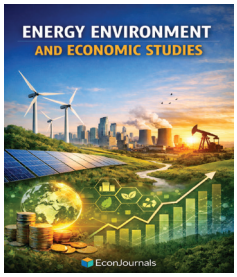

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Towards Sustainable Economic Growth in Africa: The Role of Financial Development and Energy Transition Policies

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ABSTRACT

This study examined the nexus between financial development, energy transition policies, and economic growth in Africa over the period 2000-2024. The study was motivated by the growing need to understand how financial sector development and the transition toward sustainable energy systems contribute to economic growth across African economies. Secondary data were obtained from reputable international databases and analysed using advanced panel econometric techniques to evaluate both the individual and combined effects of financial development indicators, energy transition measures, and selected macroeconomic control variables on economic growth. The findings reveal that financial development significantly promotes economic growth through improved capital market efficiency, enhanced liquidity, and stronger stock market mechanisms. However, domestic credit to the private sector was found to exert a negative effect on growth when credit allocation is inefficient and directed toward unproductive sectors. The results further show that renewable energy consumption positively and significantly influences economic growth, indicating that energy transition policies are not only environmentally desirable but also economically beneficial. In contrast, energy intensity exhibited relatively weak effects, suggesting that many African economies still face structural constraints in achieving substantial energy efficiency gains. Additionally, population growth and exchange rate fluctuations were found to influence economic performance, underscoring the importance of macroeconomic stability in sustaining growth outcomes. The study concludes that financial development and energy transition policies are complementary drivers of economic growth in Africa. Therefore, policymakers should adopt integrated frameworks that strengthen financial intermediation, promote renewable energy investments, improve energy efficiency, and maintain macroeconomic stability. Such coordinated strategies are essential for achieving inclusive, resilient, and sustainable economic growth across the African continent.

Keywords: Financial Development, Energy Transition Policies, Economic Growth
JEL Classifications: F36, Q42, F43

1. INTRODUCTION

Economic growth remains a central objective for African countries, given the continent's persistent development challenges, including poverty, unemployment, and infrastructure deficits. Over the past two decades, African economies have exhibited heterogeneous growth patterns, driven by factors such as financial development, energy availability, and macroeconomic stability (World Bank, 2022; African Development Bank, 2021). While some countries have achieved robust growth through natural resource exploitation and industrial expansion, others continue to experience sluggish performance due to weak institutions, limited capital market development, and energy deficits (Alenoghena et al., 2020; Akintola et al., 2020). Empirical studies suggest that financial sector efficiency and renewable energy adoption are critical determinants of sustainable growth, as they facilitate investment, enhance productivity, and promote structural transformation (Albert et al., 2022; Rahaman et al., 2023). Understanding the interplay between financial development, energy transition policies, and macroeconomic factors is critical for fostering

sustainable economic growth in Africa. Efficient financial systems facilitate resource mobilisation, promote productive investment, and enhance resilience to economic shocks, while well-developed capital markets improve liquidity and broaden access to finance. Simultaneously, energy transition policies, particularly the adoption of renewable energy, support industrial productivity, reduce reliance on fossil fuels, and promote environmentally sustainable development. Macroeconomic stability, including exchange rate management and inflation control, ensures growth gains are preserved, and investment confidence is strengthened. Integrating these dimensions into coherent policy frameworks is essential for accelerating inclusive, resilient, and long-term economic growth across the continent.

Financial development plays a pivotal role in shaping economic growth across African countries, as it facilitates efficient allocation of resources, mobilises savings, and supports productive investment (Alenoghena et al., 2020; Akintola et al., 2020). Over the past two decades, African economies have demonstrated varied growth trajectories, often constrained by underdeveloped financial systems, limited access to credit, and shallow capital markets (Albert et al., 2022; Okpara et al., 2018). Empirical studies highlight that robust financial systems, such as banking sector depth, stock market capitalisation, and liquidity mechanisms, enhance investment efficiency and promote long-term growth by providing the necessary financing for industrialisation, infrastructure, and technological advancement (Song and Appiah-Otoo, 2022; Judith and Chijindu, 2016). Conversely, inadequate credit allocation, inefficient banking operations, and poorly regulated markets can impede growth, as funds are diverted toward consumption or unproductive activities (Umar et al., 2021; Imoagwu and Ezeanyeji, 2019). Moreover, financial development interacts with macroeconomic stability, exchange rate management, and governance structures, underscoring the importance of a coordinated policy framework to maximise growth outcomes (Ani and Udeh, 2021). Understanding the role of financial development is particularly critical in Africa, where economies are transitioning from resource-dependent growth to more diversified, knowledge- and investment-driven models. Investigating how financial development supports sustainable and inclusive growth can inform policymakers on strategies to strengthen financial institutions, deepen capital markets, and channel credit toward productive sectors, thereby enhancing resilience and long-term economic performance across the continent (Okunlola et al., 2020; Chen et al., 2020).

