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Natural Resources, Governance and Structural Transformation in Central Africa: Empirical Analysis Using the Panel Corrected Standard Errors (PCSE) and the Feasible Generalized Least Squares (FGLS)

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Abstract

This study aims to enrich the existing literature on the importance of escaping the natural resource curse, by exploring how governance can moderate the effects of natural resources on structural transformation. The focus is on ten Central Africa nations for the period 1996-2023, and the empirical evidences are based on interactive Panel Corrected Standard Errors (PCSE) and the Feasible Generalized Least Squares (FGLS). The Natural resource rents are measured by the benefits from the total natural resources. The Governance components indices and the composite Index from the Principal Components Analysis (PCA) are employed as moderators. The hypothesis that governance components indices combined to Natural resource rents influence structural transformation in a mixed ways is evident. However, the hypothesis that the Governance composite index interacting with Natural resource rents exerts a negative influence on structural transformation is not confirmed, as the estimated relationship is statistically non-significant. For the hypothesis (3), Natural resources rents having a negative direct effect on structural transformation is verified while, governance composite index having direct negative influence on structural transformation is non-significant. Explanations for the non-validation of certain hypotheses are provided, and relevant policy implications are discussed.

Keywords

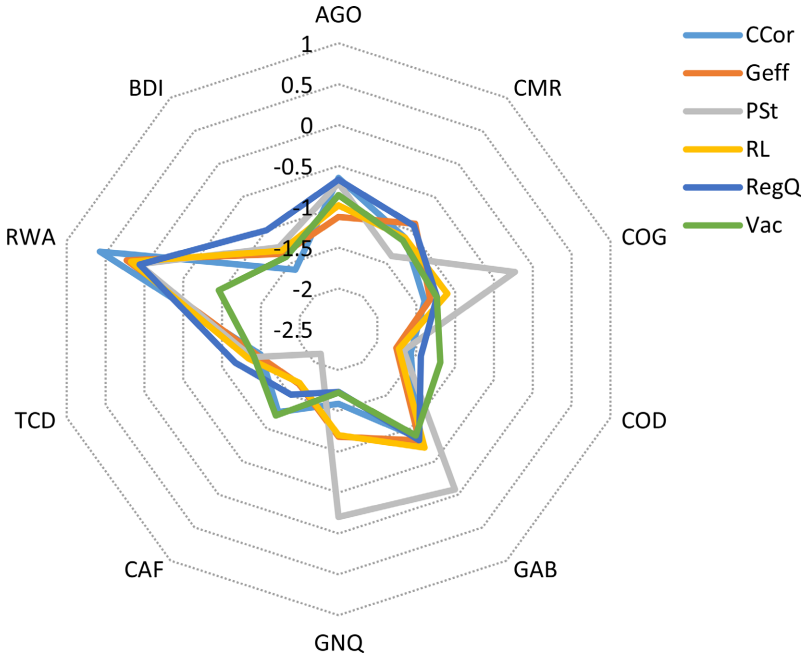
Structural Transformation, Natural Resource Rents, Governance, PCSE, FGLS,

Central Africa

1. Introduction

The issue of the governance-natural resources and structural transformation nexus has been the focus of considerable attention in recent decades, particularly in developing countries endowed with natural resources, such as those in Sub-Saharan Africa. Several economists have highlighted the intrinsic key role played by institutions and good governance practices in escaping the natural resource curse, and promoting the structural transformation (Barro, 1990; Sachs & Warner, 1995; Barro & Sala-i-Martin, 1995; Mehlum et al., 2006; Robinson et al., 2006). Lewis (1954) and Clark (1940) argue that structural transformation is a key driver of economic growth and sustainable development. It refers to the transition from a traditional, rent-based economy to a modern production-based economy in which the industrial sector contributes significantly to national income. In this context, natural resource rents can also play an important role in economic growth and may support the promotion of structural transformation in natural resource endowed Central African countries. According to EITI (2022), revenues from natural resources constitute an important source of financing in the implementation of development programs. Thus, Cameron and Stanley (2017), corroborating the above assertions, showed the importance of oil revenues in financing the various industrial sectors essential to achieving the Sustainable Development Goals (SDGs). In this economic transition, industrialization through its level of productivity and its ability to influence the development of other sectors of the economy, occupies an important place. For Avom and Nguekeng (2020), industrialization is essential to the promotion and achievement of a positive transformation of the economy in connection with institutions quality that would promote, on the one hand, innovation and the accumulation of human capital (Lucas, 1988) and, on the other hand, the efficient allocation of resources, research and development (Romer, 1986). Industrialization, fueled by natural resource revenues, is essential to promoting and achieving positive economic transformation, but this is linked to the quality of institutions, as poor governance undermines the key drivers of progress-democracy, security, and development in Central Africa. Progress made in few countries is not reflected across the subregion. Thus, Transparency International (2023) reveals that the Central Africa countries have very low scores, ranking on average among the last in terms of governance perception index (WGI, 2024). As elucidated in **Figure 1**, the radar graph provides a comprehensive overview of the Central Africa governance situation.

The radar graph shows a marked tendency among the countries of the Central Africa, of which the majority exhibits governance indices ranging from −2.5 to 0. These indices are indicative of substandard governance and fragile institutions in



Source: author, on excel. Note: PSt is the Political Stability and Absence of Violence; RL is Rule of Law; RegQ is the Regulatory Quality; Geff is the Government Effectiveness; Ccor is the Control of Corruption; Vac is the Voice and Accountability.

Figure 1. Central Africa Governance situation in 2022 (WGI, 2024).

the region. The only notable exception is Rwanda, whose governance indices approximate the neutrality threshold, and are in fact marginally positive: Ccor at 0.57, RegQ at 0.06, RL at 0.17, Geff at 0.22 and PSt at 0.07. However, despite these relatively favourable values, Rwanda exhibits an index of −0.95 for the 'Voice and Accountability' (Vac) component, indicating that civic engagement, freedom of expression, and governmental accountability towards the population are considerably constrained. This vulnerability underscores an inherent contradiction: the enhancement of institutions and certain regulatory mechanisms without concomitant progress in democratic freedoms and political transparency. The prevalence of unfavorable outcomes in the region corroborates the conclusions of Kaufmann et al. (2005), who cautioned against the inadequacy of governance mechanisms and the fragility of institutions in multiple African nations. The absence of robust and reliable cadres has a detrimental effect on both economic development and the consolidation of democracy and political stability. The radar graph provides a precise and nuanced cartography of governance within the Central Africa, emphasizing the urgency for comprehensive reform, particularly in the domains of political responsibility and citizen participation, where the disparities are most pronounced. The diagnostic assessment indicates that, while some institutional advancements have been observed, particularly in Rwanda, the majority of the Central Africa states are perpetuating a cycle of inadequate governance, resulting in significant negative outcomes that substantiate the structural fragility that has been repeatedly highlighted over several years.

Theoretically, the economic literature highlights two main approaches. The first approach argues that when natural resource endowments are combined with weak institutions and poor governance practices, they fail to help countries escape the natural resource curse and instead hinder structural transformation. According to the resource curse hypothesis, economies that rely heavily on natural resources are more likely to experience limited or low levels of structural transformation due to weak institutions and poor governance (Auty, 1993; Sachs & Warner, 1995; Sachs & Warner, 2001; Gylfason & Zoega, 2006). The second approach suggests that natural resource endowments, when combined with strong institutions and good governance practices, enable countries to escape the natural resource curse and promote structural transformation. This is in line with the theory of endogenous growth, which highlights the importance of institutions in long-term economic development and in creating an environment that fosters investment, innovation, and structural transformation (Romer, 1986; Lucas, 1988; Barro, 1990).

