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Exploring the Role of Mineral Resources, Digital Economy and Governance on Sustainable Economic Development: Novel Evidence from Emerging Economies of the Global South

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Abstract

In a contest to attain equitable economic performance, emerging economies of the Global South are rapidly strengthening their institutional framework and improving investment in the green energy sector and digitization. Also, these economies are extracting mineral resources to encourage development but still lagging in the context of an equitable growth race, which creates uncertainty among policymakers. Therefore, it is crucial to analyse the influence of mineral resources, digital economy and governance on the economic development of the emerging economies of the Global South from 1996 to 2022. In addition, the crucial role of green energy and foreign direct investment in economic growth are analysed. We use a second-generation stationarity test and a series of cointegration tests to confirm the stationarity of the variables and the stability of long-run association between them. Due to the issue of non-normality, the novel method of moments quantile regression offers robust nuances while accounting for the endogeneity issue. The outcomes indicate that mineral resources are adversely associated with sustainable economic development in the region. However, the digital economy, green energy and foreign direct investment drive sustainable growth in emerging economies in the Global South. On the other hand, institutional factors demonstrate mixed influences on sustainable economic development, where control of corruption and governance efficiency significantly lead to sustainable economic growth, while regulatory quality harms development. The study recommends strengthening the institutions, further investment in digitization initiatives, research and development and sustainable use of mineral resources to attain sustainable growth.

Keywords: Mineral resources, digital economy, green energy, control of corruption, government efficiency, sustainable economic development

JEL Classification: Q51, C33, O44

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List of abbreviations

ARDL	Autoregressive distributed lag
ASEAN	Association of South East Asian Nations
BRI	Belt and Road Initiative
CD	Cross-sectional dependence
COC	Control of corruption
DOLS	Dynamic ordinary least squares
EPRS	Environmental policy stringency
FDI	Foreign direct investment
FMOLS	Fully modified ordinary least squares
GDP	Gross domestic product
GEF	Governance efficiency
MMQR	Method of moments quantile regression
OECD	Organization of Economic Cooperation and Development
RQ	Regulatory quality
SCH	Slope coefficient heterogeneity
VAR	Vector autoregressive
VECM	Vector error correction model

1. Introduction

Natural resources are part of development initiatives since they have been an imperative source of income for decades, especially mineral resources (Li *et al*., 2024). They offer substantial prospects for economic growth by generating revenues through export earnings or taxes but can also cause resource curses by over-reliance, price fluctuations or pollution, leading to economic instability and environmental deterioration. Therefore, many emerging economies both benefit and suffer from the excessive use of mineral resources (Imtiaz and Javid, 2023; Pang *et al*., 2024). However, the current global dynamics and digitization play a crucial role in shaping economic growth. Digitization is a transformative force that includes the incorporation of data analytics and information and communication technologies. These transformations have led to changes such as automation in various sectors of the economy, making them more productive and resilient (Kraus *et al*., 2022). Digitization not only fosters innovation but also creates or attracts new businesses (Tan and Huang, 2023).

The integration of natural resources and digitization is an emerging topic of this digital era and China is a classic case of rapid digitization. It is observed that the resource rents meaningfully

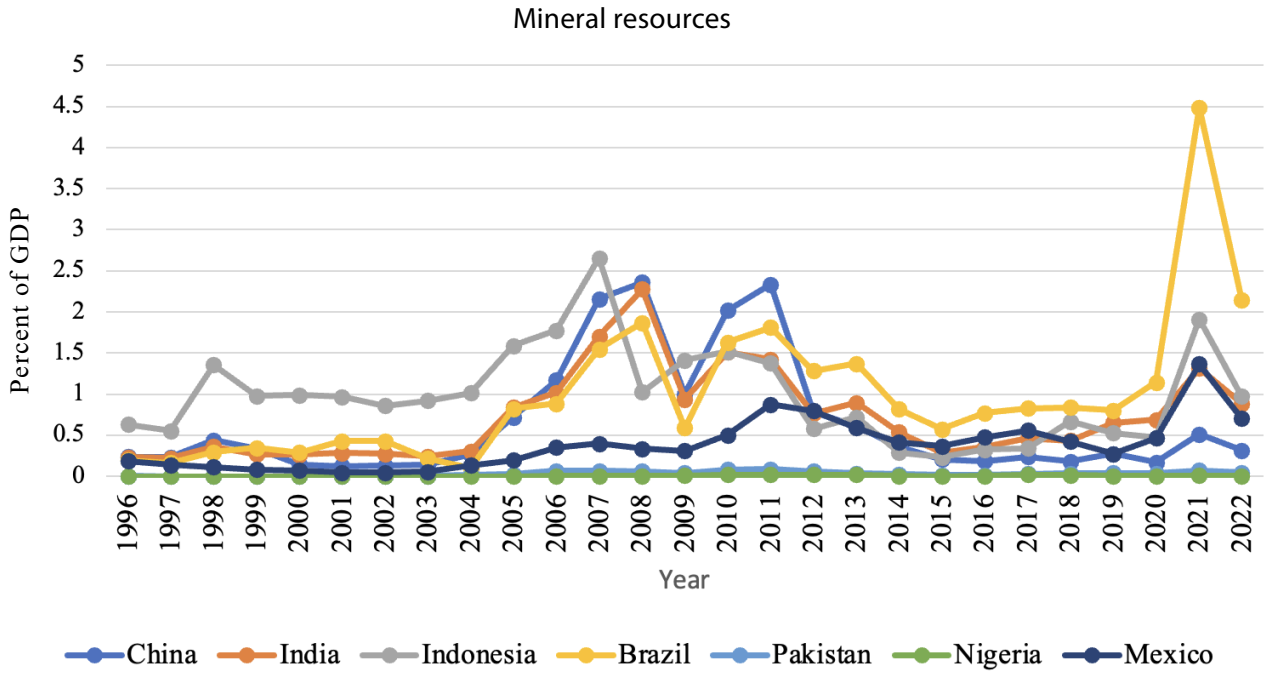
contribute to digitization. Technological advancements, such as lithium batteries and other electronic components, are part of the technological revolution. In addition to that, waste recycling and energy conversion are effectively contributing to a sustainable economy through the power of digitization. All in all, digitization is a significant driver of sustainable growth that fosters eco-innovation and development by expanding digital markets. Besides, it can be a resourceful way of limiting emissions and supporting sustainable development goals (Kraus *et al*., 2022; Tan and Huang, 2023). The digital economy drives growth, innovation and productivity at local and international levels. Above and beyond, high-tech exports are a positive sign for digital economic expansion (Wang *et al*., 2023). Therefore, the present extensive analysis seeks to illuminate the complicated relationship between mineral resources, the digital economy, sustainable economic development and other imperative factors in growing Global South economies, helping policymakers, businesses and stakeholders achieve equitable and sustainable growth.

Several other factors influence the process of economic development to ensure sustainable growth. Among these, government indicators play an imperative role. It is a known fact that sustainable growth requires good governance. The key components of governance are usually corruption control, government efficiency and regulatory quality (Wang *et al*., 2024). These are supported by digitization increasing productivity and investment opportunities in the country and increasing employment opportunities with easy access to resources (Linkov *et al*., 2018). Yet, open, responsible and efficient governance systems improve investor trust, company growth and sustainable economic growth that can be achieved by promoting the digital economy. Conversely, poor governance structures negate countries' prosperity and impede progress (Pang *et al*., 2024). Countries with strong digital governance become globally competitive by driving innovation and efficiency in different sectors/industries of the economy (Shahbaz *et al*., 2022). Hence, we use three governance indicators – corruption control, government effectiveness and regulatory quality – to explore how governance indicators promote innovation, entrepreneurship and inclusive growth in the Global South.

Global South countries such as China, India, Indonesia, Brazil, Pakistan, Nigeria and Mexico have significant economic and human potential. This potential depends on mineral resources, the digital economy and financial governance. These regions have seen substantial economic changes in recent decades due to mineral resource development, digital technology and governance reforms (Li *et al*., 2024). For instance, the mineral resources show a steady trend until the global financial crisis and maximum volatility afterwards, as seen in Figure 1. The visual inspection shows that the contribution of mineral resources to GDP is fluctuating for every economy, indicating changes in resource management or various other underlying factors (Yan, 2024). Concerning digitization, it can be observed that the graphs for all the selected economies show an increasing trend except for Pakistan and Nigeria, as mentioned in Figure 2. The overall digital

economy graph reflects the global trend of digital transformation with different degrees of acceleration across the study countries. Due to this reason, the study examines the complex relationship between these characteristics and sustainable economic development in emerging Global South economies. Hence, the study uses advanced econometric methods to uncover new insights into this complex relationship using data from 1996 to 2022. The study employs rigorous panel data methods such as method of moments quantile regression and parametric robustness tests such as cointegration regressions. Methods that account for data variability and dynamics yield robust and reliable empirical conclusions. The study uses cutting-edge econometric methods for compelling policy implications to establish complex links between mineral resources, the digital economy, governance and sustainable economic growth in the Global South.

