Research

Nexus between natural resource endowments and economic growth in selected African countries

Meshesha Zewdie Amare[1] · Wondaferahu Mulugeta[2] · Malebo Mencha[1]

Abstract

Africa began implementing the Sustainable Development Goals (SDGs) in 2015 emphasizing on sustainable management and effective use of natural capital to spur economic growth (Goals 12, 14, and 15). This study using World Bank data sets from 46 African countries selected for the years 2000 to 2022, examined the nexus between natural resource endowments and economic growth in Africa. We used the system generalized method of moments (sys-GMM) and dynamic panel threshold regression (DPTR) to analyze the data. The findings of the two-step sys-GMM estimation using 'xtabond2' revealed that when the institutional quality variable is added and excluded from the model, natural resource dependence negatively impacts economic growth, but the impact is greater when the institution is excluded. In the estimation of the interaction variable of natural resource dependence and institutional variable included in the model, natural resource dependence positively impacts economic growth. The results of the DPTR using "xthenreg" showed that when the threshold value of natural resource dependence is ≤ 1.73% of gross domestic product, natural resource dependence has a positive impact on economic growth and a negative impact when the threshold value is above 1.73%. Similarly, when the institutional quality threshold is ≤ 0.277, natural resources dependence impacts economic growth negatively; above the threshold (0.277), the impact is positive. In conclusion, natural resource endowment is a curse with no or low-quality institutions and a blessing with high-quality institutions. Thus, building strong institutions and proper utilization of natural resources helps to minimize the adverse impact of resource endowments on economic growth.

Keywords Natural resource · Economic growth · Institutional quality · Dynamic panel · Africa

1 Introduction

The contribution of natural resource endowments to economic growth is a source of discussion in the economics literature. Economic progress concentrating on the export and extraction of natural resources has grown at relatively slow rates [1]. In contrast, natural resource endowments were noted by early development economists [2, 3] as having the ability to spur economic growth by drawing capital from foreign creditors, directing primary sector rent toward profitable ventures, and preventing poverty. According to the United States Geographical Survey of 2020, Africa has been ranked first in the production of cobalt, platinum group minerals (PGMs), gold, manganese, diamond, aluminium, and chromium(It supplied more than 25 million ounces of gold and 1.1 tons of copper. At the same time, the continent contributed about 71% of cobalt (68% contributed by the Democratic Republic of Congo), 57% of PGMs (50% contributed by South Africa), 53% of manganese, and 40% of chromium (USGS, 2020). Based on

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the United Nations Economic Commission for Africa (UNECA), Africa has made a transition from MDGs to Sustainable Development Goals (SDGs) in 2015 after reviewing the continent's progress toward the MDGs, consolidating and sustaining the African economy, social, and environmental concerns. Out of the 17 goals of SDGs, three of them(Goals 12,14, and 15) are primarily focused on achieving economic growth and development by properly and efficiently utilizing natural resources including conserving and sustainably using oceans, seas, and marine resources for sustainable development.

To justify the slower economic growth of countries that are endowed with resources and the opposite link between economic growth and natural resource dependence (hereafter the NRD), economists and politicians have developed contemporary theoretical explanations. Their argument can be divided into two categories: the market method argument attached to the Dutch disease and the political argument about the quality of institutions and looking for rent [4]. The Dutch disease hypothesis places more emphasis on the function of markets than on procedures carried out through political institutions. The Dutch disease mechanism can have an impact on resource movement and spending following a shock. The effect of resource movement explains the shift of resources from other sectors, e.g., manufacturing, to the resource sector, in which higher marginal productivity exists. The spending effect describes natural resource rent crowding out other sectors of the economy; therefore, natural resource rents are unfavorable for growth [4, 5].

From an institutional standpoint, the NRD (the revenue collected from natural resources) applies to nations with low-quality institutions. NRD can promote extended growth and development in the presence of strong institutions. Strong institutions may have an impact on the growth effects of resource rents, and the institutional context of a country affects both rent-seeking and returns to entrepreneurial activity. They contend that resource booms in economies with "grabber-friendly" institutions cause labor to move from production to rent-seeking, which is detrimental to overall growth, whereas resource booms in nations with "producer-friendly" institutions enhance production [6].

Regarding the link between the NRD and economic progress on the continent, theories point out that the role of the NRD in economic growth is inconsistent. Resource blessing theories suggest that the NRD has a favorable effect on economic growth. This is because the discovery of new resources and the revenue generated from them help governments address important socioeconomic concerns such as unemployment, poverty, health, and infrastructure [7], while the resource curse hypothesis has argued that NRD leads nations to grow slowly and pushes them to poverty and conflict [8–11]. The African Economic Outlook report of 2022 indicated that the Nigerian economy is dominated by oil production and export because oil contributes more than 60% of government revenue, and 80% of foreign exchange; however, the multidimensional poverty rate of the country is about 63% and the unemployment rate is 33.3%. On the other hand, in Botswana, the diamond industry has been a major contributor to economic growth and development; its poverty rate was 20.8% in 2021 and unemployment was 25.4% in 2022. This indicates a better contribution of natural resources in Botswana compared to Nigeria.

Empirical studies on the association between economic growth and NRD have demonstrated mixed and inconclusive findings [1, 12]. Empirical studies conducted in Africa have shown the unfavorable impact of NRD on economic growth [13, 14]. For example, Angola, Nigeria, Mali, and the DRC have plentiful natural resources but still experience slow rate of economic growth [15, 16]. Conversely, other studies have found that rent from resources has a positive impact [17] For instance, resource-rich countries such as Namibia and Botswana have experienced remarkable economic growth [18, 19] while countries with scarce resources like Rwanda and Kenya have shown faster economic progress. This indicates mixed and inconsistent findings have been reported by researchers, and this blatantly demonstrates a disagreement research gap [24].

