
COL = Coal production
ORE = Metal ores production
QOD = Quarrying and other solid minerals production
GFCF = Gross fix Capital Formation
FDI = Foreign Direct Investment a proxy for technological advancement
POPGR = Population growth rate a proxy for labour force
a_0 = intercept or average effect on the dependent variable
$a_1 - a_6$ = the coefficients of the model, which measure the mean change of the RGDPR per unit change in individual independent variables.
Δ = the first difference operator
εt = the error term which covers the effect of other variables that might be excluded in the model (RGDPR).
λ = (1-δi), measures the speed of adjustment of the parameter
ECT = Error correction term
a1, a2,a3, a4, a5, and a6 are the short-run dynamic coefficients of the model.
While a8, a9,a10, a11, a12¸ a13, and a14 are the long-run dynamics coefficient of the model.
The existence of the long-run relationship among the variables was captured using the Bounds Test under Pesaran, Shin, and Smith (2001) Procedure.
The Bounds Test is premised on a null hypothesis, that there is no co-integration between the variables.

H0: a8 = 0, a9 = a10 = a11 = a12 = a13 = a14 = 0
Since our data are time series, we explore the stationarity variables, using the Augmented Dickey-Fuller unit root test.

The functional form of the model is expressed as:

Model I
RGDPR = f(COL, ORE, QOD, GCF , FDI, POPGR) …….…….... (4)
Mathematical form of equation 1, is stated as:
RGDPR = a0 + a1COL + a2ORE + a3QOD + a4GCF+ a5FDI +a3POPGR ……..(5)
Converting the system equation in equation 2 to econometric form would give us:
RGDPR = a0 + a1COL + a2ORE + a3QOD + a4GCF+ a5FDI +a6POPGR + µt……(6)
Where:
RGDPR = Real Gross Domestic product rate
COL = Coal production
ORE = Metal ores production
QOD = Quarrying and other minerals production
GFCF = Gross fix Capital Formation
FDI = Foreign Direct Investment, a proxy for technological advancement
POPGR = Population growth rate, a proxy for labour force

GDP: Several literatures have used GDP as a measure of economic growth. For instance, Hicks (1969) alongside other scholars like (Allen & Ndikumana, 2000; Asiedu, 2002; Chakrabarti, 2003; Asheghian, 2004; Adams, 2009), and Opukiri and Eduomiekumo (2015), have all used GDP to model economic growth. Conversely, Sen (1999) viewed economic growth from the point of humanitarian perception. He opined that economic growth can be best measured by the advancement in human capital development, reduction in household poverty, societal freedom, equality in political opportunities, population growth, etc. Also, several econometric concerns have emanated from these empirical procedures. GDP in real terms measures the size of the economy rather than economic growth (Grossman and Helpman 2016). Real GDP growth rate possesses a better measure of economic growth as utilized by recent scholars like Nwogwugwu et al. (2021) and Muftau and Onaopemipo (2022) etc. thus, real GDP growth rate was used as dependent variable in this study.

GCF: measures the government's investment in the economy; it is a stock of capital assets kept for productive activities in the real sector of the economy can lead to further growth in the physical capital assets of the nation. GCF is a real value added to the economy in real asset term can propelled more saving, investment and generate more wealth in the future. It is employed in the model as a control variable. It is included to eliminate the issue of spurious causal effects as a result of the omission of essential variables from the investigated relationship (Aziz, 2000).

Foreign Direct Investment (FDI): this is conceptualized as an investment in an enterprise situated in a country but controlled essentially by residents of another country (UNCTAD 2009, cited from Chidinma, et al 2019). However, FDI is an influx of foreign assets in form of capital, technology, managerial skills, and marketing enterprise into the host nation (Ndiyo and Ebong, 2003 cited from Chidinma et al 2019). Moreover, according to Agosin and Mayer (2000), FDI is valued by developing countries for the assets bundle deployed by multinational enterprises (MNEs) through investments. These assets include advanced technology, improved management proficiency, enhanced network for international product marketing and enhanced product design, superior quality characteristics, and brand names. Thus, FDI is included in this model to capture technological advancement in the country.

Sources of Data Collection and the Method of Data Analysis
The data for this research was sourced from the CBN statistical bulletin of the various years. The variables adopted in this study are RGDPR, Solid minerals production (Coal, Metal Ores, and Quarrying and other minerals), Gross capital formation (GCF); Technology Advancement proxied by FDI, and Labour force proxied by population growth rate. See table 3.1.