Figure 1: Mineral resources in emerging Global South economies

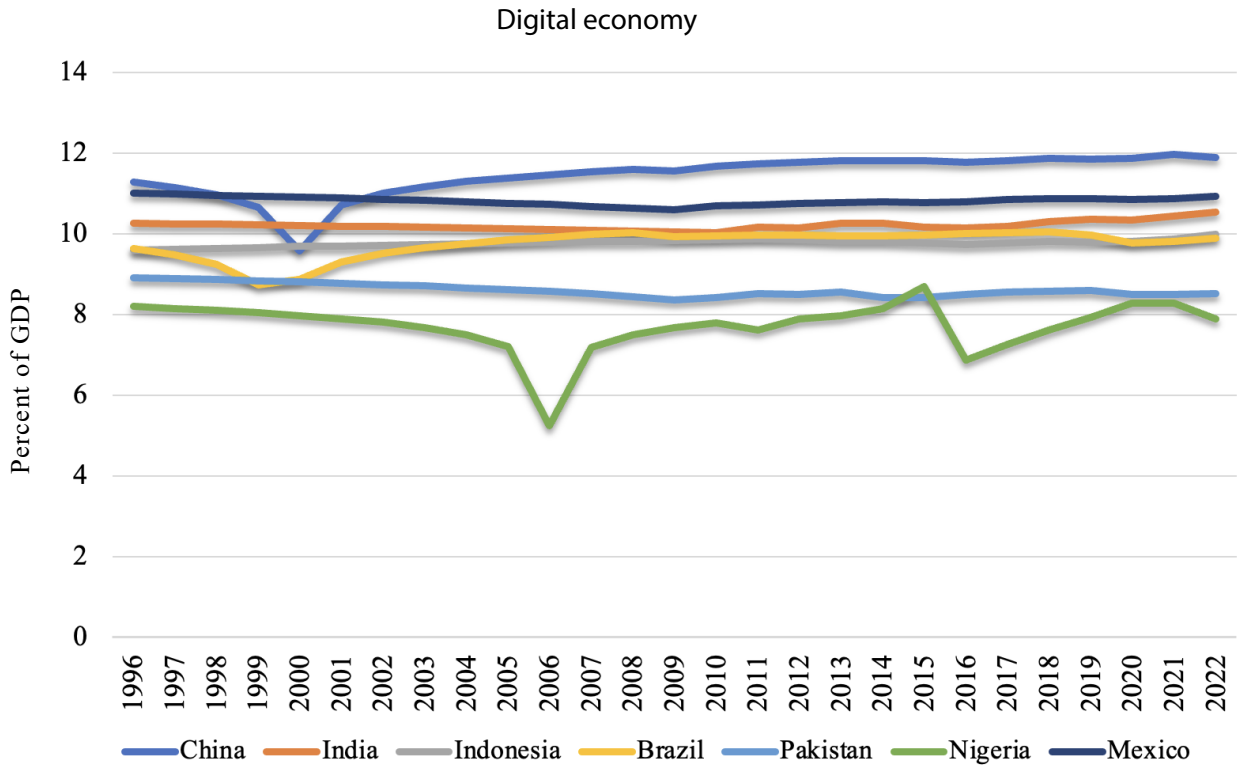


Source: Author's own elaboration

The present research is significant for policymakers, especially from the Global South. The study outcomes help formulate evidence-based strategies to promote equitable growth, technological innovation and good governance by identifying sustainable economic development drivers. These measures could help develop economies by overcoming socioeconomic issues, boosting competitiveness and ensuring long-term prosperity (He *et al.*, 2024). Besides, businesses can make intelligent investments, find development possibilities and navigate regulations by understanding the relationship between mineral resources, the digital economy and government

indicators of economic growth. Following this research, businesses may boost competitiveness and economic growth in their regions (Nyantakyi *et al*., 2023). Sustainable economic development in the Global South is crucial for national and global economic stability (Lin *et al*., 2024). Policies on equitable growth, technological innovation and effective governance make the global economy more balanced and resilient and benefit both developed and developing countries. Lastly, the research is significant to international development agencies, non-governmental organizations and other stakeholders in the Global South to create specific initiatives by improving poverty reduction, social inclusion and sustainable development initiatives. Outside academia, this will have real consequences for politicians, enterprises, international development and global economic stability.

Figure 2: High-tech exports of emerging Global South economies



Source: Author's own elaboration

Based on the background, the study has the following objectives: Firstly, it aims to explore the effect of mineral resources on economic growth by analysing how mineral resources affect economic growth in Global South regions. Secondly, the present research intends to explore the causes of digital adoption and its effects on inclusive development. Therefore, the connection between

digital technologies and economic growth is evaluated. Thirdly, to evaluate governance structures and practices and assess their efficacy in promoting openness, accountability and the rule of law, the study examines how corruption control, government efficiency and regulation affect economic progress and attain sustainable growth. Based on the above objectives**,** the study helps identify significant drivers and barriers to sustainable economic development in the Global South. It will help understand how digital infrastructure, connectivity and skills affect economic growth.

The present research is novel in the following ways. Firstly, the combined effect of mineral resources, the digital economy and governance factors are examined in the context of sustainable economic development in the Global South (Wang *et al*., 2023). This interaction is less common in the literature, which usually examines the factors individually (Song and Hou, 2024; Zhang *et al*., 2022; Van Thi Hong, 2020). Besides, this broader perspective is overlooked in the Global South. Unlike earlier works, the study analyses these characteristics together and their effects on economic growth. Secondly, the study contributes to the empirical literature by ensuring thorough and trustworthy analysis by using advanced econometric methods such as the method of moments quantile regression (MMQR) and robustness tests using parametric approaches such as cointegration regressions. Accounting for heterogeneity and dynamic impacts throughout time, these methods enable deeper variable connections in the study, which is crucial for reliable research. Hence, the study fills the literature gap by providing new empirical evidence, enriching this field and encouraging further empirical and academic research in this area. Thirdly, many studies have concentrated on developed economies or specific parts of the Global South, but the present study offers combined insights into China, India, Indonesia, Brazil, Pakistan, Nigeria and Mexico. By viewing these economies together, it hopes to better comprehend the sustainable development challenges and potential of the Global South. This research is important for Global South policymakers, enterprises and stakeholders. The analysis reveals the drivers and impediments to sustainable economic development, providing actionable insights for equitable growth, technological innovation and good governance practices. These findings can help create targeted initiatives to boost emerging economy resilience and prosperity via understanding the intricate interactions between mineral resources, the digital economy, governance and sustainable development (Zhu and Niu, 2024). The use of a comprehensive approach, modern techniques, policy significance and potential to expand academic understanding of sustainable economic growth in the Global South make it a notable contribution to the field of sustainable development.

The rest of the paper is organized as follows: Section 2 presents a literature review, Section 3 deals with data and methodology and Sections 4 and 5 document the results with discussions, conclusions and policy implications.

2. Literature Review

This section documents the literature on the dependent and independent variables used in this study.

2.1 Mineral resources, renewable energy and digital economy

Environmental pollution has been considered a consistent hurdle in achieving sustainable development, usually caused by exploiting natural resources. Hence, utilizing natural resources, especially mineral resources, to accomplish economic progression degrades the environmental quality (Zhang and Guxue, 2024). Cheng *et al*. (2023) observed a negative association between mineral resources and green growth. The study described that mineral resources significantly increase carbon emissions and their extraction negatively affects green prosperity. Despite contributing to environmental pollution, mineral resources are useful for economic growth. The study demonstrated that mineral resources are a resource curse for low-income countries but a blessing for high-income economies (Yan, 2024). In another study on a similar nexus, Song and Hou (2024) explored the negative interaction between mineral resources and economic growth in ASEAN economies. The study depicted that increasing the use of mineral resources tends to validate the resource curse hypothesis. A high level of corruption and other traditional challenges might cause it in the study countries. In another relatable study, Huang *et al*. (2020) empirically observed that mineral rents are beneficial in nurturing economic growth in developing Asian economies. The study described that natural resources are imperative for the growth and development of developing economies. Likewise, Shi *et al*. (2023) determined the positive relationship between mineral resources and economic growth using panel data in mineral-rich economies.

Shortening the emission-development gap is one of the imperative solutions to reach sustainable development goals. Therefore, the role of renewable energy has been a hot topic of debate among researchers for decades. For example, Saidi and Omri (2020) examined the positive influence of renewable energy on economic growth (GDP) and the negative association with carbon emissions in 15 renewable consumption economies. The research utilized the FMOLS and VECM approaches, and a bi-directional causal association between renewable energy and economic growth was found. Likewise, Shahbaz *et al*. (2020) examined the positive association between renewable energy and economic growth using DOLS and FMOLS in 38 renewable consumption economies. In the same vein, AlNemer *et al*. (2023) studied the positive contribution of renewable energy on economic growth in Saudi Arabia. In another research paper on a similar nexus, Wang *et al*. (2022) investigated the positive interaction between renewable energy and

economic development. The study highlighted that renewable energy contributes to economic development; however, if it is reliant on certain risks prevalent in the economy, the influence might become different. In general, nevertheless, the association is positive. On the contrary, Dogan *et al*. (2020) investigated the diverse interaction between renewable energy and economic growth in OECD economies. The study employed quantile regression and found that renewable energy negatively affects growth in central and higher quantiles, while it positively interacts with growth in low and low-central quantiles.

Foreign direct investment is required to foster technologically innovative activities and has been considered a prominent driver of economic development in a country. However, the overall influence of FDI on GDP varies depending on different factors (Utouh *et al*., 2024). Huang *et al*. (2020) discovered that FDI significantly contributes to economic development because it helps increase industrialization and technological innovation, ultimately increasing economic growth. Karahan and Çolak (2024) found a heterogeneous relationship between FDI and economic growth. The study demonstrated that the positive effect of FDI on GDP validates the FDI-induced growth hypothesis in RCEP economies.

Similarly, an asymmetric nexus between FDI and GDP is detected in the case of different-income developing countries. In another study on the investment-growth nexus, Ciobanu (2021) applied the ARDL approach to the nexus between FDI and economic growth. Besides, the causality test revealed that FDI is a crucial determinant and has a significant causal association. Labidi *et al*. (2024) empirically explored the positive interaction between FDI and economic growth, demonstrating that governance quality is crucial for fostering economic growth and development. Similarly, Cheng (2024) determined that FDI is essential to economic development, using the VAR model for the Ethiopian economy. Likewise, Minh and Trinh (2023) found a positive relationship between FDI and growth in 60 developing economies.

The digital economy has become a crucial catalyst for economic development. Zhang *et al*. (2021) examined the association between the digital economy and economic growth in China. Their research highlighted that digital infrastructure and industry are essential and notably influence regional factor productivity. In general, the relationship was described as optimistic. On a similar nexus, Gomes *et al*. (2022) assessed the association in the case of 36 OECD economies. Based on their level of economic development and advancement of technology, the impact of the digital economy is positive in endorsing economic development. Besides, strong policies regarding ICT infrastructure and social equity and their implementation are recommended for sustainable growth. Likewise, Zhang *et al*. (2022) empirically examined the nexus in BRI economies. Their empirical analysis revealed that the digital economy enhances growth and development initiatives by promoting industrial structures and digital industries.