Additionally, the effect of the threshold level of the NRD and institutional quality (hereafter the INTSQ) on the nexus between the NRD and economic growth has not been adequately investigated. Few studies have been conducted on static panel threshold regression [19, 20], and limited empirical evidence exists in Africa to determine what level of the NRD and the INTSQ is a curse or blessing to African economic growth using the recent dynamic panel threshold model (hereafter the DPTM) formulated by [21], which allows the threshold variables to be endogenous, helping to overcome the limitations of the literature on exogeneity assumptions. Thus, to the best of our knowledge, there are no prior studies that applied the dynamic panel threshold model which was developed by [21] for a condition where the threshold variable and regressors are endogenous in the effects of natural resource endowment and institutional quality on economic growth in African countries; so that we applied DPTM as a methodologically innovative approach to examine the threshold effect of natural resource endowment and institutional quality on economic growth.

Hence, it is plausible to conclude that there is no clear-cut statistical or theoretical link between the NRD and economic growth based on the aforementioned empirical and theoretical debates. This contradiction might result from the use of inconsistence in methodology, data related to natural resources (Aggregate vs disaggregated) and institutional quality

measurement issues, differentiated independent variables, and dissimilar proxy variables for measuring economic growth, such as the GDP growth rate [22] and RGDPC [23].

We were motivated to conduct this research to fill methodological inconsistency after investigating thoroughly previous literature, measurement of NRD and INSTQ variables in prior research, and after all by applying well-designed and rigorous econometric techniques to arrive at a sound finding and policy implication. Thus, why have African countries with abundant natural resources failed to grow quicker and more inclusively than those with limited natural resources? Why natural resource endowment is a blessing for some African countries and a curse for others? This shows the rationale and motivation for conducting a study on this topic to contribute to filling the existing contradictory evidence gap.

This study makes the following main contribution to the existing literature and policymakers. First, it has a methodological contribution: the use of the system GMM together with the dynamic panel threshold model provides a more comprehensive understanding of the complex relationship between natural resource endowments and economic growth in the African context. Second, the findings of the study help to broaden the evidence base; the study could offer evidence-based insights to policymakers in resource-rich African nations, enabling them to manage their natural wealth more effectively. Third the findings of the study can contribute to the ongoing debate about how resource-rich African nations can escape the resource curse and use their abundant natural resources to support long-term, sustainable economic growth. The study's policy recommendations can serve as a guide for decision-makers and contribute to Sustainable Development Goals (SDGs) in Africa.

Thus, this study examined the nexus between NRD and economic growth in 46 African countries out of 54 selected for the period from 2000 to 2022 using the resource curse and rent-seeking theories as a theoretical framework and dynamic panel and dynamic threshold panel models as an analytical model. Specifically, the study aimed to i) examine the effect of the NRD on economic growth ii) identify the role of the INTSQ in the nexus between the NRD and economic growth, and iii) analyze the dynamic panel threshold effect of natural resource rents and INTSQ on economic growth. The remainder of the paper is organized as follows: Sect. 2 explains the methods and materials, Sect. 3 presents the findings and discussion, and Sect. 4 concludes.

2 Materials and methods

2.1 Data types and sources

To meet the specific objectives outlined in this study, secondary data were collected from 46 African countries out of 54 between the years 2000 to 2022. The choice of countries and years was based on the presence of better data with fewer missing values, and we excluded 8 African countries with more missing data. Therefore, we sourced the World Bank's "World Development Indicator" (WDI) and "World Governance Indicator" (WGI). The research design used was descriptive and explanatory, with a quantitative research approach.

2.2 Dynamic panel model specification

The dynamic panel data model was preferred to the static panel data model because it assists us in solving the diversity of the entities and the endogeneity of the variables by using many instrumental variables. In addition, the existence of a "lagged dependent variable" among the regressors is a feature of dynamic relationships [25–27]. The use of the "lagged dependent variable" as an explanatory variable is in line with the work of [28, 29], and [30], in which they used lagged endogenous terms as a technique to eliminate the correlation issue between the variables, y_{it}, and $y_{i,t-1}$. The general dynamic panel model is specified as:

$$y_{it} = \alpha_i + \gamma y_{i,t-1} + x'_{it}\beta + \varepsilon_{it} \tag{1}$$

where y_{it} is the dependent variable for country i at time t, $y_{i,t-1}$ is the lag of the dependent variable, γ is constant, x'_{it} is the independent variable of country i at time t, β is the coefficient , α_i is unobserved country-specific time-invariant heterogeneity, and ε_{it} is a random term.

Most of the panel data models utilize "a one-way error component model for disturbances with $\epsilon_{it} = \alpha_{it} + u_{it}\varepsilon$. A two-way effects model permits the intercept to change over the entities and over time, which is represented as $\epsilon_{it} = \alpha_i + \gamma_t + u_{it}$ where α_i denotes the unobservable individual-specific effect, γ_t time-specific effects, and u_{it} the remainder disturbance [26, 31]. This study applied a one-way error component model of a dynamic panel (DPM) and DPTM.