Empirically, we have studies showing that corruption and poor governance can lead to inefficient use of natural resource revenues and hinder structural transformation (Wendji et al., 2024; Olomola, 2007); Vandycke, 2013); Jalloh, 2013); El-Anshasy et al., 2017), and the studies revealing that states with good governance and strong institutions are more likely to benefit from natural resources and promote structural transformation (Belaid et al., 2021; Brunnschweiler, 2008; Sarmidi et al., 2012; Karimu et al., 2017; Arin & Braunfels, 2018; Epo & Nochi Faha, 2020; Ampofo et al., 2023). These theoretical and empirical approaches are detailed in the literature review (section 2). According to UNCTAD (2019a), an increase in diversification indices in several subregions of Sub-Saharan Africa, has been observed. This is the case of the West African sub-region, where the diversification index increased from 0.74 in 2009 to 0.76 in 2019. This diversification index in Central Africa for the same periods increased from 0.82 to 0.83. Similarly, the AfDB (2020) studies covering the period from 1995 to 2018 on the transformation of African economies, showed that the weight of the primary sector to GDP recorded a decrease from 39.86% to 31.95% for the period from 1995 to 2018, while the secondary and tertiary sectors recorded an increase, from 23.8% to 26.28% and from 36.34% to 41.77%, respectively. This progression is reinforced by a slight increase of the industrial sector weight in the Gross Domestic Product (GDP) of African countries. According to the WDI (2022), this weight of the industrial sector to GDP (secondary and tertiary sectors) of the Sub-Saharan African countries increased from 10.15% in 2009 to 11.37% in 2019, while in the primary sector, it increased from 58.87% in 2009 to 54.33% in 2019. The contribution of the industrial sector to GDP, which increased from 36.80% in 1998 to 40.34% in 2021 in Central Africa (WDI, 2022), remains low despite the various mining and oil booms that have occurred in these countries (Maréchal, 2013; Gary & Karl, 2003).

Regarding the relationship between natural resources, governance, and structural transformation, the neoliberal perspective holds that natural resources con-

stitute a precondition for the economic takeoff of less advanced countries toward the industrial stage (Rostow, 1961; Balassa, 1981). Specifically, natural resources provide funds for the accumulation of physical capital, thereby increasing demand for industrial goods. However, natural resources may or may not promote structural transformation, as the outcome largely depends on the quality of institutions, particularly in countries with abundant stocks of natural resources. From these facts, the structural transformation of the Central Africa economies remains a problem to which solutions must be found.

Our main objective is to examine how governance moderates the effects of natural resource rents on structural transformation in Central Africa? Considering the above, the following testable hypotheses are considered within the remit of the empirical analysis of this study:

- Hypothesis 1: Governance components indices in Natural resource rents, influence structural transformation in a mixed way;
- Hypothesis 2: Governance composite index in interaction with Natural resources rents, exerts a negative influence on structural transformation;
- Hypothesis 3: Natural resource rents and governance composite index have a negative influence on structural transformation, respectively.

The effects of natural resources and governance have been individually formulated as first-order direct effects. However, it is important to recall that even if the first-order direct effect of governance is not significant, second-order indirect effects can be significant because the absence of significance in linear additive models does not rule out the possibility that nonlinear combinations of the corresponding variables can yield significant effects. This is essentially because in the real world, these considered variables do not exclusively act in isolation but are contingent on complementary factors. Whether the investigated nexuses are significant is a matter of empirical validity, which is the object of the following section (2).

The focus of the research is on ten countries of Central Africa and allows us to examine how the governance interfairs in natural resource rents and the structural transformation relationship. The choice of Central Africa as a study area is justified by the availability of data and the low contribution of their industrial and service sectors to GDP, with weak institutions and very low governance indices, which places Central Africa states among the worst performers in the world in terms of governance perception. This study contributes to the growing body of literature on the resource curse and underscores the importance of holistic strategies to harness the potential of natural resources for sustainable development in the Central Africa region. Besides the introduction, the rest of this study is structured into four (4) sections, which are: literature review (Section 2), data and methodology (Section 3), empirical analysis (Section 4), and concluding implications (Section 5).

2. Literature Review

It is important to recall that the present study examines how governance moder-

ates the effects of natural resource rents on structural transformation in Central Africa. Theoretically, two approaches emerge from the literature. The first approach stipulates that natural resources combined with institutions weakness and poor governance practices, do not help in escaping the natural resource curse, and hinder structural transformation. This approach, in line with the theory of the resource curse developed by Auty (1993), is the basis of all problems related to economic growth and structural transformation of African states endowed with natural resources. The primary explanation lies in institutional weakness and poor governance. The "*resource curse*" is a term used to describe the phenomenon where countries with abundant natural resources, such as minerals, fail to achieve comparable economic growth and development to those without such resources (Elbra, 2013). This concept highlights a paradox where the presence of natural resources does not guarantee success in achieving sustainable economic growth and poverty reduction (Costa & Santos, 2013). The resource curse phenomenon is often associated with pervasive corruption, a lack of secure property rights, persistently high unemployment, and striking income inequalities (Colgan, 2014). Sachs and Warner (1995) asserted that resource-rich countries have weaker manufacturing sectors than resource-poor countries because resource rents encourage economic agents to engage in rent-seeking activities, which stifles economic growth. For the natural resource curse theory, the mobilization of transmission channels is necessary to explain the effects of the natural resource curse for states endowed with natural resources. Rent-seeking, which is one of the channels, promotes corruption, political instability, conflicts, etc.

Auty (1993) believes that rent-seeking behavior leads to corruption and discourages investment. Similarly, Tornell and Lane (1999) argue that rent-seeking behavior is common in economies with high natural resource endowments and weak political and judicial institutions, calling into question the type of economic policy implemented and the legitimacy of these actors. In such contexts, rent distribution tends to lack transparency, favoring patronage networks and reinforcing the rent-seeking behavior of political and military elites. These predatory interest groups are sometimes more powerful than political parties and/or the government. This leads to "petromania" behaviors of inefficient public spending and budgetary and economic crises. These rent-seeking behaviors are common in the issuance of permits or operating licenses to extractive companies (O'Higgins, 2006). Sala-i-Martin and Subramanian (2003) argue that oil booms exacerbate rent-seeking behavior and lead to corruption and inefficient spending within government. Furthermore, Collier and Hoeffler (2005) and Ross (2004) reveal that mineral rents, if poorly managed, can also lead to autocratic rule and civil conflict, thus weakening states structures and encouraging rent-grabbing. According to Fearon and Laitin (2003), deteriorating governance quality increases the risk of wars and conflicts. Indeed, natural resources represent a significant source of funding that attracts the attention of many rebel groups and organizations. The plundering of natural resources by these nascent groups can be used to purchase

weapons, form and train militias, and challenge government forces. Colgan (2013) argues that natural resources generate tensions between neighboring states. In many parts of the world, several border disputes are linked to natural resources: Iraq's invasion of Kuwait in 1990, the war in 1995 between Peru and Ecuador over border territory reputed to be rich in oil, the conflict in the East of Congo DR, rich in rare minerals, the border dispute between Nigeria and Cameroon over Bakassi, an oil-rich area, etc.

Moreover, the second approach reveals that natural resources, combined with strong institutions and good governance practices help in escaping the natural resource curse, and promote structural transformation. This approach is in line with the endogenous growth theory, initially focused on the work of Romer (1986), Lucas (1988), and Barro (1990). This approach argues that strong institutions promote innovation, human capital accumulation (Lucas, 1988), efficient allocation of resources, and research and development (Romer, 1986). This inevitably leads to a positive structural transformation of the economy. The theory of endogenous growth argues that institutions play a crucial role in the long-term economic growth process. Indeed, it explains that economic, political, and social institutions largely determine the ability to achieve sustainable economic growth. Strong institutions, such as stable legal and regulatory frameworks, well-defined property rights, an efficient financial system, and an environment conducive to innovation, promote investment, capital accumulation, productivity, and innovation, which lead to sustained economic growth and structural transformation. Also, by encouraging structural transformation, institutions can foster the shift from an agricultural economy to a more diversified economy focused on higher value-added industries. This requires creating conditions conducive to the emergence of new industries, the development of vocational training, access to financing, and the protection of workers' rights.

In addition, Alexeev and Conrad (2011) stated excessive reliance on natural resource rents can adversely affect institutional quality in resource-rich countries. These effects can persist for a long time, thus threatening long-term economic growth. This situation is common to many transition countries with abundant resource that have experienced significant institutional changes. Furthermore, the fact that a country is endowed with natural resources often makes it difficult for the government to make the necessary institutional reforms, which can lead to growth that is not sustainable in the long term. Indeed, many historical facts have explored that resource-poor countries tend to grow faster than resource-abundant countries; it's also worth bearing in mind that natural resource wealth was not the main driving force behind the countries' economic success in the past. Despite abundant natural resources, Norway and Botswana have harnessed their natural resource windfalls to generate robust growth rates, and their experiences serve as good lessons to natural resource-endowed countries (Larsen, 2005; Holden, 2013). The Norwegian government has isolated oil rents from politically induced goals by allocating them to productive investments under a transparent operational

framework (Tsani, 2013). Similarly, Acemoglu et al. (2002) pointed out that Botswana has successfully managed its natural resource rents due to its sound governance practices and high-quality institutions especially in terms of property rights that have hitherto been mainly influenced by pre-colonial institutions. This shows the wisdom of insisting first and foremost on stepping up institutional reforms and building up good governance that is the way out of the resource curse owing to its ability to turn natural resource wealth into a boon and enable resource-abundant countries to generate robust and sustainable economic growth.

