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Natural Resource Endowments and Growth Dynamics in Africa: Evidence from Panel Cointegrating Regression

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Ibrahim A. Adekunle
(Corresponding)
Babcock Business School, Babcock University, Nigeria[1]
European Xtramile Centre of African Studies, Liège, Belgium[2]
E-mail: adekunle_ia@yahoo.com

Olukayode E. Maku
Department of Economics, Olabisi Onabanjo University,
Ago-Iwoye, Ogun State, Nigeria
E-mail: maku@oouagoiwoye.edu.ng

Tolulope O. Williams
Department of Banking and Finance, Olabisi Onabanjo University,
Ago-Iwoye, Ogun State, Nigeria
E-mail: brainwilly1@gmail.com

Judith Gbagidi
Africa PPP Advisory services
E-mail: gbagidijudith@gmail.com

Emmanuel O. Ajike
Department of Business Administration,
Babcock University, Nigeria
E-mail: ajikee@babcock.edu.ng

Research Department

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Ibrahim A. Adekunle, Olukayode E. Maku, Tolulope O. Williams, Judith Gbagidi & Emmanuel O. Ajike

Abstract

Purpose

With heterogeneous findings dominating the growth and natural resources relations, there is a need to explain the variances in Africa's growth process as induced by robust measures of factor endowments. This study used a comprehensive set of data from the updated database of the World Bank to capture the heterogeneous dimensions of natural resource endowments on growth with a particular focus on establishing complementary evidence on the resource curse hypothesis in energy and environmental economics literature in Africa. These comprehensive data on oil rent, coal rent, and forest rent could provide new and insightful evidence on obscure relations on the subject matter.

Design/methodology/approach

This paper considers the panel vector error correction (PVECM) procedure to explain changes in economic growth outcomes as induced by oil rent, coal rent and forest rent. The consideration of the (PVECM) was premised on the panel unit root process that returns series that were cointegrated at the first-order differentials.

Findings

The paper found positive relations between oil rent, coal rent and economic development in Africa. Forest rent, on the other hand, is inversely related to economic growth in Africa. Trade and human capital are positively related to

economic growth in Africa, while population growth is negatively associated with economic growth in Africa.

Research limitations/implications

Short-run policies should be tailored toward the stability of fiscal expenditure such that the objective of fiscal policy, which is to maintain the condition of full employment, economic stability, and stabilise the rate of growth, can be optimised and sustained. By this, the resource curse will be averted, and productive capacity will increase, leading to sustainable growth and development in Africa, where conditions for growth and development remains inadequately met.

Originality/value

The originality of this paper can be viewed from the strength of its arguments and methods adopted to address the questions raised in this paper. This study further illuminated age-long obscure relations in the literature of natural resource endowment and economic growth by taking a disaggregated approach to the component-by-component analysis of natural resources factors (the oil rent, coal rent and forest rent) and their corresponding influence on economic growth in Africa. This pattern remains underexplored mainly in previous literature on the subject. Many African countries are blessed with an abundance of these different natural resources in varying proportions. The misuse and mismanagement of these resources along various dimensions have been the core of the inclination toward the resource curse hypothesis in Africa. Knowing how growth conditions respond to changes in the depth of forest resources, oil resources and coal resources could be a useful pointer in Africa's overall use and management. This study contributed to the literature on natural resource-induced growth dynamics by offering a generalisable conclusion as to why natural resource-abundance economies are prone to poor economic performance. This study further asks if mineral deposits are a source or reflection of illgrowth and underdevelopment in African countries.

Keywords: Natural Resource Endowment; Economic Growth; Resource Curse Hypothesis; PVECM; Africa.

JEL Codes: C33, O44

1.0 Introduction

Despite large deposits of natural resource endowments across Africa, the distribution, income generation, and overall welfare implications are not even across countries, particularly in West Africa. While some African member countries are richly endowed with a wide range of natural resources, others barely have them, and those that have them are struggling to leverage their natural resource deposit to deliver the desired egalitarian society (Dunning, 2008). Before the arrival of colonial masters in Africa, African nations were endowed with numerous natural resources (Herbst, 2000). They include diamond, gold, iron ore, crude oil, aluminium, uranium, bauxite, manganese, tine and columbite (Shisanya, 2017). Where Nigeria has a sizeable crude oil deposit, Ghana has substantial gold deposits. In other African nations, natural resources are abundant in their complex forms and volume. Sierra Leone, Cote d'Ivoire, and Liberia have substantial deposits of diamonds. Guinea, Guinea Bissau, Sierra Leone, and Liberia have large deposits of Bauxite and Iron. In Senegal, Mali, Guinea Bissau and Togo, phosphate are found in commercial quantity (Collier, 2010).

Apart from having large deposits of natural resources since a long time ago, commercial mining and exploration of natural resource endowments across Africa did not start early enough. Inadequate technological know-how, the post-colonialisation effect, the unregularised market for natural resources, political instability, terrorism and many other deep-rooted issues are responsible for these lagged growth outcomes (Adekunle, 2020; Brandt, 2004). The structural ambiguity surrounding other forms of natural resource endowment other than oil and the over-reliance on proceeds from crude could be attributed to the illgrowth and underdevelopment largely predominant in African countries. With empirical outcomes on the mineral resource-growth relations dominated by irregularities, obscurity and inconclusiveness, policy extraction and redirection of optimal natural resource-induced growth in Africa became shabby, leading to undesirable growth outcomes. This study offers new and policy-consistent insight into the output elasticities of natural resources-induced growth capacities across Africa using up-to-date, more robust and comprehensive data on natural resource endowments while employing an appropriate estimation procedure that caters for the endogeneity of regressors to reach conclusions that can inform better policy and research on the natural-resource growth relations in Africa.