Real gross domestic product per capita(hereafter RGDPC) is the dependent variable in constant 2015 USD [9, 32, 33] and is used as a proxy variable for economic growth. The choice of regressor depends on the empirical works of [34–38] and [39]. The square of NRD was added to the model to analyze the nonlinear effect of NRD on economic growth. In addition, the interaction term of NRD and INSTQ was introduced to Eq. (2) to explore the role of strong institutions on the nexus between NRD and economic growth. Equation (2) was also estimated excluding institutional quality to investigate the linear impact of NRD on economic growth. The DPM is specified as:

$$
\begin{aligned}
\ln RGDPC_{it} = {} & \delta_0 + \delta_1 \ln RGDPC_{i,t-1} + \delta_2 \ln NRDG_{it} + \delta_3 \ln NRDG_{it}^2 + \delta_4 \ln FCEG_{it} \\
& + \delta_5 FDIG_{it} + \delta_6 \ln OPNG_{it} + \delta_7 \ln LABF_{it} + \delta_8 INSTQ_{it} + \delta_9 INF_{it} \\
& + \delta_{10} \ln CRED_{it} + \delta_{11} \ln NRDG_{it}^* INSTQ_{it} + \mu_i + \varepsilon_{it}
\end{aligned}
\tag{2}
$$

where ln is the natural logarithm; $RGDPC_{it}$ is the real gross domestic product per capita of the it^{th} country at year t, $i = 1$, 2, …,46, t = 2000, 2001, …, 2022; $RGDPC_{it-1}$ is a one-period lagged value of RGDPC; NRD_{it} is the natural resource dependence measured as the sum of oil rents, natural gas rents, coal rents (hard and soft), mineral rents, and forest rent in current US$ as a share of GDP; $NRDG^2$ is the square of the NRDG; $FCEG_{it}$ is the final consumption expenditure and is measured as the total of "government and private final consumption expenditures as a percentage of GDPin current US$"; and $FDIG_{it}$ is a foreign direct investment and is computed as the net inflow in the balance of payment in the current US$; $OPNG_{it}$ is trade openness and computed as the percentage share of the sum of exports plus imports in the current US$ to GDP; $LABF_{it}$ is the total labor force, consists of individuals who are at least 15 years old and provide labor for economic activities.

$INSTQ_{it}$ is an institutional quality index that is composed of "control of corruption (COC), government effectiveness (GEF), political stability and absence of violence (PSAV), regulatory quality (ROQ), rule of law (ROL), and voice and accountability (VAC)". All of these indicators had a value spanning from "−2.5 (weak institutional quality) to + 2.5 (strong institutional quality)". To facilitate analysis, these indicators were converted into a single positive index with a value ranging between 0 and 1. This was achieved by dividing the sum of the "maximum and actual values" by the difference between the "maximum value and minimum value". Then, the INSTQ index was computed by taking the un-weighted mean of each indicator after conversion. Accordingly, a value close to zero denotes poor institutional quality, whereas a value near one denotes strong institutional quality; $NRDG_{it}^*INSTQ_{it}$ is the interaction of $NRDG_{it}$ and INSTQ; INF_{it} is inflation, which is calculated as "the ratio of GDP in the current local currency to GDP in constant local currency"; $CRED_{it}$ is domestic credit and is measured as "total credit given to private sectors as a percentage of GDP"; μ_i is constant; δ_i are coefficients to be estimated;ε_{it} $N(0, \sigma2)$ is a random term; and μ_i and ε_{it} are independently and identically distributed.

To eliminate bias resulting from unobserved country-specific effects and possible "endogeneity bias" and when the regressors are not severely exogenous [25], we use dynamic panel data estimators. If we apply any of the static panel model regression in Eq. (2), the estimates can be biased, inefficient, and inconsistent due to the possibility of correlation between the "lagged value of the RGDPC" and the error terms. Therefore, the use of the generalized method of moments (GMM) to regress Eq. (2) yields unbiased, consistent, and efficient estimates for the population parameter, as it allows us to use more instruments to control endogeneity problems. Consequently, [28, 29], and [30] designed the generalized method of moments for conditions with periods (T) < 25 and cross-sections (N) > 25.

The GMM estimator can be a difference GMM (diff-GMM) or system GMM (sys-GMM). Diff-GMM was developed by [28] by altering Eq. (2) into a first difference to drop the nation-specific effect. Similarly, simultaneity bias can also be cleared by using lagged levels of the regressor as instruments. Nevertheless, the use of lagged levels of independent variables in diff-GMM estimators may be a weak instrument for solving the endogeneity problem and might result in incorrect implications if the dependent variables are constant [29, 40]. Moreover, the first difference estimator entails data transformation by subtracting the past values of variables from their current values may lead to information loss [30].

To avoid the shortcomings of diff-GMM, [29] and [30] created a sys-GMM estimator that totalizes difference and level equations. Hence, "variables in differences are instrumented with the lags of their levels, while variables in levels are instrumented with the lags of their differences" [41], which gives us unbiased, efficient, and consistent estimates; thus, the sys-GMM estimates the weighted average of the "difference and the level coefficients" specified in Eqs. (3) and (4).

System GMM allows us to perform the estimation through one-step and two-step estimator options. For large sample sizes such as the one we used in this study, a two-step estimator produces an estimator with greater efficiency than a one-step estimator [29]. The estimation was performed with "xtabond2" [25]. This estimator introduced more options for the use of instruments than "xtdpdsys" [42]. With reference to the works of [29] and [30], the sys-GMM is specified as level (Eq. 3) and difference equations (Eq. 4):

$$
\begin{aligned}
\ln RGDPC_{it} = {} & \delta_0 + \delta_1 \ln RGDPC_{i,t-1} + \delta_2 \ln NRDG_{it} + \delta_3 \ln NRDG_{it}^2 \\
& + \delta_4 \ln FCEG_{it} + \delta_5 FDIG_{it} + \delta_6 \ln OPNG_{it} + \delta_7 \ln LABF_{it} \\
& + \delta_8 INSTQ_{it} + \delta_9 INF_{it} + \delta_{10} \ln CRED_{it} \\
& + \delta_{11} \ln NRDG_{it}^* INSTQ_{it} + \mu_i + \varepsilon_{it}
\end{aligned}
\tag{3}
$$