Empirically, the existing literature focuses on the effects of natural resource rents combined with the governance. The importance of institutional and governance in determining the effect of natural resource rents has been widely acknowledged. Alayli (2005) revealed that the issue lies not with the natural resources themselves, but with the lack of good governance. Thus, empirical literature shows how the effects of resource leasing on structural transformation varie depending on the level of institutional development. The analysis of structural transformation can be enriched by tools, concepts and insights from empirical literature based on economic growth, and vice versa. These two fields can therefore complement each other to improve our understanding of economic dynamics. (Belaid et al., 2021; Brunnschweiler, 2008; Sarmidi et al., 2012; Karimu et al., 2017; Arin & Braunfels, 2018; Epo & Nochi Faha, 2020; Ampofo et al., 2023).

Sarmidi et al. (2012) found that natural resources could positively affect economic growth when combined with good institutional quality. Apergis and Payne (2014) studied the relationship between oil wealth and economic growth in MENA countries, noting improvements in institutions and economic reforms. Brunnschweiler (2008) found a positive correlation between natural resource revenues and economic growth, especially with strong institutions. Karimu et al. (2017) discovered that resource rents can boost public investments in sub-Saharan Africa, depending on political institutions. Arin and Braunfels (2018) emphasized the importance of institutional quality in the impact of oil revenues on long-term economic growth. Nasir and Redmond (2020) studied the effects of natural resource revenues, international trade, financial development, trade opening, and institutional quality on economic growth and human development index, showing a positive effect on economic growth but a negative impact on human development. Belaid et al. (2021) discovered that the resource-blessing hypothesis applies to MENA countries regardless of their democratic status.

They also found that the presence of a military officer as the chief of state is a key factor in determining whether the resource curse is evident. Specifically, their research revealed that countries with military leaders experience the resource curse, as oil rents do not contribute to economic growth. Leite and Weidmann (2002) found no direct link between commodity prices and economic growth, but they did identify an indirect impact of corruption hindering growth when analyzing the effect of natural resource rents on economic growth in resource-rich countries from 1970 to 1990. Papyrakis and Gerlach [2004] also explored the resource

curse hypothesis and discovered that natural resources can hurt growth in isolation but have a positive impact when considering factors like corruption, investment, and education. Olomola (2007) suggested that oil-exporting countries in Africa have been affected by the resource curse, analyzing the impact of oil rents on economic growth in African oil-exporting countries from 1970 to 2000 and highlighting the negative effects of factors such as lack of democracy and weak institutions. Vandycke (2013) provided evidence on how natural resources influence physical capital development in Eurasian economies, emphasizing the challenges posed by weak institutions and inadequate management of public investment processes. Jalloh (2013) argued that natural resources do not always lead to economic growth in resource-rich countries.

Eregha and Mesagan (2016) examined how institutional quality affects economic growth in oil-rich African countries, finding limited impact. Antonakakis et al. (2017) used a vector-based autoregressive approach to study the impact of oil dependence on economic growth in 76 countries from 1980 to 2012. They emphasized considering the endogenous nature of institutions and the influence of political institutions on the relationship between resource dependence and economic growth. The study suggests that in countries with weak political institutions, oil dependency may not lead to improved economic performance, underscoring the significance of understanding the interplay between natural resources and macroeconomic outcomes within the context of institutional quality. El-Anshasy et al. (2017) analyzed the impact of oil revenue and its volatility on economic growth, as well as the influence of institutions on this relationship using the ARDL method. The study covered the period 1961-2013 for 17 major oil-producing countries. The findings indicated that oil revenue volatility has a significant negative impact on economic growth, while a higher growth rate of oil revenue positively affects economic growth. Additionally, the study suggests that good institutions can help mitigate the adverse effects of oil revenue volatility. The combination of volatile oil revenues and inadequate governmental responses contributes to the resource curse phenomenon. Amini (2018) examined the effects of resource and institutional wealth on economic growth in developed and underdeveloped countries, finding no significant impact. Dwumfour and Ntow-Gyamfi (2018) discovered that institutional quality could offset the negative impact of resource rents on financial development in African nations. Abdulahi et al. (2019) identified institutional quality thresholds that establish a positive link between resource rents and economic growth in sub-Saharan Africa. In a study conducted by Henry (2019), the impact of mineral resource dependence on human development and economic growth in ten rich natural resource African countries was analyzed. The study revealed a weak negative correlation between human development growth and the proportion of mineral rents. The authors suggested that despite an increase in resource rents, economic growth is hindered by institutional weaknesses and corruption.

Matallah (2020) studied the relationship between oil rents and economic

growth in 11 MENA oil-exporting countries from 1996 to 2017. The study used various statistical methods to analyze the data. The findings indicate that oil revenues have a significant positive impact on the economic growth of MENA oil exporters. However, these revenues were found to be resource dependent. The study also highlights the importance of governance in revenue diversification, as oil rents tend to discourage economic diversification efforts by promoting income-focused activities. Motameni (2021) examined how oil rents affect economic growth in oil-rich countries with overvalued currencies and weak institutions. The study found that oil rents have a detrimental impact on economic growth in countries with poor institutional quality. Belarbi et al. (2021) investigated the connection between oil dependence, institutional quality, and economic growth, emphasizing the non-linear relationship and the crucial role of institutions in shaping economic outcomes in oil-dependent nations. Sun and Wang (2021) explored the relationship between natural resources, environmental pollution, and economic growth in China, revealing a negative impact of natural resources on environmental pollution and economic growth, known as the "resource curse".

Ali and Bhuiyan (2022) studied the impact of governance on physical infrastructure development in 15 MENA countries by using natural resource rent for public investment. Their findings indicate that enhancing governance quality has a positive influence on physical infrastructure development in the MENA region. The research shifts away from conventional arguments about the curse of natural resource rent and focuses on the relationship between natural resource rent, good governance, and infrastructure development. The results highlight the importance of natural resource rent and governance in infrastructure development. More recently, Ampofo et al. (2023) examined the impact of natural resources on sustainable economic development in eight resource-rich countries in sub-Saharan Africa from 1981 to 2017. This study included public debt as an explanatory variable to assess its impact on economic growth. Using the NARDL threshold test and Granger asymmetric causality tests, the researchers found that commodity prices had varying effects on economic development in different countries. Equatorial Guinea had a positive impact, while the Republic of the Congo had a negative one, supporting the resource theory. The study recommended improved public debt management and institutional enhancements to support economic development in resource-rich countries. Similarly, Chen et al. (2023) studied the impact of natural resources on human development, emphasizing the role of governance.

Analyzing data from 44 major commodity-exporting countries from 1990 to 2021, the study found that oil and gas prices supported the resource-richness hypothesis, while coal prices supported the neutral hypothesis. Good governance was found to have a positive effect on human development. The study revealed a mix of blessing and curse of resources outcomes across countries, highlighting the importance of governance for utilizing resource wealth effectively to promote inclusive growth and human development. In their study, Tatar et al. (2024) em-

ployed machine learning techniques to examine governance in countries with abundant oil resources. By applying Principal Components Analysis and K-clustering, the researchers categorized countries into six groups based on indicators of good governance. The findings of the study provide evidence in support of the resource curse theory, underscoring the connection between governance quality and the management of natural resources. To mitigate this issue, countries that rely on oil production should establish clear and transparent regulations for managing resource revenues and prioritize economic diversification. The study of Wendji et al. (2024) assessed the contribution of institutional quality to structural change in ECCAS countries. Using a sample of 11 countries from a panel of data observed covering the period from 1996 to 2021, the results show that institutional quality negatively explains the level of structural. Moreover, using disaggregated institutional quality, the effect remains the same for regulatory quality and the rule of law. Data and methodology of this study are presented in the following section.

3. Data and Methodology

This section presents the data and methodology of the study.