Energy transition policies have emerged as a critical driver of sustainable economic growth in Africa, particularly in the context of global climate change, rising energy demand, and the need for low-carbon development (EIA, 2015; Rahaman et al., 2023; Jia et al., 2023). African economies remain heavily reliant on fossil fuels, which constrains industrial productivity, increases production costs, and exposes countries to energy price volatility (Dissanayake et al., 2023; Azeakpono and Lloyd, 2020). Transitioning to renewable and low-carbon energy sources, such as solar, wind, hydro, and biomass, can improve energy reliability, reduce environmental degradation, and foster a more resilient economic structure (Alnabulsi et al., 2023). Empirical evidence demonstrates that renewable energy consumption positively contributes to GDP by enhancing industrial output, supporting infrastructure development, and enabling technological innovation, while simultaneously mitigating climate-related risks (Dickson, 2010; Ezenwa et al., 2021; Rahaman et al., 2023). Moreover, energy transition policies encourage private sector investment, attract green financing, and stimulate job creation in emerging clean energy sectors, thereby promoting inclusive growth (Jia et al., 2023; Alnabulsi et al., 2023). Effective policy implementation requires comprehensive regulatory frameworks, financial incentives, and institutional capacity to ensure renewable energy adoption is scalable and sustainable. Understanding the link between energy transition and economic growth is therefore essential for African policymakers seeking to achieve long-term development, reduce dependence on fossil fuels, and integrate environmental sustainability with economic expansion (Rahaman et al., 2023; Dissanayake et al., 2023).

Following the above discussions, we can deduce that Africa's economic growth was determined by financial development and energy intensity policies, given their essential roles in providing financial services through financial institutions and financial markets, as well as improvement in the manner in which energy is produced and utilised in Africa. Studying the roles of financial development and energy intensity on economic growth in Africa is crucial due to the continent's ongoing efforts to achieve sustainable and inclusive development. Financial development is a key driver of growth, as it facilitates efficient allocation of resources, mobilises savings, and provides credit to productive sectors, thereby stimulating investment, industrialisation, and technological advancement (Albert et al., 2022; Akintola et al., 2020). However, the effectiveness of financial systems varies across African countries, and inefficient credit allocation or shallow capital markets can hinder economic progress (Umar et al., 2021; Imoagwu and Ezeanyeji, 2019). Simultaneously, energy intensity, which reflects the amount of energy consumed per unit of output, directly influences productivity and industrial competitiveness. High energy intensity indicates inefficiencies and reliance on carbon-intensive energy sources, limiting economic expansion and increasing vulnerability to energy price shocks (Rahaman et al., 2023; Dissanayake et al., 2023). Understanding how improvements in energy efficiency and the adoption of low-carbon technologies contribute to growth is vital for designing policies that simultaneously enhance output and sustainability. In this light, this study investigates the effects of financial development measured with domestic credit to the private sector, money supply, stock market capitalisation, and stock market turnover ratio; and energy intensity policies - measured with energy intensity and renewable energy consumption on economic growth in Africa, and this results in the following questions: (a) Is there a significant relationship between domestic credit to the private sector and economic growth in Africa? (b). Can the money supply significantly influence economic growth in Africa? (c). How does stock market capitalisation influence economic growth in Africa? (d). Do energy transition and distribution losses significantly impact the economic growth of Africa? (e). What is the significant synergy between the grid transmission network stock and economic growth in Africa? (f). In what ways do grid

coverage and electrification rate affect the economic growth of Africa?

To resolve the above questions, we estimated the relationships between financial development, energy intensity policies and economic growth with the system generalised method of moments (GMM) as the baseline model and robustly checked the findings using the common correlated effects mean group (CCE-MG). Estimating the relationships between financial development, energy intensity policies, and economic growth using the system Generalised method of moments (GMM) is essential due to the dynamic and potentially endogenous nature of these variables in African economies (Arellano and Bover, 1995; Blundell and Bond, 1998). System GMM effectively addresses endogeneity, omitted variable bias, and reverse causality, which are common when assessing how financial development indicators, such as credit to the private sector, money supply, and stock market depth, influence economic growth. It also accommodates the dynamic adjustment process inherent in economic growth, capturing both short-term shocks and long-term equilibrium relationships (Song and Appiah-Otoo, 2022; Albert et al., 2022). Robustly checking these findings with the common correlated effects mean group (CCE-MG) estimator ensures that cross-sectional dependence and unobserved heterogeneity across African countries are accounted for, providing more reliable and generalisable results (Pesaran, 2006; Chudik and Pesaran, 2015). CCE-MG complements GMM by capturing the influence of common global shocks, policy spillovers, and regional interconnectedness, which are particularly relevant for Africa's integrated financial and energy markets. Using both methods strengthens the empirical validity of the study, guiding policymakers in designing evidence-based strategies for financial sector development, energy efficiency, and sustainable economic growth.