2.2 Corruption control, government effectiveness and regulatory quality

Corruption control is imperative in promoting countries' economic progression. A study of developing economies from 2002 to 2017 (Van Thi Hong, 2020) revealed that corruption control is a valuable indicator of escalating economic growth, since inefficient stock markets and trade slow down the growth of the economy. Hence, the study stressed enhancing corruption control measures to increase the economy's overall efficiency. In their renowned study on the corruption control and economic growth nexus, Leite *et al*. (2019) discovered a positive influence of corruption control on economic growth, demonstrating that controlling corruption increases economic development in the country. The study described that corruption interacts with other government components, negatively affecting growth (d'Agostino *et al*., 2016). Likewise, Cieślik and Goczek (2018) explained that in theory, it is deliberately defined that corruption hinders the growth process and demonstrated in an empirical estimation that corruption control has positively increased the economic growth of 142 study economies while also endorsing investment. Hence, international financing was recommended. Similarly, Zhuo *et al*. (2021) examined the direct influence of corruption control on economic growth in developed countries.

Government effectiveness is necessary in making prompt political decisions that directly or indirectly influence the country's growth. Şaşmaz and Sağdıç (2020) assessed the influence of government effectiveness on the GDP of European Union countries, highlighting efficient resource allocation, political stability and a regulatory environment that stimulates growth in the country. Cooray and Nam (2025) also examined the association between the same nexus in 132 developed and developing economies. The empirical results provided a direct positive and intermediating effect of government effectiveness in encouraging economic growth. Likewise, in another study on a similar nexus, the indirect role of government effectiveness was detected in the economic development of developed economies, depicting its importance in improving the economy (Zhuo *et al*., 2021).

Lastly, the influence of regulatory quality is crucial in shaping the economy's growth. It is an imperative component of good governance (Bagheri Pormehr and Zahedi Azad, 2020). In the literature, few studies on related areas have investigated the relationship, and Lee *et al*. (2021) empirically observed the role and importance of regulatory quality as a mediator in growth finance relationships. However, the effect is multifaceted, highlighting the symmetric and asymmetric associations among the study factors. Similarly, Bagheri Pormehr and Zahedi Azad (2020) examined the influence of regulatory quality on foreign direct investment and economic growth. Their four-country study described a positive interaction between regulatory quality and economic development. Similarly, Abd Rahman *et al*. (2021) and Li and Gospodarik (2022)

observed the positive role of regulatory quality in enhancing growth in upper-middle-income and Asia-Pacific economies, respectively.

2.3 Summary and research gap

After carefully assessing the available literature based on the study variables, the literature has previously explored the individual effects of mineral resources, digital economy, FDI and government indicators on economic growth. According to the current body of knowledge, the existing literature shows common trends such as the impact of mineral resources usually negatively affecting environmental quality but at the same time, enhancing economic growth (Zhang and Guxue, 2024; Cheng *et al*., 2023; Shi *et al*., 2023). Secondly, the existing literature on the role of renewable energy finds mostly positive effects on economic growth and significant emission decreases (Shahbaz *et al*., 2020; AlNemer *et al*., 2023; Wang *et al*., 2022). Thirdly, the interaction between the digital economy and economic growth is positive in endorsing economic development with effective ICT policies (Zhang *et al*., 2021; Gomes *et al*., 2022; Zhang *et al*., 2022). Fourthly, FDI fosters growth and boosts technological innovation. However, the influence is affected by other external factors (Ciobanu, 2021; Labidi *et al*., 2024; Cheng, 2024; Minh and Trinh, 2023). Lastly, the interaction between corruption control, government effectiveness and regulatory quality is positive and helps in fostering economic growth. Controlling corruption and regulatory policies are important for both developed and developing economies (Van Thi Hong, 2020; Cooray and Nam, 2025; Cieślik and Goczek, 2018; Zhuo *et al*., 2021; Abd Rahman *et al*., 2021; Li and Gospodarik, 2022).

However, due to the lack of combined comprehensive analysis, the present study proposes three models in which three different indicators for governance are employed along with other study factors, which is a new input in empirical and academic literature. The present study fills the gap by assessing the link between mineral extraction, digital technologies and economic growth focusing on how this interaction affects the country's economic growth, innovation and productivity. Besides, the influence of the digital economy signifies that the effects of high-tech exports on economic growth combined with governmental indicators in the Global South still need to be added. The present research plays an integral part in fulfilling the need for an empirical study that underscores these nexuses and highlights the complex interactions.

3. Data and Methods

Following the study objectives, we consider sustainable economic development as the primary dependent variable proxied via GDP. However, mineral resources (*MNRNTS*), digital econo-

my (*DE*), institutional factors, green energy (*EPRS*) and foreign direct investment (*FDI*) are the explanatory variables. To identify the specific influence of each institutional factor, we consider control of corruption (*COC*), governance efficiency (*GEF*) and regulatory quality (*RQ*) in separate models, given as:

$$GDP_{ti} = \varphi_1 + \alpha_1 MNRNTS_{ti} + \alpha_2 DE_{ti} + \alpha_3 COC_{ti} + \alpha_4 EPRS_{ti} + \alpha_5 FDI_{ti} + \varepsilon_t \quad (1)$$

$$GDP_{ti} = \varphi_1 + \alpha_1 MNRNTS_{ti} + \alpha_2 DE_{ti} + \alpha_3 GEF_{ti} + \alpha_4 EPRS_{ti} + \alpha_5 FDI_{ti} + \varepsilon_t \quad (2)$$

$$GDP_{ti} = \varphi_1 + \alpha_1 MNRNTS_{ti} + \alpha_2 DE_{ti} + \alpha_3 RQ_{ti} + \alpha_4 EPRS_{ti} + \alpha_5 FDI_{ti} + \varepsilon_t \quad (3)$$

In the models above, it must be noted that the φ's and α's are the intercepts and slopes, respectively. In addition, ε refers to the random error term, while the period (t) covers the period from 1996 to 2022 for the cross-sections (i) of emerging economies of the Global South, including China, India, Indonesia, Brazil, Pakistan, Nigeria and Mexico. Detailed specifications, units and sources of data are presented in Table 1.

Variables such as *MNRNTS*, *DE*, governance factors (*COC*, *GEF* and *RQ*), *EPRS* and *FDI* are justified for the analysis of the economic growth in the Global South because of their macro-importance and mutual effect. Maximization of *MNRNTS* can generate good revenues for the government, yet often it causes the "resource curse", meaning that good resource management is crucial. *DE* provides a platform that can help developing countries get to a higher level of productivity and join the world market; thus, there is a possibility that such countries can bypass certain levels of development. Concerning the governance factors, these elements are inherent and affect policies, resources and investment promotion. Therefore, it is crucial to consider these elements in the research models to capture unbiased connections between variables. Even though environmental policy stringency may seem to place certain limitations on a company's growth in the short term, it can assist in the generation of new ideas and sustainable development, specifically regarding climate change. Lastly, *FDI* is a vital instrument for capital and technology flow; however, its effectiveness is contingent upon the host country's capability to absorb and utilize *FDI* along with its institutional framework. Taking all these factors into consideration, the researchers may obtain a better tool for comprehending the character of the dynamics of the development of economic growth in the Global South and can implement more precise and efficient developmental strategies.

Table 1: Variable specification and units

Variables	Specifications	Units
GDP	Gross domestic product	(constant 2015 USD)
MNRNTS	Mineral rents	(% of GDP)
DE	High-technology exports	(current USD)
EPRS	Electricity production from renewable sources, excluding hydroelectric	(kWh)
FDI	Foreign direct investment, net inflows	(BoP, current USD)
COC	Control of corruption	Estimate
GEF	Government effectiveness	Estimate
RQ	Regulatory quality	Estimate

Source: WB (2024)

3.1 Analytical approach

Considering the raw panel data, it is necessary to compare the statistically processed information. Here, the mean, median and range figures will be used as the measures of interest. In addition, the descriptive statistic operation designed the standard deviation for each of the variables. This measure captures the turbulence of the variable, which means that it is a measure of volatility. In this work, we use three indicators of normality: kurtosis, skewness and the Jarque and Bera (1987) test of normality. The test is typically presented in the following generic form:

$$JB = \frac{N}{6}\left(S^2 + \frac{\left(K-3\right)^2}{4} \right) \tag{4}$$

In an attempt to test the stationarity of variables, we employ two diagnostic measures to distinguish the properties of panel data. Nonetheless, one of these methods (Pesaran, 2021) is based on cross-sectional dependence (CD) and the other method (Pesaran and Yamagata, 2008) relies on slope coefficient heterogeneity (SCH). Nevertheless, it is important to pay attention to the results of these diagnostic measures, as overlooking these approaches may offer misleading results (Wei *et al*., 2022). Following the essentiality, the CD test can be expressed statistically as follows:

$$CD_{Test} = \frac{\sqrt{2T}}{\left[N\left(N-1\right)\right]^{1/2}} \sum_{i=1}^{N-1}\sum_{k=1+i}^{N} T_{ik} \tag{5}$$

This test reveals a cross-sectional dependence of variables as the null hypothesis. Along with the panel CD test, the SCH test (concerning both SCH and adjusted SCH statistics) can be written as:

$$\hat{\Delta}_{SCH} = \sqrt{N\left(2k\right)^{-1}}\left(N^{-1}\acute{S} - K\right) \tag{6}$$

$$\hat{\Delta}_{ASCH} = \sqrt{N}\sqrt{\frac{T+1}{2K\cdot\left(T-K-1\right)}}\left(N^{-1}\acute{S} - 2K\right) \tag{7}$$

This test takes slope homogeneity as the null hypothesis.

The diagnostic results that coexist with the CD and SCH features in the panel allow the use of the second-generation stationarity test. Thus, in this study, the Pesaran (2007) CIPS stationarity test is utilized, which was developed later as an extension of the Pesaran (2006) unit root test as it is required for long-run forecasts. This test is based on a null hypothesis (H_0) that assumes that a series contains a unit root. Nonetheless, if the results are less than 0.01, 0.05 or 0.1, the null assumption will be rejected. The second difference is already checked if the variable is not trended. This test addressed the CD and SCH issues of the simulating panel. After the stationarity analysis, we use three measures to detect the long-run cointegration between variables. In this sense, we use the Kao (1999), Pedroni (1999) and Westerlund (2006) cointegration tests. All of these tests assume the absence of cointegration between variables.