Table 3.1 Data sources

Variables	Variable Description	Measurement	Source
RGDPR	RGDP growth rate RGDPR=$(\frac{RGDPt-RGDPt-1}{RGDPt-1})X100$	Growth rate of real Domestic product in percentage	CBN Statistical Bulletin, 2021
COL	Contribution of coal to GDP	Percentage contribution of coal to GDP	CBN statistical Bulletin, 2021
ORE	Contribution of Metal Ores to GDP	Percentage contribution of Metal Ores to GDP	CBN statistical Bulletin, 2021
QOD	Contribution of Quarrying and other Solid minerals contribution to GDP	Percentage contribution of Quarrying and other solid minerals to GDP	CBN statistical Bulletin, 2021
FDI	Foreign direct investment as a proxy for Technology advancement	Technology advancement contribution to GDP	CBN statistical Bulletin, 2021
GCF	Gross Capital Formation a proxy for physical asset	Increase in physical asset	CBN statistical Bulletin, 2021
POPGR	Population growth rate as proxy of human capital embodied in labour force	Growth rate of population in Percentage	World development indicator (WDI) 2021

Author's computation 2024

Various tests were conducted which includes; the Var lag order selection test, stationarity test, Bound Co-integration test, Breusch-Godfrey serial Correction test, CUSUM stability test, and ARDL estimation techniques to analyze data for the selected model variables.

4. DATA PRESENTATION AND DISCUSSION

The variables for the analysis are: real GDP growth rate (RGDPR), Coal (COL), Metal Ore (ORE), Quarrying and other solid minerals (QOD), Foreign Direct Investment (FDI) a proxy for technology advancement, Gross Capital Formation (GCF) and Population growth rate (POPGR).

Table 4.1 Descriptive Statistics

	RGDPR	COL	ORE	QOD	GCF	FDI	POPGR
Mean	20.34675	80.99575	73.28100	100.6708	8226.834	377883.4	2.576028
Median	14.51000	80.18500	60.15000	34.87000	2776.125	113621.5	2.572087
Maximum	75.27000	211.8200	210.7100	961.0400	58293.95	1360308.	2.680930
Minimum	4.470000	24.97000	12.93000	2.230000	87.14000	264.3000	2.488792
Std. Dev.	14.79884	46.73211	47.96814	188.4390	12619.70	435204.2	0.063593
Skewness	1.624156	0.756102	0.976253	3.317459	2.457032	0.826505	0.153419
Kurtosis	6.155458	3.379355	3.583677	14.02429	9.006419	2.226495	1.686338
Jarque-Bera	34.18074	4.051114	6.921595	275.9285	100.3751	5.551249	3.033094
Probability	0.000000	0.131920	0.031405	0.000000	0.000000	0.062311	0.219468
Sum	813.8700	3239.830	2931.240	4026.830	329073.4	15115336	103.0411
Sum Sq. Dev.	8541.225	85171.73	89736.75	1384861	6.21E+09	7.39E+12	0.157717
Observations	40	40	40	40	40	40	40

Source: Author's computation 2024.

The descriptive statistics in Table 4.1 show that RGDPR, COL, ORE, GCF, FDI, and POPGR have skewness of 1.624156, 0.756102, 0.976253, 3.317459, 2.457032, 0.826505, and 0.153419 respectively. This shows that all the variables employed in this research are positively skewed. All the variables used for analysis show evidence of no kurtosis. The Jarque-Bera statistics values show that RGDPR, ORE, GCF, and FDI are normally distributed. This is also evident in their probability values.

Table 4.2 Augmented Dickey-Fuller Unit Root Test Result

VARIABLES	ADF TEST STATISTICS @LEVEL	MacKinnon critical value @level at a 5% level	ADF TEST STATISTICS @ first Difference	MacKinnon critical value @first difference at 5% level	Included in the equation	Decision
RGDPR	-4.826363*	-3.610453	-		Intercept	1(0)
COL	-0.369506	-2.938987	-8.625487*	-2.941145	Intercept	1(1)
ORE	-3.530880*	-2.938987	-	-	Intercept	1(0)
QOD	-2.161024	-2.938987	-8.995574*	-2.941145	Intercept	1(1)
POPGR	-5.151357*	-2.960411	-	-	Intercept	1(0)
GCF	-3.969485*	-2.938987	-	-	Intercept	1(0)
FDI	-1.562919	-2.938987	-6.965280*	-2.941145	Intercept	1(1)

***Significant at 5% level**
Source: Authors' Computation 2024

The ADF test result in Table 4.2 show that COL, QOD, and GCF exhibit a random walk but became stationary after differencing once, while RGDPR, ORE, POPGR, GCF, and FDI were all stationary at levels. Thus, it becomes expedient to test for the presence of any co-integration vectors within the variables using the bound test and the Johansen co-integration test.