The structural ambiguity in the role of natural resources towards sustainable growth and development underpins this research. A good number of authors believed that the discovery of natural resources and the subsequent revenue generated thereof helped countries to address critical socio-economic concerns such as poverty, health, infrastructure, education and unemployment (see Havranek, Horvath, & Zeynalov, 2016; Herbst, 2000; Zallé, 2019 for some examples). Quite recently, however, proponents of the resource curse literature have linked the endowment of natural resources to a series of adverse outcomes like economic decline, corruption and autocratic rule (see Boschini, Pettersson, & Roine, 2007; Sala-i-Martin & Subramanian, 2013; Van Der Ploeg, 2011 for an extensive review). This structural ambiguity in the resource endowments and dynamic growth relations could be due to omitted variable bias and model misspecification. The omitted variable or misspecification challenges might stem from reliance on the singularity of either oil rent, coal rent or forest rent as a measure of natural resource endowments on growth, leading to non-generalisable outcome in the multidimensionality effect of natural resource endowments on economic growth in Africa. It is, therefore, imperative to establish a clear line of thought on the natural resource endowments-growth relations using up-to-date, robust and comprehensive data on oil rent, coal rent, and forest rent from the updated World Bank database in the most suiting manner. It is a consensus that substantial mineral resources induce economic growth, but how this growth pattern unfold remains *apriori* unclear. Estimating multidimensional regressors on natural resource endowments in Africa will proffer clarity on the idiosyncratic resource's identification channels of dynamic growth that have long been unclear. Thus, researching the growth initiatives and potentials of natural resources in their disaggregated compositions forms part of a broader attempt to analyse critical issues in natural resource management, emphasising their utilisation's economics and regulatory aspects.

The effort to revamp the mineral resource sector in African countries is laudable in the face of increased export and resource earnings; however, the growth transformation pattern of the Asian Tigers makes such strides thought of in mere terms. The economy of most Asian tigers is majorly non-oil driven, and their large and active foreign earnings come from their non-oil sector (Page, 1994; Shin, 2007). Growth and development patterns observable in African countries with vast and abundant natural resources are far little compared to the growth statistics from the Asian Tigers (Reppas & Christopoulos, 2005). Although African countries are blessed with massive proven deposits of solid minerals widely distributed across different geography, it remains unclear what portion of growth can be attributed to the mineral deposit in Africa. In this study, we challenge the longstanding conjecture that large mineral deposits are responsible for growth in African nations. In tandem with the resource-curse proponent in African nations who argued that sizeable natural resource deposit does not guarantee growth and development, this study builds on other existing studies on the subject matter to offer a generalisable conclusion on the mineral-growth relationship in Africa.

There is no doubt that proceeds of minerals mined were the financial hallmark of African nations during and after colonialism; however, economic diversification in terms of technological advancement in the areas of information technology, growth in the entertainment industry, agricultural development and so on is an essential concept to consider as outliers in the growth and development objectives of African nations. Considering time-variant falls in the international price of crude, with natural resources reassessed and regarded as growth complementary and not singular growth-inducing, there is an urgent need to quantify the growth outcomes as induced by natural resources such that policy lessons can be learnt, and policy formulation can be redirected for optimal economic growth outcomes. Although the growth-inducing capacity of mineral resources is not in question, the empirical reality of whether it has led to growth or can continue to guarantee sustainable growth and development remains ambiguous. Meeting global demand for mineral resources will require exploration in low and middle-income countries to replace the existing sources of supply in Organisation for Economic Cooperation and Development (OECD) countries (Humphreys, 2015), often the locations of social, economic, and developmental challenges.

This study contributed to the literature on natural resource-induced growth dynamics by offering a generalisable conclusion as to why natural resource-abundance economies are prone to poor economic performance. This study further asks if mineral deposits are a source or reflection of illgrowth and underdevelopment in African countries. To establish a clear line of thought on the Africa Dutch-disease phenomenon, which has favoured increased rent-seeking behaviour, corruption and gratuitous bottlenecks, greed and authoritarian type of leadership (military dispensation), and sometimes lack of labour-based learning and education, we estimate the output elasticities of natural resource-growth relations most appropriately using the updated database of the World Bank to capture the heterogeneous dimensions to natural resource endowments measurement. Previous studies relied heavily on either oil rent, oil price or crude deposit as a measure of mineral deposit. However, oil rent does not exclusively capture other forms of natural resource endowment. We used oil rent, coal rent and forest rent data obtained from the updated database of the World Bank (2017) as more robust that captures the multidimensional nature of natural resource endowments adequately. Our study leads the debate on mineral resource deposits and growth outcomes in Africa while using a more robust measure of resource endowments and an appropriate estimation procedure.

2.0 Literature Review

The literature on natural resources and growth outcomes has grown tremendously in cross-country and country-specific studies, but the dominant roles played by mineral deposits on economic growth in Africa remain grossly understudied. In the submission of Ofori and Grechyna (2021), who examined the interactive influence of remittances and resource factors on economic growth in sub-Saharan Africa (SSA) with a sample comprising forty-three (43) nations from 1990, through 2017, forest rent is positively related to economic growth. With a battery of econometric procedures that include pooled ordinarily least school, the fixed and random effect estimation procedure and the dynamic generalised method of moment, other results were a negative relationship among oil rent, natural gas rent and economic growth in SSA. These natural resources component disaggregation shows how useful narrative on biodiversity and green initiatives could lead to realising growth and development objectives most sustainably. For Shittu, Musibau and Jimoh (2021), the role of institutions and human capital development was essential to optimise the influence of natural resources on growth. The authors lean empirical credence to this assertion by analysing data spanning 1990 through 2017 using the Auto Regressive Distributed Lag (ARDL) procedure. The authors found positive relations between natural resource endowment and economic growth. A major drawback in this research is the inability to show how the interactive terms in the institutions and natural resource factors influence the economic growth of these regions. Olayungbo (2019) examined the effects of oil revenue on economic growth in Nigeria, using the Bayesian time-varying parameter and found that oil revenue and exports positively and significantly influence economic growth. In the findings of Dwumfour and Ntow-Gyamfi (2018) where they examined the influence of natural resources on financial development in 38 African countries, the impact of natural resources rents was found to be ambiguous and further highlighted the negative impact of resource rents on financial development in the SSA region using the system generalised method of moment's estimation procedure. In a related but separate study, Zalle (2019) analysed the conditional effects of natural resource dependence on human capital, quality of institutions, and economic growth. Using the ARDL Model, the authors found the existence of a long-term adjustment mechanism between natural resources, economic growth, human capital, and institutions in Africa. The author argued that natural resources have a negative influence on economic growth. Similarly, Henry (2019) examined the influence of dependence on mineral resources on human development and economic growth in ten (10) African States. The authors found a tenuous negative association between average growth in human development and the relative weight of mineral rents. The authors argued that the average growth in resource rents does not materialise in higher economic growth because of weak institutions and corruption. In a related but separate study, Tiba and Frikha (2019), using annual data from 26 African countries and employing the fully modified ordinary least square (FMOLS) and dynamic ordinary least square (DOLS) technique investigated the linkage between economic growth and natural resources endowment. The authors found a significant negative relationship between change in resource endowment and economic growth. They argued that an increase in natural resource endowment leads to a decrease in economic growth providing empirical evidence to the Resource Course hypothesis existing in extant literature (see Sachs & Warner (2001) ; (Ding & Field, 2005) ; (Brunnschweiler & Bulte, 2009); (Cerny & Filer, 2011)(Shao & Yang, 2014 for extensive review).