Following the cointegration test, the long-run elasticities will be evaluated. For diagnostic measures to be considered, an efficient and adequate approach should be used to analyse the coefficients. Owing to the non-normality of the data in question, we use the method of moments quantile regression (MMQR) approach of Sarkodie and Strezov (2018). The approach is not confined to simple regressions but also to specific scales and locations, considering endogeneity and non-normality problems. This approach estimates various quantiles (1 to 99) instead of estimating mean impact. Under certain assumptions, the equation depicts location-scale variance $Q_y(\tau|R)$, which is reported below:

$$Y_{it} = \alpha_i + \beta R_{it} + \left(\gamma_i + \rho\acute{Z}_{it}\right)\mu_{it} \tag{8}$$

where $p(\gamma_i + \rho\acute{Z}_{it} > 0) = 1$ is the probability function and α, β, γ and ρ are the predicted coefficients. Additionally, the fixed effect is portrayed by i and captured by α_i and γ_i for a finite set ($i = 1, 2, \ldots, n$). However, the distinctive characteristic R (k-vector) is shown by Z, whereas its changeableness is reported by ι, presented as:

$$Z_1 = Z_1\left(R\right), \quad = 1, 2, \ldots, k \tag{9}$$

In the prior model, R_{it} is IID (*i.e.*, independently and identically distributed) throughout i and t, yet sustaining quantiles and outside reserves (Machado and Santos Silva, 2019).

Following this reasoning, the primary models (*i.e.*, Equation 1, 2 and 3) may generally be presented in the following form:

$$Q_y\left(\tau|R_{it}\right)=\left(\alpha_i+\gamma_i q\left(\tau\right)\right)+\beta R_{it}+\rho\dot{Z}_{it}\,q\left(\tau\right) \tag{10}$$

In this work, we have chosen *MNRNTS*, *DE*, *EPRS* and *FDI* as control variables while considering the institutional instruments such as *COC*, *GEF* and *RQ* in separate models as primary regressors – captured by R_{it}. All these variables are converted into natural logarithmic form. Also, R_{it} expresses the quantile distribution covering the coefficients of regression – signified via Y_{it} – and acts as a dependent variable (*GDP*). Additionally, the expression "$-\alpha_i(\tau) \equiv \alpha_i + y_i q(\tau)$" labels the vector section that consistently influences *i*, with no influence on the intercept. Finally, $q(\tau)$ delivers the τ-th sample of quantiles revealing $Q_{0.25}$, $Q_{0.50}$, $Q_{0.75}$ and $Q_{0.90}$, where the expression is given as:

$$min_q \sum_i \sum_t \theta_\tau \left(R_{it} - \left(\gamma_i + \rho \dot{Z}_{it} \right) q \right) \tag{11}$$

where $\theta_\tau(A) = (\tau - 1)\, AI\{A \leq 0\} + TAI\{A > 0\}$ indicates the expression of assessment.

Once the results are obtained using appropriate measures, we move towards robustness testing of models using parametric approaches. In this respect, we use fully modified ordinary least squares (FMOLS) and dynamic ordinary least squares (DOLS). In addition to these estimators, we also use the pairwise Granger causality test of Dumitrescu and Hurlin (2012) to detect causality between regressors and dependent variables.

4. Results and Discussion

This section includes descriptive statistics, slope homogeneity tests, cross-sectional dependence studies, stationarity tests, cointegration results, quantile regressions, robustness checks and causality assessments. This comprehensive analysis seeks to understand economic processes and propose sustainable development strategies for the Global South.

4.1 Empirical results

4.1.1 Descriptive statistics

The research commenced with a descriptive analysis of the variables. The mean and median values show balance in the data. Among all the study factors, GDP has the highest statistical mean value at 11.98, followed by digital economy and foreign direct investment at 9.76 and 10.08, respectively. The range of available data is represented with minimum and maximum values. The standard deviation column reflects the value of dispersion in the dataset. The skewness

and kurtosis statistics describe the shape of distribution (whether the distribution is symmetrical or asymmetrical) by measuring the degree of peakedness of the distribution. Except for economic growth and mineral rents, the remaining variables are negatively skewed. For kurtosis, all the variables show asymmetrical distribution. The Jarque–Bera and probability distribution confirms the non-normality of the dataset, depicting the study factors exhibiting non-normal distribution. The statistical values of the descriptive analysis are presented in Table 2 below.

Table 2: Descriptive and normality statistics

	GDP	*MNRNTS*	*DE*	*EPRS*	*FDI*	*COC*	*GEF*	*RQ*
Mean	11.98	0.54	9.76	7.79	10.09	−0.61	−0.28	−0.314
Median	12.00	0.30	9.92	9.90	10.28	−0.52	−0.20	−0.31
Maximum	13.21	4.49	11.97	11.82	11.54	0.17	0.81	0.44
Minimum	11.16	0.00	5.25	0.00	8.16	−1.50	−1.21	−1.29
Std. dev.	0.48	0.65	1.23	4.35	0.76	0.39	0.45	0.40
Skewness	0.51	2.15	−0.46	−1.20	−0.32	−0.13	−0.28	−0.12
Kurtosis	3.07	9.99	3.03	2.54	2.41	2.02	2.36	2.24
Jarque–Bera	8.23	530.02	6.58	46.70	6.05	8.11	5.57	5.00
Probability	0.02	0.00	0.04	0.00	0.05	0.02	0.06	0.08
Observations	189	189	189	189	189	189	189	189

Source: Author's own calculations

4.1.2 Slope heterogeneity and cross-sectional dependence

Table 3 shows the values of slope heterogeneity for all the study models 1, 2 and 3. It signifies the differences in relationships among variables across regions or groups. It helps in highlighting the variable correlation. The statistical values for all the models show significant values at a 1% significance level. The estimated and adjusted coefficient results depict that each model has rejected the null hypothesis of no slope heterogeneity with their respective significance levels. This means that associations between dependent and explanatory factors vary across the models. In general, the test shows homogeneity across the study models and leads us to assess the long-run associations among the variables.

Table 3: Slope homogeneity

Test	Model 1	Model 2	Model 3
SCH	11.901***	12.719***	12.316***
SCH$^{adj.}$	13.828***	14.778***	14.310***

Note: *** indicate significance at the 1% level.

Source: Author's own calculations

The results of cross-sectional dependence are presented in Table 4 below. It is applied to observe the cross-sectional dependence of variables to ensure the validity and reliability of panel data over time. The CD test results below show that most of the variables reject the null hypothesis of no correlation. The statistical values of the variables *GDP*, *MNRNTS*, *GEF*, *EPRS* and *FDI* shows significant coefficients at a 1% significance level, rejecting the null hypothesis of no interdependence. The values are 23.135, 12.918, −2.730, 14.631 and 14.509, respectively. The general results show that some variables reject the null hypothesis of no interdependence while some reject the hypothesis of interdependence. The degree of dependence varies for the variables, showing that each variable affects economic development differently.

Table 4: Cross-sectional dependence

Variable	CD test	Prob.
GDP	23.135***	0.000
MNRNTS	12.918***	0.000
DE	0.895	0.371
COC	–1.080	0.280
GEF	–2.730***	0.006
RQ	0.263	0.793
EPRS	14.631***	0.000
FDI	14.509***	0.000

Note: *** indicate significance at the 1% level.

Source: Author's own calculations

4.1.3 Stationarity testing and cointegration analysis

To avoid spurious regression results, stationarity tests are applied in econometric analysis. Table 5 shows the outcomes from unit root testing. At level I(0), only a few variables such as mineral rents and government effectiveness are stationary, while the rest shows no sign of stationarity. At first difference I(1), all the study variables become stationary, depicting constant mean and variance values with time at a 1% significance level. Additionally, the negative coefficients denote that the variables have a unit root. The validation of stationarity after the first difference signifies and supports that the model can be tested further for analysis.

Table 5: Stationarity testing

Variable	I(0)	I(1)
GDP	–1.793	–3.428***
MNRNTS	–3.040**	–5.462***
DE	–1.472	–3.736***
COC	–2.078	–4.297***
GEF	–2.791*	–5.309***
RQ	–2.451	–5.366***
EPRS	–0.726	–3.612***
FDI	–3.509***	–5.336***

Note: *, **, *** indicate significance at the 10%, 5% and 1% level, respectively.
Source: Author's own calculations

The study applies comprehensive cointegration tests known as the Kao residual and Pedroni residual tests for each model (1, 2 and 3), presented in Table 6. The asterisks depict a strong presence of cointegration among the variables. The asterisks on the coefficients reject the null hypothesis of no cointegration. The detailed analysis indicates that each study variable is statistically and significantly correlated with economic growth in Global South region economies. Further, the Westerlund test validates the presence of a significant correlation among the variables. This portrays that renewable energy, digital economy, FDI and governance indicators are statistically correlated with economic growth in the long run.

Table 6: Cointegration results

Kao residual test			
Specs	**Model 1**	**Model 2**	**Model 3**
Modified D-F test	−5.626***	−4.791***	−5.188***
D-F test	−2.926***	−2.457***	−2.693***
Augmented D-F test	−1.625*	−1.510*	−1.259
Unadjusted modified D-F test	−4.465***	−3.705***	−4.292***
Unadjusted D-F test	−2.679***	−2.188**	−2.485***
Pedroni residual test			
Modified PP test	2.5711***	2.200**	2.652***
PP test	0.6111	−0.468	0.655
Augmented D-F test	0.1484	−0.852	0.425
Westerlund test			
Variance ratio	3.9794***	3.654***	4.151***

Note: *, **, *** indicate significance at the 10%, 5% and 1% level, respectively.
Source: Author's own calculations

4.1.4 Regression analysis

The MMQR approach is employed for regression analysis. The results of Model 1 are presented in Table 7 below. Firstly, mineral rents show an insignificant association. Initially, the effect is positive, but then it becomes negative, indicating an inverse association of mineral rents with economic growth. Secondly, the digital economy is positively and significantly associated with economic growth, depicting the contributing effect of the digital economy on economic growth. Thirdly, corruption control plays a positive role in increasing economic development. Fourthly, the influence of renewable energy on economic growth is initially positive, but it becomes negative in the second, third and fourth quantiles. Fifthly, the impact of FDI on GDP is positive in all the quantiles, describing an encouraging effect of FDI on economic development. Figure 3 presents a graphical presentation of the variables whose values are documented in Table 7 below.