$$
\begin{aligned}
\Delta \ln RGDPC_{it} = {} & \delta_0 + \delta_1 \Delta \ln RGDPC_{i,t-1} + \delta_2 \Delta \ln NRDG_{it} + \delta_3 \Delta \ln NRDG_{it}^2 \\
& + \delta_4 \Delta \ln FCEG_{it} + \delta_5 \Delta FDIG_{it} + \delta_6 \Delta \ln OPNG_{it} \\
& + \delta_7 \Delta \ln LABF_{it} + \delta_8 \Delta INSTQ_{it} + \delta_9 \Delta INF_{it} \\
& + \delta_{10} \Delta \ln CRED_{it} + \delta_{11} \Delta \ln NRDG_{it}^* INSTQ_{it} + \mu_i + \varepsilon_{it}
\end{aligned}
\tag{4}
$$

2.3 Dynamic pane threshold model

The initial panel threshold model (PTM) suggested by [43] is relevant to the static panel model, which demands that threshold variables be exogenous. This model cannot be applied to dynamic panel data. Hence, by expanding the [43] model, [21] developed the DPTM to circumvent the limitations of exogenous threshold variables of the static panel threshold model. The DPTM allows both the threshold variable and regressor to be endogenous and uses the first diff-GMM approach to estimate coefficients. We used this model to examine whether the impacts of the NRD and INSTQ variables on economic growth vary with their values. The DPTM is specified as follows:

$$
y_{it} = \left(I, x\prime_{it}\right)\theta_1 I\{q_{it} \leq \gamma\} + \left(I, x\prime_{it}\right)\theta_2 I\{q_{it} > \gamma\} + \mu_{it} + \varepsilon_{it}
\tag{5}
$$

where y_{it} is the dependent variable (economic growth), $x\prime_{it}$ is a set of time-varying independent variables including the lagged dependent variable, I {,} is the indicator function showing the regimes outlined by the threshold variable, q_{it} is the threshold variable, γ is the threshold parameter, θ_1 and θ_2 are the coefficients attached to the lower and upper regimes, respectively, μ_{it} is the unobserved individual fixed effect, and ε_{it} is the error term. Considering the NRD and INSTQ as threshold variables, their threshold effects are specified as (Eq. 6 & Eq. 7):

$$
\begin{aligned}
\ln RGDPC_{it} = {} & \psi_1 \ln RGDPC_{i,t-1} + \beta_{11} \ln NRDG_{it} + \beta_{21} \ln FCEG_{it} \\
& + \beta_{31} FDIG_{it} + \beta_{41} \ln OPNG_{it} + \beta_{51} \ln LABF_{it} \\
& + \beta_{61} INF_{it} + \beta_{71} \ln CRED_{it} + \mu_i + \varepsilon_{it}, \ \text{if NRDGit} \leq \gamma
\end{aligned}
$$

$$
\psi_2 \ln RGDPC_{i,t-1} + \beta_{12} \ln NRDG_{it} + \beta_{22} \ln FCEG_{it} + \beta_{32} FDIG_{it} + \beta_{42} \ln OPNG_{it} + \beta_{52} \ln LABF_{it} + \beta_{62} INF_{it} + \beta_{72} \ln CRED_{it} + \mu_i + \varepsilon_{it}, \ \text{if NRDGit} \leq \gamma
\tag{6}
$$

$$
\begin{aligned}
\ln RGDPC_{it} = {} & \psi_1 \ln RGDPC_{i,t-1} + \beta_{11} \ln NRDG_{it} + \beta_{21} \ln FCEG_{it} \\
& + \beta_{31} FDIG_{it} + \beta_{41} \ln OPNG_{it} + \beta_{51} \ln LABF_{it} \\
& + \beta_{61} INF_{it} + \beta_{71} \ln CRED_{it} + \beta_{82} INSTQ_{it} \\
& + \mu_i + \varepsilon_{it}, \ \text{if INSTQit} \leq \gamma
\end{aligned}
$$

$$
\begin{aligned}
& \psi_2 \ln RGDPC_{i,t-1} + \beta_{12} \ln NRDG_{it} + \beta_{22} \ln FCEG_{it} + \beta_{32} FDIG_{it} \\
& + \beta_{42} \ln OPNG_{it} + \beta_{52} \ln LABF_{it} + \beta_{62} INF_{it} + \beta_{72} \ln CRED_{it} \\
& + \beta_{82} INSTQ_{it} + \mu_i + \varepsilon_{it}, \ \text{if INSTQit} \leq \gamma
\end{aligned}
\tag{7}
$$

2.4 Variable description and source

The description, expected sign, and sources of both the dependent and independent variables used in the analytical model specification are detailed in Table 1.

Table 1 Variable description, expected sign, and source

| Variables	Description	Exp. sign	Source
Dependent variable			
RGDPC	Real Gross Domestic Product per capita (constant 2015USD)	–	WDI, 2023
Independent variable			
RGDPC$_{i, t-1}$	A year lag of Real Gross Domestic per capita	–/+	WDI, 2023
NRDG	Total natural resource rent (% of GDP)	–/+	WDI, 2023
FDIG	Foreign direct investment(net inflow)	–/+	WDI, 2023
OPNG	Trade openness (% of GDP)	+	WDI, 2023
LABF	Labor force, total	–/+	WDI, 2023
FCEG	Final consumption expend (% of GDP)	–/+	WDI,2023
INF	Inflation (annual %)	–/+	WDI, 2023
CRED	Domestic credit to the private sector (% of GDP)	–/+	WDI, 2023
INSTQ	Institutional quality(index)	–/+	WGI, 2023

