# SUSTAINABLE FINANCE AND NATURAL RESOURCE CURSE: TESTING THE VALIDITY OF MULTIVARIATE VAR MODEL FOR THE GHANAIAN MINING INDUSTRY

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**Abstract**
Africa harbors over 30% of the world's mineral reserves, yet nearly half of its population remains mired in poverty, a paradox that has long confounded economists and policymakers. This study interrogates Ghana's mining sector, the continent's second-largest gold producer, through the transformative lens of sustainable finance. Using a Multivariate Vector Autoregressive (VAR) and Vector Error Correction (VEC) framework with annual data from 1990 to 2023, it unravels the intricate interplay between natural resource rents, financial development, institutional quality, and environmental sustainability. Results reveal that mineral revenue shocks produce profound short- and long-term impacts: while extractive wealth temporarily fuels fiscal expansion, it simultaneously exacerbates financial misallocation and environmental degradation when governance and regulatory oversight are weak. Granger causality analyses highlight a bidirectional relationship between financial deepening and ecological decline, emphasizing that unchecked financial growth accelerates environmental vulnerability. Critically, the study demonstrates that Ghana's resource-curse trap is not inevitable; rather, it persists due to underdeveloped sustainable finance structures and fragmented institutional oversight. Policy pathways emerge clearly: embedding green financial instruments, enforcing adaptive fiscal governance, and promoting transparent institutional practices can convert volatile extractive rents into resilient, inclusive, and environmentally conscious growth. By reframing natural resources not as a curse but as a strategic asset, this research offers a roadmap for Africa's resource-rich economies to harness wealth responsibly, bridging the divide between abundance and prosperity.

**Keywords:** Sustainable Finance; Natural Resource Curse; Multivariate VAR model; Institutional Quality; Ghana's Mining Industry

## Introduction

Africa's paradox of plenty continues to challenge conventional economic wisdom. Despite being richly endowed with minerals, oil, and gas reserves, many African nations remain economically fragile, earning the enduring label of "resource-rich yet poor." This structural dilemma is not merely a question of abundance but of mismanaged wealth and inadequate financial mechanisms that fail to transform natural endowments into long-term prosperity. Against this backdrop, this study interrogates whether sustainable finance embedded in financial practices integrating environmental, social, and governance (ESG) considerations can serve as a transformative conduit, with Ghana's mining industry providing a compelling case study.

Natural resources wield the power to either catalyze growth or entrench stagnation, depending critically on governance and financial stewardship. The resource curse hypothesis, advanced by Sachs and Warner (2001), posits that resource-abundant nations often experience slower economic growth than resource-scarce counterparts. Yet, this claim is far from universal. Empirical evidence from advanced economies such as the United States, Canada, China, and the United Kingdom confirms adverse growth effects of resource dependence (Haseeb et al., 2021; Wu et al., 2018; Wang et al., 2021). Conversely, African-focused studies reveal that robust financial inclusion, institutional quality, and governance efficiency can mitigate the curse (Shobande & Enemona, 2021; Di John, 2011; Yilanci et al., 2021). This divergence highlights a critical insight: resource abundance is not inherently detrimental; rather, the absence of sustainable financial structures dictates developmental outcomes.

Ghana's mining sector exemplifies this duality. As Africa's second-largest gold producer, with annual outputs of approximately 158 tonnes accounting for over 90% of mineral exports (Girard, 2021; Worlanyo & Jiangfeng, 2021), the sector anchors national revenue and employment. Gold, bauxite, manganese, and diamonds collectively contribute significantly to GDP. Yet, persistent poverty, income inequality, and environmental degradation underscore the governance and financing dilemmas that constrain equitable growth. Despite a two-decade average GDP growth of 5% (Amankrah, 2021; Sisso & Beaumais, 2018), the benefits of mineral wealth remain unevenly distributed, with the resource-rich South prospering while the underdeveloped North lags. The advent of oil production in 2011, projected to yield approximately USD 1 billion annually (Kumah-Abiwu, 2017), further heightened expectations for inclusive growth but simultaneously exposed vulnerabilities in fiscal management and sustainable capital formation.

Sustainability, as articulated by the World Commission on Environment and Development (1987), entails meeting present needs without compromising future generations, integrating economic viability, environmental stewardship, and social equity (Kuhlman & Farrington, 2010; Moran & Kunz, 2014b). Recent scholarship

emphasizes the interdependence of these dimensions, underscoring the necessity of integrative approaches (Amaral et al., 2020; Kouloukoui et al., 2019; Endl et al., 2021). In this light, sustainable finance—through instruments such as green bonds, ESG-compliant investments, and social finance initiatives—emerges as a pivotal enabler. By aligning capital allocation with ethical, social, and environmental objectives, sustainable finance transforms extractive revenues into pathways for inclusive development (Khan et al., 2020; Guan et al., 2020; Ahlström & Monciardini, 2022). Yet, despite global sustainable finance assets exceeding USD 35 trillion by 2022 (Global Sustainable Investment Alliance, 2022), Sub-Saharan Africa accounts for less than 1% of such capital, constraining the integration of resource management with sustainability imperatives.

In Ghana, weak financial intermediation and limited access to green credit mechanisms have curtailed the mining sector's potential to contribute meaningfully to the Sustainable Development Goals (SDGs), particularly SDG 7 (Affordable and Clean Energy), SDG 8 (Decent Work and Economic Growth), and SDG 13 (Climate Action). Empirical studies demonstrate that aligning financial markets with sustainability objectives mitigates environmental externalities, stabilizes resource rents, and fosters technological innovation in extractive industries (Esposito et al., 2019; Zhang et al., 2022). Globally, nations such as Nigeria, Venezuela, and Mexico continue to struggle with resource dependence, with evidence revealing a strong negative correlation between resource intensity and economic growth (Adams et al., 2019; Dogan et al., 2020; Badeeb et al., 2020; Tang et al., 2022). These patterns underscore the centrality of institutional quality, governance, and sustainable finance policies in mediating the resource-growth nexus.

Mining remains among the world's most capital-intensive industries, ranked fifth globally (Hilson & Hu, 2022). Ghana's historical trajectory—from colonial extraction to neoliberal reforms in the 1980s—reflects the duality of promise and peril inherent in resource exploitation. Despite reforms such as privatization of state-owned mines and updated mineral policies, production volatility persists due to fluctuating commodity prices, weak institutional oversight, and insufficient investment in sustainable financial mechanisms (Tuokuu et al., 2019; Cobbinah & Amoako, 2018). This scenario raises a critical question: can sustainable finance serve as a stabilizing force, converting extractive volatility into resilient and inclusive growth?

To interrogate this question, the study employs a Multivariate Vector Autoregressive (VAR) and Vector Error Correction (VEC) framework, augmented by the Bayer and Hanck cointegration test, examining short- and long-term causal linkages between financial access, natural resource rents, human development, and environmental performance using annual data from 1970–2022 (World Development Indicators, Bank of Ghana, Penn World Tables). The study is

theoretically anchored in Institutional, Stakeholder, and Stewardship theories, positioning finance as an endogenous driver shaping governance and resource allocation (Atil et al., 2020; Zallé, 2019; Ahmed et al., 2016).

By bridging finance, sustainability, and resource governance, this research moves beyond the conventional "blessing or curse" debate. It illuminates how responsible credit systems, ESG-aligned investments, and inclusive capital flows can reshape Ghana's mining trajectory, offering empirically grounded insights and policy recommendations that resonate across resource-dependent economies. Consequently, it sets a compelling stage for subsequent chapters, inviting readers to explore nuanced analyses, actionable strategies, and transformative frameworks for sustainable development.