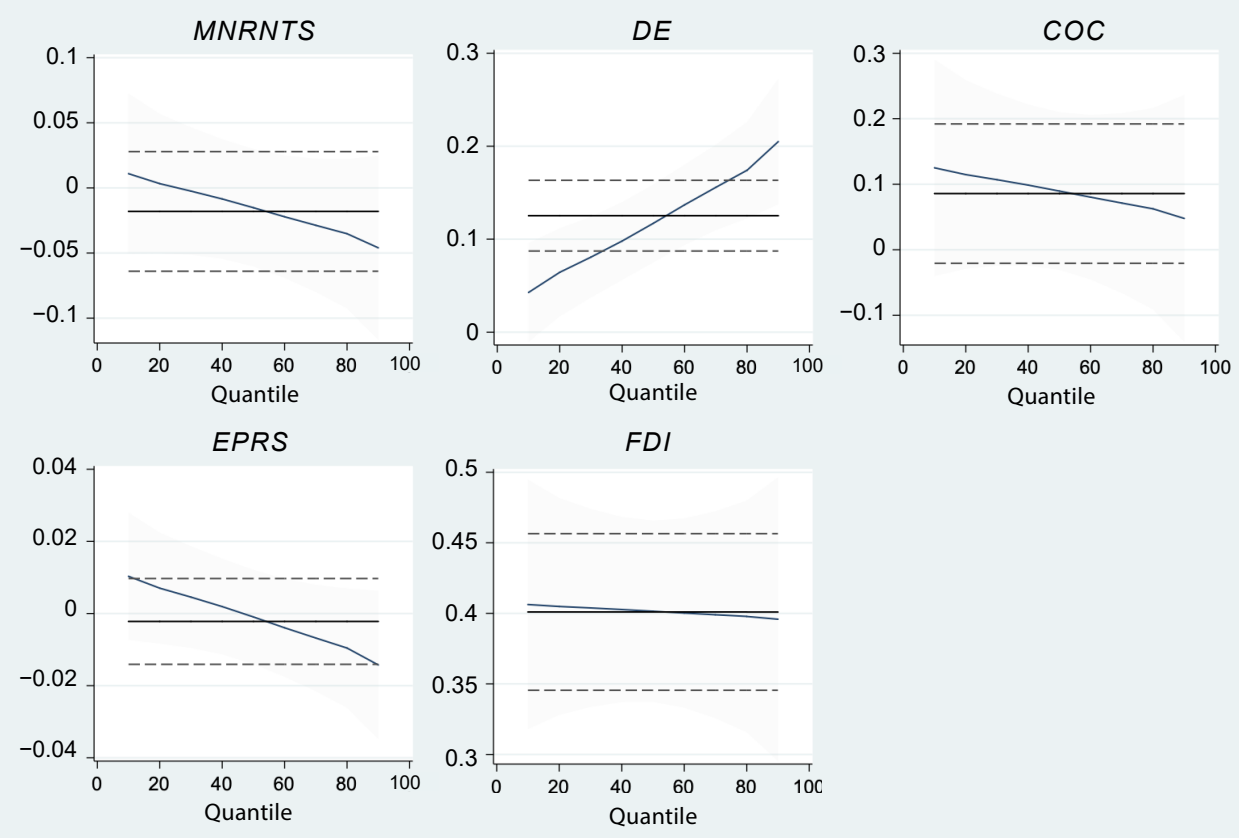
Table 7: Quantile results – MMQR [Model 1]

Variable	Location	Scale	Quantiles			
			$Q_{0.25}$	$_{Q0.5}0$	$Q_{0.75}$	$Q_{0.90}$
MNRNTS	−0.018 [0.123]	−0.019 [0.017]	0.001 [0.026]	−0.015 [0.023]	−0.032 [0.028]	−0.046 [0.036]
DE	0.125*** [0.021]	0.055*** [0.015]	0.073*** [0.023]	0.117*** [0.021]	0.166*** [0.024]	0.205*** [0.034]
COC	0.086 [0.062]	−0.026 [0.045]	0.111 [0.070]	0.090 [0.061]	0.066 [0.074]	0.048 [0.096]
EPRS	−0.002 [0.007]	−0.008* [0.005]	0.006 [0.007]	−0.001 [0.007]	−0.008 [0.008]	−0.014 [0.010]
FDI	0.401*** [0.033]	−0.004 [0.024]	0.404*** [0.0037]	0.402*** [0.033]	0.398*** [0.040]	0.396*** [0.051]
Constant	6.789*** [0.349]	−0.308 [0.252]	7.080*** [0.390]	6.835*** [0.345]	6.561*** [0.415]	6.344*** [0.543]

Note: *, *** indicate significance at the 10% and 1% level, respectively.

Source: Author's own calculations

Figure 3: Quantile estimates of Model 1



Source: Author's own elaboration

The results of Model 2 are presented in Table 8 below. Firstly, mineral rents again show insignificant association. The effect in all the quantiles is negative, indicating an inverse association between mineral rents and economic growth. Secondly, the role of the digital economy is positively associated with economic growth, depicting the contributing effect of the digital economy on economic growth in most quantiles. Thirdly, the role of government effectiveness is negative in economic development, indicating that increasing government effectiveness decreases the growth rate. The interconnection can be directly or indirectly affected by the role of poverty in the economy. Fourthly, the influence of renewable energy on economic growth is initially positive, but it becomes negative in the third and fourth quantiles. Fifthly, the impact of FDI on GDP is positive in all the quantiles, describing an encouraging effect of FDI on economic development under government effectiveness. Figure 4 presents a graphical presentation of quantiles for all the variables incorporated in Model 2.

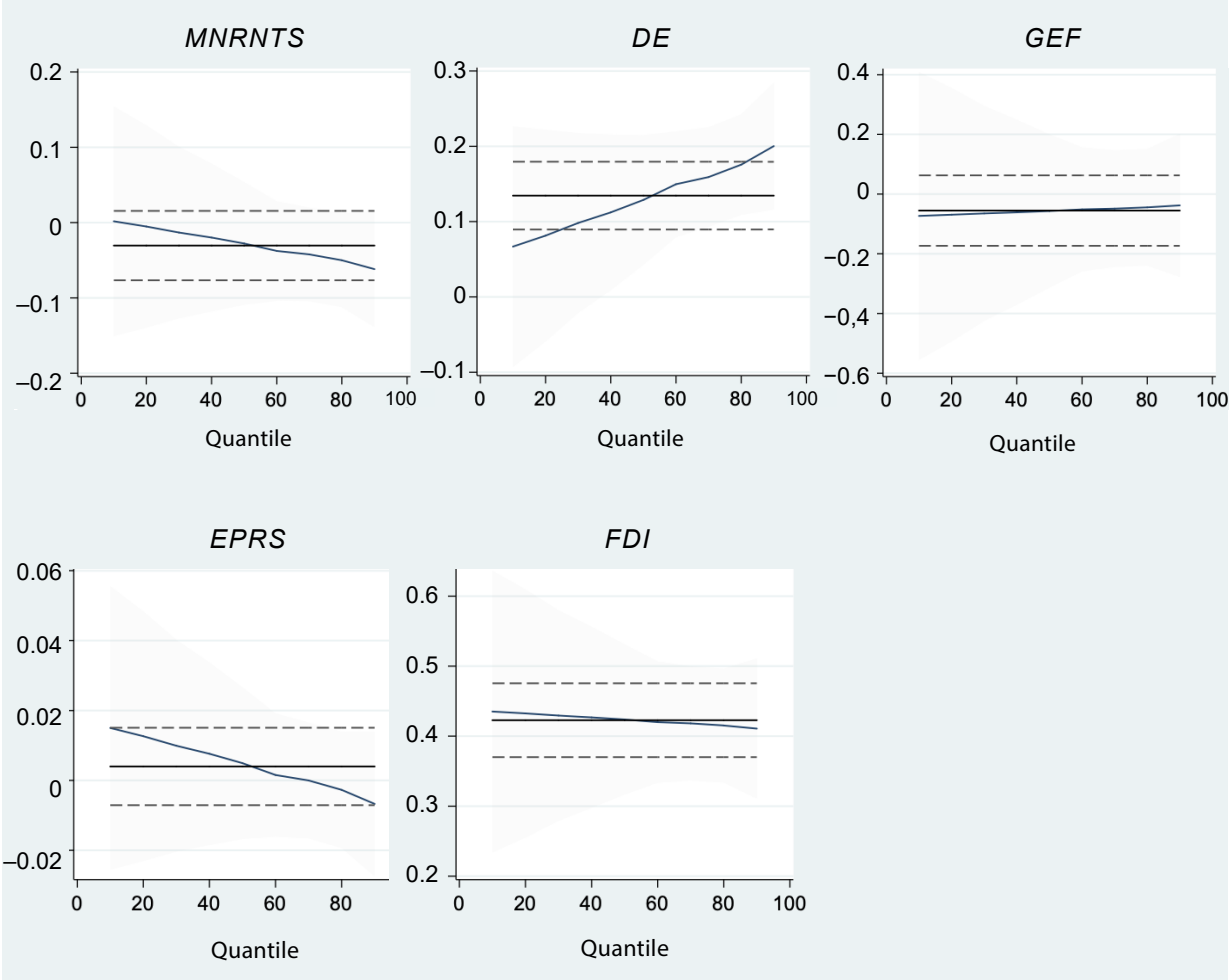
Table 8: Quantile results – MMQR [Model 2]

Variable	Location	Scale	Quantiles			
			Q0.25	Q0.50	Q0.75	Q0.90
MNRNTS	−0.030 [0.039]	−0.022*** [0.034]	−0.009 [0.064]	−0.028 [0.042]	−0.045 [0.031]	−0.062 [0.039]
DE	0.135*** [0.043]	0.047*** [0.036]	0.089 [0.067]	0.129*** [0.044]	0.164*** [0.033]	0.200*** [0.043]
GEF	−0.055 [0.123]	0.012*** [0.105]	−0.067 [0.201]	−0.057 [0.0131]	−0.047 [0.098]	−0.038 [0.122]
EPRS	0.004 [0.011]	−0.008*** [0.009]	0.011 [0.017]	0.005 [0.011]	−0.001 [0.008]	−0.007 [0.011]
FDI	0.423*** [0.051]	−0.009*** [0.044]	0.431*** [0.084]	0.424*** [0.055]	0.417*** [0.041]	0.411*** [0.051]
Constant	6.369*** [0.647]	−0.159*** [0.552]	6.524*** [1.057]	6.389*** [0.688]	6.268*** [0.516]	6.145*** [0.645]

Note: *** indicate significance at the 1% level.