3.1. Data

This present study focuses on 10 countries of the Central Africa and uses data covering the period from 1996 to 2023. Following the survey closest to the current positioning, two main data sources are used for the study, namely: (i) the World Development Indicators (WDI) of the World Bank and (ii) the World Governance Indicators (WGI) of the World Bank. The sample lists of Central Africa nations and Central Africa oil-producing nations are provided in Appendix 1, while the definitions of the variables and the corresponding sources are provided in Appendix 2. Appendices 3 and 4 provide relevant information on descriptive statistics and the correlation matrix, respectively. In accordance with the relevant literature on the subject, the dependent variable that is employed to address structural transformation is based on the value added of manufacturing and services (% of GDP), while natural resource rents, from a complementary strand of literature (Gylfason & Zoega, 2006), are measured by the benefits derived from the total natural resources. Except the six components of governance, the composite index of governance is also used as a moderator variable, interacting with natural resource rents. The governance composite index is calculated by approximation using Principal Component Analysis (PCA). Principal Component Analysis is one of the multivariate statistical techniques that allows reducing the number of variables applied to individuals while maintaining the integrity of the information. The use of PCA for governance composite index follows the existing literature on the subject (Arif & Rawat, 2018; Ndouniama et al., 2021), and its results are provided in **Table 1**. The Kaiser 1 criterion is used to retain the first Principal Component (PC), which represents approximately 67.87% of the information explaining the

variations of all the 6 components of governance. The Kaiser-Meyer-Olkin (KMO) test was performed significantly with a p-value of 0.7518 (>0.5), justifying the use of PCA to create the composite indicator. The results of the KMO test and the scree plot of eigen values after PCA are provided in Appendix 5.

Table 1. Principal component analysis (PCA) of the governance composite index.

Principal Components	Component Matrix (Loadings) Gnce	Proportion	Cumulative Proportion	Eigen-Value
PSAVT	0.3526	0.6787	0.6787	4,072
RegQ	0.4540	0.1410	0.8197	0.846
Rlaw	0.4777	0.1148	0.9345	0.689
Vacc	0.2886	0.0291	0.9636	0.174
Geff	0.4546	0.0263	0.9899	0.158
Ccor	0.3891	0.0101	1	0.060

Source: author, on stata 17. Note: Test of Kaiser-Meyer-Olkin measure of sampling adequacy scoring coefficients. Kmo: 0.7818 > 0.5, It justifies the use of PCA to create the Governance Index. The governance composite index is generated as Gnce.

In line with the existing literature on structural transformation, two main control variables are adopted in the conditioning information set to account for omitted variables bias, namely annual population growth, and physical capital (captured by gross fixed capital formation). The quality of governance in support of natural resources is the interaction variables that allows specifying the mechanism through which natural resources influence structural transformation. Note that the control variables are used in robustness check analyses and in separate specifications to avoid instrument proliferation. Concerns about instrument proliferation are always evident when many independent and control variables are involved in the estimation exercise.

3.2. Methodology

Recalling the relevance relationship between governance, natural resources rents and structural transformation, our baseline model with structural transformation is a linear function of independent and control variables, expressed as follows:

$$LTS_{it} = \alpha_0 + \alpha_1 POPgr_{it} + \alpha_2 Gfcf_{it} + \theta_1 LRN_{it} + \beta_j \left(LRN * X_j\right)_{it} + \gamma_1 \left(LRN * Gnce\right)_{it} + \varepsilon_{it} \quad (1)$$

To verify the indirect effects of natural resources in interaction with governance on structural transformation, we combine the natural resource rents with the six governance components individually, and the governance composite index. This gives the specifications with the indirect effects of natural resources combined to governance components indices on the one hand (hypothesis 1), and the natural resources in interaction with the composite governance index, on the other hand

(hypothesis 2):

$$LTS_{it} = \alpha_0 + \alpha_1 POPgr_{it} + \alpha_2 Gfcf_{it} + \theta_1 LRN_{it} + \beta_j \left(LRN * X_j\right)_{it} + \varepsilon_{it} \quad (1a)$$

$$LTS_{it} = \alpha_0 + \alpha_1 POPgr_{it} + \alpha_2 Gfcf_{it} + \theta_1 LRN_{it} + \gamma_1 \left(LRN * Gnce\right)_{it} + \varepsilon_{it} \quad (1b)$$

In order to verify the direct effects of Natural resource rents and governance, on structural transformation (hypothesis 3), the governance composite index (specification 2) is employed as a governance indicator:

$$LTS_{it} = \alpha_0 + \alpha_1 POPgr_{it} + \alpha_2 Gfcf_{it} + \theta_1 LRN_{it} + \varphi_1 Gnce_{it} + \varepsilon_{it} \quad (2)$$

LTS denotes the logarithm of structural transformation, measured by the value added of manufacturing and services as a percentage of GDP; LRN denotes the logarithm of natural resource rents, assessed by the benefits derived from total natural resources. Popgr is measured by the annual population growth rate; X_j represents the governance components indices (j = 1, …, 6), and Gnce is the composite index of governance obtained by principal component analysis (PCA); Gfcf, the gross fixed capital formation (%GDP) represents investment in physical capital, particularly in industrial, transport, energy infrastructure, etc. $LRN * Gnce$ is the interactive variable that combines the composite index of governance and natural resource rents. $LRN * X_j$ denotes the interactive variables of naturel resources rents combined to the governance components indices (X_j ; j = 1, …,6), individually. The subscript i (i = 1, …, N) denotes the countries, and the subscript t (t = 1, …, T) denotes the period. $\alpha_i, \beta_j, \gamma_i, \theta_i$ and φ_i are the parameters to be estimated; ε_{it} is the error term. The variables are used in linear and/or logarithmic forms, thus expressing the dynamic characteristics of the relationship and allowing comparisons, where the estimated coefficients can be interpreted as elasticities.

4. Empirical Analysis

This section analyses the indirect and direct effects, respectively. Subsection 4.1 focuses on the indirect effects of natural resource rents and governance on structural transformation (evaluation of Hypotheses 1 and 2). Considering the defined subsample, point 4.1.1 deals with indirect effects of the interaction of natural resources and the components indices of governance on structural transformation (specification 1a), while point 4.1.2 analyzes the indirect effects of the interaction of natural resources rents and governance composite index on structural transformation (specification 1b). Subsection 4.2 analyzes the direct effects (evaluation of hypothesis 3). The robustness analysis and further discussions of the results are carried out in subsection 4.3. Before discussing the empirical results, it should be noted that information criteria are used to determine whether the evaluated models withstand empirical validity. The estimation process begins with the analysis of the statistical properties of the data by testing the stationarity, cointegration, transversal dependence, and homogeneity of the series covering the period from

1996 to 2023. Considering the panel of 10 Central Africa countries, the Prais-Winsten regression model with Panel Corrected Standard Errors (PCSE), which also controls for heteroscedasticity and serial correlation, is used to estimate all the models. For robustness checks and to observe the consistency of the results, we deploy the Feasible Generalized Least Squares (FGLS) techniques. Given that both PCSE and FGLS techniques pertain to only the conditional mean of the dependent variable, we re-estimate again specifications (1a) and (1b) using the FGLS technique for the specific analysis of the sub-region revealing the complexity of territorial dynamics. We recall that PCSE technique is a static panel data technique suitable for estimating long run analysis. It is applicable when the number of cross sections is less than the time dimension $(N < T)$ and controls for cross sectional dependence, autocorrelation and heteroscedasticity. It is therefore necessary to verify the stationarity through the Levin et al. (2002) (LLC), and Im et al. (2003) (IPS) tests (**Table 2**), the cointegration through the Kao (1999), Pedroni (2004) and Westerlund (2007) tests, and the transversal dependence and homogeneity through the transversal dependence test (LM test by Breusch and Pagan, 1980), which allows checking if the residuals are correlated between transversal units, and the homogeneity test (Modified Wald test by greene, often cited in contexts like Petersen, 2009) to check the heterogeneity of coefficients in a panel model.

All the data set are tested to determine the integration order of I (0) or I (1). The tests have conducted to check whether our variables are not stationary at level, but they are stationary at first difference. Furthermore, Levin et al. (2002) found that the use of panel unit root tests is more efficient than time series unit root. However, the IPS unit root test is more critical than the LLC unit root test due to its appropriateness for regression of heterogeneity unit root. Essentially, the LLC and IPS tests allow us to explain the stationarity and significance of the study variables in first difference (or integrated of the same order 1). Indeed, the IPS and LLC tests in general, do not allow us to reject the null hypothesis of the presence of a unit root (**Table 2**).