This study departs from existing literature by simultaneously exploring the interlinked roles of financial development and energy transition policies on economic growth in Africa over the period 2000-2024, providing a more comprehensive framework than previous studies that often examined these factors in isolation (Albert et al., 2022; Rahaman et al., 2023). Prior research has highlighted the individual significance of financial development, such as domestic credit to the private sector, banking sector depth, and stock market capitalisation, in promoting investment efficiency and industrialisation (Alenoghena et al., 2020; Akintola et al., 2020), while separate studies have emphasised the impact of energy transition policies and renewable energy adoption on productivity and economic resilience (Jia et al., 2023; Ezenwa et al., 2021). However, few studies have combined these dimensions to analyse their joint effects on African economic growth, leaving a gap in understanding the potential synergy between financial systems and energy policies. Moreover, many existing analyses rely on static or ordinary least squares techniques, which fail to account for endogeneity, dynamic adjustments, and cross-sectional dependence inherent in panel data across heterogeneous African countries (Umar et al., 2021; Song and Appiah-Otoo, 2022). By employing the system Generalised method of moments (GMM) as the baseline estimator, this study addresses these methodological limitations, capturing both short-term shocks and long-term equilibrium effects (Arellano and Bover, 1995; Blundell and Bond, 1998). The robustness of findings is further strengthened using the common correlated effects mean group (CCE-MG) estimator, which accounts for unobserved common factors and cross-sectional dependence, offering a more reliable and generalisable understanding of how financial development and energy transition policies jointly shape economic growth in Africa (Pesaran, 2006; Chudik and Pesaran, 2015).

This study contributes to knowledge by providing empirical evidence on the simultaneous influence of financial development and energy transition policies on African economic growth, bridging a critical gap in existing literature. By integrating multiple indicators of financial development—including domestic credit to the private sector, money supply, stock market capitalisation, and stock market turnover ratio—with energy intensity and renewable energy consumption, the research offers a nuanced understanding of how these sectors interact to promote sustainable growth (Song and Appiah-Otoo, 2022; Rahaman et al., 2023). The findings demonstrate that efficient financial systems mobilise resources, channel credit toward productive sectors, and enhance investment efficiency, while effective energy transition policies reduce reliance on fossil fuels, increase industrial productivity, and mitigate climate-related risks. Methodologically, the combined use of system GMM and CCE-MG strengthens the empirical validity of the results by addressing endogeneity, omitted variable bias, and cross-sectional dependence, which are often overlooked in prior studies (Arellano and Bover, 1995; Pesaran, 2006). Practically, the study provides actionable insights for policymakers by highlighting the importance of harmonising financial and energy sector reforms to stimulate inclusive, low-carbon, and resilient economic growth. The research thus advances theoretical understanding by establishing a comprehensive framework linking finance, energy policy, and growth, while offering evidence-based guidance for sustainable development planning across diverse African contexts (Alnabulsi et al., 2023; Rahaman et al., 2023).

The subsequent chapters were structured as follows. Chapter Two presents a comprehensive review of the existing literature, highlighting theoretical and empirical insights on financial development, energy transition policies, and economic growth in Africa. Chapter Three outlines the research methodology, detailing the data sources, variable measurement, and econometric techniques employed, including the system generalised method of moments (GMM) and the common correlated effects mean group (CCE-MG) estimator. Chapter Four presents and analyses the empirical results, providing a detailed discussion of the findings in relation to the study objectives and existing research. Finally, Chapter Five concludes the study by summarising key findings, drawing evidence-based inferences, and offering practical policy recommendations aimed at enhancing financial development, promoting energy transition, and fostering sustainable economic growth across Africa.

2. THEORETICAL REVIEW

2.1. The Endogenous Growth Theory

The endogenous growth model has been prominently advanced by many scholars, Romer (1986), Lucas (1988), and Rebelo

(1991), stating that continuous progression can be achieved endogenously (Ibrahim and Mohammed, 2020). The endogenous growth model intends to resolve problems stemming from the neoclassical growth models, like the assumption that economies cease growing at some level when not stimulated by exogenous progress in technology (McCallum, 1996). The endogenous growth model factors in the functions of organisations such as the capital market, money market and government in the roles played by them together with other aspects of production like capital, labour, and human capital (Ibrahim and Mohammed, 2020). Endogenous growth theory relates that the performance of economic growth is tied to income circulation, technology, and financial improvement (Odo et al., 2017).