Having ascertained that the variables are stationary at different levels, 1(0) and 1(1), it therefore, implies that the ARDL model is appropriate for our estimation. Hence, we proceed to estimate our model using the ADRL model. First, we conduct the bound and Granger causality test.

Table 4.3 Bound Test Result

Panel A		
Test Statistics	Value	K
F-statistics	6.010929*	6
Panel B		
Critical Value Bound	1(0)	1(1)
(at 5% Significance level)	2.45	3.61

*Significance at 5%
Source: Authors' Computation using E-view 9

Since our F-statistics of 6.01 from our bound test result is higher than the critical upper bound of 3.61 at 5 % significance level, we clinch that there is a long-run correlation between Nigeria economic growth and solid mineral resources production in Nigeria from 1982 to 2021.

Table 4.4 Johansen's Co-Integration Test Result

Series: D(RGDPR)

Exogenous series: D(COL) D(ORE) D(QOD) D(FDI) D(GCF) D(POPGR)

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.391327	17.87305	3.841466	0.0000

The result in Table 4.4 show that there is one (1) co-integrating equation, revealing the presence of a long-run relationship between solid mineral resources and Nigeria economic growth. Having ascertained that both the bound test and Johansen Co-integration test confirm the existence of a long-run co-integration among the variables in our model, we proceed to estimate the long-run model.

Table 4.5 ARDL Model Estimation

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
RGDPR(-1)	0.059918	0.159050	0.376726	0.0702
COL	0.027024	0.147762	0.182891	0.8562
COL(-1)	0.338414	0.137001	2.470146	0.0199
ORE	0.098068	0.409048	0.239748	0.0813
ORE(-1)	-0.704743	0.484708	-1.453952	0.1571
QOD	0.017804	0.014997	1.187236	0.0241
GCF	5.10E-05	0.002729	0.018677	0.7205
FDI	3.89E-06	1.08E-05	0.361445	0.0737
POPGR	-250.6573	134.9119	-1.857934	0.0737
POPGR(-1)	261.3503	128.1931	2.038723	0.0510
C	2.158914	201.7326	0.010702	0.9915
R-squared	0.549729	Mean dependent var		22.19410
Adjusted R-squared	0.466285	S.D. dependent var		16.22836
S.E. of regression	13.89305	Akaike info criterion		8.333400
Sum squared resid	5404.471	Schwarz criterion		8.802610
Log likelihood	-151.5013	Hannan-Quinn criter.		8.501748
F-statistic	3.384869	Durbin-Watson stat		1.501887
Prob(F-statistic)	0.009840			

Source: Author's own computation using E-view 9

F(0.5) (6, 33)
$F_{CAL} > F_{TAB}$ (3.38 > 2.42)

Table 4.5 showed that the model is statistically significant. It also shows that RGDPR (-1) exerts a positive and significant impact on Nigeria's Economic Growth, Lag coal (COL (-1)), ORE, QOD, FDI and lag POPGR (-1) are all positive and significant to RGDPR. Therefore, null hypothesis one ($H_0$1) was rejected, and we conclude that solid mineral resources production in Nigeria have considerable (significant) impact on Nigerian economic growth (RGDPR) process in the study period. The result conforms to the finding of Nwogwugwu et al. (2021). It implies that solid minerals production drives economic growth process, increase in solid mineral production will lead to a spontaneous upsurge in the RGDPR. A rise in solid mineral resources production will contribute to labour absorption, and reduce the prevalent unemployment rate in Nigeria. In addition, an increase in solid mineral production will also stimulate growth in foreign exchange earnings.

On the other hand, gross capital formation (GCF) was positively but not significantly related to Nigeria's economic growth process in the study period. Kanu, and Ozurumba (2014), and Nweke et al (2017) in their research study had similar findings. The result indicates that gross capital formation has not been properly channeled to Nigeria's economic growth programmes. Labour force (POPGR) exerts negative and significant impact on Nigeria's economic growth (RGDPR).

