Solid Mineral and Economic Growth in Nigeria

Kingdom Mienebimo, PhD, Student,
Niger Delta University, Wilberforce Island
Amassoma, Bayelsa

Dr Baghebo, Michael
(Assoc. Prof of Economics)
Department of Economics, Faculty of Social sciences,
Niger Delta University, Wilberforce Island, Nigeria
Corresponding Author Dr Michael Baghebo,
Email: michaelbaghebo@ndu.edu.ng
PO BOX 1147, Yenagoa, Bayelsa State, Nigeria
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Abstract

This research investigates the complex relationship between solid mineral exploration and economic growth in Nigeria. The study examines several variables, including real gross domestic product (GDP), solid mineral deposits, gross fixed capital formation, population growth, exchange rates, and inflation rates. These factors are analyzed using economic theories such as the neoclassical and endogenous growth models. Empirical findings highlight the diverse impacts of solid minerals development on economic growth across various nations. The study utilized the Auto Regressive Distributed Lag (ARDL) model, analyzing time series data from 1981 to 2022. Stationarity tests were conducted on the time series data, and all results were evaluated at a 5% significance level. Findings revealed that solid minerals had a positive but statistically insignificant impact on economic growth in Nigeria. The study recommends that the government should develop a solid mineral growth plan and enhance the regulatory framework governing the sector to stimulate economic growth in Nigeria.

Keywords: *Solid Mineral, Economic Growth, Autoregressive Distributed Lag Model*

1.1 Introduction

Nigeria is blessed with an abundance of solid minerals, including iron ore, coal, limestone, and gold. Despite these vast resources, the mining sector's contribution to the nation’s economic growth has been minimal. As Nigeria, known for its extensive mineral wealth, faces a critical point, the country is grappling with policy reforms aimed at rejuvenating the underperforming mining industry. The mining sector has long been viewed as a potential driver of economic growth and development (National Bureau of Statistics, 2022). The establishment of the proposed Solid Minerals Corporation is seen as a strategic effort to diversify Nigeria's revenue base and enhance its position as a major exporter of crucial solid minerals. The solid mineral sector encompasses coal mining, metal ores, quarrying, and other minerals (Central Bank of Nigeria [CBN], 2020).

Despite the widespread availability of these resources, their contribution to Nigeria's Gross Domestic Product (GDP) has been underwhelming over the past three decades. For instance, solid mineral output, as reported by the CBN (2020), fell from N67.14 billion in 1981 to N29.09 billion in 1990, and further declined to N21.31 billion in 2000. However, from 2003, there was an upward trend, with output increasing from N23.20 billion in 2003 to N51.88 billion in 2010, and further to N96.60 billion in 2018 and N106.2 billion in 2020. Nevertheless, when analyzed as a percentage of GDP, the contribution of solid minerals has generally declined over time, dropping from 0.44% in 1981 to 0.15% in 1990, and then to 0.089% in 2000, before rising slightly from 0.093% in 2010 to 0.15% in 2020.

The lackluster performance of the solid mineral sector has been attributed to inadequate geoscience data, limited funding, insufficient infrastructure, federal-state tensions, illegal mining, community conflicts, weak regulatory oversight, poor enforcement of regulations, and unfavorable business conditions (Ministry of Solid Mineral Development [MSMD], 2023).

Regarding economic growth, Nigeria's economy recovered from recession in the early 1980s and reached a growth rate of about 6.4% in 1989. However, growth slowed to an average of 2.6% between 1990 and 1999. From 2000 to 2014, GDP grew at an average rate of 7.9%, but this declined to 2.65% in 2015 and further recessed to -1.62% in 2016. A slow recovery followed, with growth rates of 0.81% in 2017 and 1.92% in 2018 (CBN, 2018). By the end of 2021, the National Bureau of Statistics (NBS) reported a GDP growth of 3.4%, surpassing initial projections (NBS, 2022).

To revitalize the mining sector, the Nigerian government established the Ministry of Solid Mineral Development in 1999, which spurred renewed interest in the sector. The solid mineral industry has also emerged as an alternative source of foreign exchange, particularly given the instability of oil revenues due to fluctuating global oil prices, challenges in the Niger Delta, and other factors such as ineffective management, limited benefits, and weaker institutional development (Natural Resource Governance Institute [NGRI], 2015).