## Literature Review

### Conceptual Review

#### Concept of Sustainability

The term sustainability originates from the Latin word sustinere, meaning "to support and sustain" (Iqbal et al., 2018). Agyei-Boakye (2022) defines sustainability as an end-state where environmental and human requirements are both addressed within a dynamic balance. It embodies three interconnected dimensions consisting of social, environmental, and economic—often referred to as the "triple bottom line" of people, planet, and profit (Anand et al., 2021). These dimensions must coexist harmoniously since deficiencies in one cannot be offset by excellence in another (Viveros, 2016). Social sustainability embraces equity, cultural integration, and local socio-political engagement (Ballet et al., 2020; Kohl et al., 2020), addressing challenges like access to health, education, and affordable housing (Omoloso et al., 2021). the study further expand this to "development sustainability," integrating justice, equity, and social capital. Environmental sustainability, the most debated dimension entails maintaining ecological capacity and biodiversity. The 2015 United Nation (UN) sustainable development goals (SDGs) and the Paris Agreement consolidated global commitment to balanced, resilient, and climate-smart growth (UN, 2015).

#### Conceptual Definition of Sustainable Finance

The concept of *sustainable finance* emerged as global awareness of environmental and economic interdependence deepened (Howes et al., 2017). Its roots trace to the 1992 Rio de Janeiro Earth Summit, which catalysed the establishment of the UNEP Finance Initiative (UNEP-FI)—a partnership between UNEP and over 200 financial institutions aimed at integrating environmental stewardship into financial practices. Sustainable finance seeks to align economic growth with social equity and ecological balance by mobilising capital for green, inclusive, and climate-resilient investments. According to the Centre for Responsible Business (2016), it is "the practice of creating economic and social value through financially sustainable models, products, and markets." The UNEP-FI (2015) and Hafner et al.

(2020) emphasise incorporating environmental, social, and governance (ESG) factors into investment decisions to drive long-term sustainable outcomes. Globally, sustainable financial assets surpassed US$35 trillion in 2021, representing nearly 36% of total professionally managed funds (ICMAGROUP, 2020). The approach mitigates climate and systemic risks while advancing transparency and value generation (Bank of England, 2019; Migliorelli, 2021). It encompasses green, social, and environmental finance, enhancing financial resilience, reducing operational risks, and supporting the global transition toward a climate-neutral economy (UN PRI, 2018; Ziolo et al., 2019; Setyowati, 2020).

**The Concept of Natural Resources Curse**

The resource curse, or paradox of plenty, describes the persistent failure of resource-rich nations to translate mineral wealth into sustainable growth and social welfare (Natural Resource Governance Institute, 2015). Despite hosting nearly 30% of global mineral reserves, sub-Saharan Africa remains home to over 40% of the world's poor, highlighting this paradox (Adamu et al., 2021). Coined by Auty (1993) and empirically established by Sachs & Warner (1995), the theory posits that economies reliant on non-renewable resources such as oil, gas, and minerals experience slower growth, weaker institutions, and heightened inequality. The framework later evolved to capture governance failures, corruption, and civil conflicts (Ovadia & Graham, 2022; Spence, 2021; Vélez-Torres & Méndez, 2022). Global initiatives like the Extractive Industries Transparency Initiative (EITI) emerged to counteract these effects (Vijge et al., 2019). Scholars differentiate between the economic resource curse—marked by low growth and volatility (Itumoh, 2020; Mlambo, 2022)—and the political resource curse, where rentier regimes exhibit authoritarian tendencies and conflict proneness (Ross, 2018; Ovadia, 2020; Hunziker & Cederman, 2022). Empirical studies affirm that resource rents correlate with governance fragility and income disparity, although exceptions such as Botswana, Canada, and Norway demonstrate institutional resilience (Frynas & Buur, 2020; Dong et al., 2019). Contemporary analyses now emphasize lootability dynamics which contrasts easily extractable resources like alluvial diamonds with capital-intensive ones like oil and gas (Watts, 2018; Farzanegan et al., 2018) to explain the persistence of state fragility in resource-dependent economies.

**Theoretical Framework**

This study is anchored on institutional theory, stakeholder theory, and stewardship theory, which collectively illuminate the behavioural and structural dimensions of sustainability governance in the Ghanaian mining industry. According to Pilato (2019), institutional theory provides a conceptual lens for examining how formal institutions such as business associations, civil society organisations, and regulatory agencies and informal norms, traditions, and customary laws shape corporate sustainability behaviour. It explains why sustainability programmes assume diverse forms across contexts. Institutional theory posits that firms adopt

sustainable practices under coercive, mimetic, or normative pressures (Greenwood & Meyer, 2008), where regulators, civil society, and communities act as key enforcers. Empirical evidence emanating from Liu et al., 2022 suggests that over 65% of mining firms in sub-Saharan Africa engage in sustainability initiatives primarily in response to institutional mandates and reputational concerns.

Complementing this, stakeholder theory emphasises that firms exist within complex networks of interdependent actors whose interests must be balanced (Amoah & Eweje, 2020). In Ghana's extractive sector, the study of Marashdeh et al., 2021 underscore that host communities, regulators, and investors hold divergent expectations that shape corporate legitimacy. Aligning with this view, over 48% of stakeholder-related conflicts in West African mining operations stem from perceived governance inequities and unmet social responsibilities. The stewardship theory further offers an ethical counterpoint to agency theory, portraying managers as custodians of societal welfare. It advocates moral responsibility, accountability, and prudent management of natural resources for collective benefit (Balch, 2021; Makle-Ridley, 2021). In this light, stewardship extends beyond corporate profitability toward sustainable development imperatives, ensuring that resource revenues are equitably utilised for human advancement (Lehrer & Segal, 2020). Together, these theories provide an integrated framework for understanding how institutional, ethical, and relational forces collectively influence sustainability governance in Ghana's mining sector.

**Empirical Review**

The empirical review in this study is based on a number of studies reviewed and emphasizes significant concepts, trends, and the method of analysis employed by relevant papers. The study explored several studies as well as the various theories put out and how they correlated with the concepts of sustainability, sustainable finance, resource curse, and mining.

**Review of Related Studies in the Global Context**

Recent empirical research on the interaction between financial development and natural resource dependency provides diverse insights into the "resource curse" and "resource blessing" paradigms. Asif et al. (2020) and Dogan et al. (2020) examined Pakistan's economy using time series data from 1975–2017, applying the ARDL-Bounds testing approach with Variance Decomposition Analysis (VDA) and Impulse Response Functions (IRF). Their results revealed that while forest and oil rents enhanced financial development in the short run, long-run dynamics showed a negative correlation between coal, gas, and oil rents and domestic credit to the private sector, validating the "financial resource curse." Notably, the VDA forecasted persistent variance shocks in financial performance up to a decade ahead, underscoring structural volatility.

In Saudi Arabia, Anser et al. (2020), Nassani et al. (2019), and Alfalih & Hadj (2022) explored the sustainability of resource-driven growth through technological innovation from 1970–2018. They found that energy-intensive industrialization elevated carbon emissions by approximately 2.7% annually, despite short-term growth benefits, confirming that resource rents fuel emission-intensive development unless accompanied by digital and trade policy reforms.

Li et al. (2021), Wei et al. (2020), and Pan et al. (2021) reassessed the institutional failure hypothesis in G7 economies between 1980–2018. Their findings refuted the long-run existence of the resource curse, arguing that robust financial markets—rather than institutions alone—convert resource wealth into financial growth, with over 85% of variance in rent utilization explained by market efficiency (Jianqiang et al., 2020).

In the Malaysian context, Ali & Ramakrishnan (2022) and Jia & Yang (2022) employed Fourier-based ARDL and DOLS models from 2002–2018 to reveal mixed results: while banking development displayed a financial resource curse, the stock market exhibited a "resource blessing." Finally, Wang & Chen (2020), Wang et al. (2022), and Song et al. (2020) found that in China's 30 provinces between the years of (2006–2018), natural resource endowment constrained ecological efficiency, particularly in the western and central provinces, where eco-efficiency scores averaged 22% lower than in the eastern provinces. Collectively, these studies affirm that the natural resource-finance nexus remains contextually contingent, shaped by institutional robustness, technological adaptation, and ecological management capacity.