Serial Correlation Test result

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.134873	Prob. F(1,26)	0.2965
Obs*R-squared	1.631114	Prob. Chi-Square(1)	0.2015

The result above reveal that the model is free from serial correlation since the p-value (0.2015) is higher than the 5% (0.05) level of significance, and thus, fit for the OLS estimate.

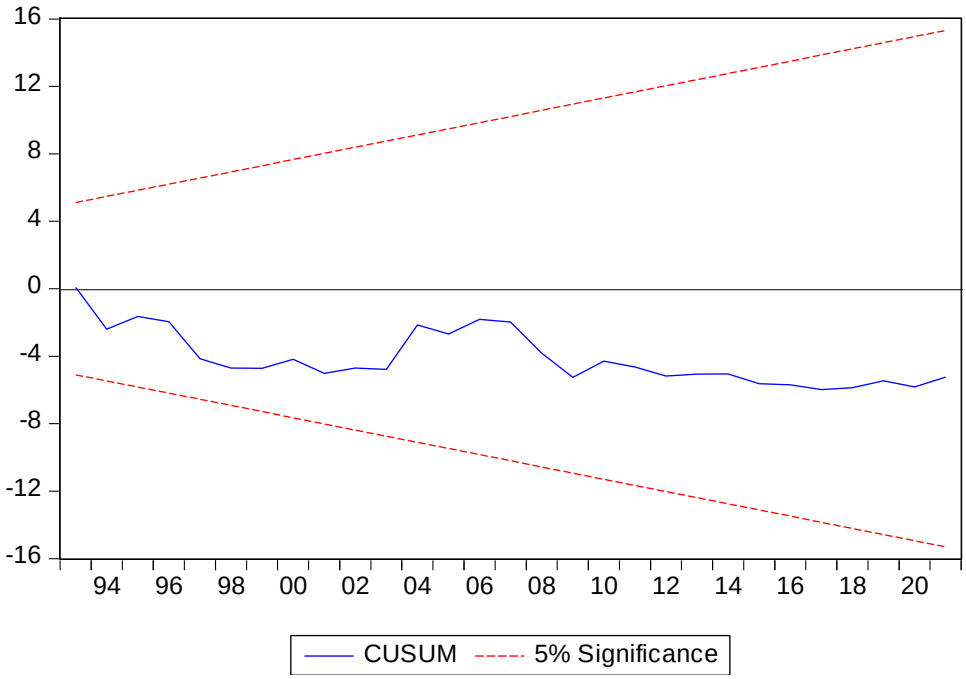

Figure 4.2.1: CUSUM Cumulative Test

The CUSUM cumulative test result in Figure 4.2.1 displays the stability of the coefficients of the model and a confirmation of the normality of errors. The CUSUM statistic is within the critical bounds of the 5% level of significance parameter stability. Hence, the model is stable and free from serial correlation, it is safe therefore, to estimate ARDL long-run and error-correcting model.

Table 4.6. ARDL Cointegrating and Long-Run Error Correction Test Result

Dependent Variable: RGDPR Method: ARDL				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
COL	0.388730	0.211826	1.835134	0.0771*
ORE	-0.645342	0.255290	-2.527875	0.0174*
QOD	0.018939	0.016453	1.151091	0.0594*
GCF	0.000054	0.002904	0.018670	0.9852
FDI	0.000004	0.000011	0.364279	0.7184
POPGR	11.374507	81.871810	0.138931	0.8905
C	2.296517	214.467505	0.010708	0.9915
ECT(-1)	-0.940082	0.159050	-5.910616	0.0000*

*Indicate 5% level of Significance

Source: Authors' computation 2024

From the result above the ECT (-1) (Error-correcting term) of -0.940082 is well specified and is significant at 5% level. This reveals a feedback mechanism of about 94% of the preceding year's imbalance from the long-run RGDPR elasticity. The absolute value of ECT (-1) revealed that about 94% of the disequilibrium in the short-run and long-run growth model was offset within a year. Thus, the significance of the ECT offer more evidence of the long-run co-integration dynamics that prevailed between the real GDP growth rate and its regressors.