The pressing question remains: How has solid mineral exploration affected Nigeria's economic growth? Solid mineral exploration encompasses a spectrum of activities, from locating and extracting minerals to producing solid formations with stable shapes and volumes. In contrast, economic growth refers to a sustained increase in the value of goods and services produced within an economy over time (Jhingan, 2014).

Successive Nigerian administrations have endeavored to diversify the economy beyond oil dependence by harnessing the country's mineral resources and agricultural potential. Recent government initiatives have aimed to transform Nigeria from a mono-product economy. However, questions remain about the effectiveness of these interventions in making other sectors significantly contribute to economic growth. Beyond oil exports, sectors such as solid minerals, agriculture, industry, transportation, communications, and food production have attracted government focus.

Scholars like Baghebo (2012) and Ekaette (2009) highlighted the paradox of Nigeria's oil-dependent economy, where economic growth has not led to proportional job creation or poverty

reduction. Similar concerns were echoed by Bawa and Mohammed (2017) and Baridam (2008), who noted rising unemployment alongside economic growth. This disparity is attributed to the oil sector's control by a small fraction of the population, including expatriates and political elites, limiting its linkage and multiplier effects on the broader economy. The local-content policy of former President Goodluck Jonathan's administration, aimed at increasing domestic participation, is commendable if implemented sincerely.

Nigeria's over-reliance on oil has overshadowed other non-oil sectors, reducing foreign reserves and worsening unemployment and poverty levels. Hence, it is essential to assess the impact of non-oil exports on Nigeria's economic growth, which is the focus of this study. Specifically, this research examines the short- and long-term effects of non-oil exports, including agricultural, solid mineral, and manufacturing exports, on economic growth in Nigeria.

The rest of the paper is structured as follows: Section Two briefly reviews the relevant literature; Section Three outlines the methodology and model specifications; Section Four presents and interprets the data; and Section Five discusses the conclusions and policy recommendations.

2. Literatures Review

This section deals with the conceptual clarification, theoretical frameworks and empirical literature.

2.1 Conceptual Clarifications

2.1.1 Solid Minerals

According to the International Valuation Guidance Note for Extractive Industries (2017), minerals are defined as any naturally occurring substances that are valuable or useful to humans and found in the Earth's crust. Similarly, the Committee on National Policy on Solid Minerals (1995), as cited by Odumodu (2020), defines minerals as naturally occurring substances extracted from the Earth's crust that provide benefits to mankind. These minerals are categorized into groups such as non-metallic, nonferrous, and ferrous minerals. Odumodu (2020) further classifies minerals into solid and liquid categories, while still aligning with the definitions mentioned. Solid minerals specifically refer to naturally occurring substances located above or below the Earth's surface (Odiase-Aiegimenlen, 2016).

In Nigeria, aside from crude oil, key minerals produced include coal, marble, limestone, cassiterite (tin ore), columbite, and gas. Notably, the first five belong to the solid minerals category (Anyanwu, Oaikhena, Oyefusi, & Dimowo, 1997).

2.1.2 Economic Growth

Economists have long debated the most fitting definition of economic growth. A common convention is that real per capita income or output serves as the most dependable indicator of a nation's economic performance at any given time, with changes in these metrics reflecting shifts in overall welfare (Oriavwote & Eshenake, 2013). Economic growth is typically defined as an increase in the production of goods and services in an economy over a specified period. It is commonly expressed as a percentage increase in real Gross Domestic Product (GDP), which adjusts for inflation to provide a clearer view of growth by eliminating the distorting effects of price changes (Omojimite, 2012).

Economic growth is generally measured by GDP, representing the market value of all officially recognized final goods and services produced within a country during a specific timeframe. GDP per capita is frequently used as an indicator of a country's standard of living, though it does not directly measure personal income. As a critical concept in macroeconomics, GDP ties closely to national accounts and was first formulated by Simon Kuznets in a 1934 report to the U.S. Congress. Despite its widespread adoption as a primary economic indicator after the Bretton Woods Conference in 1944, Kuznets cautioned against using GDP as a sole measure of societal welfare.