In other climes, Muhanji, Ojah, and Soumare (2019) examined the influence of natural resource rents on external indebtedness and welfare in Africa Countries. Using the generalised methods of the moment (GMM), the authors found that minerals and oil resource rents negatively affected indebtedness. They argued that mineral and oil resource rents and quality institutions enhance welfare. Ajide, Adenuga, and Raheem (2020) examined the influence of natural resources rent on terrorism in forty-nine African countries. Employing a negative binomial regression, the authors found natural resources to have an unconditional effect on transnational and total terrorism. Perez and Claveria (2020) investigated the relationship between human development, economic growth, and dependence on mineral resources in 10 African states. The authors found the existence of a weak negative linkage between average growth in human development and the relative mineral rents. They argued that there is an inverse relationship between growth in mineral dependence and economic growth. A more recent study by Ampofo, Cheng, Asante, and Bosah (2020) investigated the relationship between natural resources and long-run economic growth using data from the top ten (10) mineral-rich countries in the world. The authors implemented a nonlinear vector autoregressive (VAR) and Granger causality analysis and reported heterogeneity of results among the observed countries. The authors found a significant long-run relationship between total natural resource rent and economic growth. They observed a unidirectional linear causality from natural resources to economic growth in Saudi Arabia, Brazil, India, Venezuela, and the Democratic Republic of Congo (DRC). On the contrary, they found evidence in support of the natural resource curse hypothesis in Australia and India where an increase in total resources rent negatively affects the economy and a decrease in total natural resources rents positively affects economic growth.

In a different clime, Wu, Li, and Li (2018) examined the validity of the natural resource course in China using a set of panel data and employing the regression technique and found a significant positive relationship between natural resources and economic growth. They argued that natural resources show a more decisive role in promoting economic growth. This finding is in line with the results of Ben-Salha, Dachraoui, and Sebri (2018) who investigated the relationship between natural resource rents and economic growth in top resource-abundant countries over the period 1970-2013. Using a pooled mean group estimation procedure, the authors found that resource rents positively affect economic growth and the causality relationship between natural resources rent and economic growth, providing empirical evidence undermining the natural resource curse hypothesis in the work of Sinha and Sengupta (2019), who investigated the association between natural resource rents, globalisation, and human development in thirty 30 Asia Pacific countries. Using Bootstrapped Quantile regression, the author found that individual resource rents positively impact human development, whereas the pool of natural resources has a negative impact on human development in the presence of globalisation. Sun, Ak, Serener, and Xiong (2020) investigated the influence of natural resources on financial development in seven emerging economies, using the Westerlund Panel co-integration and Augmented Mean group test, which found financial development to be adversely affected by natural resources. In a more elaborate study, Redmond and Nasir (2020) used panel data from 30 countries and employed four estimation techniques Fixed effects (FE), Random effects (RE), Panel Fully Modified Least Square (PFMOLS) and Panel Dynamic Least Square (PDLS) found that natural resource abundance has a significant positive impact on economic growth and an insignificant negative effect on human development.

In all of this study across and beyond African borders, the influential roles of natural resources as an invigorating component of growth remains dimply discerned. This is because most research has relied on measures of natural resource deposits in quantile times. Oil price, crude price, and crude deposit are the most pervasive natural resource deposit measures in the previous study. We build upon the shortcomings of previous research and measure mineral/natural resource deposits with oil rent, coal rents, and forest rents as a more robust and comprehensive measure of natural resource endowment. We estimate the contemporaneous influence of these variables in the growth-inducing model of Africa. Findings from the study are expected to redirect policy agenda and sustainable natural resource management in Africa.

3.0 Methodology

In gauging natural resources as a barometer for growth outcomes in Africa, this paper adopts the Barrow-type (1991) growth model. Following the works of Mankiw *et al.* (1992), Sala-i-Martin (1992), Sachs and Warner (1999), Lederman and Maloney (2002) and Hoeffler (2002), and by controlling for non-natural resource factors that influence long-run growth, we specify a growth equation that accounts for the effects of natural resources as follows:

$$y_{it} = \propto + \sum_{i=1\ldots20}^{n=1} \pi_n NAT_{RES_{it}} + \sum_{i=1\ldots20}^{n=1} \omega_n X_{it} + \mu_{it} \qquad \textbf{(1)}$$

Where $y_{it}$is the growth rate of Gross Domestic Product (GDP), $NAT_{RES_{it}}$is the composite natural resource endowments in African member countries, and $X_{it}$is the set of controlled variables introduced into the model.