2.2. Supply—Leading Hypothesis

The supply-leading hypothesis, which was propounded by Hugh T. Patrick (1966), suggests that financial deepening stimulates growth. The existence and development of the financial markets bring about a higher level of saving and investment and enhance the efficiency of capital accumulation. This hypothesis contends that well-functioning financial institutions can promote overall economic efficiency, create and expand liquidity, mobilise savings, enhance capital accumulation, transfer resources from traditional (non-growth) sectors to the more modern growth-inducing sectors, and also promote a competent entrepreneur response in these modern sectors of the economy. The work of Demirguc-Kunt and Levine (2008) in a theoretical review of the various analytical methods used in finance literature found strong evidence that financial deepening is important for growth. To them, it is crucial to motivate policymakers to prioritise financial sector policies and devote attention to policy determinants of financial deepening as a mechanism for promoting growth.

2.2.1. Demand—following hypothesis

Demand - The following hypothesis was also propounded by Hugh T. Patrick (1966). This hypothesis view is that the development of the financial markets is merely a lagged response to economic growth. This implies that any early efforts to develop financial markets might lead to a waste of resources, which could be allocated to more useful purposes in the early stages of growth. As the economy advances, demand for financial services increases, leading to greater financial development. Some research work postulates that economic growth is a causal factor for financial development. According to them, as the real sector grows, the increasing demand for financial services stimulates the financial sector (Olawumi et al., 2017).

2.3. Empirical Review

2.3.1. Energy transition policies and economic growth

Rahaman et al. (2023) investigated the impact of energy consumption on economic growth, and the study used the NARDL approach to show that both positive and negative changes in renewable energy consumption positively impact GDP in South and East Asian countries, while urbanisation has a negative effect. Jia et al. (2023) explored the impact of renewable energy consumption on economic growth. The study adopted ordinary least squares regression and found that renewable energy consumption directly contributes to economic growth in 90 Belt and Road countries, influencing growth indirectly through gross capital formation and trade. Dissanayake et al. (2023), in their study on the effect of renewable energy consumption on economic growth, found no Granger-causal relationship between GDP and renewable energy consumption outside Economies in Transition but noted a one-way relationship between GDP and CO_2 emissions. Alnabulsi et al. (2023) investigated the effect of renewable energy consumption on economic growth in Jordan using the ARDL estimation model, and the study showed that renewable energy consumption, along with CO_2, capital formation, and population growth, positively impacts GDP in Jordan.

Tu et al. (2025) investigate the impact of China's New Energy Demonstration City (NEDC) policy on corporate ESG performance using a difference-in-differences approach with data from 2009 to 2019. The study finds that energy transition policies can significantly hinder ESG outcomes by increasing financial constraints, limiting green innovation, and raising bankruptcy risks. The negative effects are especially pronounced in highly competitive and pollution-intensive industries. The paper underscores the need for policymakers to balance environmental objectives with corporate sustainability considerations. Van Hung (2025) investigates the dynamic effects of FDI, mineral markets, GDP, non-renewable energy, and other factors on the UK's energy transition using QQR and NCQ methods. The study highlights that renewable energy, FDI, financial development, and urbanisation strongly support the country's transition toward sustainable energy. Conversely, GDP, non-renewable energy, and mineral markets show mixed impacts, reflecting varying economic and structural influences. The findings provide actionable policy insights for promoting renewable energy adoption and achieving low-carbon growth objectives. Idris and Rhaman Razaq (2025) examine the nonlinear effects of energy transition, green growth, and emissions on economic growth across 36 Asia-Pacific countries using spline regression. The study finds that moderate energy transition and green growth levels enhance growth, while very high levels require targeted strategies to sustain performance. High emissions consistently exert negative effects on economic growth. The research provides actionable insights for policymakers to promote renewable energy, green innovation, and emissions reduction to support sustainable development. Aghababaei et al. (2025) analyze the global shift from fossil fuels to renewable energy across 118 countries (2012-2022) using K-Means clustering with seven economic and energy indicators. The study identifies nine distinct country clusters, revealing that nations within the same income group can follow very different energy transition paths. Some lower-income or structurally constrained countries achieve notable renewable electricity penetration, highlighting that development level alone does not determine transition success. Differences in renewable energy shares, emissions, energy trade, and investment patterns underscore the importance of structural context. The findings support context-specific policy approaches and enhance understanding of diverse global sustainability transitions.