GDP reflects the total output in economics, defined as the volume of goods or services produced by a firm, industry, or country over a set period, whether these outputs are consumed directly or used for further production. Understanding national output is vital in macroeconomics since it directly correlates with a nation's wealth rather than the mere possession of large sums of money. Net output is positive when the quantity is produced and negative when used as input in production processes. The term "gross" in GDP implies that it measures production without distinguishing between its various uses, such as immediate consumption, investment, or replacement of depreciated assets. "Domestic" indicates that GDP captures the economic activity within a nation's borders, encompassing private and public consumption, government expenditures, investments, and net exports over a given period, usually calculated annually.

2.2 Theoretical Framework

This study explores the impact of solid mineral exploration on economic growth by discussing both the neoclassical and endogenous growth theories. However, the study adopts the endogenous growth theory, which is based on the AK growth model. This theory posits that economic growth is primarily influenced by internal, or endogenous, factors rather than external, or exogenous, elements.

2.2.1 The Neoclassical Theory of Growth

The neoclassical growth theory emerged in the late 1950s and 1960s following extensive research in the field of economic growth. Key contributors to this theory include American economist Robert Solow, a Nobel Laureate, and British economist J. E. Meade. The neoclassical growth model emphasizes the role of capital accumulation and saving decisions as crucial drivers of economic growth. It incorporates a two-factor production function that includes capital and labor as key determinants of output, with an additional exogenous factor—technology—introduced to enhance the production function. Thus, the neoclassical growth model can be expressed through the following production function:

(2.9)

Where

Y = Gross Domestic Product (GDP),

K = Stock ofcapital,

Amount of unskilled labour

A = exogenously determined level of technology.

A change in the exogenous variable, technology, results in a shift in the production function. The technology parameter AAA can be integrated into the production function in two main ways. A common approach is to assume that technology enhances labor, leading to a production function that is expressed as follows:

Y = f!KAL] (2.10)

Labor-augmenting technological change means that it enhances the productivity of labor. Another significant method of integrating the technology factor into the production function is to assume that technological progress boosts the productivity of all factors, including both capital and labor, rather than enhancing labor alone. This is how the production function in equation (i) above is formulated. To reiterate, in this approach, the production function is expressed as follows:

= (2.11)

In this context, AAA represents total factor productivity, capturing the efficiency of both capital and labor inputs. When estimating the production function in this manner, the contribution of AAA to overall output growth is known as the Solow residual, which reflects the portion of output growth not explained by changes in capital and labor inputs.

Unlike the fixed proportion production function of the Harrod-Domar growth model, the neoclassical growth model employs a variable proportion production function, allowing for a flexible substitution between capital and labor in the production process. This flexibility is why it is termed the neoclassical growth model, as earlier neoclassical models also utilized such variable proportion functions.

Another key difference between the neoclassical growth model and the Harrod-Domar model is the assumption that planned investment and savings are always in equilibrium due to immediate price adjustments, including interest rates. Neoclassical growth theory emphasizes supply-side factors like capital and technology as determinants of a country's economic growth rate, unlike the Harrod-Domar model, which views aggregate demand as a limiting factor.

In this model, economic growth is driven in the short run by increased savings and capital formation, though it is constrained by diminishing returns to capital. While the neoclassical model assumes constant returns to scale, it recognizes that capital and labor individually experience diminishing returns.

2.2.2 Endogenous Growth Theory

Endogenous Growth Theory is an economic approach that seeks to explain long-term economic growth by focusing on internal factors such as human capital, technological advancements, and the accumulation of knowledge. Unlike exogenous growth theories that attribute economic progress to external influences like capital accumulation, endogenous growth theories argue that growth is primarily driven by factors within the economy itself.

A significant feature of Endogenous Growth Theory is its emphasis on the role of foreign capital inflows as a driver of economic development. Foreign capital, whether through foreign direct investment (FDI) or foreign portfolio investment, can substantially enhance a country's economic growth. This is particularly significant in the context of knowledge transfer, technology dissemination, and productivity gains that often accompany foreign investment.