The error correcting term in Table 4.6, showed that RGDPR is influenced by coal (COL), and Quarrying and other solid minerals (QOD). Metal ores have negative impact on RGDPR. Gross capital formation, foreign direct investment, and population growth rate had insignificant but positive influence on Nigerian economic growth (RGDPR). In other words, capital formation, technology, and human capital in Nigeria have not been fully utilized for production activities particularly in the solid minerals sector. This observation is also in conformity with the findings of Nweke et al. (2017). This, therefore, calls for urgent attention of government and its agencies to embark on manpower training and recruitment of the very best to effectively manage sensitive positions in the solid mineral sector. Furthermore, the coefficients of COL, QOD, GCF, FDI and POPGR are 0.38870, 0.018939, 0.000054, 0.000005 and 11.374507 respectively, indicating that a unit increase in COL, QOD, GCF, FDI and POPGR will bring about 0.4, 0.19, 0.01, 0.001 and 11.4 increase in real GDP growth rate (RGDPR).

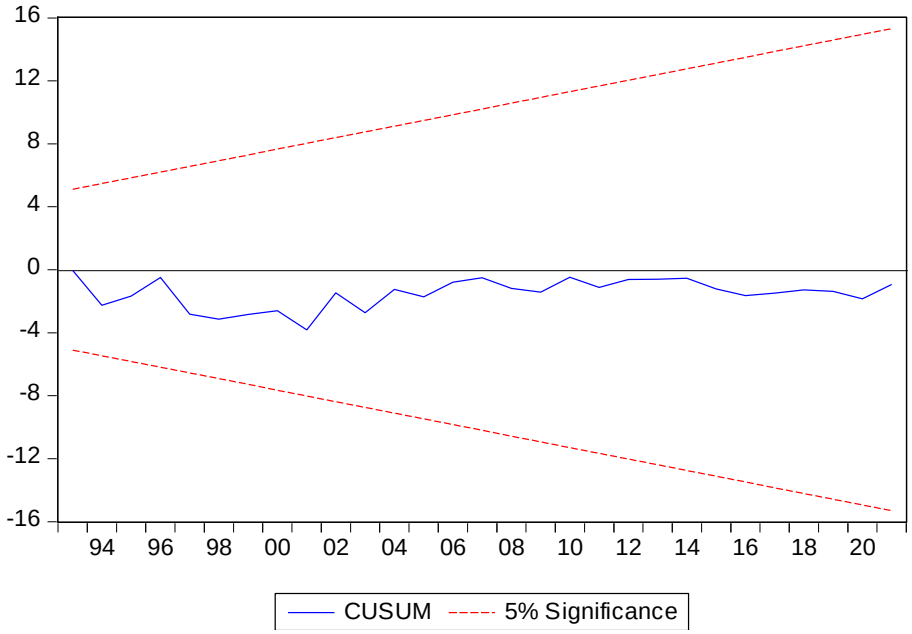

Figure 4.2.2 Long-Run CUSUM Stability Test

The long-run CUSUM test revealed that the model is stable as shown by the blue lying between the acceptable region at 5% level of significance. Thus, suggesting that the model estimate is robust and adequate to draw inferences with much confidence.

Conclusion and Recommendations

This study empirically explored the solid mineral resources sector and economic growth in Nigeria between 1982 and 2021. It observed that, increase in investment in solid minerals would have considerable positive impact on Nigeria's real GDP growth, generate gainful employment, and raise foreign exchange earnings and total national income. This implies that the solid mineral sector is a critical contributor to the Nigeria's real GDP growth in the study period. However, Metal Ores in the long run had a negative but significant influence on RGDPR, indicating that exploitation of some solid minerals (Metal Ores) deposits have not been given prime attention to by the Nigerian government. The solid mineral subsector if well positioned, will provide foreign exchange earnings, absorb more labour, reduce illegal mining, and can serve as a promoter of growth and development in Nigeria's economy.

Based on the findings of the study, we made the following recommendations:

i. Increase investment in solid minerals: Although solid minerals were found to drive economic growth within the period of study, their impact is still little, thus, government should increase investment in the solid minerals subsector. Increase in solid mineral extraction will engender increase in the economic growth of the nation.
ii. Proper monitoring and regulating framework on the Nigeria solid mineral subsector. Government in collaboration with the Ministry of Solid Mineral Development should properly fortify its regulating and monitoring framework to eliminate illegal activities and minimize leakages in the solid minerals subsector.
iii. Private participation in the activities of the solid mineral subsector: Nigerian government should as a matter of urgency encourage private investment in solid mineral resources by providing the required infrastructure, security, and political environment needed to stimulate private investment.
iv. There is need for the government and its agencies to embark on manpower training and recruitment in the solid mineral subsector of the economy to man key positions.

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