Azam et al. (2025) examine the effects of energy transition policies on economic growth using an augmented Solow Growth Model with data from 80 developed and developing countries (2000-2021). The study finds an inverse U-shaped relationship,

where renewable energy investments boost growth in early-stage developing economies but yield diminishing returns in advanced economies. For developed countries, the findings highlight the need for resource efficiency and investment in new renewable technologies, such as energy storage. The research emphasises stage-specific policy measures, including workforce retraining and community adaptation, to support low-carbon transitions. The study provides empirical evidence guiding policymakers on balancing energy transition, economic growth, and social equity. Abe and Azubuike (2024) explore the convergence of energy justice and energy transition in Africa, emphasising its critical role in achieving sustainable development and addressing climate challenges. The study highlights the continent's unique energy transition opportunities and constraints, which differ from those in the Global North. It underscores the importance of integrating justice principles into policy frameworks to ensure inclusivity and equitable benefits across society. The research points out the underrepresentation of African contexts in energy justice studies despite their growing energy demand. The article guides the design of clean energy transitions that balance development goals with market creation. Tian et al. (2024) systematically reviewed 102 studies to clarify the relationship between energy transition and economic development, noting inconsistent and varied conclusions across the literature. The study finds that research on this topic has grown significantly, with many studies focusing on cross-regional contexts. Relationships between energy transition and economic development are diverse, including promotion, inhibition, bidirectional causality, and ineffectiveness. Key factors influencing energy transition include technology, finance, governance, human capital, taxation, rents, and FDI, while major barriers involve resource scarcity, path dependence, and uneven development. The review provides a comprehensive synthesis and identifies directions for future research to better understand energy transition dynamics globally.

2.3.2. Financial development and economic growth

Albert et al. (2022) studied the impact of financial development on economic growth in Nigeria (1980-2019) using ordinary least squares. They explored four equations with GDP as the dependent variable. Results showed positive relations between economic growth and paired variables (real interest rate, gross domestic savings), (real interest rate, private sector credit), and (savings, private sector credit). However, combining all 3 variables, real interest rate and savings had an insignificant negative impact, while private sector credit had a significant positive impact on Nigeria's growth. Song and Appiah-Otoo (2022) employed a dataset that comprises 31 provinces in China to study the impact of financial technology (fintech) on economic growth from 2011 to 2017. The instrumental variable-generalised method of moments technique was employed, and the result showed that fintech has a positive impact on the economic growth of China. Ani and Udeh (2021) studied the effect of the exchange rate on economic growth in Nigeria from 2009 to 2018. The study utilized an ordinary least squares model, and it was found that the exchange rate has a positive and significant impact on economic growth in Nigeria. Manasseh et al. (2024) examine how digital financial innovation influences financial system development in COMESA using ARDL-based panel estimators and robustness checks via DGMM. The study finds that ATMs, POS, mobile payments, and mobile banking significantly drive long-run financial development, while institutional quality and macroeconomic stability further strengthen this relationship. The authors recommend coordinated regional financial innovation policies to harmonise short-run divergences and enhance long-term technological diffusion across COMESA economies. Otto et al. (2011) examined the relationship between financial sector performance and economic growth in Nigeria using 24 years of data from the Central Bank of Nigeria amid major banking and financial sector reforms. The study found that financial sector performance has a positive and significant relationship with economic growth, highlighting the sector's critical role in driving Nigeria's economic development.

Umar et al. (2021) explored the impact of financial development on economic growth in Nigeria from 1980 to 2019. Using nonlinear autoregressive distributed lag analysis, they identified a lasting connection between asymmetries. Results showed that positive financial development shocks negatively impacted both short and long-term growth, with negative shocks having a similar effect. Inflation had a significant positive impact, while uncertain financial globalisation exhibited no meaningful connection to Nigerian economic growth. Akintola et al. (2020) studied the impact of financial sector development on economic growth in Nigeria using quarterly data between 2000Q1 and 2019Q4 using the autoregressive distributed lag technique. The results indicated that while financial deepening, banking system liquidity and all share index had positive and significant impact on the growth of real output in the long run, the behaviour of exchange rate spread was consistent with falling levels of real output growth. Manasseh et al. (2025) examine the impact of financial technology and innovation on bank performance in ECOWAS from 1997 to 2022 using the ARDL technique. The study employs ROA and ROE as performance indicators, with fintech proxied by mobile and internet banking, while innovation is captured through ATMs, POS, mobile payments, and mobile money. Findings reveal a strong long-run relationship, showing that fintech and financial innovations enhance bank profitability across member states. The authors emphasise the need for strengthened regulatory frameworks and targeted investments to support fintech-driven performance gains. The study also addresses inconsistent findings in previous literature by providing clearer empirical evidence on the fintech-bank performance nexus. Alenoghena et al. (2020) studied the impact of financial development on economic growth from 1980 to 2018. They used the NARDL approach to analyse their connection, finding a U-shaped asymmetrical relationship. The research determined that the financial development variables and economic growth are cointegrated in the long run. Threshold regression indicated that when broad money falls below 17.73% of GDP or credit to the private sector drops below 6.03% of GDP, Nigeria's economic growth declines.