Foreign capital flows impact endogenous growth through various mechanisms. Firstly, FDI can introduce advanced technologies and managerial expertise, stimulating innovation and boosting the productivity of local companies (Aghion & Howitt, 1998). Secondly, access to foreign capital markets allows domestic firms to fund research and development, further driving technological innovation and economic expansion (Jones & Romer, 2010).

The mathematical representation of endogenous growth theory frequently includes elements like human capital (H), physical capital (K), technology (A), and labor (L). A prominent model within this framework is Romer's (1986) AK model, which describes output (Y) as a function of physical and human capital and technology:

$Y=A \cdot Ka \cdot H1-aY = A \cdot K^a \cdot H^{1-a}Y=A \cdot Ka \cdot H1-a$

In this equation, AAA denotes the level of technology, KKK stands for physical capital, HHH represents human capital, and aaa is the proportion of output attributed to physical capital.

Foreign capital inflows can be introduced into the model as an influencing factor on the technology parameter (AAA). As foreign investment increases, it can lead to technological spillovers, the diffusion of knowledge, and enhanced productivity, thereby elevating the technology level (AAA). This results in continued economic growth propelled by internal factors.

The implications of foreign capital inflows within the framework of Endogenous Growth Theory are extensive. They not only contribute to technological advancement and productivity enhancement but also promote a more innovative and dynamic domestic economy. However, it is crucial to manage the potential downsides, such as overreliance on foreign capital, and maintain a balance between domestic and foreign investments to achieve sustainable growth.

Endogenous Growth Theory offers a comprehensive perspective on long-term economic development, incorporating the effects of foreign capital flows. Its formula captures the interdependence of human and physical capital, technology, and labor, with foreign capital acting as a crucial catalyst for sustained economic growth.

2.3 Empirical Literature

Numerous empirical studies have explored the relationship between solid minerals and economic growth using different models and variables. A summary of some of these studies is provided below.

Muftau and Onaopemipo (2022) conducted a study on the impact of solid mineral development on Nigeria's economic growth, published in the African Journal of Economics and Sustainable Development. They employed the Auto Regressive Distributed Lag (ARDL) approach using time series data from 1981 to 2019. The study tested the stationarity of the time series, with all results evaluated at a 5% significance level. Findings indicated that solid mineral development had an insignificant positive impact on economic growth in Nigeria. The study recommended the dedicated implementation of solid mineral development plans, enhanced regulatory frameworks, and other measures to accelerate Nigeria's economic growth.

Ahmed (2022) conducted an overview of Nigeria's solid mineral potentials, challenges, and prospects. Despite Nigeria’s rich mineral resources, the sector contributes less than 3% to the nation’s GDP. This underperformance is attributed to overdependence on oil, political instability, weak legal and regulatory frameworks, and outdated geoscientific data, which hinder investment decisions. Recent government initiatives aim to attract foreign investment by providing updated geoscientific data, strengthening legal frameworks, and fostering a conducive investment environment. If effectively implemented, these efforts could revitalize the sector, potentially raising its GDP contribution to 10%. Harnessing these resources could drive economic growth, create jobs, and foster national development.

Nwogwugwu, Nwokoye, and Ebenebe (2021) examined the relationship between solid mineral development and economic growth in Nigeria, using time series data from 1980 to 2020. They applied the canonical cointegrating regression (CCR) model to assess the solid mineral-economic growth nexus. The results revealed that increased solid mineral production

significantly positively affected economic growth, primarily through investments in intermediate and capital goods, which boost aggregate demand. Additionally, the findings indicated that solid mineral exports are crucial for economic growth, whereas mineral depletion could hinder it by eroding business confidence and slowing economic activities. The study recommended increased funding and support for research and technological advancements to optimize solid mineral production and promote renewable resource development.

Mohammed, Abdurrauf, and Bukola (2020) assessed the impact of non-oil exports, including solid minerals, on Nigeria's economic growth. The study considered agricultural exports, solid mineral exports, manufacturing exports, and overall economic growth, using time series data for analysis. The findings revealed that agricultural and manufacturing exports positively and significantly impact economic growth. However, solid mineral exports had a negative and significant impact, attributed to the export of unrefined minerals that are later re-imported as expensive finished products. The study recommended that government investment in agriculture, industry, solid mineral exploration, and manufacturing could enhance production in these sectors and increase the export of goods and services.