Extending the theoretical framework for clarity and control purposes, we rewrite equation **1** to be:

$$growth_{it} = \propto + \sum_{i=1\dots20}^{n=1} \pi_n OIL_{RENT_{it}} + \sum_{i=1\dots20}^{n=1} \omega_n COAL_{RENT_{it}} + \sum_{i=1\dots20}^{n=1} \theta_n FOREST_{RENT_{it}} + \gamma_n X_{n_{it}} + \rho_i + \in_i + \mu_{it}$$

where $X_{it} = trade_{it} + Pop_{growth} + Human_{Cap_{it}}$ and $\mu_{it} = \partial_i + \varphi_i s_i + \varepsilon_{it}$ ……………………

(2)

Where $OIL_{RENT_{it}}$is oil resource rent (measured as the outcome variable from world price calculation of crude oil production when production costs have been deducted); $COAL_{RENT_{it}}$is coal resources rent (measured as the aggregation of hard and soft coal less cost of production at world prices); $FOREST_{RENT_{it}}$ is forest rent (measured as round wood harvest multiplied by the sum of average prices and rental rate of the region); $X_{n_{it}}$ is the vector of the control variable that is not of primary interest (trade, population growth and human capital development), but we cannot rule out because of their higher precision and relevance;ρ_i is country specific-effect, $\in_i$ is the time-fixed effect;i represents the selected African countries, t is the year of observations and μ_{it} encompasses time-invariant possible heterogeneity across cross-sections (∂_i), unobservable common factors which are not restricted ($\varphi_i s_i$) and the idiosyncratic error term (ε_{it}). π_n, ω_n, θ_n, and γ_n are the output elasticities of the natural resource-induced growth model.

Rewriting it in growth form with a panel analysis specification such that it adjusts for the disparity in units and measurement yields the following:

$$lngrowth_{it} = \propto + \sum_{i=1\dots20}^{n=1} \pi_n lnOIL_{RENT_{it}} + \sum_{i=1\dots20}^{n=1} \omega_n lnCOAL_{RENT_{it}} + \sum_{i=1\dots20}^{n=1} \theta_n lnFOREST_{RENT_{it}} + \sum_{i=1\dots20}^{n=1} \gamma_n \, lnX_{n_{it}} + \rho_i + \in_i + \mu_{it}$$

$X_{it} = trade_{it} + Pop_{growth} + Human_{Cap_{it}}$ and $\mu_{it} = \partial_i + \varphi_i s_i + \varepsilon_{it}$ … … … … … … … …

(3)

From the model, $ln$is the logarithm (growth form) of the regressors, $\propto$gives the values of the response variable when the regressors are zero; all other variables remain as earlier defined. Assuming all data follow a panel unit root process and the error terms were a stationary process ($\mu_{it} \sim I(0)$), model **(3)**therefore depicts a panel co-integration model with a panel vector error correction model (PVECM) as follows;

$$\Delta lngrowth_{it} = \propto + \varphi ECM_{i,t-1} + \sum_{i=1\ldots20}^{n=1} \pi_n \Delta lnOIL_{RENT\,it} + \sum_{i=1\ldots20}^{n=1} \omega_n \Delta lnCOAL_{RENT\,it} + \sum_{i=1\ldots20}^{n=1} \theta_n \Delta lnFOREST_{RENT_{it}} + \sum_{i=1\ldots20}^{n=1} \gamma_n \Delta lnX_{n_{it}} + \rho_i + \in_i + \mu_{it}$$

$X_{it} = trade_{it} + Pop_{growth} + Human_{Cap_{it}}$ and $\mu_{it} = \partial_i + \varphi_i s_i + \varepsilon_{it}$ … … … … … … … …

(4)

The $ECM_{i,t-1}$is the error term of the co-integration model in a panel setting; $\varphi$is the short-term adjustment effect. $\varphi < 0$ implies that long-term relationship does not inhibit changes in economic development in the short term, while a greater than sign suggests the opposite.

Data

Our study used panel data for twenty (20) African countries based on regional classifications from 1980 to 2018 (39 years). Our scope is guided by data availability and the desire to limit the investigation to the African context. With five (5) major regions in Africa, we selected South Africa, Zimbabwe, Botswana, and Angola in Southern Africa; Kenya, Burundi, Tanzania, and Rwanda in Eastern Africa; DR Congo, Cameroun, Gabon, and Equatorial Guinea in Equatorial Africa; Nigeria, Ghana, Senegal and Côte d'Ivoire in West Africa; and Eritrea, Sudan, Burkina Faso and Mali in Africa Transition Zone. Our selection of countries is informed by the data availability and desire to limit attention to Africa. We assume homogeneity across time and cross-section in the natural resource-induced growth model, although verified (structural characteristics of African nations are identical and thus eliminating heterogeneity bias). The data are mainly obtained from the World Bank Database (World Bank, 2018). Growth dynamics were measured with GDP per capita as used in the work of Ben-Salha et al. (2018); oil rent was measured as the difference between crude production less total production cost at world prices in tandem with Ishak and Farzanegan (2020); coal rent was measured as the aggregation of hard and soft coal less cost of production at world prices in consonance with Adedoyin, Gumede, Bekun, Etokakpan, & Balsalobre-lorente (2020); forest rent was measured as round wood harvest multiplied by the sum of average prices and rental rate of the region in tandem with Canh, Schinckus and Thanh (2020). To establish the robustness and avert problems of omitted variable bias, we introduced relevant control variables in some logical fashion. These control variables have high relevance in explaining changes in growth dynamics in Africa even when they are not variables of core interest. The control variables are trade diversification (measured as trade openness in consonance with the work of Onanuga, Odusanya& Adekunle (2020)), population growth was measured as population (total) in its time-series form and across cross-sections in tandem with Khan, Hou and Le (2021) and human capital was measured as gross enrolment rate at the secondary education level in consonance with contemporary human capital literature (see Ibrahim, 2018; Ibrahim & Sare, 2018; Ogundari & Awokuse, 2018 for some examples). The intuition is that trade interactions lead to greater regional and international cooperation in the global system. Since humans are at the core of growth and development initiatives, trade interactions where the large and active population are adequately trained and empowered with resources from resources sales will most likely lead to growth outcomes measured in quantum terms. The variables of the study and their respective descriptions and sources are contained in Table 1.