**Review of Related Studies in the African Context**

Empirical discourse on Africa's natural resource–finance nexus reveals a complex interplay between economic rents, institutional efficiency, and financial development. Dwumfour & Ntow-Gyamfi (2018) and Lashitew & Werker (2020) both applied the resource curse theory across 38 African economies between the years of 2000 and 2012 using the Arellano-Bond GMM estimator. Their analysis revealed that resource rents contribute approximately 32% of GDP in most African countries—with Angola and Zambia showing extreme dependence at 52.6% and 12.5%, respectively. Yet, no robust correlation emerges between resource rents and financial development (FD), suggesting that the "curse" materializes mainly under weak institutional conditions. Using Z-scores as FD indicators, they reveal the curse is most severe in Sub-Saharan Africa and among lower-income nations, whereas institutional strength mitigates the adverse effects of rents on credit expansion.

Complementary evidence by Mulwa & Mariara (2016) and Fowowe (2018) situates the curse within the frameworks of the Dutch Disease and institutional explanations. Drawing on OLS and seemingly unrelated regressions (SUR) across 47 African nations, their findings indicate that GDP per capita growth correlates

negatively but insignificantly with total natural resource abundance. Disaggregated estimates, however, show that mineral and primary resource dependence impede growth, while oil endowment yields modestly positive effects. Their results affirm that governance quality, particularly improvements in property rights and corruption control enhances the growth trajectory of resource-rich economies.

Adams et al. (2019) further extend the debate by linking globalization, governance, and multinational corporations (MNCs) to the persistence of the resource curse in oil-rich developing countries (ODCs). Their findings demonstrate that the ethical and accountability practices of MNCs shape resource outcomes, making globalization a determinant of whether nations succumb to or escape the "curse." Nath (2015) and Kalombo (2022) shift attention toward sustainability metrics, showing that adjusted net savings (ANS) in Sub-Saharan Africa have declined, with many nations recording negative values since 2010. Wealth accumulation remains fastest in lower-middle-income economies with limited natural capital, whereas resource-dependent regions like Latin America and the Middle East exhibit stagnation.

Finally, Igwe & Amadi (2020) and Henry (2019) integrate Marxian and institutional perspectives, identifying capitalism's exploitative mechanisms and institutional fragility as core determinants of the curse. Employing cointegration and error-correction models (Ndjokou & Tsopmo, 2017), they found that resource dependency exerts long-term negative effects on growth, while sound institutions transform resource wealth into recovery potential.

**Review of Related Studies in the Ghanaian Context**

The Ghanaian experience provides a nuanced lens through which the dynamics of sustainable finance and the natural resource curse can be examined. Shobande and Enemona (2021) and Musah et al. (2022) applied a Multivariate VAR Model, integrating Bayer and Hanck cointegration and Granger causality tests, to assess the link between sustainable finance and the resource curse in Ghana and Nigeria. Their findings underscore that sustainable finance significantly moderates the resource curse through the Human Development Index, establishing a positive link between macroeconomic stability and natural resource management. Policy implications emphasize the design of adaptive financing frameworks to mobilize domestic investment in natural resource governance, given that Ghana's mining and oil sectors account for over 8% of GDP and 40% of export revenue.

At the community level, Aubell & Mensah (2007) examined residents' perceptions in Tarkwa-Nsuaem and found extensive ecological degradation—deforestation, mine pits, and water contamination—despite rising mining output. With 77 participants sampled via snowball and purposive techniques, the study revealed a paradox of wealth and deprivation, urging inclusive governance in environmental oversight.

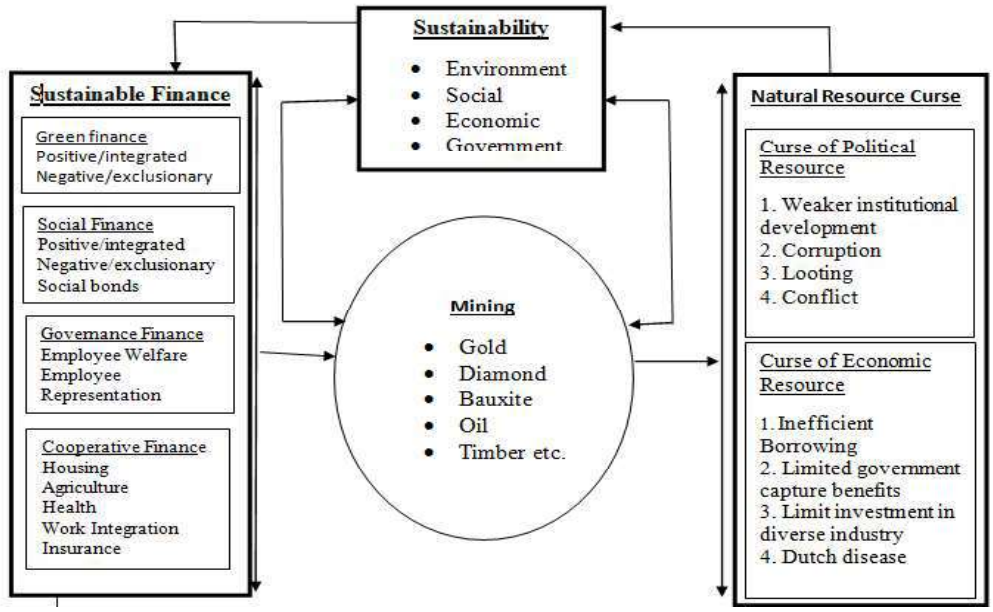
In exploring the oil economy, Siakwah (2016) employed actor-network theory to demonstrate how Ghana's democratic institutions partially insulate the nation from the oil curse, even as global assemblages of actors and markets shape local outcomes. Similarly, Ayelazuno (2014) used a critical political economy approach to show how Ghana's liberal democracy and gold mining legacy have not fully eliminated enclave extractive dependency, sustaining patterns of uneven capitalist development.

Further, Phillips et al. (2016), Andrews & Siakwah (2020), and Mohan et al. (2018) collectively highlight the political nature of oil extraction, sovereignty, and governance. Their findings affirm that while Ghana's state institutions exhibit resilience, structural inequalities and global capital dynamics continue to influence the nation's oil-driven development trajectory.

## 2Conceptual Framework

The figure below highlights the conceptual framework for the study. Here, the key variables and their interconnectedness are pictorially elaborated.

**Figure 1: Conceptual Framework for the Study**




***Source: Authors Own Construction, 2025***

The conceptual framework above illustrates the dynamic interconnections between sustainable finance, natural resource curse, and sustainability within the Ghanaian mining sector. At its core, the model situates mining activities—notably in gold, diamond, bauxite, oil, and timber—as both economic catalysts and potential sources of structural vulnerability. These extractive industries influence, and are influenced by, financial, institutional, and environmental systems.

Sustainable finance operates through four primary mechanisms: *green finance, social finance, governance finance,* and *cooperative finance.* Green finance promotes environmental accountability and low-carbon initiatives, mitigating ecological degradation from mining. Social finance fosters equity, social cohesion, and community welfare, countering the exclusionary effects of extractive operations. Governance finance enhances employee welfare and representation, strengthening institutional integrity, while cooperative finance supports livelihood diversification through housing, agriculture, and insurance—key pillars for inclusive economic growth.

These financial mechanisms collectively influence the dimensions of sustainability, thus, environmental, social, economic, and governmental by mobilising capital toward responsible production and resource efficiency. When effectively managed, sustainable finance mitigates the curse of political resources manifested in weak institutions, corruption, looting, and conflict and the curse of economic resources, typified by inefficient borrowing, narrow fiscal benefits, limited industrial diversification, and Dutch Disease effects.

Conversely, weak or exclusionary financial systems amplify these curses, trapping resource-rich economies like Ghana in cycles of rent-seeking and environmental degradation. Thus, the framework posits a bidirectional relationship: mining revenues influence the flow and design of sustainable finance, while the strength of sustainable finance determines whether resource wealth translates into long-term sustainability or perpetuates institutional fragility. The mediating role of sustainability dimensions underscores that effective governance, equitable finance, and environmental stewardship are indispensable in transforming Ghana's natural resource endowments from a potential curse into a sustainable development catalyst.