Source: Author's own calculations

Figure 4: Quantile estimates of Model 2



Source: Author's own elaboration

Table 9 presents the results of Model 3 below. Firstly, the effect of mineral rents shows a negative association with economic growth, indicating that increasing utilization of mineral rents decreases economic growth. Secondly, the digital economy is positively and significantly associated with economic growth, again depicting the effects of the digital economy on economic growth. Thirdly, the role of regulatory quality is mixed with economic development in Global South region economies. Fourthly, the influence of renewable energy on economic growth is positive overall, which shows that renewable energy is resourceful in enhancing economic growth. Fifthly, the influence of FDI on GDP is positive in all the quantiles, describing an encouraging effect of FDI on economic development. Figure 5 presents a graphical presentation of the variables of Model 3, whose statistical values are documented in Table 9 below.

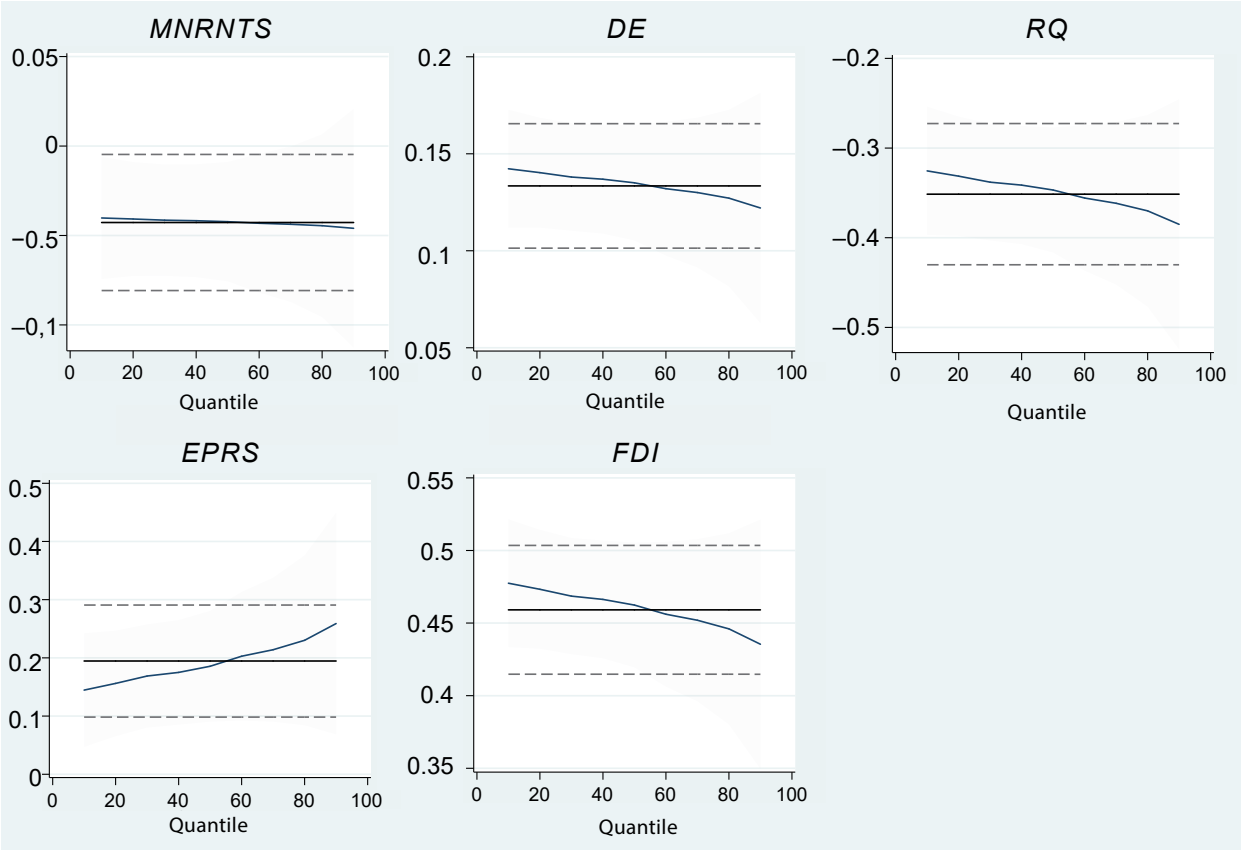
Table 9: Quantile results – MMQR [Model 3]

Variable	Location	Scale	Quantiles			
			$Q_{0.25}$	$Q_{0.50}$	$Q_{0.75}$	$Q_{0.90}$
MNRNTS	−0.043** [0.018]	−0.002*** [0.012]	−0.041** [0.016]	−0.042** [0.017]	−0.044* [0.024]	−0.046 [0.024]
DE	0.133*** [0.016]	−0.006*** [0.011]	0.139*** [0.014]	0.135*** [0.015]	0.129*** [0.021]	0.122*** [0.021]
RQ	−0.351*** [0.038]	−0.019*** [0.025]	−0.335*** [0.033]	−0.347*** [0.036]	−0.366*** [0.050]	−0.385*** [0.050]
EPRS	0.019*** [0.005]	0.004*** [0.003]	0.016*** [0.005]	0.019*** [0.005]	0.022*** [0.007]	0.026*** [0.007]
FDI	0.459*** [0.023	−0.013*** [0.015]	0.471*** [0.020]	0.462*** [0.022]	0.449*** [0.031]	0.435*** [0.031]
Constant	5.804*** [0.203]	0.281*** [0.312]	5.563*** [0.177]	5.735*** [0.191]	6.016*** [0.268]	6.300*** [0.268]

Note: *, **, *** indicate significance at the 10%, 5% and 1% level, respectively.

Source: Author's own calculations

Figure 5: Quantile estimates of Model 3



Source: Author's own elaboration

4.1.5 Robustness check and causality analysis

Before moving towards causality analysis, a robustness check is employed to check the reliability of the models. The research uses parametric approaches such as the panel FMOLS and panel DOLS tests, the results of which are presented in Table 10. The role of mineral rents is negative in each of the models. The impact of the digital economy is positive, with economic growth in all three models (1, 2 and 3) in both parametric approaches. Next, the influence of renewable energy and FDI is positive, with GDP denoting that both variables are resourceful in encouraging growth under corruption control, regulatory quality and government effectiveness. Lastly, corruption control and government effectiveness positively interacts with economic growth, whereas the role of regulatory quality is negatively associated with economic growth. Overall, the robustness analysis is reliable based on the findings above. After the successful analysis, the study moves forward with causality analysis.

Table 10: Robustness via parametric approaches

Panel FMOLS			
Variables	**Model 1**	**Model 2**	**Model 3**
MNRNTS	−0.027	−0.016*	−0.042*
DE	0.302***	0.247***	0.302***
COC	0.066	–	–
GEF	–	0.159***	–
RQ	–	–	−0.026**
EPRS	0.026***	0.028***	0.027***
FDI	0.282***	0.254***	0.289***
Panel DOLS			
MNRNTS	−0.043*	−0.026*	−0.034
DE	0.281***	0.263***	0.328***
COC	0.100*	–	–
GEF	–	0.224***	–
RQ	–	–	−0.090**
EPRS	0.024***	0.032***	0.024***
FDI	0.243***	0.179***	0.278***

Note: *, **, *** indicate significance at the 10%, 5% and 1% level, respectively.
Source: Author's own calculations

Table 11 shows causality assessment outcomes from the pairwise Dumitrescu causality test. It shows causal association among the following pairs of variables: *GDP* → *MNRNTS*, *GDP* → *DE*, *GDP* → *FDI*, *COC* → *GDP*, *GDP* → *COC*, *GDP* → *GEF* and *GDP* → *RQ*. All these pairs show the effect caused by another variable. The arrows signify the causal relationship and the asterisks show the level of significance for each variable.

Table 11: Causality assessment: pairwise Dumitrescu–Hurlin panel causality tests

H_0:	*W*-stat.	*Z*bar-stat.	Prob.
MNRNTS → GDP	2.330	0.115	0.908
GDP → MNRNTS	4.338**	2.253	0.024
HTE → GDP	2.768	0.581	0.560
GDP → HTE	4.762***	2.705	0.006
FDI → GDP	2.269	0.050	0.959
GDP → FDI	7.001***	5.089	0.000
COC → GDP	4.511**	2.437	0.014
GDP → COC	7.062***	5.154	0.000
GEF → GDP	1.718	−0.536	0.591
GDP → GEF	5.588***	3.584	0.000
RQ → GDP	3.258	1.103	0.269
GDP → RQ	4.174**	2.078	0.037

Note: **, *** indicate significance at the 5% and 1% level, respectively.
Source: Author's own calculations