Table 1: Variable Description Source: Table created by Author

Abbreviation	Description	Measured As	Source	Motivating Study
$growth$	The growth rate of GDP	GDP per capita	World Development Indicator (WDI)	Ben-Salha et al. (2018)
OIL_{RENT}	Oil Rent	Crude Production less Production Cost at World Prices	World Development Indicator (WDI)	Ishak and Farzanegan (2020)
$COAL_{RENT}$	Coal Rent	Hard and Soft Coal Less Production Cost at World Prices	World Development Indicator (WDI)	Adedoyin, Gumede, Bekun, Etokakpan and Balsalobre-lorente (2020)
$FOREST_{RENT}$	Forest Rent	Round Wood Harvest multiplied by Sum of Average Prices at a rental rate of the region	World Development Indicator (WDI)	Canh, Schinckus and Thanh (2020)
$trade$	Trade	Trade Openness	World Development Indicator (WDI)	Onanuga, Odusanya and Adekunle (2020)
Pop_{growth}	Dynamic Population Growth	Population	World Development Indicator (WDI)	Khan, Hou and Le (2021)
$Human_{Cap}$	Human Capital	Gross enrolment at Secondary Level	World Development Indicator (WDI)	Ibrahim (2018); Ibrahim and Sare (2018); Ogundari and Awokuse (2018)

Estimation Strategy

To reach an evidence-based conclusion on resource abundance and its effect on growth in Africa, our estimation procedure takes a stepwise approach. We began by reporting the descriptive statistics to establish the normalities conditions of our cross-country variations in line with Adekunle (2020). Subsequently, we estimated the variance inflation factors to unravel the collinearity of regressors. This approach is superior to the conventional co-variance matrix reported in previous literature because of its high precision in setting a clear line of thought on the non-violation of the linearity assumption of the classical linear regression model $(Cov\, U/X = 0)$. We are aware of the time and year fixed effect overlapping, which could pose serious endogeneity problems. As such, we tested for common factor restrictions using thePesaran cross-sectional dependence (CD) test (Pesaran, 2004). In a related clime, we determine if the slope of parameters follows a heterogenous path to avoid spurious, non-policy consistent estimates. This was done using the Pesaran and Yamagata slope homogeneity test (Pesaran & Yamagata, 2008). Because of the likelihood of cross-sectional dependence and slope homogeneity, we employed second-generation panel unit roots tests. These second-generation panel unit root tests consider cross-sectional dependence and slope homogeneity (Pesaran, 2015) which the first-generation panel unit root test ignored. Thus, producing estimates that are optimal under mild assumptions. Our second-generation panel stationarity tests are the cross-sectionally augmented test (CADF) of Pesaran (2007) and the Hadri LM confirmatory stationarity test (Hadri, 2000). To establish cointegrating relations, the Durbin-Hausman co-integration (Westerlund, 2007) test was preferred to the Pedroni (1999) because of its relative sensitivity to cross-sectional dependence and slope homogeneity. With data following a panel unit root process and the error, terms were a stationary process $(\mu_{it} \sim I(0))$, we proceed to estimate the dynamic panel vector error correction model. The dynamic panel vector error correction model has specification built to prevents the long-run convergence behaviour of the regressors to their long-run characteristics by gradually adjusting to its short-run equilibrating position.

4.0 Results

Table 2, presents summary of statistics of the data under investigation. This summary contains averages, sample observations, relative standard deviation, the minimum (MIN) values as well as their maximums (MAX). In our sample frame, growth dynamics is averagely pegged at 46.672%; an implication of relative growth among countries in Africa.

Table 2: Summary Statistics

Variables	Obs	Mean	Standard Deviation	MIN	MAX
Growth rate of GDP	780	46.672	3.679	1.112	5.662
Oil Rent	780	23.321	1.123	2.622	7.752
Coal Rent	780	62.682	3.211	2.552	5.782
Forest Rent	780	21.792	1.772	1.622	9.232
Trade	780	22.781	2382	1.831	4.242
Population Dynamics	780	23.832	2.973	1.214	12.783
Human Capital	780	22.783	1.638	2.727	7.222

Source: Author, 2020
Note: Summary Statistics reported in their level forms.

Collinearity Statistics

Well above the covariance matrix, the variance inflation factors have high precision in establishing a clear line of thought on the co-variance properties of the regressors. The rule of thumb posits that the tolerance value should be greater than two (2) and less than five (5) to show uncorrelated regressors. Based on the results presented in Table 3, we conclude that the variables do not violate the collinearity assumptions of the classical linear regression model $(Cov\, \mu/X = 0\,)$. With apparent evidence supported by the VIF, we can estimate output elasticities in our model with marginal hindrances of endogeneity of regressors.

Table 3: Variance Inflation Factor

Variables	Collinearity Statistics	
	Tolerance	**VIF**
Oil Rent	0.355	4.562
Coal Rent	0.132	2.435
Forest Rent	0.252	3.342
Trade	0.237	3.332
Dynamic Population Growth	0.315	4.166
Human Capital	0.327	4.158

Source: Author, 2020

Note: Dependent variable is Economic Growth Outcome measured with GDP per capita—decision Rule: Tolerance values ≥ 0.2, and VIF values ≤ 5.

Cross-Sectional Dependence and Homogeneity of Slopes

In contemporaneous and leading panel data studies, cross-sectional data are almost identical with notable variances (Ahmed & Wahid, 2011). Different but related indices of natural resources endowment, as well as growth enhancing factors across Africa, makes cross-sectional data in our sample frame susceptible to cross-sectional dependence and this may lead to unreliable output elasticities of the regressor. To avert such measurement challenges, we begin by estimating the interdependence of cross-sections following Pesaran (2015). Further examination of the component regressor was done by establishing the slope properties of the regressors. Heterogenous slopes and not heterogenous intercepts common in standard estimation procedures are the most pervasive options for averting misleading estimates (Breitung & Das, 2005). We tested the null of no cross-sectional dependence (CD) using the Pesaran (2004) cross-sectional dependence test. We established the homogeneity of the slope using the Pesaran and Yamagata (2008) slope homogeneity test. The estimated values of the delta tilde ($\tilde{\Delta}$) and adjusted delta tilde (adj$\tilde{\Delta}$) at varying levels of probability indicates the rejection of null of slope homogeneity of regressors at a 1% level of significance (Table 4). In Table 4 also, Pesaran (2004) confirms the existence of cross-sectional dependence with probability values less than 1%. The presence of cross-sectional dependence and homogeneity of slope calls for estimation procedures that control for such disturbances. We proceed to estimate second-generation panel stationarity tests such as the cross-sectionally augmented test (CADF) of Pesaran (2004) and the Hadri LM confirmatory stationarity test (Hadri, 2000) because of their high-level precisions and capacity to control for cross-section dependence and homogeneity of slopes in panel data econometrics. In consonance with Phillips and Sul (2003), we followed this path to avert spurious outcomes when cross-sectional dependence and slope homogeneity are not controlled for.