**Research Design and Strategy**

Given the research design and strategy, the study adopts the World Bank data known as the World Development Indicators (WDI) is the primary World Bank collection of development indicators and relevant, high quality, and internationally comparable statistics about global development and the fight against poverty. Recognizing the private and public sector's efficiency at allocating resources and spurring economic growth, the World Bank Group seeks to identify obstacles to its development. Methodologically, this study follows the study of Shahbaz (2017) and Sun et al. (2020) by estimating the relationship between financial development and natural resource curse herein measured by natural resource rents and the role played by the mediating variable, thus institutional variable using a dynamic model while adjusting the resource rents variable to a growth of the mining sector.

In order to allow for an investigation of the persistence of growth from financial development and natural resource rents management, the study uses a dynamic

model to estimate the stated relationship. This became necessary due to the nature of the data of choice. All variables are drawn from the literature reviewed. Moreover, the variables are selected because, whilst they seem theoretically and intuitively plausible to most likely influence the financial development behavior on natural resource rents, their empirical findings remain inconclusive in the literature. Therefore, on the basis of the theoretical and intuitive reasoning from the proposed integrated framework that informs the thesis they are explored in this section. The chapter further considered the population and sample utilized in the thesis while describing the reliability and validity standards used to ensure the integrity of the thesis.

## Data Sources and Description of Variables

### Data Sources

The study makes use of an annual time series dataset from 1996 to 2021. Data on the variables in the study are gathered from various secondary sources. To begin, data on Natural resource rents denote the total rent received through coal, mineral, forest, oil, and natural gas rents of Ghana are obtained from the World Development Indicators (WDI) of World Bank Data-set. Second, the study uses a new proxy for the financial development index developed by Svirydzenka (2016). The traditional measure for financial development, such as domestic credit to the private sector or stock market capitalization ratio to gross domestic product (GDP) does not cover the multidimensional approach of financial development. Therefore, a new variable for financial development is used in this study. It provides a multidimensional approach to cover the depth, efficiency, and accessibility of financial markets and institutions. Data for the financial development index is obtained from the International Monetary Fund (IMF) database. Third, this study also uses a new approach to measure human capital. The used the human capital index (HCI) developed by Penn World Table (PWT, 9.1), which not only covers labor market information and is also adjusted for the estimated returns to education. It also varies across countries having different levels of education. Fourth, Trade openness which measures the degree of openness in terms of increasing or restricting trade with other countries. It is calculated by summing exports and imports and dividing them by gross domestic product (GDP). Data for exports, imports, gross domestic product (GDP) and fifth, data on institutional quality are obtained from the World Governance Indicators, which is proxied by the corruption control index (WGI). The data measurements and sources are described in Table 3.2.

**Table 3.2: Data source and measurement**

| S/No. | Variable | Definition | Unit of measurement | Source |
|---|---|---|---|---|
| | **Macroeconomic variables Indicators** | | | |
| 1 | NRR | total natural resource rents | Coal + mineral + forest + oil + natural gas rents | World Bank Data base (WDI), (2021) |
| 2 | FD | Financial development index developed by | multidimensional approach to cover the depth, efficiency, and accessibility of financial markets and institutions | International Monetary Fund (IMF) database |
| 3 | HD | Human development | human capital index (HCI) | Penn World Table (PWT, 9.1) |
| 4 | TOP | Trade openness | measures the degree of openness in terms of increasing or restricting trade with other countries | World Bank Data base (WDI), (2021) |
| | **Institutional Governance Indicators** | | | |
| 5 | COC | Control of Corruption | Index | World Governance Indicators (2021) |

**Source: Researchers' compilation**

## Empirical Model Specification

Following the study of Shahbaz (2017) and Sun et al. (2020) by estimating the relationship between financial development and natural resource rents functional relationship is specified:

$$NRR_t = f(FD_t, X_t)\upsilon_t \quad \text{.....(3.1)}$$

Equation (3.1) suggests that natural resource rents at time *t* depends on the financial development, other explanatory variables to control for the functional relationship and other unobserved factors, captured in the error term (*v*). *X* is a vector of economic and non-economic determinants of natural resource rents management. As mentioned above, these factors include human development, trade openness and corruption control index. $v = \ln\varepsilon$ is the random error term.

While Equation (3.2) serves as the baseline model, it does not capture several factors that may affect natural resource rents, among which human development, trade openness and corruption control index are paramount to this study. To study the extent to which financial development contributes to natural resource management, the study augments the baseline model by these control variables and a set of explanatory variables. The resulting operational model is expressed as:

$$NRR_t = \alpha + \beta FD_t + \delta HD_t + \gamma TOP_t + \eta COC_t + \upsilon_t \quad \text{.....(3.2)}$$

Taking the natural logs of both sides with the exception of inflation rate and corruption control index yields a log-linear model of the form:

$$\ln NRR_t = \alpha + \beta \ln FD_t + \delta HD_t + \gamma \ln TOP_t + \eta COC_t + \upsilon_t \quad \text{.....(3.3)}$$

where ln is the natural log operator. *NRR* is the natural resource rents which is the sum of Coal, mineral, forest, oil and natural gas rents of the economy in year *t*. *FD* is the financial development index which is a multidimensional approach to cover the depth, efficiency, and accessibility of financial markets and institutions. *HD* is human development developed by Penn World Table (PWT, 9.1), which not only covers labor market information and is also adjusted for the estimated returns to education. *TOP* is trade openness which is captured by the ratio of the sum of imports and exports to GDP. COC is corruption control index which serves as the institutional governance indicator and it ranges between -2 - +2. *v* is the error term.

**Definition of Variables: Description and Measurement of Variables**

**Outcome variable: Natural Resource Rents**

The estimates of natural resources rents are calculated as the difference between the price of a commodity and the average cost of producing it. This is done by estimating the price of units of specific commodities and subtracting estimates of average unit costs of extraction or harvesting costs. These unit rents are then multiplied by the physical quantities countries extract or harvest to determine the rents for each commodity as a share of gross domestic product (GDP). Accounting for the contribution of natural resources to economic output is important in building an analytical framework for sustainable development. In some countries earnings from natural resources, especially from fossil fuels and minerals, account for a sizable share of GDP, and much of these earnings come in the form of economic rents - revenues above the cost of extracting the resources. Natural resources give rise to economic rents because they are not produced. For produced goods and services competitive forces expand supply until economic profits are driven to zero, but natural resources in fixed supply often command returns well in excess of their cost of production. Rents from nonrenewable resources - fossil fuels and minerals as well as rents from over harvesting of forests indicate the liquidation of a country's capital stock. When countries use such rents to support current consumption rather than to invest in new capital to replace what is being used up, they are, in effect, borrowing against their future.

**Financial Development Index**

The literature that treats financial sector development and its impact on various economic phenomena does not recognize a single indicator of financial development measurement, nor do the various regulators sector have a single indicator to measure its development. Divergences in financial development proxies uses have prompted the International Monetary Fund (IMF) staff to create an indicator that includes all aspects of financial sector development. A typical empirical study approximates financial development with either one of two measures of financial depth the ratio of private credit to GDP or stock market capitalization to GDP. However, these indicators do not take into account the complex multidimensional nature of financial development. Therefore, a new variable for financial development is used in this study. It provides a

multidimensional approach to cover the depth, efficiency, and accessibility of financial markets and institutions.

**Other explanatory variables**

The literature is replete with several economic and non-economic determinants of central natural resource rents management. To account for the effects of these factors, a number of control variables are included in the study. These include trade openness as a percentage of GDP, human development and index of corruption

Theoretically, trade openness is positively related to natural resource rents. Trade openness is a measure of economic policies that either restrict or invite trade between countries. For example, if a country sets a policy of high trade tariffs, thus restricting the desirability of international trade, this restrictive policy will inhibit other countries from sending exports and accepting imports from that country. Trade openness is measured as the sum of a country's exports and imports as a share of that country's GDP (in %). Therefore, the share of export and import in Ghana's GDP is employed as a proxy for trade openness and it is expected that the more Ghana engages in international trade, the growth-related benefits to the natural resource rents increase. The term human capital refers to the economic value of a worker's experience and skills. Human capital includes assets like education, training, intelligence, skills, health, and other things employers value such as loyalty and punctuality. As such, it is an intangible asset or quality that is not (and cannot be) listed on a company's balance sheet. Human capital is perceived to increase productivity and thus profitability. The more investment a company makes in its employees, the chances of its productivity and success become higher. Human capital is an intangible asset or quality not listed on a company's balance sheet. It can be classified as the economic value of a worker's experience and skills. Human capital index (HCI) developed by Penn World Table (PWT, 9.1), which not only covers labor market information and is also adjusted for the estimated returns to education. It also varies across countries having different levels of education.