Micah and Ibitomi (2020) explored the challenges and strategies for solid mineral resource exploration in Nigeria. The study identified problems such as inadequate infrastructure, illegal mining, unfavorable laws, high capital requirements, and a shortage of professionals in the sector. It proposed strategies, including resource control policies, private sector involvement in mineral exploration, secured tenure for private miners, and the establishment of environmental protection funds. The study concluded that while many issues hinder the sector's revenue generation, implementing these strategies could attract investors, develop the sector, and optimize its benefits for the country.

Zayone, Henneberry, and Radmehr (2020) examined the effects of agricultural, manufacturing, and mineral exports on Angola's economic growth using data from 1980 to 2017. The study employed an Autoregressive Distributed Lag (ARDL) model to estimate the impact of sectoral exports on economic growth. The results showed that while exports from manufacturing, minerals, and agriculture drove long-term economic growth in Angola, only non-manufacturing exports (agricultural and mineral) contributed to short-term GDP growth. Additionally, mineral exports significantly impacted long-term non-export GDP, while agricultural exports had a short-term effect.

Chidinma, Emilia, and Stella (2019) conducted a study on the impact of investments on solid mineral development in Nigeria. Utilizing a multivariate vector autoregressive (VAR) model with annual time series data from 1981 to 2016, the study investigated the interaction between investment and solid mineral development. Before applying the VAR model, the researchers assessed the time-series properties of the data using tests such as ADF, Ng-Perron for unit roots, and the Autoregressive Distributed Lag cointegration test, along with the Vector Error Correction Mechanism (VECM). Their findings revealed that while domestic investment had an insignificant effect on solid mineral development, foreign direct investment had a positive but not significant impact, whereas foreign portfolio investment negatively affected solid mineral development. The study suggested that reforms are needed to improve investment guidelines, operational procedures, and regulatory frameworks within the solid mineral sector.

Olade (2019) explored the status of solid mineral deposits and mining in Nigeria, highlighting that the sector contributed a mere 0.5% to the GDP in 2018. Annual production was about 40 million metric tons valued at approximately 34 billion naira ($95 million USD). The primary minerals produced were industrial rocks such as limestone, granite, and sand, while metallic minerals like lead-zinc and gold contributed minimally to exports. The study noted that Nigeria's mineral sector lacks major mining operations due to unfavorable geological conditions and a lack of large-scale deposits. The author recommended efforts to diversify the economy by increasing the production and domestic use of industrial minerals and improving the sector's contribution to GDP.

Richardson and Nelson (2019) examined the potential of economic diversification to enhance solid mineral development in Nigeria. Their study, using a multiple linear regression model, found that solid mineral development could significantly benefit Nigeria by creating jobs, developing infrastructure, and improving internally generated revenue. However, achieving these benefits requires the implementation of effective policies.

Orji, Eleanya, Mohammed, et al. (2018) investigated the role of the solid mineral sector in Nigeria’s economic diversification. The study, which involved 135 questionnaires distributed in Zamfara and Taraba states, found that inadequate funding, lack of proper legislation, and ethnic sentiments adversely impacted solid mineral mining. Recommendations included generating accurate scientific data, issuing affordable sale licenses, employing professionals to enhance mineral education and investment, and creating a supportive environment through tax reductions and improved security.

Oruonye and Ahmed (2018) studied the challenges and prospects of solid mineral mining in Taraba State, Nigeria. They used secondary data from existing literature and primary data from field observations and interviews. The study identified issues such as illegal mining, lack of equipment, poor technical capacity, and inadequate infrastructure. Recommendations included providing capital through soft loans, offering tax incentives, and improving collaboration between the Federal Ministry of Mines and Steel Development and state agencies.

Edeme, Onoja, and Damulak (2018) found that solid mineral development positively impacts economic growth in Nigeria using time series data from 1960 to 2015. Similarly, Ajie, Okoh, and Ojiya (2019) demonstrated that an increase in solid mineral development, including activities such as quarrying and mining of ores, contributes significantly to Nigeria's GDP.