Table 4: Pesaran-Yamagata's Homogeneity and Pesaran Cross-Sectional Dependence Test

Test	**Statistics**	**P-Value**	
$\tilde{\Delta}$	42.52*	0.000	
adj$\tilde{\Delta}$	56.81*	0.003	
Variables	**Pesaran CD Test**	***p val***	***corr***
Growth rate of GDP	26.452	0.000	0.988
Oil Rent	12.344	0.000	0.327
Coal Rent	54.432	0.000	0.541
Forest Rent	31.945	0.000	0.847
Trade	48.562	0.000	0.259
Dynamic Population Growth	83.173	0.000	0.638
Human Capital	45.619	0.000	0.932

Source: Author, 2020

Note: $* P < 0.01$, $** P < 0.05$ respectively; At 1% significance, we established cross-sectional dependence in our series using thePesaran (2004) CD test.

Panel Unit Root

In Table 5, we reported the second-generation panel stationarity tests from the cross-sectionally augmented test (CADF) of Pesaran (2004) and the Hadri LM confirmatory stationarity test (Hadri, 2000). Both panel unit roots tests confirm stationarity at first difference across all the series I(1). These empirical outcomes establish an apparent need to uncover the co-variance characteristics of the data in the natural resource-induced dynamic growth model in Africa. We proceed to estimate the Durbin-Hausman co-integration (Westerlund, 2007) test to establish long-run cointegrating relations because of its relative sensitivity to cross-sectional dependence and slope homogeneity (a major drawback of the Pedroni co-integration test (Pedroni, 1999).

Table 5: Panel Stationarity Testing: CADF and Hadri LM Panel Unit Root Test

Variable	@Levels		@First difference		Order of Integration
	CADF	HADRI	CADF	HADRI	
	Intercept {Trend & Intercept}				
The growth rate of GDP	0.673 {0.672}	0.462 {0.623}	0.442* {0.686}*	0.451* {0.812}*	I(1)
Oil Rent	-0.773 {-0.723}	-0.752 {0.723}	-0.931* {0.679}*	0.321* {0.572}*	I(1)
Coal Rent	1.783 {0.7682}	-2.771 {0.882}	-3.551* {0.163}*	0.972* {0.551}*	I(1)
Forest Rent	0.773 {0.663}	0.453 {0.824}	0.225* {1.588}*	1.781* {1.252}*	I(1)
Trade	0.882 {1.725}	0.552 {0.894}	0.512* {0.582}*	0.839* {0.432}*	I(1)
Dynamic Population Growth	0.826 {1.628}	0.573 {0.641}	1.157* {0.522}*	1.776* {0.771}*	I(1)
Human Capital	1.453 {1.727}	0.272 {0.743}	1.321* {0.321}*	1.562* {0.771}*	I(1)

Source: Authors, 2020

T-Stat values of intercept estimates are reported in the text box while T-Stat values of trend & intercept estimates are in the parentheses; $* \ P < 0.01$, $** \ P < 0.05$ respectively

Dynamic OLS (DOLS) and Cointegration Test

A synopsis for panel dynamic ordinary least square for equation (4) is presented as follows and for the sake of clarity, let $y_{it} = (lngrowth_{it})$ be a scalar and

$(x_{it} = lnOIL_{RENT\,it}, lnCOAL_{RENT\,it}, lnFOREST_{RENT\,it}, X_{n_{it}})$ be a k dimensional factor, then $(y_{it}, x'_{it})'$is a $(k+1)$ dimensional vector of observations that satisfies the following:

$$y_{it} = \alpha_i + \delta t + \emptyset_t + y'x_{it} + u^*_{it} \qquad \textbf{(5)}$$

Where $(1, -y')$ is a vector of co-integration between $y_{it}$and x_{it}, $y_{it}, -y'x_{it}$is a composite equilibrium error that comprises of α_i(individual-specific effect), δt (individual-specific linear trend) and $\emptyset_t$(time-specific factor). $u^*_{it}$is the idiosyncratic error term that is independent across *i*with a possibility of dependence across *t.*

Setting $\delta t = 0$and $\emptyset_t = 0 \forall i \; and \; t$ in **(5)** yields

$$y_{it} = \alpha_i + y'x_{it} + u^*_{it} \qquad \textbf{(6)}$$

To control for any endogeneity that might arise assuming that $\mu_{it}$is correlated with at most $\rho_i$leads and lags of $v_{it} = \Delta x_{it}$, we projected μ_{it}on the leads and lags and obtained the following $u^*_{it} = \sum_{s=-\rho_i}^{\rho_i} \delta'_i, s^{v_{it-s}} + \mu_{it} = \sum_{s=-\rho_i}^{\rho_i} \delta'_i, s^{x_{it-s}} +$

$$\mu_{it} = \delta'_i Z_{it} + \mu_{it} \qquad \textbf{(7)}$$

Where δ_i, s is the projection coefficients that is a $k \times 1$ vector. Substituting the orthogonal projection of μ_{it} in **(7)** into **(6)** yields

$$y_{it} = \alpha_i + y'x_{it} + \delta'_i Z_{it} + u^*_{it} \qquad \textbf{(8)}$$

Equation (8) gives the panel dynamic OLS estimator.