Table 2. Stationarity tests of IPS and LLC.

Tests	Variables	Trend	Demean	No-constant	Conclusion
			Level		
IPS	LTS	−2.122**	−2.584***		I (0)
	LRN	−3.624***	−2.888***		I (0)
	Popgr	3.386	1.396		-
	Gfcf	−4.492***	−1.564*		I (0)
	Gnce	−2.419***	0.466		I (0)
LLC	TS	−1.566*	−2.014**	−2.981***	I (0)
	LRN	−2.785***	−3.583***	−2.275**	I (0)
	Popgr	−10.951***	21.488***	−1.666**	I (0)

Continued

	Gfcf	−2.398***	−2.082**	−0.561	I (0)
	Gnce	−2.470***	−2.067**	−1.325*	I (0)
			First Difference		
	LTS	−9.502***	−9.177***		I (1)
	LRN	−8.736***	−8.492***		I (1)
IPS	Popgr	−2.844***	−5.495***		I (1)
	Gfcf	−9.420***	−9.197***		I (1)
	Gnce	−8.728***	−8.725***		I (1)
	LTS	−7.898***	−8.576***	−13.270***	I (1)
	LRN	−7.985***	−9.516***	−14.091***	I (1)
LLC	Popgr	−16.033***	−20.267***	−12.757***	I (1)
	Gfcf	−8.508***	−9.664***	−15.003***	I (1)
	Gnce	−6.698***	−9.477***	−11.679***	I (1)

Source: author, on Stata 17. ***, ** and * explain the levels significance at 1%, 5% and 10%, respectively. Note: I (1) and I (0) represent the significance and stationarity respectively, in first difference and in level of the variables.

The result of the transversal dependence test shows that the null hypothesis of independence is rejected at the 1% significant level, as the probability values turned out to be below 1%. The series therefore exhibit transversal dependence. It means that a shock occurring in the Central Africa can be transmitted to other countries in the sub-region. Moreover, the results of the homogeneity test show that the null hypothesis of homogeneity of slope coefficients is rejected. These results therefore support country-specific heterogeneity. The results of the cointegration and transversal dependence and homogeneity tests are shown respectively in Table 3(a), Table 3(b) and Table 4.

Table 3. (a) Cointegration Tests; (b) Westerlund (2007) cointegration test.

(a)

Tests	*t*-Statistics
Kao (1999) cointegration	
Modified Dickey-Fuller t	−1.564*
Dickey-Fuller t	−1.139
Augmented Dickey-Fuller t	−5.598***
Unadjusted modified Dickey-Fuller t	−1.928**
Unadjusted Dickey-Fuller t	−1.318*
Cointegration of Pedroni (1999; 2004)	
Modified Phillips Perron - t	4.250***

Continued

Phillips Perron - t	−2.429***
Augmented Dickey Fuller - t	−0.316

Source: author, on Stata 17. Note: ***, ** and * explain the levels significance at 1%, 5% and 10%, respectively.

(b)

Cointegration test (Westerlund, 2007)		
	Statistic	P-value
Variance Ratio	2.690***	0.003
Variance Ratio (with trend)	3.907***	0.000
Variance Ratio (all panels trend)	2.141**	0.016

Source: author, on Stata 17. Note: ***, ** and * explain the level significance at 1%, 5% and 10%, respectively. The significance results of the cointegration test (Westerlund, 2007) at 1%, 5% and 10% levels, indicate the existing of long run relationship among the variables.

Table 4. Transversal dependence and Homogeneity tests.

Test	Statistic	P-value
Transversal dependence Test (Breusch-Pagan LM test)		
LM test (Breusch & Pagan, 1980)	$Chi^2 = 136.12$	0.0000
Homogeneity Test (Modified Wald test)		
Modified Wald test	$Chi^2 = 148.99$	0.0000

Source: author, on Stata 17.

The results of Pedroni's cointegration tests confirm those of Kao's (1999) tests. There is a cointegrated panel model.

The Westerlund test is the second-generation panel cointegration tests proposed by Westerlund (2007). This technique is suitable in the presence of CSD (Cross-Sectional Dependence) in the data, and the null hypothesis of no cointegration can be rejected at the 1%, 5%, and 10% signifcance levels. Finally, given the presence of cross-sectional dependence in the data and cointegration among the variables, the Prais-Winsten regression model with Panel-Corrected Standard Errors (PCSE) under Correlation (Psar1) independent, is employed.

The null hypothesis (H0) of independence is rejected at the 1% significant level, as the P-values is egal to 0.000. The homogeneity test shows that the null hypothesis (H0) of homogeneity is rejected.

4.1. Analysis of Indirect Effects

This subsection analyzes the indirect effects of natural resource rents in interaction with the governance components indices (individually) on structural transformation on the one hand, and the indirect effect of natural resource rents in

interaction with the composite index of governance on structural transformation, on the other hand.

4.1.1. Indirect Effects of Natural Resources Rents Combined with Governance Components Indices on Structural Transformation

The results in Table 5 provide valuable insight into Hypothesis 1, which states that natural resource rents, combined with different aspects of governance, have mixed effects on structural transformation within Central Africa. In line with Kaufmann et al. (2005)'s definition, we have explored three major forms of governance: political, economic, and institutional. Each has unique relationship

Table 5. Governance components, natural resources rents and structural transformation.

		Dependent variable: Structural Transformation (%GDP)					
		(1)	(2)	(1)	(2)	(1)	(2)
		Institutional Governance		Economic Governance		Political Governance	
Long run	LRN	−0.226*** (0.023)	−0.203*** (0.025)	−0.229*** (0.024)	−1.162*** (0.025)	−0.196*** (0.019)	-0.187*** (0.024)
	LR * Cc	−0.027** (0.013)					
	LRN * Rlaw		−0.004 (0.013)				
	LRN * Geff			−0.027** (0.013)			
	LRN * RegQ				0.025** (0.012)		
	LRN * PSAVT					0.006 (0.005)	
	LRN * Vacc						0.007 (0.013)
	Popgr	−0.0003 (0.014)	0.001 (0.014)	0.004 (0.014)	0.001 (0.014)	−0.001 (0.014)	0.002 (0.014)
	Gfcf	0.002*** (0.0007)	0.0019** (0.0008)	0.002*** (0.0007)	0.002*** (0.0007)	0.0015* (0.0008)	0.002** (0.0008)
	Constant	4.405*** (0.073)	4.409*** (0.077)	4.389*** (0.076)	4.393*** (0.076)	4.439*** (0.077)	4.402*** (0.076)
R^2 (%)		97.22	97.22	97.04	97.25	97.30	97.25
Countries		10	10	10	10	10	10
Observations		280	280	280	280	280	280
Wald test		152.21***	139.29***	147.30***	146.95***	142.05***	140.78***

Source: author, on Stata 17. Note: standard errors in parenthesis; ***, ** and * explain the levels significance at 1%, 5% and 10%, respectively.

with various related components indices and natural resources rents. The results are mixed overall. Regarding institutional governance, only the interaction between natural resources rents and the control of corruption has a negative and significant effect at the 5% level on structural transformation, suggesting that an increase induces a decrease of structural transformation by 0.027. For economic governance, the interactions between natural resources and government effectiveness, on the one hand, and between natural resources rents and regulatory quality on the other hand, showed negative and positive significant effects at the 5% level on structural transformation, respectively. It means that, an increase induces a decrease and rise in structural transformation by 0.027 and 0.025, respectively.

Finally, for political governance the interaction between natural resources rents and political stability, and the interaction between natural resources rents and voice accountability, both have a positive and non-significant effect on structural transformation. These findings highlight the complexities of the interactions between natural resources rents and various aspects of governance in understanding structural transformation in the Central Africa. According to a World Bank study, natural resources can have contradictory effects on countries' economic and social development, depending on the quality of their governance. Indeed, while good governance can help to maximize the benefits of natural resources for structural transformation, poor governance can result in inefficient revenue allocation from these resources, as well as corruption and political instability.

4.1.2. Indirect Effects of Natural Resource Rents Combined with Composite Index of Governance, on Structural Transformation

Within Central Africa findings in Table 6 show that, the interaction between natural resource rents and the composite index of governance has a negatif and non-significant effect on structural transformation. The composite index of governance in Central Africa therefore does not influence the relationship between natural resource rents and structural transformation. This can be justified by the heterogeneity of governance components, the socioeconomic context and the complexity of interactions.