Source: Authors formulation, 2024 WDI = "World Development Indicator", WGI = "World Governance Indicator", Exp.sign = expected sign

Table 2 Descriptive statistics of variables

Variables	Obs	Mean	Std. Dev.	Min.	Max.
RGDP per capita	1058	2489.41	3030.06	255.10	16,747.36
NRD	1058	11.74	11.70	0.0024	88.59
Final consumption Expd	1058	83.76	16.55	16.713	140.81
Openness	1058	54.42	28.85	7.81	175.38
Labor force	1058	8,513,257	1.13e+07	121,592	7.33e+07
Foreign direct investment	1058	8.17e+08	2.03e+09	−7.40e+09	4.07e+10
Inflation	1058	12.889	86.018	−24.847	2630.123
Domestic credit	1058	20.604	22.426	0.0016	142.422
Institutional quality	1058	0.3672	0.1136	0.1181	0.6741

Sources: Authors computation, 2024

Fig. 1 Associations between NRD and INTSQ
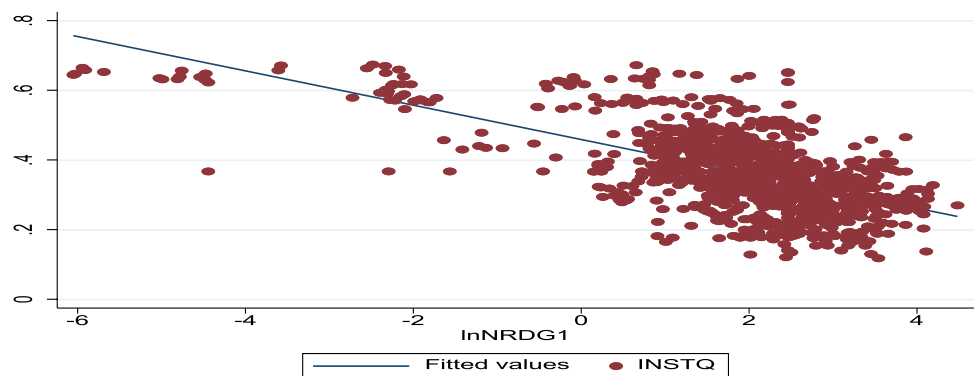
3 Results and discussions

3.1 Descriptive statistics

The descriptive results of the variables used in the study are depicted in Table 2. All sampled countries had RGDPC mean value of 2489.41, with a minimum value of 255.1 for Ethiopia in 2003 and a maximum value of 1647.36 for Seychelles in 2020 (all values in constant US dollars). NRD had a mean value of 11.74% as a percentage share of GDP; the lowest value

Table 3 Pairwise Correlation Matrix

|	lnGDPC	lnNRDG	lnFCEG	lnOPNG	lnFDIG	lnLABF	INSTQ	INF	lnCRED
lnGDPC	1.0								
lnNRDG	−0.3124	1.0							
lnFCEG	−0.5454	−0.2161	1.0						
lnOPNG	0.5201	−0.0737	−0.3248	1.0					
lnFDIG	0.0913	−0.0016	−0.0146	−0.0616	1.0				
lnLABF	−0.1692	0.1464	0.0173	−0.3440	0.1665	1.0			
INSTQ	0.3824	−0.6271	0.0024	0.2933	0.0426	−0.1253	1.0		
INF	−0.0456	0.0376	0.0075	−0.0989	−0.0089	0.0623	−0.1081	1.0	
lnCRED	0.3583	−0.2784	−0.0801	0.1496	0.0900	0.1221	0.3185	−0.0870	1.0

Source: Authors computation, 2024

was 0.0024% in 2019 for Mauritius, and the highest was 88.59% in 2000 for Equatorial Guinea, using current US dollars. In current U.S. dollars, Equatorial Guinea's final consumption expenditures in 2005 and Chad's in 2002 had minimum and maximum values of 16.713% and 140.81% of GDP, respectively, with a mean value of 83.76%.

The INTSQ consists of six indicators, each with a range of values from 0 to 1. The mean INTSQ score was 0.367. Mauritius had the highest institutional quality index (0.674) in 2014, while Libya had the lowest (0.1188) in 2019. The labor force's mean value is 8,513,257, with minimum and maximum values of 121,592 and 7.33e + 07, respectively; the mean net investment inflow in current US dollars is 8.17e + 8; and Angola registered the lowest net inflow of FDIG in 2017, while South Africa recorded the highest net inflow in 2021. Similarly, the average rate of inflation was 12.889%, domestic credit had a mean value of 20.604% of GDP in USD, and the mean value of trade openness in current USD was 54.42% of GDP. The scatter graph in Fig. 1, which was fitted with institutional quality values for sampled countries from 2000 to 2022, also indicated an inverse relationship between the NRD and the INTSQ in Africa.

Table 3's pairwise correlation matrix demonstrated that, for the years 2000–2022, there was a negative correlation between the rent from natural resources and real GDP per capita (or economic growth) in the sampled African nations. This result aligns with the resource curse theory. There was a negative correlation between institutional quality and natural resource rent, but a positive correlation between institutional quality and economic growth. This suggests that there are low-quality institutions in Africa, and it's likely that the continent's institutions will get worse due to the rent from its natural resources. Likewise, final consumption expenditure, labor force and inflation correlated negatively with economic growth. However, domestic credit, trade openness and foreign direct investment were correlated positively with economic growth.

The scatter graph in Fig. 2, which was fitted with lnRGDPC values for sampled countries from 2000 to 2022 presents the relationship between lnRGDPC and lnNRDG for all sampled countries from 2000–2020. The fitted line indicated natural resource rent has a negative relationship with real GDP per capita.