In estimating the dynamic OLS with a residual $\widehat{\mu_{it}}$, we assumed that

$$\varepsilon_{it} = \{(\Delta lnOIL_{RENT\,it}, \Delta lnCOAL_{RENT\,it}, \Delta lnFOREST_{RENT\,it}, X_{n_{it}})\} \quad \textbf{(9)}$$

Secondly, for $\widehat{\mu_{it}}$and ε_{it} , the long-run co-variance matrix was adjusted by adopting the Barlett kernel function with a bandwidth of three in order to get a consistency estimator. All explanatory variable was adjusted accordingly and using equation 8), the DOLS that estimates the regression equation (4) is a consistent estimator and the results are shown in the tables below.

Panel Cointegration

We prefer the Westerlund (2007) co-integration test to the Pedroni (1999)test due to its relative sensitivity to cross-sectional dependence and slope homogeneity. Westerlund (2007)produces consistent estimates under the mild assumption. Since it disregards lag information about integrating orders of series, it is widely applicable in a broader context. By permitting spatial correlation of cross-sectional dependence, the Westerlund (2007) test controls for unobserved heterogeneity of regressors that characterises panel data estimation. The result presented in Table 6 shows that variables in Africa's natural resource-induced dynamic growth model tend to their long-run equilibrating position even when cross-sectional dependence exists. Our result is robust at a 1% level of significance. With data following a panel unit root process and the error, terms were a stationary process $(\mu_{it} \sim I(0))$, we proceed to estimate the dynamic panel vector error correction model. The dynamic panel vector error correction model has specifications built to prevent the long-run convergence behaviour of the regressors to their long-run characteristics by gradually adjusting to its short-run equilibrating position. Hence, we proceed to estimate the dynamic panel ordinary least square regression to gradually adjust back to short-run equilibrium from their long-run convergence.

Table 6: Westerlund (2007) Durbin-Hausman Panel Cointegration Test

	t value	***p val***
dh_g	-711	0.000*
dh_p	0.623	0.000*

Source: Authors, 2020
Note, $* \ P < 0.01$, $** \ P < 0.05$ respectively. We confirmed the regressors co-move at a 1% level of significance.

Table 7: Panel Vector Error Correction Model (PVECM)

Variable	Coefficient	t-Statistics	Prob
$ECM_{i,t-1}$	-0.2354	-3.103	0.003*
Oil Rent	0.787	2.710	0.014**
Coal Rent	0.511	1.094	0.028**
Forest Rent	-0.354	-0.884	0.003*
Trade	0.758	1.711	0.002*
Population	-0.413	-1.099	0.042*
Human Capital	0.236	0.884	0.018**
F Stat	36.642		0.000*
Adjusted R^2	0.679		
Countries	20		
Observations	780		

Source: Authors, 2020
Coefficient values are reported in the text box while Standard Errors are in the parentheses; $* \ P < 0.01$, $** \ P < 0.05$ respectively

The result of the panel vector error correction model was reported in Table 7. The coefficient of the error component is appropriately signed (negative and statistically significant at 1%). The coefficient of the error correction term defines the convergence speed and adjuststhe long-run converging characteristics of the model to its short-term equilibrium at the rate of 24%. The F-stat value of 36.642 shows that the overall model is significant at 1% with probability values pegged at 0.000. The adjusted R^2 value of 0.679 implies that the collective capacities of the regressors to predict variation in the response variable is 67.9%. By intuition, 32.1% variation in the dynamic growth responses in Africa is accounted for by factors other than those considered in the model.

Short-run dynamics results from the estimated model reveal some impressive results. First, oil rent and coal rent which are measured by their relative production less the associative cost at world prices have positive and significant relations with growth dynamics at a 5% level of significance in Africa. Hence, a percentage increase in oil and coal rent will lead to 0.787% and 0.511% increase in the economic growth dynamic in Africa. Except when other factors such as corruption, and institutional bottleneck, impedes the expected positive relations in the natural resources-growth nexus, oil being the major player in most oil-producing African nations and coal which is in large quantity in African geographies will lead to growth in the resource-host nation while also having a multiplying effect in non-oil driven nation by extension. The reinvigorating findings from this study set out to refute the claims of many studies on the Africa Dutch-disease phenomenon which has favoured increased rent-seeking behaviour, corruption and gratuitous bottlenecks, greed and authoritarian type of leadership (military dispensation), and sometimes lack of labour-based learning and education. We do not entirely rule out the existence of the Dutch diseases in Africa, but we argued that they exist in terms that are negligible and not enough to sabotage the realisation of growth and development objectives in Africa. Our positive oil rent-dynamic growth relations align with the findings of Eregha and Mesagan (2020) in their analysis of oil-rich African countries; Apergis, El-Montasser, Sekyere, Ajmi and Gupta (2014) in their studies on Dutch disease effects of oil rent on Agriculture in MENA countries. Nonetheless, forest rents are negatively related to dynamic growth in Africa at a 1% level of significance. This implies that a percentage increase in forest rent will lead to a 0.354% decrease in development in Africa. This inverse relation in the forest rent-growth dynamic relationship could be a result of many years of mismanagement of the forest resources in Africa's industrialisation path. Environmental degradation consequences associated with forest mining sometimes outweigh the gains from the forest resource rent leading to sub-optimal growth and development outcomes. In fact, forest mining is largely discouraged in some green initiative-centric economies because of their capacity to meet increasing food demands, shelter, bio-energies, medicine and so on. Our forest rent-dynamic growth negative relations are in consonance with the findings of Huang et al. (2020) in their analysis of forest, mineral and oil resources in the economic growth of Asian countries.