4.2. Analysis of Direct Effects

This subsection analyzes the direct effects of natural resource rents and governance composite index on structural transformation, respectively (Hypothesis 3). The findings are shown in Table 7 for both natural resource rents and governance composite index.

Table 6. Governance composite index, natural resource and structural transformation.

		Dependent variable: Structural Transformation Central Africa (1)
Long run	LRN	−0.197***
		(0.018)

Continued

Popgr	0.002 (0.014)
Gfcf	0.002** (0.0008)
LRN * Gnce	−0.0005 (0.003)
Constant	4.404*** (0.077)
R^2 (%)	97.16
Countries	10
Observations	280
Wald test	139.86***

Source: author, on Stata 17. Note: standard error in parenthesis; ***, ** and * explain the levels significance at 1%, 5% and 10%, respectively.

4.2.1. Direct Effect of Natural Resource Rents on Structural Transformation

The results in Table 7 are essential for assessing the direct effects of natural resource on structural transformation in Central Africa in the long-run. Analyzing the specification (2) and considering the predefined control variables, natural resource rents have a negative and significant effect at 1% level on structural transformation, suggesting that an increase induces a decrease in structural transformation by 0.210. These results validate the initial hypothesis and are consistent with the natural resource curse theory, as supported by Gniniguè and Tchalim (2021) as well as other previous studies such as those of Sachs and Warner (2001) and Gylfason and Zoega (2006).

4.2.2. Direct Effect of Governance Composite Index on Structural Transformation

Table 7 shows that the results of the composite governance index reveal a non-significant direct effect on structural transformation in Central Africa. This can be explained by the complexity of the interactions between the components of governance. As the relationship between natural resource rents and structural transformation is complex, the composite index may mask these interactions by providing an overview that does not reflect the specific nuances of the different dimensions of governance.

The non-significant effect of population growth on structural transformation can be explained as follows: First, rapid population growth does not automatically lead to improved structural transformation. Indeed, rapid population growth can place excessive pressure on limited resources, infrastructure and services, thereby constraining the economy's ability to restructure towards more productive and innovative sectors. Without adequate investment in education, health and

Table 7. Natural resources rents, governance composite index and structural transformation.

		Dependent variable: Structural Transformation (%GDP)	
		(1)	(2)
Long run	LRN	−0.210*** (0.018)	−0.209*** (0.056)
	Gnce	−0.007 (0.012)	−0.006 (0.012)
	Popgr	0.007 (0.014)	-
	Gfcf	-	0.002*** (0.0007)
	Constant	4.467*** (0.072)	4.409*** (0.068)
R^2 (%)		96.46	97.23
Observation		280	280
Countries		10	10
Wald test		135.95***	141.62***

Source: author, on Stata 17. Note: standard errors in parenthesis; ***, ** and * explain the levels significance at 1%, 5% and 10%, respectively.

vocational training, the growing population may lead to a surplus of low-skilled labour, thereby maintaining dependence on low value-added activities. Secondly, the concentration of revenue among a small elite limit the equitable redistribution of the wealth generated, which would be necessary to enable the entire population to participate fully in the development process. This structural inequality prevents the expansion of the domestic market and hinders the creation of the inclusive economic dynamics that are essential for structural transformation. A growing population that remains economically marginalized does not contribute effectively to the diversification of economic activities. Thirdly, the ineffective integration of the population into development strategies constitutes a major obstacle to structural transformation. When public policies and development programmes fail to mobilize demographic capacities through education, citizen participation, and economic inclusion, the potential positive effects of population growth on the sectoral evolution of the economy remain limited or may even be non-existent.

Finally, the very long-term nature of the effects of population growth on structural transformation also explains the insignificant results observed in the analysis. Deep changes in the economic structure resulting from profound demographic changes often take several decades to become clearly apparent. Empirical studies measuring short- or medium-term effects are therefore unlikely to capture these complex and delayed dynamics, which explains the absence of a statistically significant relationship in the results. The positive and significant effect at the 1%

level of Gfcf on structural transformation highlights the importance of considering public investment in GDP, physical capital and urban factors in structural transformation. This finding is in line with previous research, such as that of Wendji et al. (2024), which highlights the positive impact of this variable on manufacturing development. These results provide valuable insights into the economic dynamics of infrastructure investment, private sector development, economic diversification, and effective governance of natural resources in the Central Africa region and contribute to enriching the existing literature on the subject.

Gfcf is crucial for the creation of infrastructure, such as roads, ports and energy facilities, which are necessary to support other economic sectors, particularly industry and services. By investing in fixed capital, countries can improve their productivity and competitiveness, which is essential for successful structural transformation. Capital investments can have multiplier effects on the economy. For example, infrastructure construction can generate employment and stimulate demand in other sectors, thereby promoting economic diversification. Increased investment can also attract foreign investment, which can further strengthen structural transformation. Natural resource rents can provide significant funds to finance infrastructure and capital investment, stimulating Gfcf. Increased revenues from natural resources can also encourage governments to invest more in development projects, thereby improving economic and social conditions. The Central Africa region has significant natural resources, but excessive dependence on these resources can hinder structural transformation if revenues are not reinvested effectively. By focusing on Gfcf, countries in the region can better manage their natural resource rents to promote sustainable economic growth and reduce vulnerability to resource price shocks.

4.3. Robustness Analysis and Other Discussions

This section checks the robustness and discusses the results.

4.3.1. Robustness Checks

For robustness checks and to observe the consistency of the results, we deploy the Feasible Generalized Least Squares (FGLS) techniques, and use oil rents as an indicator of rents derived from natural resources.

- **Robustness check by the FGLS under Correlation (Psar1) independent**

In econometric modelling, FGLS (Feasible Generalized Least Squares) models are used to optimize estimation efficiency in linear regression models. This approach is relevant when errors are either homoscedastic or autocorrelated. In the context of model parameter estimation, FGLS proposes a methodical approach that considers the covariance structure of the errors. This approach is particularly relevant for improving the accuracy of model coefficient estimates. FGLS is a statistical tool that can be applied in various panel data analysis contexts. It allows for the control of specific effects and time trends. The findings in **Table 8** show that the total natural resources rents (LRN) maintain a significantly negative long-run nexus on structural transformation. However, the statistically significant find-

ings from FGLS model (Correlation (Psar1) independent) appear to have the same magnitude as PCSE model (Correlation (Psar1) independent).

Table 8. Governance components indices, natural resources rents and structural transformation.

		Dependent variable: Structural Transformation (%GDP)					
		(1)	(2)	(1)	(2)	(1)	(2)
		Institutional Governance		Economic Governance		Political Governance	
Long run	LRN	−0.226*** (0.023)	−0.203*** (0.025)	−0.229*** (0.024)	−1.162*** (0.025)	−0.196*** (0.019)	−0.187*** (0.024)
	LR * Cc	−0.027** (0.013)					
	LRN * Rlaw		−0.004 (0.013)				
	LRN * Geff			−0.027** (0.013)			
	LRN * RegQ				0.025** (0.012)		
	LRN * PSAVT					0.006 (0.005)	
	LRN * Vacc						0.007 (0.013)
	Popgr	−0.0003 (0.014)	0.0019 (0.014)	0.004 (0.014)	0.001 (0.014)	−0.001 (0.014)	0.002 (0.014)
	Gfcf	0.002*** (0.0007)	0.0019** (0.0008)	0.002*** (0.0007)	0.002*** (0.0007)	0.0015* (0.0008)	0.002** (0.0008)
	Constant	4.405*** (0.073)	4.409*** (0.077)	4.389*** (0.076)	4.393*** (0.076)	4.439*** (0.077)	4.402*** (0.076)
Countries		10	10	10	10	10	10
Observations		280	280	280	280	280	280
Wald test		152.21***	139.29***	147.30***	146.95***	142.05***	140.78***

Source: author, on Stata 17. Note: only the coefficients and the standard errors (in parenthesis) are presented in this table; the estimations were done using the FGLS; ***, ** and * explain the levels significance at 1%, 5% and 10%, respectively.

This overall validates the previously established basic findings in the Central Africa, although some coefficients of the control variables have improved.