Lastly, the quality of institutions is a non-economic factor that may also affect revenue mobilization. As a proxy for the quality of institutions, a corruption index is included in the analysis. Widespread corruption may severely hamper natural resource rents management in the economy.

**A priori Expectations**

Basing on the empirical results, it's expected that the findings of the study will show whether or not the selected variables of interest that is quality of institutions, curroption index, trade, human capital and exports among significant others explored under the study will exhibit evidence of actually impacting natural resource curse management in the Ghanaian economy.

**Estimation Techniques**

Time series econometric techniques are employed to estimate the parameters of Eq. (3.3). With the data covering 39 years (1980-2018), it is important to assess the time series properties of the variables employed in the study. This is to ensure that there exists a long-run (equilibrium) between tax revenue and its determinants as specified in Eq. (3.3). Hence, the test for unit root of the variables is carried out using the Augmented Dickey-Fuller (ADF) test to assess the stationarity properties of the variables. The test for unit root is important to ascertain the absence of $I(2)$ series (i.e. integration of order 2), since their presence would lead to the collapse of the Auto-Regressive Distributed Lags (ARDL) approach to cointegration and estimation of Eq. (3.3).

**The Augmented Dickey-Fuller (ADF) unit root test**

The ADF test for unit root entails the estimation of the following equation, which links the change in variable $y$ to its first lagged level, and lagged changes:

$$\Delta y_t = \mu + \alpha y_{t-1} + \varphi_1 \Delta y_{t-1} + \gamma_2 \Delta y_{t-2} + ... + \varphi_p \Delta y_{t-p} + \in_t \quad .....(3.4)$$

where $y$ is a vector of the variables used in the study, $\Delta$ is the first difference operator, $p$ is the optimal lag length (on the Akaike Information Criterion (AIC)). $\epsilon$ is the error term.

The unit root test is done by testing the null hypothesis that $\hat{\alpha}$, the coefficient on $y_{t-1}$, is equal to one (unity), against the alternative hypothesis that it is statistically less than unity:

$H_0$: $\alpha = 1$ against $H_1$: $\alpha < 1$

Using the $t$ test on $\hat{\alpha}$, a rejection of the null hypothesis implies that the series has no unit root and is therefore stationary. That is, their statistical properties such as mean, variance, and autocorrelation, are constant or do not vary over time. On the other hand, failure to reject the null hypothesis suggests that variable is non-stationary.

**Johansen Cointegration Test**

Secondly, we test the presence or otherwise of cointegration between the series of the same order of integration through forming a cointegration equation. The basic idea behind cointegration is that if, in the long-run, two or more series move closely together, even though the series themselves are trended, the difference between them is constant. It is possible to regard these series as defining a long-run equilibrium relationship, as the difference between them is stationary (Hall and Henry, 1989). A lack of cointegration suggests that such variables have no long-run relationship: in principal they can wander arbitrarily far away from each other (Dickey et. al., 1991). We employ the maximum-likelihood test procedure established by Johansen and Juselius (1990) and Johansen (1991). Specifically, if $Y_t$ is a vector of n stochastic variables, then there exists a p-lag vector auto

regression with Gaussian errors of the following form: Johansen's methodology takes its starting point in the Vector Auto regression (VAR) of order P given by:

$$y_t = \mu + \Delta_i y_{t-1} + ---+ \Delta p y_{t-p} + \varepsilon_t \quad \text{.....(3.5)}$$

Where $Y_t$ is an nx1 vector of variables that are integrated of order commonly denoted (1) and $\varepsilon_t$ is an nx1 vector of innovations. This VAR can be rewritten as:

$$\Delta y_t = \mu + \eta y_{t-1} + \sum_{i=1}^{p-1} \tau_i \Delta y_{t-1} + \varepsilon_t \quad \text{.....(3.6)}$$

Where:

$$\Pi = \sum_{i=1}^{p} A_{i=1} \text{ and } \tau i = -\sum_{i=1}^{p} Aj \quad \text{.....(3.7)}$$

To determine the number of co-integration vectors, Johansen (1988, 1989) and Johansen and Juselius (1990) suggested two statistic test, the first one is the trace test ($\lambda$ trace). It tests the null hypothesis that the number of distinct cointegrating vector is less than or equal to q against a general unrestricted alternatives q = r. the test calculated as follows:

Where;

$$\lambda trace(r) = -T \sum_{i-r+1} \ln(1 - \hat{\lambda}_t) \quad \text{.....(3.8)}$$

T is the number of usable observations, and the $\lambda_1$,s are the estimated eigenvalue from the matrix.

**The Vector Error Correction Mechanism (VECM) Estimation Technique**

The estimation of equation (3) shows which of the natural resource rents determinants exerts the greater impact on natural resource rents, and whether natural resource rents influences any of the variables. From equation (3) above, the conditional vector error correction model (VECM) can be specified as follows:

$$\Delta NRR_t = \alpha_1 + \sum_{i=1}^{p} \beta_{i1} \Delta \ln FD_{t-i} + \sum_{i=1}^{p} \kappa_{i1} \Delta \ln HD_{t-i} + \sum_{i=1}^{p} \varpi_{i1} \Delta \ln TOP_{t-i} + \sum_{i=1}^{p} \varphi_{i1} \Delta \ln COC_{t-i} +$$

$$\delta_1 ECM_{t-1} + \upsilon_{1t} \quad \text{.....(3.9)}$$

$$\Delta FD_t = \alpha_2 + \sum_{i=1}^{p} \beta_{i2} \Delta \ln NRR_{t-i} + \sum_{i=1}^{p} \kappa_{i2} \Delta \ln HD_{t-i} + \sum_{i=1}^{p} \varpi_{i2} \Delta \ln TOP_{t-i} + \sum_{i=1}^{p} \varphi_{i2} \Delta \ln COC_{t-i} +$$

$$\delta_2 ECM_{t-1} + \upsilon_{2t} \quad \text{.....(3.10)}$$

$$\Delta HD_t = \alpha_3 + \sum_{i=1}^{p} \beta_{i3} \Delta \ln NRR_{t-i} + \sum_{i=1}^{p} \kappa_{i3} \Delta \ln FD_{t-i} + \sum_{i=1}^{p} \varpi_{i3} \Delta \ln TOP_{t-i} + \sum_{i=1}^{p} \varphi_{i3} \Delta \ln COC_{t-i} +$$

$$\delta_3 ECM_{t-1} + \upsilon_{3t} \quad \text{.....(3.11)}$$

$$\Delta COC_t = \alpha_4 + \sum_{i=1}^{p} \beta_{i4} \Delta \ln NRR_{t-i} + \sum_{i=1}^{p} \kappa_{i4} \Delta \ln FD_{t-i} + \sum_{i=1}^{p} \varpi_{i4} \Delta \ln HD_{t-i} + \sum_{i=1}^{p} \varphi_{i4} \Delta \ln TOP_{t-i} +$$

$$\delta_4 ECM_{t-1} + \upsilon_{4t} \quad \text{.....(3.12)}$$

where $\Delta$ is the first difference operator and ln is the natural logarithm. The estimated parameter links the short run dynamics to the long run relation as the means by which the system is restored to long run equilibrium condition, in the event of shocks to any of the regressors. The residuals $\upsilon_{it}$ are assumed to be normally distributed and white noise which is the one period lagged error-correction term derived from the co-integration equation.