Further evidence revealed that trade diversification and human capital is positive and statistically related to dynamic growth relations in Africa at 1% and 5% level of significance, respectively. This implies that a percentage increase in trade diversification and human capital will lead to a 0.758% and 0.236% increase in growth and development in Africa. Export diversification involving sales of natural resources align with rent and royalties generations, and when such fund is spent on citizen emancipation, it leads to improved production capacities. The relevance of trade and human capital in natural resource-growth relations defines the point of divergence from the growth enhancement role of natural resource endowments for host and non-host nations. When accrued funds from resource sales are mismanaged, it leads to resource course, but when such funds are invested in mass emancipation, particularly education, it instigates new and higher waves of productive capacities leading to sustainable growth. In related but distinct findings, Ibrahim and Sare (2018) and Redmond and Nasir (2020) found support for positive relations in the trade, human capital and growth relationship respectively. Finally, the population is inversely related to growth at a 5% level of significance. This implies that a percentage increase in population will lead to a 0.413% decrease in growth dynamics in Africa. With Africa's population estimated to reach 2.4 billion in 2050, concerns about social welfare are beginning to manifest. At this exacerbating population growth trend, the African economy will struggle to make a notable improvement in the overall well-being of its citizenry even under the most favourable economic conditions (Drechsel, Gyiele, Kunze, & Cofie, 2001).

5.0 Conclusions, Implications, Limitations and Suggestions for Further Studies

The relationship between natural resource endowments and the economic growth of African nations have been studied along various dimension and time. The empirical outcome of these macroeconomic phenomena is two-fold. While some studies found the existence of the resource curse theory, others found growth complementary and inducing capacity of natural resources. This empirical divide in the literature on natural resources and development in Africa could be a result of misspecification and omitted variable bias. The omitted variable or misspecification challenges might stem from reliance on the singularity of either oil rent, coal rent or forest rent in measuring the corresponding influence of natural resource endowments on growth and as such produces outcomes that are less reliable for a wide range of multidimensionality effect of natural resource endowments on economic growth in Africa. To address these inadequacies in the empirical relations between natural endowments and economic development in Africa, this paper uses comprehensive data set from the updated database of the World Development Indicator to capture the heterogeneous dimensions to natural resource endowments. We took cognisance of cross-sectional dependence and slope homogeneity of regressors in establishing a clear line of thought on the subject matter. We estimated the panel stationarity of the series using the second-generation cross-sectionally augmented test of Pesaran (2007) and the Hadri LM (2000) confirmatory analysis test. We relied on the panel vector error correction estimation techniques when data followed a panel unit root process, and the error terms were stationary processes. Results from the oil rent, coal rent and forest rent-induced dynamic growth in Africa reveal positive relations between oil rent, coal rent and economic development in Africa. Forest rent, on the other hand, is inversely related to economic growth in Africa. Trade and human capital are positively related to economic growth in Africa, while population growth is negatively associated with economic growth in Africa. Based on the findings from this paper, short-run policies should be tailored towards the stability of fiscal expenditure such that the objective of fiscal policy which is to maintain the condition of full employment, and economic stability and to stabilise the rate of growth can be optimised and sustained. By this, the resource curse will be averted, and productive capacity will increase, leading to sustainable growth and development.

To clarify ambiguity in the natural resource-growth relations in Africa, policymakers, and the society at large need to have evidence-based policy documents that assign a numerical weight to heterogeneous resource deposits and the channels by which they guarantee growth outcomes. Considering desirable growth similar to what is obtainable in developed nations have been largely elusive in Africa, it is essential to have a set of policies and practical recommendations that is conducive enough to rejuvenate declining dividends of natural resource deposit in Africa. With positive relations observed among oil rent, coal rent and economic growth in Africa, it is essential for resource stakeholders and governments at all levels to check the irregularities with business cycles, movement in international oil prices and challenges of oil production such that an upward increase in oil rent could lead to improve economic conditions for Africa's resource-rich nations. A considerable number of oil-producing African nations have their refineries working at sub-optimal production levels and in extreme cases transport their crude oil to a foreign country to refine at exorbitant rates (Adekunle &Oseni, 2021). These practices are a lot of times the by-product of non-functional institutions and corrupt practices (Adekunle, 2020). These practices reduce the marginal values of resource endowment and also limit the capacity of the state to cater for their burgeoning needs. Thus, leading to a resource curse. Thus, resources-rich African nations should invest a fair percentage of their accruing proceeds of natural resources in good institutions and leadership through training, empowerment and leadership capacity building.

Increased investment in energy exploration facilities within the terrain of resource-rich nations could block leakages along the entire oil exploration value chain (Adekunle &Oseni, 2021). African resource-rich nations should look inward at their use and management of factor endowment. Rather than export primary products like natural resources, consideration should be placed on how to transform these resources into finished products on home soil. This will ensure industrialisation starts and ends in domestic terrain. Strict adherence to the international oil production quota could also be useful in setting international oil prices in the global oil market (Ghoddusi, Nili&Rastad, 2017). African governments of resource-rich nations should deploy policies and practices that could reduce structural bottlenecks in the production value chain. Training and reskilling programmes should be organised at the interval to enhance methods and approaches to production. Economic diversification remains one of the most pervasive options for resource-rich nations to resolve problems of over-dependence.

With inverse relations between forest rent and growth outcomes in Africa, policymakers and society at large need to preserve biodiversity. Considering the social and private benefits of forest resources, stringent policies should be placed around it use. For example, massive deforestation should be controlled and green financing and green development options should be pursued aggressively. Innovative use and management of forest resources could proffer a lasting solution to Africa's resource curse inclinations. Positive relations in trade, human capital development and economic growth in Africa necessitate the need for resource-rich African nations to enhance their trade policies to generate an optimum return on their resource deposits. Policies such as bilateral agreements that govern the seamless exchange of resources in terms of both oil and technological resources between oil-rich African nations and oil-recipient nations for the socio-economic development of resource-rich African nations should be prioritised. This will ensure investments financed with proceeds from resource deposits have multiplier effects and could reach a wide audience (the economically marginalised).

While we establish credible outcomes on the natural resource-growth relations in Africa, the findings of this study are limited to the data obtainable from accredited sources as well as the scope and depth of resources available at the time of research. Beyond natural resource-growth relations in Africa, country-specific analysis of the natural resource-growth relationship will produce empirical outcomes that could redefine policy and research in a way that is most inclined to the development objectives of each nation.

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