- **Robustness check by the Oil rents indicator**

Seven countries of the Central Africa out of ten in our study are producers of oil resources. Oil resources are one of the strategic natural resources, which may have a related influence on structural transformation in the Central Africa. For

this robustness check, we use the oil resource rents indicator after employing the total natural resource rents as an independent variables. The specification states that the results in Table 9 validate the strength of the substantial and negative long-run nexus. Nevertheless, the results are more convincing with the Oil rents. These negative effects confirm the natural resource curse (Auty, 1993) for most central African states having the natural resource advantages. Furthermore, although slightly negative in scale in runs of the value of its coefficients, Oil rents are significant at the 1% level.

Table 9. Natural resource rents, oil resource rents, governance composite index, and structural transformation.

		Dependent variable: Structural Transformation		
		(Central Africa) Natural Resource_Rents	Central Africa _Oil Oil_Rents	Central Africa _Oil Natural Resource_Rents
Long run	LRN	−0.197*** (0.018)		−0.185*** (0.019)
	LOil		−0.111*** (0.016)	
	Popgr	0.002 (0.014)	−0.039 (0.056)	−0.050 (0.050)
	Gfcf	0.002** (0.0008)	0.003*** (0.001)	0.002** (0.001)
	LRN * Gnce	−0.0005 (0.003)		0.0006 (0.003)
	LOil * Gnce		−0.007 (0.005)	
	Constant	4.404*** (0.077)	4.121*** (0.117)	4.557*** (0.135)
Countries		10	7	7
Observations		280	189	196
Wald test		139.86***	73.69***	138.10***

Source: author, on Stata 17. Note: standard errors in parenthesis; ***, ** and * explain the levels significance at 1%, 5% and 10%, respectively. Central Africa _Oil: Central Africa Oil producing countries. The estimations were done using the FGLS.

The interaction variable (between oil resource rents and the governance composite index) showed a non-significant effect on structural transformation. Moreover, the population growth rate has non-significant influence on structural transformation. As determined by the proportion of public investment in GDP, physical capital (Gfcf) has a positive and statistically significant coefficient within Central Africa at 5% level, and Central Africa _Oil at 5% and 1% levels for Natural resource rents and Oil rents employed as independent variables, increasing the structural transformation index by 0.002, 0.002 and 0.003, respectively.

4.3.2. Further Discussion of Findings

From these results, four lessons are formulated:

- *The different aspects or components of governance in Natural resource rents: existence of mixed effects on structural transformation.*

This relationship presents coefficients with mixed effects (non-significant, significant, positive and negative effects). These mixed effects complicate the understanding of interactions between natural resources and the different aspects of governance on the structural transformation within Central Africa. This is explained by the fact that each aspect of governance influences structural transformation differently within Central Africa. These heterogeneous results are like those of the study of Avom and Mignamissi (2013) and the UNCTAD (2019b), which arrived at mixed conclusions for the countries of Central Africa. Thus, the hypothesis 1 is verified.

- *The composite index of governance in interaction with Natural resource rents: existence of non-significant effect on structural transformation within Central Africa.*

The diversity of governance components, the socio-economic context and the complexity of interactions explain the non-significant effect of the composite index of governance in Natural resource rents.

Diversity of governance components: The composite governance index aggregates several dimensions such as transparency, the rule of law, the fight against corruption, political accountability, administrative efficiency, etc. Each dimension plays a distinct role in the processes of structural transformation of the economy. For example, transparency can strengthen investor confidence and facilitate the optimal allocation of resources, while the rule of law ensures the protection of property rights and the enforcement of contracts. However, these dimensions do not all have the same intensity of impact or the same temporality of effect. Some can trigger rapid economic change, while others are part of a longer-term dynamic. Thus, at the aggregate level, the effects may be 'mixed' or attenuated, masking the differentiated importance of the components. Some dimensions may even produce antagonistic effects, hence the need for a decomposed analysis.

Next, *the influence of the socio-economic context*: the political and economic context in which governance operates significantly, modulates its influence. Political stability is a minimum prerequisite for improvements in governance to translate into structural transformation. On the other hand, in countries facing internal conflicts, recurring crises or governmental instability, institutional mechanisms are weakened, reducing the effectiveness of governance policies. Furthermore, macroeconomic conditions such as the level of development, trade openness and economic diversification also contribute to modulating this effect. An unfavourable socio-economic environment can thus neutralise the potential gains of good governance, resulting in a less obvious correlation at the aggregate level.

Finally, *the complexity of natural interactions between resources and governance*: the link between revenues from natural resources and structural transformation is inherently complex due to the multiplicity of channels of action and

interaction. Natural resources can generate high rents which, in the absence of effective governance, lead to phenomena such as Dutch disease, increased corruption and clientelism. A synthetic composite index cannot capture these specific dynamics. For example, strong governance in the fight against corruption will not have the same effect if the management of oil revenues is opaque but transparent budget allocation mechanisms are robust. The overall synthesis therefore masks the nuances linked to the interaction between each dimension of governance and the mechanisms of redistribution, budget management or public investment that determine structural transformation.

- *Natural Resource Rents: Limits Structural Transformation in Central Africa.*

This lesson corroborates the results of Wendji et al. (2024) research carried out in the Central Africa, with the negative effects on the structural transformation and validates the theory of the curse theory of natural resources developed by Auty (1993), which is considered as the basis of all problems related to natural resources. The main reason is the weakness of institutions and the poor management of revenues from natural resources.

5. Concluding Implications

This section presents the conclusion and policy implications.

5.1. Conclusion

The present study has examined how the governance moderates the effects of natural resource rents on structural transformation. The research focus is on ten Central Africa nations, using panel data for the period 1996-2023. The Panel-Corrected Standard Errors (PCSE) estimator is employed to assess the problem statement within the remit of interactive regressions. The governance, employed as moderator, is measured as a governance composite index from the Principal Components Analysis on the one hand, and as the governance components indices (Control of Corruption, Government Effectiveness, Political Stability, Rule of Law, Regulatory Quality, and Voice and Accountability), on the other hand. Oil resource rents and the FGLS are also employed respectively for robustness checks. The following main finding is established. The hypothesis that Natural resource rents combined with governance components influence structural transformation in a mixed ways is evident. Furthermore, the hypothesis that Governance composite index in interaction with Natural resource rents, exerts a negative influence on structural transformation is not confirmed as, the relationship is non-significant. For the hypothesis (3), Natural resource rents having a negative direct effect on structural transformation is confirmed while governance composite index having direct negative influence on structural transformation is non-significant. Policy implications are discussed in what follows.

5.2. Policy implications

The lessons learned from the finding allow us to formulate implications for eco-

nomic policies. "Poor governance being responsible for the poverty of many countries rich in natural resources", it is therefore necessary for Central Africa governments to engage:

- Effective governance, characterized by transparency, accountability and citizen participation, that can contribute to political stability. Economic policies that promote effective governance can reduce conflicts related to natural resource exploitation. Greater stability enables an environment favourable to investment and long-term planning, thus facilitating structural transformation.
- Economic policies must ensure that revenues from natural resources are reinvested in key sectors such as education, health and infrastructure. Effective governance can assist in directing these resources towards projects that have positive impact on structural transformation.
- Economic policies should include measures to strengthen the institutions that manage natural resources. This includes anti-corruption policies and accountability mechanisms. Strong institutions ensure that resource rents are managed responsibly, reducing the risk of the "resource curse" and promoting sustainable structural transformation.
- Economic policies should encourage diversification by supporting sectors such as agriculture, manufacturing, and services. Proactive governance can facilitate these efforts by creating an enabling environment for businesses.
- Revenues from natural resources need to be invested in infrastructure development (transport, energy, information technology). Effective governance can ensure that these investments are directed towards priority projects. Better infrastructure underpins growth in other economic sectors, thus facilitating structural transformation.
- Economic Policies should ensure that the benefits of natural resources are shared across the population through redistribution and social inclusion programmes. Inclusive governance can strengthen these efforts. Reducing inequality can enhance social cohesion and stability, which are essential for successful structural transformation.
- Economic policies need to integrate environmental concerns into natural resource management. Governance that values sustainability can promote responsible exploitation practices. A sustainable approach can prevent environmental degradation and ensure that natural resources remain available for future generations, thus supporting long-term structural transformation.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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Appendices

Appendix 1: Central Africa countries

Central Africa: Angola, Burundi, Cameroon, the Central African Republic, Congo, Gabon, Equatorial Guinea, the Democratic Republic of Congo, Rwanda and Chad.