4.2 Discussion of findings

We utilized the method of moments quantile regression and parametric robustness analysis to determine the impact of governance indicators, mineral rents and digital economy on economic growth in Global South region economies. The study outcomes are consistent with a few studies in the literature, which are documented subsequently. Firstly, the role of mineral rents on economic growth despite any governance indicator is negative. The impact result in one way or another is reliable with the outcomes of Song and Hou (2024) and Chen *et al*. (2023). This implies that

increasing utilization of mineral resources tends to validate the resource curse hypothesis. Also, high corruption and other traditional challenges might further aggravate the situation. Secondly, the digital economy and economic growth are positive in all the models under each governance indicator. The outcome is reliable based on the results of Zhang *et al*. (2021) and Gomes *et al*. (2022). This implies that the digital economy is a crucial catalyst for economic development, indicating that digital infrastructure and industry are essential for economic progression. In addition, strong policies regarding ICT infrastructure implementation are required for sustainable development. Thirdly, the influence of renewable energy on economic development has shown mixed responses under different governance indicators, which is somehow reliable according to the studies of Wang *et al*. (2022) and Dogan *et al*. (2020). This implies that renewable energy is a beneficial contributor to economic development; however, depending on specific circumstances, the influence might become different. The diverse interaction between renewable energy and economic growth might occur due to price volatility, energy poverty risks and excessive usage of nonrenewable development in the study countries. Fourthly, the nexus between FDI and economic growth is positive overall, showing that FDI helps foster growth and development. These arguments were also claimed in the studies of Utouh *et al*. (2024) and Huang *et al*. (2020). This implies that FDI fosters technologically innovative activities because it helps increase growth initiatives that promote industrialization and technological innovation in the country. Fifthly, the interconnection between governance indicators and economic growth can be directly or indirectly affected by the role of poverty or other external factors in the economy. However, improved governance can escalate the growth rates in the economy (Ochi *et al*., 2024). Hence, the role of corruption control is positive with economic growth, implying that the positive influence of controlling corruption increases economic development opportunities in the country. This nexus result is consistent with the studies of Leite *et al*. (2019) and Zhuo *et al*. (2021). Next, the relationship between regulatory quality and economic growth is negative. Uncertain regulatory environments or poorly designed regulations might cause this occurrence. Lastly, the impact of government effectiveness is also negative, denoting inefficiency in governance that hinders the country's growth. In one way or another, these arguments were also claimed in the studies of Lee *et al*. (2021) and Zhuo *et al*. (2021), respectively.

5. Conclusion and Policy Implications

There is a scarcity of study of the individual effects of mineral resources, digital economy, FDI and government indicators on economic growth. The present study concentrated on a combined comprehensive analysis proposed in three models in which three different indicators for governance were employed. Hence, the study investigated the nexus between mineral resources, the dig-

ital economy, FDI, government indicators and economic growth to fill this void. For this purpose, the study utilized panel data methodology such as MMQR, FMOLS and DOLS based on available data characteristics. Our research advances the theoretical and empirical understanding of the factors driving sustainable economic development in the Global South, contributing to the development economics debate. This research fills gaps in the literature and gives new insights, enriching this discipline and laying the groundwork for future research. The present investigation highlighted that countries use digital technologies to transform their economy. Digital infrastructure, digital literacy, foreign direct investment, renewable energy and governance indicators have a crucial effect on the country's economic development.

Based on the study findings, the following recommendations are made.

Policies on the digital economy must be strengthened because they could improve lives of millions by tackling crucial concerns connected to sustainable economic growth in the Global South. Secondly, policies related to mineral resources must be reformed. Economic policymakers must understand how mineral resources, the digital economy, governance and sustainable economic development in rising Global South economies interact and formulate reasonable strategies to foster growth and development. It is recommended to invest in eco-friendly technology and create high-value products that will not only create job opportunities but also increase trade among countries. Thirdly, policy proposals to boost the economic growth of the Global South should be created using the research findings. They should develop methods to maximize mineral resource use, digital economy possibilities and governance frameworks that highlight inclusive growth, technological innovation and strong governance policies and promote sustainability with long-term prosperity. Governments must strengthen policies regarding digital infrastructure and transparent revenue management. In this case, adaptive governance can be of utmost importance. The governments can continuously monitor and adapt strategies that will improve digitization and resource management. Fourthly, a contribution to academic knowledge in development economics by developing unique insights into the interaction between mineral resources, the digital economy, governance and sustainable economic development is required. For this purpose, spreading knowledge encourages more research and publishing findings in peer-reviewed publications and academic conferences. Besides, Global South policymaking and practice should be informed with evidence-based insights and recommendations. It is recommended to engage policymakers, government agencies and stakeholders to incorporate research findings into policy and programme design that will promote sustainable development by identifying ways for inclusive, resilient and ecologically sustainable economic growth in emerging economies. It is suggested to develop partnerships with international development organizations, NGOs and the commercial sector to undertake research-based sustainable development initiatives. This will empower the stakeholders by providing enterprises, civil society organizations and local communities

with knowledge and skills to participate actively in sustainable economic development efforts. Besides, providing capacity-building and knowledge-sharing mechanisms can be resourceful for stakeholders to capitalize on research-identified opportunities and problems. Global economic stability and prosperity would be supported by fostering inclusive and sustainable economic development in the Global South. Governments should support policies that promote balanced economic growth, minimize inequality and strengthen emerging countries' resilience to external shocks.

5.1 Study limitations and future recommendations

Firstly, future research could further investigate the connection of environmental regulations with the study factors to provide a more comprehensive understanding of sustainable development practices in China and other economies. Secondly, the findings may or may not apply to other developing countries due to their diverse social, political and economic structures. Therefore, the study suggests evaluating the applicability of this study to other economies for analysing the observed relationships more comprehensively. Besides, cross-country comparisons are recommended for a detailed understanding of the variables and their aspects for each economy.

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References

Abd Rahman, N. H., Ismail, S., Ahman, E., et al. (2021). The effect of regulatory performance on economic growth. *Entrepreneurship and Sustainability Issues*, 8(3), 604–617. https://doi.org/10.35609/gcbssproceeding.2020.11(142)

AlNemer, H. A., Hkiri, B., Tissaoui, K. (2023). Dynamic impact of renewable and nonrenewable energy consumption on CO2 emission and economic growth in Saudi Arabia: Fresh evidence from wavelet coherence analysis. *Renewable Energy*, 209(C), 340–356. https://doi.org/10.1016/j.renene.2023.03.084

Bagheri Pormehr, S. and Zahedi Azad, N. (2020). The Role of Regulatory Quality on the Impact of Foreign Direct Investment on Economic Growth. *Program and Development Research*, 1(3), 167–210. https://doi.org/10.22034/pbr.2020.109249

Chan, S. G., Ramly, Z. and Karim, M. Z. A. (2017). Government spending efficiency on economic growth: Roles of value-added tax. *Global Economic Review*, 46(2), 162–188. https://doi.org/10.1080/1226508X.2017.1292857

Cheng, S., Shu, C., Jin, M., et al. (2023). Balancing resources and sustainability: analyzing the impact of mineral resources utilization on green growth. *Resources Policy*, 86(A), 104143. https://doi.org/10.1016/j.resourpol.2023.104143

Cheng, Y. (2024). Impact of Foreign Direct Investment (FDI) on Economic Development in Ethiopia. *World Journal of Management Science*, 2(1), 32–41. https://doi.org/10.61784/wms240182

Cieślik, A. and Goczek, Ł. (2018). Control of corruption, international investment, and economic growth–Evidence from panel data. *World Development*, 103(C), 323–335. https://doi.org/10.1016/j.worlddev.2017.10.028

Ciobanu, A. M. (2021). The impact of FDI on economic growth in case of Romania. *International Journal of Economics and Finance*, 12(12), 1–81.

Cooray, A. and Nam, Y.-S. (2025). Public social spending, government effectiveness, and economic growth: an empirical investigation. *Applied Economics*, 57(1), 52–66. https://doi.org/10.1080/00036846.2024.2302933

d'Agostino, G., Dunne, J. P. and Pieroni, L. (2016). Government spending, corruption and economic growth. *World Development*, 84(C), 190–205. https://doi.org/10.1016/j.worlddev.2016.03.011

Dai, S. and Du, X. (2023). Discovering the role of trade diversification, natural resources, and environmental policy stringency on ecological sustainability in the BRICST region. *Resources Policy*, 85(B), 103868. https://doi.org/10.1016/j.resourpol.2023.103868

Dogan, E., Altinoz, B., Madaleno, M., et al. (2020). The impact of renewable energy consumption to economic growth: a replication and extension of Inglesi-Lotz (2016). *Energy Economics*, 90, 104866. https://doi.org/10.1016/j.eneco.2020.104866

Dumitrescu, E. I. and Hurlin, C. (2012). Testing for Granger non-causality in heterogeneous panels. *Economic Modelling*, 29(4), 1450–1460. https://doi.org/10.1016/j.econmod.2012.02.014

Gomes, S., Lopes, J. M. and Ferreira, L. (2022). The impact of the digital economy on economic growth: The case of OECD countries. *RAM: Revista de Administração Mackenzie*, 23(6). https://doi.org/10.1590/1678-6971/eRAMD220029.en

He, K., Gan, Y. and Wu, H. (2024). Natural resources, decentralized system, financial inclusion and sustainable development: Evidence from top emerging economies with resources abundance. *Resources Policy*, 89, 104674. https://doi.org/10.1016/j.resourpol.2024.104674

Huang, Y., Raza, S. M. F., Hanif, I., et al. (2020). The role of forest resources, mineral resources, and oil extraction in economic progress of developing Asian economies. *Resources Policy*, 69(C), 101878. https://doi.org/10.1016/j.resourpol.2020.101878

Imtiaz, A. and Javid, S. (2023). Resource curse or blessings hypothesis in Pakistan: The role of financial development and oil prices in era of globalization. *Resources Policy*, 86(A), 104206. https://doi.org/10.1016/j.resourpol.2023.104206

Jarque, C. M. and Bera, A. K. (1987). A test for normality of observations and regression residuals. *International Statistical Review / Revue Internationale de Statistique*, 55(2), 163–172. https://doi.org/10.2307/1403192

Kao, C. (1999). Spurious regression and residual-based tests for cointegration in panel data. *Journal of Econometrics*, 90(1), 1–44. https://doi.org/10.1016/S0304-4076(98)00023-2

Kraus, S., Durst, S., Ferreira, J. J., et al. (2022). Digital transformation in business and management research: An overview of the current status quo. *International journal of information management*, 63, 102466. https://doi.org/10.1016/j.ijinfomgt.2021.102466

Karahan, Ö. and Çolak, O. (2024). The causality relationship between foreign direct investment and economic growth in RCEP countries. *Journal of Economic and Administrative Sciences*, 40(1), 95–110. https://doi.org/10.1108/JEAS-04-2022-0112

Labidi, M. A., Ochi, A. and Saidi, Y. (2024). Relationship Analysis Between FDI and Economic Growth in African Countries: Does Governance Quality Matter? *Journal of the Knowledge Economy*, 15(4), 16511–16540. https://doi.org/10.1007/s13132-023-01710-1

Lee, C. C., Olasehinde-Williams, G., Olanipekun, I. (2021). Financial systems, regulatory quality, and economic growth. *The Journal of International Trade & Economic Development*, 30(2), 246–274. https://doi.org/10.1080/09638199.2020.1847172

Leite, N. S., Lucio, F. G. C. and Ferreira, R. T. (2019). Long-term effects of corruption control and economic freedom on economic growth. *Theoretical Economics Letters*, 9(8), 2965–2974. https://doi.org/10.4236/tel.2019.98183

Li, J., He, W. and Li, G. (2024). Natural resources, economic complexity and growth nexus: Role of digital governance in addressing the resource curse. *Resources Policy*, 92, 105003. https://doi.org/10.1016/j.resourpol.2024.105003

Li, R. and Gospodarik, C. G. (2022). The impact of digital economy on economic growth based on pearson correlation test analysis. In: Jansen, B. J., Liang, H., Ye, J. *International Conference on Cognitive based Information Processing and Applications (CIPA 2021)*. Berlin: Springer, vol. 2, pp. 19–27. ISBN 978-981-16-5854-9.