**Chapter Summary**

This chapter presented highlights on the methodology utilized for the study. After a brief introduction, the research design as well as data sources and related model specification was presented. Next, the definition of variables, apriori expectations and the estimation techniques used are here after elaborated on. Finally, the summary of the chapter is outlined.

**Analysis and Discussion of Findings**

This section presents and discusses the empirical results from the analysis of the impacts of financial development on natural resource rents of Ghana while accounting for other control variables such as human development, trade openness and institutional governance indicator of corruption index. It begins with a descriptive analysis of the variables used in the study in Section 4.1. Section 4.2 presents and discusses the results from the analysis of the time series properties of the data and cointegration tests. The main empirical results on the long-run impacts of financial development on natural resource rents are reported and discussed in Section 4.3. Section 4.4 concludes the chapter with the discussion of the results from the short-run dynamics.

**Descriptive analysis**

Figure 4.1 shows that between 1996 and 2021 natural resources rents, a percentage of GDP alternated, which mirrors the rising and falling of the resource rents over the years. It has its lowest value of 7.06, a proportion of GDP especially 2006. However, the natural resource rents reached its highest peak in 2011 with a value of 16.29, a percentage of GDP. Broad financial development however, displayed a smooth trend through the period.

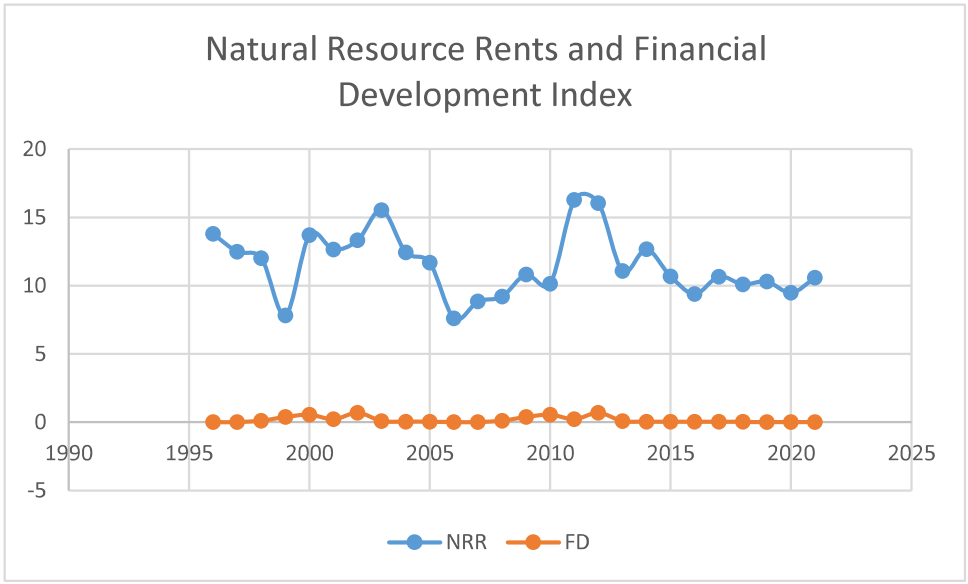



**Figure 4. 1: Trends in Natural Resource Rents and Financial Development of Ghana**
*Source*: Own construct based on data from the 2021 from WDI and IMF.

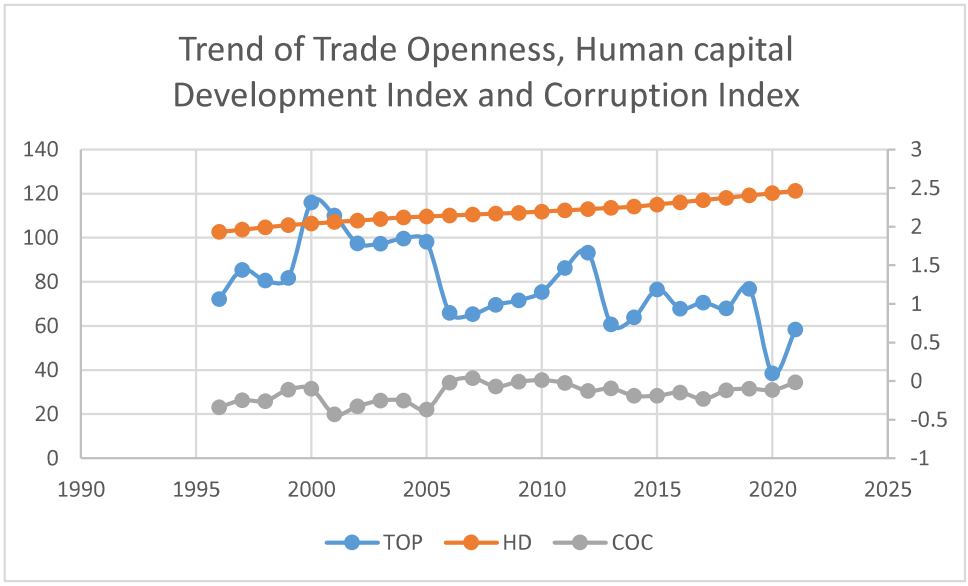



**Figure 4. 2: Trade Openness, Human Capital Development and Corruption Index**
Source: Own construct based on the 2021 WDI, Penn World Table (PWT, 9.1) and WGI.

In terms of the other macroeconomics and institutional variables, Figure 4.2 demonstrated that the variables have been alternating over the years although with upward trends except human development index that showed a complete upward trend without alternations.

**Table 4. 1: Pairwise correlations**

| | Variable | [1] | [2] | [3] | [4] | [5] |
|---|---|---|---|---|---|---|
| [1] | NRR | 1 | | | | |
| [2] | FD | 0.3379* | 1 | | | |
| [3] | TOP | 0.5789* | 0.4860* | 1 | | |
| [4] | HD | 0.2950* | -0.2755* | -0.5864* | 1 | |
| [5] | COC | -0.3955* | 0.0768* | -0.4987* | 0.4312* | 1 |

Note: * indicates no statistical significance. All other correlation coefficients are statistically significant at least 5% level.

Table 4.1 showed the pairwise correlations (or the degrees of association) among the variables employed in the study. Of particular interest are the correlation coefficients in column 1, which show the degrees to which natural resource rents is associated with the number of macroeconomic and other explanatory variables. The correlation coefficient between natural resource rents and financial development is 0.3379. It is both positive and statistically significant, suggesting that both variables do not only move in the same direction but are also moderately correlated. To what extent improvements in financial development over the study period can be 'causally' attributed to changes in natural resource rents and policy measures is the main subject of this study, and is empirically investigated in this chapter.

**Table 4. 2: Summary statistics**

| **Variable** | **Obs.** | **Mean** | **Std. Dev.** | **Minimum** | **Maximum** |
|---|---|---|---|---|---|
| Natural Resource Rents (% of GDP) | 26 | 11.5119 | 2.3329 | 7.6087 | 16.2914 |
| Financial Development Index | 26 | 0.1653 | 0.2218 | 0.0019 | 0. 6773 |
| Trade (% of GDP) | 26 | 78.7354 | 17.4636 | 38.5168 | 116.0484 |
| Human Development Index | 26 | 2.1861 | 0.1460 | 1.9316 | 2.4648 |
| Corruption Index | 26 | -0.1577 | 0.1257 | -0.4289 | 0. 0390 |

Source: Researcher's Computation, 2022

Table 4.2 presents the summary statistics of all the variables included in the study. The average natural resource rents over the period 1996-2021 is 11.51%, with its lowest being 7.608% in 2006 and the highest being 16.291% in 2011. On average, 0.165% is the value of financial development changes took place each year during the study period with the lowest value of 0.001% and a highest value of 0.677%. Trade openness has an average value of 78.735% with a minimum and maximum values of 38.516 and 116.048% respectively. Average annual human development index of Ghana is 2.186 index with a standard deviation of 0.146 index over the study period. The mean corruption index of -0.157 index with a standard deviation value of 0.125 index which suggests that Ghana is partly corrupt (not clean), hence the presence of some weakness in Ghana's institutions.