Chen et al. (2020) examined the asymmetric influence of financial development on economic growth in Kenya from 1972 to 2017 using non-linear autoregressive distributed lag (NARDL). The results posit that positive shocks in financial development in the short run and its negative shocks in the long run increase and decrease economic growth, respectively. Regarding inflation,

its positive (negative) shocks in both runs, respectively, reduce (increase) economic growth. In comparison, positive shocks in financial development that spur growth in the short run and negative shocks in financial development (government expenditure) that increase (reduce) growth are the most dominant effects, as the rest of the shocks insignificantly affect growth. Ezenwa et al. (2021) examine the relationship between renewable energy consumption and economic growth. The study adopted ordinary least squares regression and found a bidirectional causality between renewable energy consumption and GDP in Nigeria, with negative effects on GDP between 1990 and 2007, but positive impacts from 2009 to 2015. Azeakpono and Lloyd (2020) examined the impact of renewable energy consumption on economic growth. The study adopted ordinary least squares regression and reported that although renewable energy consumption and economic growth increased in Nigeria from 1990 to 2016, renewable energy had no significant positive impact on economic growth, with no causality between the two. Relatedly, Manasseh et al. (2023) investigate how digital finance and financial inclusion influence economic growth in nineteen COMESA countries from 1997 to 2018 using a panel ARDL approach. The study finds that key digital finance indicators—such as ATMs, POS, mobile banking, and mobile money accounts—are significant long-run drivers of growth. Evidence of bidirectional causality suggests that digital finance, financial inclusion, and economic growth reinforce one another. However, poor institutional quality and macroeconomic volatility undermine these gains, highlighting the need for policies that strengthen digital finance ecosystems and inclusion to support sustainable regional growth. Similarly, Manasseh and Ede (2024) highlight digital finance as a transformative force for economic development, linking its benefits to financial inclusion, cost efficiency, and improved credit access. They emphasise that advanced cybersecurity measures—such as real-time fraud detection, compliance systems, and user education—are essential for maintaining trust and safeguarding financial transactions. While digital finance accelerates growth by expanding access and enhancing financial services, the authors caution that cybersecurity risks remain significant and require robust regulation and continuous innovation. The study underscores digital finance as a catalyst for development, but one that must be supported by strong security frameworks to protect users and the financial system.

Okunlola et al. (2020). Investigated the causal relationship between financial development indicators and economic growth using the Toda and Yamamoto approach for the period 1985-2015. The Toda and Yamamoto approach is based on an augmented VAR modelling, and the findings include that a bi-directional causality was found between financial market indicators and economic growth, while unilateral causality running from stock market indicators to GDP was established. Imoagwu and Ezeanyeji (2019) studied the impact of financial development on economic growth from 1986 to 2017. They used error correction and Toda-Yamamoto tests, finding a short-term positive link between financial development and growth, but a negative impact in the long-term. Causality was from finance to growth. Stock market cap bolstered short-term growth, but hindered it long-term. Interest rate had a slight short-term positive impact, but a significant negative long-term effect. The domestic credit ratio's positive impact was only long-term. Causality was observed from various sectors to financial development. In Okpara et al.'s (2018) study, the econometric analysis of financial development's impact on Nigeria's economic growth is explored using vector error correction and Granger Causality tests. The study establishes a lasting link between financial development and economic growth. Various financial development indicators foster economic growth. Short-term causalities are identified: Capital market liquidity (VST/GDP) and economic growth display mutual influence, as does economic volatility (CPS/GDP). Market Capitalisation ratio (MKTCAP/GDP), Broad money velocity (M2/GDP), and the banking system's role in economic financing (DD/M1) unidirectionally propel economic growth. This highlights the role of financial development indicators in driving immediate economic growth.