Olalekan, Afees, and Ayodele (2016) conducted an empirical analysis on the mining sector's contribution to Nigeria's economic development. Their study, which covered data from 1960 to 2012, found that the mining sector’s contribution to GDP remains low due to the country's reliance on crude oil. They recommended focusing on the development of mining potentials to diversify the economy and achieve rapid growth.

Overall, these studies provide a comprehensive view of the role of solid mineral development in Nigeria's economic growth and offer valuable insights for policymakers and stakeholders in the sector.

3. Research Methodology

This research utilizes an ex-post facto design, analyzing historical data without any manipulation or control over the variables involved. The dataset is sourced from secondary materials, specifically the Central Bank of Nigeria Statistical Bulletin (2022) and the World Bank Development Indicators (2022). The study employs the Autoregressive Distributed Lag (ARDL) model, analyzing time series data from 1981 to 2022. This approach is quantitative in nature, focusing on the collection and examination of secondary data using econometric methods such as unit root and bound tests.

3.1 Model Specification

Building on the discussion in section two, the study adopts the endogenous growth theory, which is based on the AK growth model. This model posits that economic growth is primarily driven by internal factors, rather than external influences. The endogenous growth theory emphasizes the role of internal mechanisms in fostering economic prosperity.

Starting with the simple AK model which is of the following form:

$$Y_t=f(A_tK_t) \quad (3.1)$$

In this model, YYY represents national output, KKK denotes the composite measure of capital stock, and AAA is a constant under the assumption of constant returns to scale (CRS). The CRS assumption replaces the neoclassical growth theory's notion of diminishing returns to scale, allowing for investment to significantly impact long-term growth and making growth endogenous (Hussien & Thirwall, 2000). However, capital stock can be further divided into physical capital and human capital, leading to the revised model:

$$Y_t =Af(K_t) \quad (3.2)$$

Where L stands for labour force

This implies that:

$$Y_t =AK +AL \quad (3.3)$$

If $y = {}^{Y}\!/_{A}$ then $k = {}^{K}\!/_{A}$, and / = =~/A, then equation (3.3) can be re-written as follows:

$$Y_t =po+pjk_t +(32/_t \quad (3.4)$$

Where; y represents output, k stands for physical capital, and [is human capital.

It is logical to assume that the productive utilization of resources, such as solid mineral development, will affect the output of any economy. Therefore, it is essential to incorporate solid mineral development into the equation as follows:

$Y_t = Po+P\ 1<t + \quad + P3SMID_t + p_t$ (3.5)

In order to capture other relevant macroeconomic variables such as exchange rate (x1) and inflation (x2) as controlled variables, we introduced them into the equation as follows:

$^{Y}t = Po+Pj<t + P2t +^{p}3SMID_t +P4X_{7}+f35X2+fJ_t$ (3.6)

2.2 Model Specification

The primary aim of this study was to examine how solid mineral exploration affects economic growth in Nigeria. Based on the endogenous growth theory, the approach to achieving this goal involves adapting the endogenous growth model, which is represented as:

$RGDP_t = p_0+pjSMID_t + p_2GFCF_t + p_3P0PGR_t + p_4EXR + p_5INFR_2+p_t$ (3.7)

Where:

RGDPGR = Real Gross Domestic Product Growth Rate as a proxy for economic growth

SMID = Solid Mineral Development proxied by the subsector's contribution to GDP

GFCF = Gross Fixed Capital Formation as a proxy for capital

POPGR= Population growth rate as a proxy for labour

EXR = Exchange Rate

INF = Inflation Rate proxied by the consumer price index

Po = Intercept parameter or average effect on dependent variable if all the variables are excluded from the model, especially when all the explanatory variables are set at zero values.

Pi — P5 = The parameters or partial regression coefficients of the model, measuring the change in the mean value of the RGDPGR per unit change in individual explanatory variable, while holding other variables constant.

= the stochastic disturbance term that captures the effect of other variables not included in the model on economic growth.