Fig. 2 Relationship between economic growth and NRD from 2000 to 2022
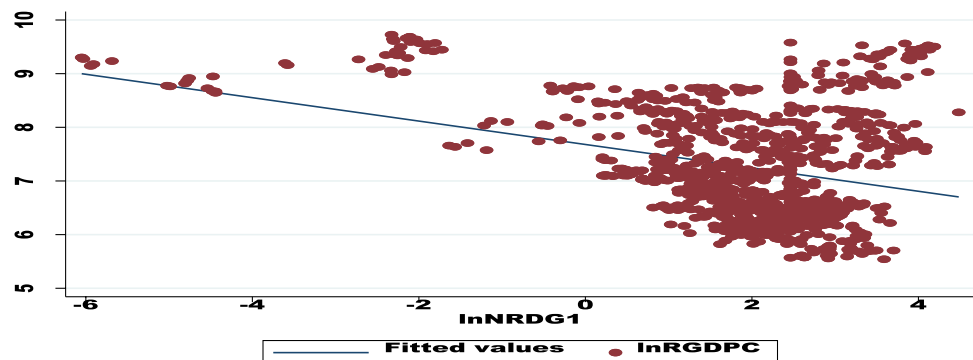
Table 4 Two-step system GMM estimates

Variable	Estimate 1 coef.	Estimate 2 coef.	Estimate 3 coef.	Estimate 4 coef.
Lag-Real GDP per capita	0.9597***	0.9569***	0.9476***	0.9568 ***
	(0.0192)	(0.0162)	(0.0142)	(0.0209)
Natural resource rent	−0.0094*	−0.0139***	0.1414**	−0.0257*
	(0.0049)	(0.0048)	(0.0593)	(0.0129)
NRDG_Sqr	–	–	–	0.2857
	–	–	–	(0.1983)
NRDG*INSTQ	–	–	−0.3067**	–
	–	–	(0.1328)	–
Institutional quality	0.0842**	–	0.7362**	0.0852
	(0.0395)	–	(0.2974)	(0.2379)
Domestic credit	0.00026	0.0010	0.0028	−0.0026
	(0.0031)	(0.0033)	(0.0041)	(0.0017)
Final-consumption expen	−0.1013***	−0.1102***	−0.0619*	−0.0844***
	(0.0241)	(0.0191)	(0.0315)	(0.0199)
Trade openness	0.0290**	0.0334**	0.0029	0.0287*
	(0.0142)	(0.0138)	(0.0224)	(0.0164)
Foreign direct Invest	0.0194*	0.0194	0.0248	0.0145*
	(0.0110)	(0.0124)	(0.0184)	(0.0079)
Labor force	0.0019	0.0018	0.0011	−0.0091
	(0.0031)	(0.003)	(0.010)	(0.0095)
Inflation	−0.00006	−0.00006	−0.00009	−0.00005
	(0.00005)	(0.0001)	(0.00008)	(0.00006)
-cons	0.1545	0.2332	−0.2890	−0.6388
	(0.3375)	(0.03505)	(0.4994)	(0.4911)
F-Statistics: P- value	0.000***	0.000***	0.000***	0.000***
No. of Obs	1012	1012	1012	1012
No. countries	46	46	46	46
No. Instruments	45	44	45	45
AR(2): p- value	0.885	0.962	0.548	0.843
Hansen J-test: p -value	0.325	0.321	0.220	0.243

Source: Own Computation, 2024. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively. The figures in brackets represent the standard errors. All variables are in natural logarithm form except for the institutional quality index and inflation. Estimate 1 is with the institutional variable, Estimate 2 is without the institutional variable, Estimate 3 is with the interaction term, and Estimate 4 is with the square of the NRD

3.2 Econometric analysis

3.2.1 Impact of NRD on economic growth

The findings of the two- step system GMM using the "xtabond2" estimator are presented in Table 4. The Arellano—Bond test for AR (2) is greater than the probability level of 0.05, implying no serial correlation among the regressors. The Hansen test of over-identification restriction also showed that the probability level is greater than 0.05, indicating that all restrictions of over-identification are valid. Similarly, the number of instruments for all estimation options was less than the number of countries, which again indicates that the instruments used as groups were valid.

The first estimation was conducted by including the institutional quality variable (estimate1). This option is needed to check the impact of NRD on economic growth when the INSTQ is included. The second option shows the direct impact of NRD on economic growth when the institutional variable is excluded from the regression (estimate 2). The estimation results for both options illustrated that the lag of RGDPC is significant at the 1% probability level. This implies that the

economic growth of the current period is influenced by the growth of the preceding period. This finding also indicates that the link between NRD and economic growth is dynamic. This finding coincided with the findings of [44] and[45].

With the institutional variable included (estimation1) in the analytical model, NRD has a negative coefficient and is significant at the 10% level. A 1% increase in NRD is associated, on average, with a 0.0094% decline in economic growth, *ceteris paribus*. This finding corresponds with the results of [9], and [45], and contradicts the findings of [46] in which their results showed a positive contribution of the NRD to economic growth.

When an institutional quality variable is excluded from the estimation (estimation 2), NRD has a negative coefficient and is significant at the 1% level. A percentage rise in the NRD causes, on average, economic growth to fall by 0.0139%, other factors remain constant. Our findings are in agreement with the results of [33] and [47]. In sum, regression with and without the institutional quality variable suggests that NRD hurts economic growth; however, the impact of NRD on growth is lessened (0.0094) when the institutional variable is added to the model than when it is excluded (0.0139). This highlights the significance of strong institutions in the nexus between the NRD and economic growth. This finding validates the resource curse hypothesis for African countries from 2000 to 2022.