More so, Manasseh et al. (2025) investigate how bank credit to the private sector and financial deepening influence Nigeria's economic growth from 1990 to 2021, grounding the analysis in the supply-leading hypothesis. Using the MacKinnon residual cointegration test and the ARDL framework, the authors establish a long-run relationship among the variables. Findings show that private-sector credit and financial deepening significantly promote growth, with the ECM indicating a strong speed of adjustment toward equilibrium. The study's policy relevance lies in its recommendations for strengthening credit allocation, reinforcing financial system stability, and supporting long-term economic expansion. Ofanson et al. (2010) argued that achieving the objectives of the National Economic Empowerment and Development Strategy (NEEDS) requires comprehensive financial sector reforms, including stronger regulation, improved governance, enhanced financial infrastructure, and greater capitalisation. The authors further emphasised promoting financial deepening and expanding access to affordable credit and innovative financial products, particularly for small and medium-sized enterprises, to stimulate economic growth. Judith and Chijindu (2016) examined the relationship between financial development and economic growth in Nigeria between 1987 and 2014 using the error correction and Granger causality test to assess the finance-growth link. The findings indicate that financial development and economic growth move along together in the long run. It was revealed that credit to the private sector, stock market capitalisation and inflation hurt the economy, while broad money supply, trade openness and foreign direct investment exert a positive influence on the economy. The error correction term in the model provided us with the correctional influence on the speed of adjustment, which indicated that errors of divergence from equilibrium were corrected at the rate of 86% each year. The Granger causality tests show that gross domestic product was Granger causal for foreign direct investment, without a feedback system. Oshota and Badejo (2015) empirically investigated the impact of remittances on economic growth in Nigeria, covering the period of 1981-2011. The method of analysis employed was the error correction model, and the result revealed that remittances positively impacted economic growth in Nigeria, while Logan et al. (2025) investigated how commercial bank development influences economic growth using a panel ARDL framework with data from 1996 to 2018. The study incorporates bank credit, financial deepening, deposits, and lending rates alongside governance indicators and key macroeconomic controls. Findings indicate that

commercial bank development significantly promotes long-run economic growth, aligning with the supply-leading hypothesis. However, weak governance—especially poor regulatory quality, rule of law, and corruption control—undermines banking sector effectiveness, highlighting the need for strong institutional reforms to sustain growth. Relatedly, Mwitta (2022) examines how Foreign Direct Investment (FDI) impacts Tanzania's economy by utilising time-series data from 1990 to 2020 and a Vector Error Correction Model (VECM). The research identifies a statistically significant positive relationship between inward FDI and real GDP growth in the long run.

2.4. Gap in Literature

The reviewed literature reveals several important gaps that justify the present study on the effects of financial development and energy-intensity policies on economic growth in Africa using System GMM and CCE-MG. First, most existing studies overwhelmingly rely on country-specific time-series methods such as ARDL, NARDL, OLS, ECM, and VAR-based causality tests, limiting their ability to capture cross-country heterogeneity and dynamic endogeneity, which are crucial for policy-relevant generalisations in Africa. Second, although many studies examine renewable energy consumption and economic growth, they neglect energy-intensity policies, which differ conceptually from energy consumption and play a central role in Africa's low-carbon development agenda. Third, the literature largely focuses on linear or symmetric relationships, even though financial development and energy dynamics in Africa are known to be structurally uneven and sensitive to shocks, suggesting a need for models that account for cross-sectional dependence, unobserved heterogeneity, and policy asymmetries—gaps that CCE-MG effectively addresses. Fourth, existing research tends to examine financial development or renewable energy in isolation, with very few studies integrating both within a single empirical framework, despite their strong theoretical interdependence in shaping long-run growth. Fifth, most studies rely on single-country evidence (Nigeria, Jordan, Kenya, China), making it difficult to understand broader continental patterns or to evaluate how varying institutional, financial, and energy-policy structures condition growth outcomes. Finally, evidence from Africa remains limited, fragmented, and often contradictory, particularly regarding the direction and strength of causality between financial development, energy policy variables, and growth. Accordingly, the use of System GMM and CCE-MG provides a methodological advancement by addressing endogeneity, accounting for structural cross-country differences, and capturing long-run heterogeneous effects, thereby filling critical empirical and methodological gaps in the existing body of knowledge.

3. MATERIALS AND METHODS

3.1. Theoretical Framework

The AK model of endogenous growth was used as the theoretical framework of this study. Harrod (1939) and Domar (1946), who assumed a fixed-coefficient aggregate production function, were the authors of the first versions of this model. Frankel (1962) developed the first model with substitutable factors and knowledge externalities in order to reconcile the positive long-run growth outcome of Harrod-Domar with the factor substitutability and market-clearing elements of the neoclassical model. The Frankel model showed a constant savings rate, in contrast to Romer's (1986) AK model with intertemporal consumer maximisation. The idea that learning-by-doing externalities could boost productivity was put forth by Arrow in 1962. Then, Lucas (1988) developed an AK model, according to which the growth of human capital makes it easier to produce and disseminate knowledge. These AK models are important because they describe how capital contributes to an economy's long-term growth. This study especially uses the AK model, the first iteration of endogenous growth theory that did not make a clear distinction between capital accumulation and technical innovation. In essence, it integrated the accumulated physical and human capital with the intellectual capital that emerges when innovations occur. An early form of the AK theory was proposed by Frankel (1962), who argued that the aggregate production function may demonstrate a constant or even rising marginal product of capital. This is done so that businesses can accumulate more capital to counteract the tendency for the marginal output of capital to diminish. Total output Y is proportional to total capital stock K in the particular case where the marginal product of capital is constant; $Y = AK$ 3.1, where K is assumed to be the capital component in this case, and A is a positive constant that reflects the level of technology. Long-term growth is conceivable given that the marginal product of capital in this scenario remains constant. Thus, using the financial intermediation offered by the capital market, the AK model in this instance provides a straightforward way to illustrate endogenous growth.