List of the Central Africa oil producers countries

Angola, Cameroon, Chad, Democratic Republic of Congo, Equatorial Guinea, Gabon, and Republic of Congo

Appendix 2: Variables and Data Sources

Variable	Description	Source
	Variables of interest	
LTS	LTS is the logarithm of **the structural transformation index**. Structural transformation is the process by which an economy moves from dependence on agriculture towards industrialization and economic diversification. This index is used to measure the level of structural transformation in a country or region. For this study, structural transformation is measured as the sum of manufacturing value added (% GDP) and services value added (% GDP). The strutural transformation index was used in the work of Mama and Ongono (2019) The logarithm of Structural transformation index is the dependent or endogenous variable.	WDI (2022)
LRN	The logarithm of the **Total Natural resources rents** is the sum of oil rents, natural gas rents, coal rents (hard and soft), mineral rents, and forest rents, expressed as a percentage of GDP. Natural resource rents are profits derived from natural resources. These correspond to the sum of profits from oil, natural gas, coal (anthracite and hard coal), minerals and forests. This variable was used in the work of Gylfason and Zoega (2006). This is the main independente variable. The expected sign is negative.	WDI (2022)
	Governance Composite Index (from PCA)	
Gnce	**Gnce** is the aggregate variable of governance obtained by Principal Component Analysis (PCA), a multivariate technique that allows inter-correlated variables to be combined into a single variable. It was carried out using six (6) other indicators taken from the WGI (2024) database (Voice and accountability, political stability, government effectiveness, rule of law, regulatory quality and control of corruption) using Stata 17 software. This composite indicator of the quality of governance was used in the work of Arif and Rawat (2018), and Ndouniama et al. (2021). According to Kaufmann et al. (2005), the measurement of this indicator is between −2.5 and +2.5 depending on whether it indicates good governance (0 to 2.5) or weak governance (−2.5 to 0). The expected sign is negative.	PCA
Control variables		
Popgr	**The annual population growth rate** is the exponential growth rate of the population in the middle of year $t-1$ to t, expressed as a percentage. The population is based on the facto definition of population, which includes all residents regardless of their legal status or citizenship. The expected sign is positive.	WDI (2022)
Gfcf	**Gross fixed capital formation** (% GDP) represents investment in physical capital, particularly in transport, infrastructure and electrical energy. Transport, infrastructure and energy availability promote the development of high-productivity activities. It is measured by gross fixed capital formation (GFCF). The expected sign is positive.	WDI (2022)
Governance Components indices		
CCor	**Control of Corruption**: captures perceptions of the extent to which elites and private interests	

	exercise public power for private gain, including both petty and grand forms of corruption, as well as "capture" of the state. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, ie ranging from approximately −2.5 to 2.5. It was used in the work of Wendji et al. (2024). The expected sign is negative.	WGI (2024)
Geff	**Government Effectiveness**: captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, ie ranging from approximately −2.5 to 2.5. The expected sign is negative.	WGI (2024)
PSAVT	**Political Stability and Absence of Violence/Terrorism**: measures perceptions of the likelihood of political instability and/or politically motivated violence, including terrorism. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, ie ranging from approximately −2.5 to 2.5. The expected sign is positive.	WGI (2024)
Rlaw	**Rule of Law**: captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular, the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, ie ranging from approximately -2.5 to 2.5. The expected sign is negative.	WGI (2024)
RegQ	**Regulatory Quality**: captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, ie ranging from approximately −2.5 to 2.5. The expected sign is positive.	WGI (2024)
Vacc	**Voice and Accountability**: captures perceptions of the extent to which a country's citizens are able to participate in selecting their, as well as freedom of expression, freedom of association, and a free media. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, ie ranging from approximately −2.5 to 2.5. The expected sign is positive.	WGI (2024)
Combined variables (interaction)		
LRN * Gnce	**Interactive variable** (Natural resource rents and the composite index of governance) is the variable that allows us to estimate the combined effect of the governance composite index and the natural resources rents, on structural transformation. The expected sign is negative.	
Loil * Gnce	**Interactive variable** (oil rents and the composite index of governance) allows us to estimate the combined effect of the composite index of governance and oil rents, on structural transformation. The expected sign is negative.	
LRN * X_j	**Interactive variables (**Natural resource rents and the components indices of governance (*j=1, …, 6*) allows us to estimate the combined effects of the Natural resource rents and the components indices of governance (individually), on structural transformation. The expected signs are positive and/or negative (+/−)	
Other variable		
LOil	Is the logarithme **of Oil rents.** Oil rents come from revenues generated by the sale of crude oil on the international market. They may also include revenues from petroleum products such as petrol, diesel and other petrochemicals. The expected sign is negative.	WDI (2022)

Source: Author. The data come from the WDI (2022), WGI (2024) and PCA.

Appendix 3: Descriptive Statistics

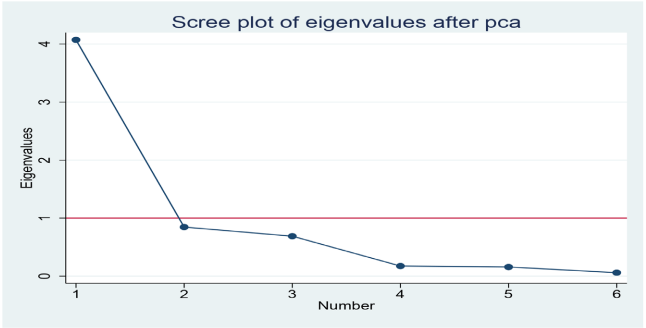
Variable	Obs	Mean	Std. Dev.	Min	Max
LTS	280	3.865363	.239516	3.12786	4.271175
LRN	280	2.897168	.728857	1.328872	4.127151
Popgr	280	2.96694	.890338	.2596475	8.117947
Gfcf	280	22.12464	11.5054	2.1	81.02102
LOil	189	2.51945	1.326961	-1.13348	4.062818
Ccor	280	-1.093408	.4798657	-1.647852	.7764261
Geff	280	-1.122269	.4366364	-1.880911	.3883626
PSAVT	280	-1.008027	.857585	-2.847852	.6402106
Rlaw	280	-1.179209	.4387639	-1.918399	.2051505
RegQ	280	-1.068878	.4559637	-2.096586	.3351291
Vacc	280	-1.220011	.3227907	-1.999409	-.3211722
Gnce	280	3.00e-08	2.017922	-3.935247	6.442592

Appendix 4: Correlation Matrix

	LTS	LRN	Popgr	Gfcf	Gnce
LTS	1.0000				
LRN	-0.6587 0.0000	1.0000			
Popgr	-0.2657 0.0000	0.3202 0.0000	1.0000		
Gfcf	-0.3697 0.0000	0.3507 0.0000	0.2970 0.0000	1.0000	
Gnce	0.1849 0.0019	-0.2942 0.0000	-0.0940 0.1164	0.1664 0.0052	1.0000

Variable	VIF	1/VIF
LRN	1.39	0.718950
Gfcf	1.32	0.759419
Gnce	1.21	0.826802
Popgr	1.17	0.854725
Mean VIF	1.27	

Appendix 5: Result of Kaiser-Meyer-Olkin Test and Scree Plot of Eigen Values after PCA



Kaiser-Meyer-Olkin measure of sampling adequacy

Variable	kmo
PSt	0.5999
RegQ	0.8274
RL	0.7295
Vac	0.7168
Geff	0.9185
CCor	0.6788
Overall	0.7518

	Gnce	Ccor	Geff	PSAVT	Rlaw	RegQ	Vacc
Gnce	1.0000						
Ccor	0.7852 0.0000	1.0000					
Geff	0.9173 0.0000	0.7295 0.0000	1.0000				
PSAVT	0.7116 0.0000	0.3196 0.0000	0.6472 0.0000	1.0000			
Rlaw	0.9640 0.0000	0.7603 0.0000	0.8657 0.0000	0.7405 0.0000	1.0000		
RegQ	0.9162 0.0000	0.6810 0.0000	0.7841 0.0000	0.5255 0.0000	0.8448 0.0000	1.0000	
Vacc	0.5824 0.0000	0.2725 0.0000	0.3980 0.0000	0.2508 0.0000	0.4626 0.0000	0.6391 0.0000	1.0000

Variable	VIF	1/VIF
Rlaw	11.77	0.084963
RegQ	5.42	0.184340
Geff	4.59	0.217980
Ccor	4.05	0.246886
PSAVT	3.73	0.267839
Vacc	1.91	0.523279
Mean VIF	5.25	