3. Results and Discussion

The analysis utilized the Autoregressive Distributed Lag (ARDL) model to examine the data. This approach offers a detailed understanding through the coefficients, standard errors, t-tests, probability values, and diagnostic tests.

Unit Root Test

To assess the impact of solid mineral development on economic growth in Nigeria, the study conducted a unit root test using the Augmented Dickey-Fuller (ADF) statistic at a 5 percent significance level. This test determines whether the series are stationary at level [I(0)] or at first difference [I(1)]. For the ARDL model to be applicable, the series must not be I(2). The ADF test is based on the null hypothesis that the series has a unit root, which could lead to spurious regression results if not properly addressed. Ensuring the absence of unit roots is crucial to validate the reliability of the regression analysis.

Table 4.1 Unit Root Test using Augmented Dickey-Fuller (ADF) Test

Variables	***Augmented Dickey-Fuller Test***		**Lag**	**Order of int.**	**Remark**
	@ level	**@ 1st Diff**			
Log(RGDP)	-1.965535	-3.921868	Maxlag=9 I(1)		Stationary
Log(SMID)	-3.882839	-	Maxlag=9	I(0)	Stationary
Log(GFCF)	-7.098652	-	Maxlag=9	I(0)	Stationary
POPGR	0.831754	-4.784324	Maxlag=9	I(1)	Stationary
EXR	-1.427347	-5.815986	Maxlag=9	I(1)	Stationary
INFR	-4.480565	-	Maxlag=9	I(0)	Stationary
	-4.234972	-4.205004			
TestofCV	-3.540328	-3.526609			
	-3.202445	-3.194611			

Source: *Author's own computation using E view 10*

The results presented in Table 4.1 indicate that the variables Log(SMID), Log(GFCF), and INFR are stationary at level, as the absolute values of their ADF statistics exceed the critical values at the 5 percent significance level. In contrast, Log(RGDP), POPGR, and EXR are stationary only at first difference, with their ADF statistics also exceeding the critical values at

the 5 percent level. Therefore, we classify SMID, GFCF, and INFR as I(0), while RGDP, POPGR, and EXR are categorized as I(1).

Cointegration Estimation (ARDL Bounds Test) for Long-Run Relationships

The conditions for applying the ARDL model are met, allowing for the use of cointegration bounds tests. The F-statistic will be used to assess whether there is a long-term relationship among the variables. The ARDL approach is effective in capturing both the long-term and short-term dynamics without losing information about the long-term relationships.

Table 4.2: ARDL Bounds Test result for cointegration

F-Bounds Test		**Null Hypothesis: No levels relationship**		
Test Statistic	**Value**	**Signif.**	**I(0)**	**I(1)**
F-statistic	10.59985	10%	2.08	3
k	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15

Source: *Author's own computation using E view 10*

From Table 4.2, it can be observed that there is evidence of a long-term relationship among the variables, as the F-statistic exceeds the upper bound of the Pesaran critical value at the 5 percent significance level. Consequently, we reject the null hypothesis and infer that a long-run relationship exists between the independent variables and the dependent variable.

ARDL Estimates of the Long-Term Regression

The outcomes of the ARDL long-run regression analysis are detailed in Table 4.3.

Table 4.3. ARDL Long Run Regression Estimates for the Model
Dependent Variable: RGDP

Levels Equation Case 2: Restricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(SMID)	0.948168	0.766406	1.237162	0.2379
LOG(GFCF)	-2.487288	3.939250	-0.631412	0.5387
POPGR	0.546539	1.323394	0.412982	0.6864
EXR	0.173548	0.320611	0.541303	0.5975
INFR	-0.675222	1.050998	-0.642458	0.5317
C	14.93974	61.64062	0.242368	0.8123

Source: *Author's own computation using E view 10*

The long-run regression estimates are detailed in Table 4.3. The results suggest that while solid mineral development, population growth, and exchange rates positively influence economic growth in Nigeria, these effects are not statistically significant at the 5 percent level. This

implies that increases in solid mineral exploration, population growth, and exchange rates have the potential to enhance economic growth in the long term. Conversely, gross fixed capital formation and inflation rate negatively impact economic growth, though these effects are also not statistically significant at the 5 percent level. This indicates that higher levels of intellectual capital (human capital) and inflation may hinder economic growth in Nigeria.