Institutional quality has a positive coefficient and is significant at the 5% level, as presented in Table 4 (estimation1). *Ceteris paribus*, a unit change in the INSTQ is therefore linked to an average increase in economic growth of 8.42%. Our findings are in accordance with those of [22] and [48]. Final consumption expenditure has a negative coefficient and is significant at the 1% level in both estimations 1 and 2. This can be interpreted as a percentage increase in final consumption expenditure causing economic growth to decline by 0.1013% and 0.1102%, respectively. Our findings concur with the results of [49]. This implies that government expenditure might be diverted from development-contributing programs to non-development concerns. Besides, more private consumption expenditures may be incurred on imported goods and services than on capital goods. Trade openness has a positive coefficient and is significant at the 5% level. A 1% change in trade openness resulted in a 0.029% and 0.033% increase in economic growth in both estimates, respectively. This finding corresponds with the findings of [20].

In the estimation with INTSQ added, FDI has a positive coefficient and is significant at the 10% level. Ceteris paribus, a one percent surge in FDI boosts economic growth by 0.0194%. Our estimate is in agreement with the results of [49]. However, these findings disagreed with the findings of [45] In contrast, FDI has an insignificant impact on economic growth when the institutional variable is dropped from the model.

3.2.2 Impact of NRD on economic growth with interaction and square terms

The regression results of the interaction and the square term of NRD are presented in Table 4. To determine the effect of strong institutions on the nexus between the NRD and economic growth, we investigated the interaction between the NRD and the INSTQ. When the interaction variable (NRDG*INSTQ) is included in the model specification (estimate 3), the results of the two-step sys-GMM show that NRD is significant and has a positive impact on economic growth at a probability level of 5%. This can be interpreted as a percentage changes in natural resource rent resulting in, on average, a 0.141% change in economic growth, *ceteris paribus*. In the same estimation, the INTSQ has a positive coefficient and has a significant impact on economic growth at the 5%.

The interaction variable (NRDG*INSTQ) affects economic growth significantly and negatively at a probability level of 5%. The negative sign of the interaction term coefficient revealed that indexed values of institutional quality will reduce the positive influence of the NRDon economic growth over time [50] and is a sign of weak institutional quality in Africa. Our finding is consistent with the works of [51] and contradicts the findings of [52], whose findings showed that the interaction term has a positive coefficient. This finding implies that when the interaction term and institutional variable are estimated together in the model, NRD influences economic growth positively and is in support of the resource blessing hypothesis. This indicates that countries need to build strong institutions to reduce the negative impact of NRDon economic growth.

When the square of the NRD is included in the analytical model, the estimates of the quadratic effect (estimate 4) revealed that NRD impacts economic growth negatively and significantly at the 10% level. Its square term does not significantly affect economic growth, implying that the relationship between NRD and economic progress is linear. However, the exact test for the shape of the relationship was tested by "*utest*", which was proposed by [53]. The test results indicated the presence of a monotonic relationship (t- value = 1.43 and p = 0.0793). This monotonic relationship between NRD and economic growth indicates the possibility of the presence of a dynamic threshold effect. To this end, the findings in Table 5 of the DPTM bootstrap linearity test confirmed the presence of a threshold effect (p = 0.00).

Table 5 Dynamic panel threshold regression result

Variable	Natural resource rent		Institutional variable	
	Coef.	Std. err.	Coef.	Std. err.
Lower regime, % of obs($q_{it} \leq \delta$)	36.7%	–	21%	–
Lag-RGDPC	0.9380***	0.0725	0.5939***	0.0523
NRD	0.1116**	0.0443	−0.1074***	0.0271
INSTQ	–	–	−2.8550***	0.8327
Domestic credit	−0.0318	0.0257	−0.0603***	0.0199
Final consumption expd	−1.0604***	0.1946	−0.1983***	0.0647
Openness	0.0408	0.0464	0.0687	0.0453
Foreign direct Invest	−0.4887**	0.2249	0.4536**	0.2198
Labor force	0.0282	0.0373	0.1712***	0.0507
Inflation	−0.0002***	0.00006	−0.0004***	0.00007
Upper regime,% of obs($q_{it} > \delta$)	63.3%		79%	
Lag-RGDPC	−0.2387***	0.0629	−0.1361***	0.0495
NRD	−0.2809***	0.0394	0.0932***	0.0229
INSTQ	–	–	3.1946***	0.8146
Domestic credit	0.0088	0.0349	0.1068***	0.0185
Final consumption expd	0.6019***	0.2141	−0.3771***	0.1195
Openness	0.1954***	0.0417	0.0013	0.0633
Foreign direct Invest	0.6437***	0.2357	−0.5296**	0.2492
Labor force	0.0821***	0.0254	0.0779**	0.0334
Inflation	0.0005***	0.0001	−0.0008**	0.0003
-Cons	−17.163***	4.858	12.3050**	4.9690
Threshold (r)	1.730***	0.2194	0.277	0.0193
Test of Linearity(bootstrap p- value)	(0.000)	–	(0.000)	–

Source: Authors Computation, 2024. *** and ** denotes significance at the 1%, 5% and 10% levels, respectively. NRD and INSTQ are threshold variables. All variables are in natural logarithm form except for the institutional quality index and inflation

Besides, FCEG and FDIG have negative and positive influences on economic growth at probability levels of 1% and 10%, respectively, with quadratic terms incorporated in the model. Our finding matches the findings of [54], who found a negative and significant effect of FCEG on economic progress.