Lin, Y., Wang, Q. J. and Zheng, M. Q. (2024). Nexus among digital economy, green innovation, and green development: Evidence from China. *Emerging Markets Finance and Trade*, 60(4), 704–723. https://doi.org/10.1080/1540496X.2023.2258260

Linkov, I., Trump, B. D. and Poinsatte-Jones, K. (2018). Governance strategies for a sustainable digital world. *Sustainability*, 10(2), 440. https://doi.org/10.3390/su10020440

Machado, J. A. F. and Santos Silva, J. M. C. (2019). Quantiles via moments. *Journal of Econometrics*, 213(1), 145–173. https://doi.org/10.1016/j.jeconom.2019.04.009

Minh, V. T. H. and Trinh, P. T. T. (2023). The impact of FDI on economic growth in developing countries: the role of FDI inflow and trade openness. *The Economics and Finance Letters*, 10(3), 216–229.

Nyantakyi, G., Gyimah, J. and Sarpong, F. A., et al. (2023). Powering sustainable growth in West Africa: exploring the role of environmental tax, economic development, and financial development in shaping renewable energy consumption patterns. *Environmental Science and Pollution Research*, 30(50), 109214–109232. https://doi.org/10.1007/s11356-023-30034-5

Ochi, A., Saidi, Y. and Labidi, M. A. (2024). Nonlinear threshold effect of governance quality on poverty reduction in South Asia and Sub-Saharan Africa: A dynamic panel threshold specification. *Journal of the Knowledge Economy*, 15(1), 4239–4264. https://doi.org/10.1007/s13132-023-01271-3

Pang, D., Jin, X. and Zheng, K., et al. (2024). A road toward green growth: Optimizing the role of mineral resources, fintech innovation and effective governance in G-20 economies. *Resources Policy*, 92, 104983. https://doi.org/10.1016/j.resourpol.2024.104983

Pedroni, P. (1999). Critical values for cointegration tests in heterogeneous panels with multiple regressors. *Oxford Bulletin of Economics and statistics*, 61(S1), 653–670. https://doi.org/10.1111/1468-0084.0610s1653

Pesaran, M. H. and Yamagata, T. (2008). Testing slope homogeneity in large panels. *Journal of econometrics*, 142(1), 50–93. https://doi.org/10.1016/j.jeconom.2007.05.010

Pesaran, M. H. (2006). Estimation and inference in large heterogeneous panels with a multifactor error structure. *Econometrica*, 74(4), 967–1012. https://doi.org/10.1111/j.1468-0262.2006.00692.x

Pesaran, M. H. (2007). A simple panel unit root test in the presence of cross-section dependence. *Journal of Applied Econometrics*, 22(2), 265–312. https://doi.org/10.1002/jae.951

Pesaran, M. H. (2021). General diagnostic tests for cross-sectional dependence in panels. *Empirical Economics*, 60(1), 13–50. https://doi.org/10.1007/s00181-020-01875-7

Saidi, K. and Omri, A. (2020). The impact of renewable energy on carbon emissions and economic growth in 15 major renewable energy-consuming countries. *Environmental Research*, 186, 109567. https://doi.org/10.1016/j.envres.2020.109567

Shahbaz, M., Wang, J. and Dong, K., et al. (2022). The impact of digital economy on energy transition across the globe: The mediating role of government governance. *Renewable and Sustainable Energy Reviews*, 166, 112620. https://doi.org/10.1016/j.rser.2022.112620

Sarkodie, S. A. and Strezov, V. (2018). Empirical study of the environmental Kuznets curve and environmental sustainability curve hypothesis for Australia, China, Ghana and USA. *Journal of cleaner production*, 201, 98–110. https://doi.org/10.1016/j.jclepro.2018.08.039

Şaşmaz, M. Ü. and Sağdıç, E. N. (2020). The effect of government effectiveness and rule of law on economic growth: the case of European union transition economies. *Dokuz Eylül Üniversitesi İşletme Fakültesi Dergisi*, 21(1), 203–217. https://doi.org/10.24889/ifede.729490

Shahbaz, M., Raghutla, C., Chittedi, K. R., et al. (2020). The effect of renewable energy consumption on economic growth: Evidence from the renewable energy country attractive index. *Energy*, 207, 118162. https://doi.org/10.1016/j.energy.2020.118162

Shi, J., Liu, Y. and Sadowski, B. M., et al. (2023). The role of economic growth and governance on mineral rents in main critical minerals countries. *Resources Policy*, 83(C), 103718. https://doi.org/10.1016/j.resourpol.2023.103718

Song, X. and Hou, W. (2024). Mineral resources and growth nexus in ASEAN countries: What role do trade diversification, ICT, and financial inclusion play in the resource curse spectrum? *Resources Policy*, 91(C), 104847. https://doi.org/10.1016/j.resourpol.2024.104847

Tan, Y. and Huang, S. (2023). Sustainable development through digitalization: An exploration of natural resource extraction in China. *Resources Policy*, 86(A), 104240. https://doi.org/10.1016/j.resourpol.2023.104240

Ullah, S., Luo, R., Ali, K., et al. (2023). How does the sectoral composition of FDI induce economic growth in developing countries? The key role of business regulations. *Economic research-Ekonomska istraživanja*, 36(2), 2129406. https://doi.org/10.1080/1331677X.2022.2129406

Utouh, H. M. L., Mchukwa, E. W. and Tibuhinda, R. N. (2024). The Effects of Foreign Direct Investment on Economic Growth (Gross Domestic Product) in Tanzania. Economic Insights-Trends and Challenges, 13(2), 89–100. https://doi.org/10.51865/EITC.2024.02.07

Van Thi Hong, P. H. A. M. (2020). Impacts of corruption control on economic growth in relationship with stock market and trade openness. *The Journal of Asian Finance, Economics and Business*, 7(12), 73–84. https://doi.org/10.13106/jafeb.2020.vol7.no12.073

Wang, F., Wong, W.-K., Wang, Z., et al. (2023). Emerging pathways to sustainable economic development: An interdisciplinary exploration of resource efficiency, technological innovation, and ecosystem resilience in resource-rich regions. *Resources Policy*, 85(A), 103747. https://doi.org/10.1016/j.resourpol.2023.103747

Wang, Q., Dong, Z., Li, R., et al. (2022). Renewable energy and economic growth: New insight from country risks. *Energy*, 238(PC), 122018. https://doi.org/10.1016/j.energy.2021.122018

Wang, S., Li, J. and Zhao, E. (2024). Exploring the role of financial technologies and digital trade in shaping trade-adjusted resource consumption in E7 countries. *Resources Policy*, 88, 104495. https://doi.org/10.1016/j.resourpol.2023.104495

Wang, Y., Wu, Q. and Razi, U. (2023). Drivers and mitigants of resources consumption in China: Discovering the role of digital finance and environmental regulations. *Resources Policy*, 80(C), 103180. https://doi.org/10.1016/j.resourpol.2022.103180

WB (2024). *World Development Indicators*. [Retrieved 2024-05-07] Available at: https://databank.worldbank.org/source/world-development-indicators#

Wei, J., Rahim, S. and Wang, S. (2022). Role of environmental degradation, institutional quality, and government health expenditures for human health: Evidence from emerging seven countries. *Frontiers in Public Health*, 10, 870767. https://doi.org/10.3389/fpubh.2022.870767

Westerlund, J. (2006). Reducing the size distortions of the panel LM Test for cointegration. *Economics Letters*, 90(3), 384–389. https://doi.org/10.1016/j.econlet.2005.09.002

Yan, H. (2024). Financial development, violence, and resource curse: How mineral resources are contributing towards growth of resource-rich countries. *Resources Policy*, 89, 104546. https://doi.org/10.1016/j.resourpol.2023.104546

Zhang, J. and Guxue, K. (2024). Fostering sustainability: Exploring natural resources, mineral resources, and their impact on carbon reduction, economic growth. *Resources Policy*, 92, 104979. https://doi.org/10.1016/j.resourpol.2024.104979

Zhang, J., Zhao, W., Cheng, B., et al. (2022). The impact of digital economy on the economic growth and the development strategies in the post-COVID-19 era: evidence from countries along the "Belt and Road". *Frontiers in public health*, 10, 856142. https://doi.org/10.3389/fpubh.2022.856142

Zhang, W., Zhao, S., Wan, X., et al. (2021). Study on the effect of digital economy on high-quality economic development in China. *PloS one*, 16(9), e0257365. https://doi.org/10.1371/journal.pone.0257365

Zhu, X. and Niu, X. (2024). Impact of fintech, mineral resources extraction, and globalization on social inequality: Exploring the role of technology innovation in G10 economies. *Resources Policy*, 89(C), 104606. https://doi.org/10.1016/j.resourpol.2023.104606

Zhuo, Z., Musaad O, A. S., Muhammad, et al. (2021). Underlying the relationship between governance and economic growth in developed countries. *Journal of the Knowledge Economy*, 12(3), 1314–1330. https://doi.org/10.1007/s13132-020-00658-w