ARDL-ECM Test for Short-Run Dynamics

Given the detection of a long-run cointegration relationship by the ARDL Bound test, the ARDL-ECM test was performed to address short-run dynamics. The results are shown in Table 4.4.

Table 4.4. ARDL-ECM Test for the Model Dependent Variable: RGDP

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(RGDP(-1))	-0.451036	0.113250	-3.982659	0.0016
DLOG(SMID)	0.310901	0.038683	8.037069	0.0000
DLOG(SMID(-1))	0.031521	0.052737	0.597705	0.5603
DLOG(SMID(-2))	-0.159937	0.041121	-3.889440	0.0019
DLOG(SMID(-3))	-0.099020	0.034155	-2.899099	0.0124
DLOG(GFCF)	-0.067500	0.020294	-3.326092	0.0055
DLOG(GFCF(-1))	0.145900	0.024561	5.940256	0.0000
DLOG(GFCF(-2))	0.075535	0.018492	4.084653	0.0013
POPGR	6.255542	1.376522	4.544456	0.0006
POPGR(-1)	-58.16415	16.28538	-3.571556	0.0034
POPGR(-2)	54.75985	16.44596	3.329684	0.0054
EXR	-0.039001	0.007886	-4.945457	0.0003
EXR(-1))	-0.075793	0.011070	-6.846805	0.0000
EXR(-2)	-0.069756	0.010147	-6.874243	0.0000
INFR	-0.019147	0.004815	-3.976457	0.0016
INFR(-1)	0.058231	0.005684	10.24472	0.0000
INFR(-2)	0.032346	0.006132	5.275033	0.0002
INFR(-3)	0.010031	0.003680	2.725640	0.0173
CointEq(-1)*	-0.138214	0.013272	-10.41368	0.0000

R-squared	0.764499	Mean dependent var	0.040449
Adjusted R-squared	0.630867	S.D. dependent var	0.036529
S.E. ofregression	0.009605	Akaike info criterion	-6.146300
Sum squared resid	0.001753	Schwarz criterion	-5.327507
Log likelihood	135.7797	Hannan-Quinn criter.	-5.854980
Durbin-Watson stat	2.220946		

* p-value incompatible with t-Bounds distribution.
Source: *Author's own computation using E view 10*

3. The results of the short-run dynamics analysis are shown in Table 4.4. The regression results from the ARDL-ECM model reveal an adjusted R^2 of 0.630867, indicating that approximately 63% of the variability in economic growth can be explained by the explanatory variables, suggesting a good model fit. The Durbin-Watson statistic of 2.220946 suggests that there is no significant serial correlation in the residuals. The coefficient of the error correction term is -0.138214, reflecting the short-run adjustment dynamics. This coefficient indicates a moderate adjustment rate, as it suggests that about 14% of the deviation from the long-run equilibrium in the previous year is corrected within the current year. This supports the ARDL bounds test results, affirming a cointegration relationship and demonstrating the model's ability to adjust towards long-term equilibrium.

4. Conclusion

The study analyzed the impact of solid mineral exploration on economic growth in Nigeria using annual time series data from 1981 to 2022. The findings indicated that solid mineral exploration has a modest positive effect on economic growth. This suggests that the solid mineral sector has not yet achieved significant prominence in contributing to economic growth, reflecting its limited impact. Additionally, it points to possible issues such as high levels of illegal activities and inefficiencies within the sector.

Recommendations

Based on the study's findings, the following recommendations are proposed:

i. The government should prioritize the effective implementation of the solid mineral development plan to boost sustainable mineral production and enhance economic growth.

ii. The Ministry of Solid Mineral Development should reinforce its regulatory framework to combat illegal activities and reduce sectoral leakages.

iii. The government should reassess capital formation strategies to ensure that capital is deployed productively across the country.

iv. There should be a focus on enhancing human capital development, particularly in education and skills training, as empirical evidence suggests that human capital development has not significantly impacted national economic growth.

v. The Central Bank of Nigeria should revisit its policies on inflation and exchange rates to ensure they contribute effectively to long-term economic growth.

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