3.2.3 Dynamic panel threshold model

Based on the work of [21], the dynamic panel threshold model(DPTM) was regressed based on the "xthenreg" command in STATA 17 software. The "utest" statistical test detects the presence of a monotonic relationship between NRD and economic growth. This shows that searching for the threshold effect using the square term has limitations because it imposes a prior restriction that the effect of the threshold variable (hereafter TV) on the dependent variable needs to be monotonically and symmetrically increasing and decreasing with the level of the TV [55].

The regression results of a DPTM using an institutional variable and NRD as threshold variables are presented in Table 5. When NRD is considered a TV, the threshold (r) parameter is 1.73%, such that approximately 36.7% and 63.3% of the observations fall into the lower and upper regimes of NRD, respectively. The coefficient of lagged real GDPC is positive and significant at the 1% level for the low percentage of natural resource rent per GDP (lower regime). However, it has a negative coefficient for the higher percentage of NRD per GDP (upper regime) and is significant at the 1% probability level. The same finding was obtained when INSTQ was used as a TV. This illustrated that the previous year of economic growth enhances the subsequent lower regime of economic growth and retards the upper regime of economic growth in the current year.

NRD positively and significantly impacts economic growth at the 1% level when its percentage share of GDP is less than or equal to 1.730% (lower regime) and negatively impacts economic growth when its share of GDP is greater than 1.730% in the upper regime. The mean RGDPC below this threshold level is 7.61 USD, and that above the threshold level

is 7.07 USD. This showed that economic growth will decrease as the ratio of NRD to GDP increases and those nations with greater natural resource endowments will experience lower economic growth than those with fewer natural resource endowments. This finding supports the resource curse hypothesis. Final consumption expenditure, foreign direct investment, and inflation negatively impact economic growth at lower NRDGs and impact economic growth more quickly and significantly at higher NRDGs.

When institutional quality is used as the threshold variable, the threshold parameter is 0.277, with 21% and 79% of the observations falling into the lower and upper regimes of an institutional quality variable, respectively. The findings indicated that NRD negatively and significantly impacts economic growth when the INTSQ is less than or equal to 0.277 (lower regime) and has a significant and positive impact on economic growth when the INSTQ variable is greater than 0.277 (upper regime) at the 1% level. Below the threshold level of the INTSQ, natural resource dependence has a mean value of 2.71% of GDP, and RGDPC has a mean value of 7.03 USD, while above the threshold level, NRD has a mean value of 1.65% of GDP, and RGDPC has a mean value of 7.34 USD. This implies that nations with weak INSTQs depend largely on NRD and score lower on RGDPC, whereas, nations with robust INSTQs are relatively less dependent on NRD and have higher RGDP [44] and [23]. Found results that matched our findings. This indicates that for African nations with robust institutions, NRD has a favorable impact on economic growth. Hence, the NRD is a blessing for nations with robust institutions. In the lower regime of the INSTQ, the institutional variable itself negatively and significantly impacts economic growth, whereas in the upper regime, it impacts economic growth positively and significantly impacts economic growth. This shows that strong institutions are needed to enhance economic growth.

Inflation and FCEG have significant negative effects on economic growth in the lower and upper regimes of institutional quality variables. Domestic credit has a positive and negative impact on the lower and upper regimes of the INSTQ variable, respectively. Foreign direct investment has a positive impact on economic growth in the lower regimes of the INSTQ variable, but it harms economic growth in the upper regimes.

4 Conclusion and Policy Implications

The findings of the two-step system GMM estimation indicated that NRD negatively and significantly impacts economic growth with and without the inclusion of institutional variables in the analytical model specification. However, the negative impact of the NRD is greater when the institutional variable is excluded from the estimation, implying that the INSTQ plays a greater role in the nexus between the NRD and economic growth. This finding supports the resource curse hypothesis for the continent. The interaction variable (INSTQ*NRD) positively and significantly impacts economic growth. This implied the importance of strong institutions for making the NRD contribute positively to African economies. This finding supports the resource blessing theory. Regression from the DPTM indicated the presence of a threshold value. When the threshold level of NRD is ≤ 1.73% of GDP, NRD impacts economic growth positively and has a greater mean effect on RGDPC, whereas above the threshold value, NRD contributes negatively to economic growth and has a lower RGDPC than does the lower regime. This implies that as the percentage share of NRD in GDP increases, economic growth is negatively impacted by natural resource rents. This finding also agrees with the resource curse hypothesis. Thus, mobilizing a significant amount of natural resource rent is needed to reduce the negative effect of NRD and realize sustainable development goals (SDGs) in Africa. Similarly, when the threshold level of the INSTQ index is ≤ 0.277, the NRD contributes negatively to economic growth but positively impacts economic growth above the threshold value. This demonstrates that strong institutions are important for making the NRD contribute positively to economic growth. Therefore, improving the current institutional arrangement as done by Ghana and Uganda and aligning domestic plans with Agenda 2030 and 2063 as practiced by Ethiopia from Growth and Transformation Plan (GTP-II) to Climate Resilient Green Economy (CRGE) will help achieve the Sustainable Development Goals.

Finally, we conclude that nations endowed with natural resources need to build strong institutions to make the NRD a blessing for their economic progress. This means, utilizing natural resources sustainably and effectively is crucial for achieving sustainable growth and development in Africa, which will help to end hunger, poverty, and improve living conditions. This is realized through proper adoption and implementation of goals of Agenda 2030 and Agenda 2063. Hence, enhancing the conservation, management, and utilization of natural resources as well as diversifying land-based resources (minerals) to ocean, sea, and marine resources like fisheries, aquaculture, and tourism helps achieve the SDGs in Africa.

This study did not estimate the threshold levels of the NRD and INSTQ of each country. We also consider natural resource endowments in aggregate form. Therefore, future research is needed to estimate the country-specific threshold level and analyze the disaggregated impact of the NRD on economic growth using recent data.

Declarations

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