**Unit root test results**

Table 4.3 shows the results of the ADF tests for unit roots. As evident from the t-statistics of the level results, the null hypothesis of unit root (non-stationarity) is not rejected for all the variables. However, after first differencing, all the variables achieved stationarity, and the null hypothesis that each variable has a unit root is strongly rejected at 1% significant level. The overall conclusion from these results is that attained stationarity at first differencing. Armed with this finding, the study proceeded with the cointegration test.

**Table 4. 3: ADF Unit root test results**

| Label | Variable | Level | Difference | Conclusion |
|---|---|---|---|---|
| NRR | Natural Resource Rents | -3.3457 | -6.3058* | I(1) |
| FD | Financial Development | -3.1533 | -7.9509* | I(1) |
| TOP | Trade Open (% of GDP) | -2.7010 | -5.9903* | I(1) |
| HD | Human Development Index | -3.2070 | -5.6620* | I(1) |
| COC | Corruption Index | -2.6203 | -5.8805* | I(1) |

**Note: *,**** indicate significance at 1% and 5% level respectively

After passing through the unit root test, the next stage is to check the long-run relationship among the variables using a co-integration approach. For this purpose, the study applied the Johansen approach to co-integration proposed since the variables are integrated of the first order. It is the pre-requisite to choose an appropriate lag length before proceeding to the co-integration test. Moreover, the selection of lag-length should be performed carefully because an inappropriate lag-length may lead to biased results and is not acceptable for policy analysis. Therefore, to ensure that the lag length was selected appropriately, the study used the Akaike information criterion (AIC) that helps to identify pertinent lag length. The AIC criterion provides dynamic results and has exceptional properties compared with the Schwartz Bayesian criteria (SBC). The results are reported in Table 4.4.

**Table 4.4: Lag Selection Criteria Result**

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | -104.6837 | NA | 0.0044 | 8.7746 | 9.0184 | 8.8423 |
| 1 | -6.3666 | 149.4419* | 1.32e-05* | 2.9093* | 4.3719* | 3.3150* |

Endogeneous: NRR, FD, TOP, HD, COC
Exogeneous: Constant
Note: * indicates lag selection by the criteria
Source: Author's computation using Eviews 10

Table 4.4 comprises the result of the lag order criteria conducted on the Vector Autoregressive (VAR) system. This is with the view to determining the appropriate lag length for the VAR estimation. The appropriate lag length selected by all the criteria is lag 1. The likelihood ratio, the final prediction error, the Akaike

information, the Schwarz and Hannan criteria selected lag 1 as shown by the asterisk at 5% significance level. Therefore, a lag of one is considered appropriate and has been selected for the estimation process on the result of the lag selection criteria. Hence, the Vector Error Correction Mechanism (VECM) was estimated using one lags, which is consistent with the optimal lag length recommended by the optimal lag length criteria.

**Co-integration Test**

According to Johansen (1991) co-integration can be used to establish whether there exists a linear long term economic relationship among variables. In this regards, Johansen (1991) asserts that co-integration allows researchers to specify a process of dynamic adjustment among the co-integrated variables and in disequilibrated markets. Given that the series are I(1), the co-integration of series is a necessary condition for the existence of a long run relationship. The co integration results of both the Trace and Maximum-Eigen value statistic of the Johansen co integration test are presented and displayed in Table 4.5

.

**Table 4.5: Johansen Co-integration Test Result**

| Hypothesized No of CEs | Eigen-Values | Trace Statistic | 0.05 C.V. | Prob** |
|---|---|---|---|---|
| None * | 0.8393 | 105.1527 | 69.8188 | 0.0000 |
| At most 1 * | 0.6621 | 61.2633 | 47.8561 | 0.0017 |
| At most 2 * | 0.6294 | 35.2184 | 29.7970 | 0.0108 |
| At most 3 | 0.2493 | 11.3951 | 15.4947 | 0.1883 |
| At most 4 | 0.1713 | 4.5112 | 5.8414 | 0.1037 |
| **Hypothesized No of CEs** | **Eigen-Values** | **Max-Eigen value** | **0.05 C.V.** | **Prob**** |
| None * | 0.839381 | 43.88932 | 33.87687 | 0.0023 |
| At most 1* | 0.662168 | 28.04494 | 27.58434 | 0.0476 |
| At most 2 * | 0.629402 | 23.82333 | 21.13162 | 0.0204 |
| At most 3 | 0.249358 | 6.883849 | 14.26460 | 0.5030 |
| At most 4 | 0.171360 | 4.5112 | 5.8414 | 0.1037 |

Trace test indicates 4 cointegrating eqn(s) at the 0.05 level
Max-Eigen-value test indicates 4 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values
**Source:** Author's computation using Eviews 10

It can be seen from Table 4.5 that both the trace statistic and the maximum Eigen value statistic indicate the presence of three co-integration among the variables. The value of the calculated Trace statistic is greater than the 0.05 critical value (105.1527 > 69.8188); (61.2633 > 47.8561); (35.2184 > 29.7970) respectively while the corresponding P-value (0.0000; 0.0017; 0.0108) are less than the 0.05 significance value respectively. Hence the null hypothesis of no co-integration is rejected at the 0.05 significance level. This confirms the existence of a stable long-run relationship among NRR as the dependent variable, financial development

(FD), trade openness (TOP), human capital development index (HD) and corruption index (COC as independent variables.

Similarly, the Max-Eigen statistic conforms to the result of the Trace statistic. From Table 3, the value of the calculated Trace statistic is greater than the 0.05 critical value (48.8893 > 47.8561); (28.0449 > 27.5843); (23.8233 > 21.1316) respectively while the corresponding P-value (0.0023; 0.0476; 0.0204) are less than the 0.05 significance value respectively. Hence, the null hypothesis of no cointegration is rejected while the alternative hypothesis of the presence of cointegration is accepted at the 0.05 significance level.

Base on the indication of three co-integrating vector among the variables, the estimated long-run equilibrium relationship for NRR can be derived from the normalized vectors as presented in Table 4.6.

**Long Run Coefficients' Results**

Table 4.5 presents the empirical results showing the impacts of foreign direct investments on the value added of the mining industry to GDP, while controlling for the impacts of other influential factors. Column 1 reports the baseline model based on the ordinary least squares (OLS). Reported in column 2 are estimates from our preferred VECM estimator. Similar results are reported in column 3 (FMOLS) and column 4 (DOLS) to demonstrate the robustness of the long-run estimates.

**Table 4. 5: Estimated Long-run Impacts of NRR**

| Variable | OLS | VECM | FMOLS | DOLS |
|---|---|---|---|---|
| FD(-1) | 1.7929** | -3.9107* | -2.5869** | -2.4384** |
| | (0.3868) | (0.2979) | (0.1388) | (1.1492) |
| TOP(-1) | 0.0594 | 0.7244* | 0.0496 | -0.1376 |
| | (0.0358) | (0.0822) | (0.0385) | (0.2041) |
| HD(-1) | 1.8406 | -2.7339 | 1.8637 | 2.1715 |
| | (3.4798) | (5.6698) | (3.8453) | (7.7495) |
| COC(-1) | -4.3859 | -8.6735* | -2.4077 | -1.2295 |
| | (4.1670) | (0.5789) | (4.3034) | (2.3589) |
| Constant | 1.8136 | -43.891* | 2.7885 | 12.0708 |
| | (9.0391) | (14.293) | (10.1775) | (16.1063) |
| $R^2$ | 0.3752 | 0.3043 | 0.3885 | 0.6407 |
| Adj. $R^2$ | 0.2562 | 0.2509 | 0.2662 | 0.4160 |

*Note:* Dependent variable: *NRR.* VECM model of lag 1 was selected for model (1) based on the Schwarz Bayesian Criterion. * and ** indicate statistical significance at 1% and 5% levels respectively. The values in parenthesis are standard errors.

The coefficients of the financial development (FD) indexes are negative and significant at the conventional error levels. This indicates that, regardless of the econometric estimator or method used, financial development index exerts negative and significant effects on natural resource rents in Ghana. The coefficient of financial development index in model 2 (VECM model) suggests that the elasticity

of natural resource rents with respect to financial development index is -3.9107. It implies that a 1% increase in financial development index reduces natural resource rents by 3.9107%. While the estimated financial developments' elasticities of natural resource rents in models 3 (FMOLS model) and 4 (DOLS model) are lower (-2.5869%) and (-0.2.4384%) respectively, they are both negative and statistically significant. This demonstrates the robustness of the impacts of financial development index on natural resource rents in Ghana. This also confirms the resource curse hypothesis where the development of the financial sector dampens natural resource rents instead of improving it. This result is consistent with evidence from elsewhere. For instance, Asif et al (2020); Zameer & Shahbaz (2021), Atil etal (2020); Dogan, et al (2020) all explore the dynamic interaction between financial development and natural resources rents, conclude that in the long run, there is a negative relationship between coal rents, forest rents, natural gas rents, and oil rents and domestic credit to private sector (financial development), which supports the "natural resource curse hypothesis" in a country. The other findings support the "financial resource curse" concept in a country by demonstrating that whereas coal and oil rents reduce the overall money supply (financial development), natural gas rents reduces market capitalization (financial development indicator). A recent study by Shobande & Enemona (2021); Musa et al (2022), used the Multivariate VAR Model to evaluate sustainable finance and natural resource curse in Ghana and Nigeria offered more proof of the financial resource curse affecting Ghana and Nigeria.

Turning attention to the control variables, the results show that the coefficient of trade openness shows significance in most of the models indicating that apart from financial development that influences natural resource rents, other determinants of natural resources is trade openness in the models. In all the models, trade openness increases natural resource rents in the long run. A 1% increase in trade openness would lead to a 0.7244% increase in natural resource rents.

In addition, institutional quality index captured by the index of corruption indicated significance to reduce natural resource rents into Ghanaian economy. In all the models, corruption index is found to reduce natural resource rents. A 1% increase in the index of corruption using the VECM model would lead to a decrease in natural resource rents by 8.6735%. This implies that the weak institutions and regulations reduces resource rents. The result is in line with the study of Siakwa (2006) who found out that natural resource rents reduced in the presence of weak democratic institutions.

The coefficients of determination of the 4 models indicate that the value ranges between 30.4% - 64.4% with model 4 (OLS) having the highest coefficient of determination (64.07%).

**Short run Results**

The results of the parsimonious and short run error correction model are reported in Table 4.6. Of particular interest is the coefficient of the error correction term (ECM), which captures the speed of adjustment towards the long-run equilibrium as a result of changes in the determinants of mining industry value added to GDP. From the results, the coefficient of ECM (-0.3917) is both negative and statistically significant. The coefficient, implies that a deviation from the long-run in the previous period is corrected by 39.17% in the current period. This also confirms the presence of cointegration or a long-run relationship between natural resource rents and its determinants.

**Table 4. 6: The short run model**

| Variable | Coefficient | Std. error | t-statistic | Probability |
|---|---|---|---|---|
| $D(NRR_{(-1)})$ | 0.1988** | 0.0814 | 2.0631 | 0.0267 |
| $D(FD_{(-1)})$ | 0.7387** | 0.2424 | 2.350 | 0.0118 |
| $D(TOP_{(-1)})$ | 0.0333 | 0.0826 | 0.4040 | 0.8896 |
| $D(HD_{(-1)})$ | -44686 | 10.7140 | -0.4342 | 0.8796 |
| $D(COC_{(-1)})$ | 7.4912 | 6.3621 | 1.1994 | 0.1343 |
| $ECM_{(-1)}$ | -0.3917** | 0.163 | -5.508 | 0.0264 |

*Notes*: Dependent variable: Δ(NRR). VECM model of lag 1 was selected using on the Schwarz Bayesian Criterion. ***, ** and * indicate statistical significance at %1, 5% and 10% levels respectively.

The results suggest that changes in natural resource rents in the previous year $\Delta(NRR_{(t-1)})$ can induce positive impacts on changes natural resource rents in the current period, possibly due to short-run. In addition, and in the short run, financial development index contributes to natural resource rents. This is not consistent with the evidence from the long-run results, financial development index reduces natural resource rents. With respect to the control variables, it is found that changes in trade openness, human development index, and corruption index in the previous period (but not in the current period) do not impact significantly on natural resource rents in the short run.

**Table 4. 7: Diagnostic checks**

**Panel A: Goodness of fit**

| | |
|---|---|
| F-statistic | 2.6453 |
| Prob (F-ststistic) | 0.0000 |
| $R^2$ adjusted | 0.3041 |

**Panel B: Breusch-Godfrey Serial Correlation Lagrangian Multiplier (LM) Test**:
Null hypothesis: No serial correlation

| | | | |
|---|---|---|---|
| F-statistic | 2.3689 | Prob. F(2,11) | 0.2687 |
| Obs*R-squared | 6.3135 | Prob. Chi-Square(2) | 0.1584 |

**Panel C: Heteroscedasticity Test: Breusch Pagan-Godfrey**
Null hypothesis: Homoscedasticity

| | | | |
|---|---|---|---|
| F-statistic | 1.3921 | Prob. F(10,12) | 0.2942 |

| | | | |
|---|---|---|---|
| Obs*R-squared | 12.4176 | Prob. Chi-Square(10) | 0.2651 |
| Scaled explained SS | 1.7943 | Prob. Chi-Square(10) | 0.9982 |

**Panel D: Residual Normality Test**

Null hypothesis: Residuals are multivariate normal

| | | | |
|---|---|---|---|
| Joint F-statistic | 4.1281 | Prob. Chi-Square (11) | 0.5311 |

To ascertain the validity of the results for policy inference, tests for serial correlation, heteroscedasticity and residual normality were conducted. The results of the diagnostic checks are provided in Table 4.7. As shown in Panel A, the F-statistic for the joint significance all the explanatory variables is statistically significant at 1 percent. This suggests that all independent variables are together significant in determining natural resource rents. The values $R^2$ (coefficient of determination) indicate that the variations in explanatory variables included in the model account for 30.4% - 64.3% of the variations in natural resource rents. This suggests a very good fit of the model, thereby confirming its predictive power.

Lastly, the test results in panels B, C, and D, show the absence of serial correlation, heteroscedastic residuals/errors, and residual non-normality respectively. This is because their probabilities (p-values) are well above the 5 percent significance level, indication the absence of significant evidence to reject the null hypotheses that the errors are serially correlated (Panel B), homoscedastic (have constant variance) (Panel C) and residual non-normality (Panel D).

## Conclusion

This study illuminates the intricate interplay between sustainable finance and natural resource rents in Ghana's mining sector, revealing that financial development, while conventionally expected to bolster resource-based growth, exerts a statistically significant negative influence on natural resource rents in the long run (VECM elasticity = -3.9107, $p < 0.01$). This finding empirically reinforces the "financial resource curse" hypothesis, aligning with Asif et al. (2020), Zameer & Shahbaz (2021), and Atil et al. (2020), who highlight similar dampening effects of domestic credit expansion on extractive rents. Conversely, the short-run results suggest that financial development can temporarily enhance resource rents, indicating a dynamic adjustment consistent with the institutional, stakeholder, and stewardship theoretical frameworks underpinning this study, which emphasize endogenous finance and governance in mediating resource outcomes. Control variables such as trade openness and institutional quality further substantiate the critical role of governance and policy in harnessing resource wealth. While our findings echo the resource curse evidence from Nigeria and Venezuela (Dogan et al., 2020; Badeeb et al., 2020), they diverge from studies suggesting unmitigated benefits of financial expansion in resource-rich contexts (Haseeb et al., 2021; Wu et al., 2018). By integrating VAR-VECM and cointegration analyses, this research offers a robust empirical foundation, inspiring a reimagined approach to sustainable

finance as a transformative mechanism for equitable, resilient, and environmentally aligned resource governance.

Following the conclusion herein, policy implications are clear: strengthening institutional frameworks, enhancing financial intermediation, integrating green and social finance mechanisms, and promoting transparency in mining revenues are essential to mitigate the resource curse.

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