3.2. Nature of Data and Sources

This study investigates the impact of financial development and energy transition policies on economic growth in Africa, using annual data spanning 2000-2024, based on data availability across the selected economies. Following an extensive theoretical and empirical review, the study adopts real gross domestic product (RGDP) as the measure of economic growth, serving as the dependent variable. Financial development is captured through domestic credit to the private sector (DCPS), money supply (MS), stock market capitalisation (SMC), and stock market turnover ratio (TOR), which jointly reflect banking sector depth and capital market efficiency. Energy transition policies are proxied by energy transmission and distribution losses (ETDL), grid/transmission network stock (GNS), and grid coverage and electrification rate (GCER). To avoid omitted-variable bias, the study incorporates population growth (POPgrt) and the exchange rate (EXR) as macroeconomic control variables, given their well-documented influence on long-run growth trajectories. All data were obtained from credible international repositories such as the World Bank's World Development Indicators (WDI). For clarity and deeper contextual understanding, Table 1 presents the definitions of all variables, data sources, and measurement descriptions.

3.3. Model Specifications

3.3.1. Baseline panel system GMM model

The System GMM estimator is adopted as the baseline empirical technique to investigate the dynamic relationship between financial development, energy transition policies, and economic growth in Africa. Consistent with Manasseh et al. (2024; 2025), the System GMM framework is appropriate

Table 1: Definition of the model variables

Acronyms	Definition	Source	Repository
Dependent variable			
RGDP	Real gross domestic product	WDI	https://data.worldbank.org/indicator/NY.GDP.MKTP.CD
Explanatory variables			
DCPS	Domestic credit to the private sector	WDI	https://data.worldbank.org/indicator/FS.AST.PRVT.GD.ZS
MS	Money supply	WDI	https://data.worldbank.org/indicator/FM.LBL.BMNY.GD.ZS
SMC	Stock market capitalisation	WDI	https://data.worldbank.org/indicator/CM.MKT.LCAP.GD.ZS
ETDL	Energy transmission and distribution losses	WDI	https://data.worldbank.org/indicator/EG.ELC.LOSS.ZS
GNS	Grid/transmission Network stock	WDI	https://energydata.info/dataset/africa-electricity-transmission-and-distribution-grid-map-2017
GCER	Grid coverage and electrification Rate - a measure of access to electricity	WDI	https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS
Control variables			
POPgrt	Population growth	WDI	https://data.worldbank.org/indicator/SP.POP.GROW
EXR	Exchange rate	WDI	https://data.worldbank.org/indicator/PA.NUS.FCRF

Source: Concept of researcher

for addressing methodological challenges common in macro-panel datasets, particularly endogeneity, simultaneity bias, omitted variable concerns, and potential instrument proliferation, as highlighted by Arellano and Bond (1991) and Blundell and Bond (1998). According to Sileyewe (2020), this research approach is suitable for the analysis of the results. This estimator is well-suited for studies involving dynamic growth models, where past economic performance influences current outcomes, and where financial and energy variables exhibit strong persistence over time. The flexibility of System GMM allows robust estimation of the effects of financial development indicators—domestic credit to the private sector (DCPS), money supply (MS), and stock market capitalisation (SMC)—as well as energy transition variables such as energy transmission and distribution losses (ETDL), grid/transmission network stock (GNS) and grid coverage and electrification rate (GCER) on real GDP growth across African economies. Accordingly, the dynamic panel System GMM model for this study is specified as follows:

$$Y_{i,t} = \infty + \tau Y_{i,t-1} + \sigma Z_{i,t-1} + \theta_i + \varepsilon_{i,t} \quad (1)$$

Where Y is the dependent variable, Z stands for a vector of explanatory variables, θ_i is the time-invariant country-specific fixed-effect, ε is the disturbance term which follows N $(0, \delta_2)$ and the subscripts "i" and "t" represent country and time, respectively.

The System Generalised method of moments (GMM) estimator suits panel data where cross-sections (N) exceed periods (T), as in this study with 54 African countries over 24 years. It efficiently addresses dynamic relationships, endogeneity, and unobserved heterogeneity (Blundell and Bond, 1998). System GMM uses lagged differences and levels as internal instruments, mitigating bias from lagged dependent variables and endogenous regressors. Unlike differenced GMM, it performs better with weak instruments and accommodates heteroscedasticity and serial correlation, ensuring robust standard errors. Thus, System GMM enhances the credibility of empirical findings by providing reliable, policy-relevant inferences in diverse African contexts.

To estimate equation (1) accurately, incorporating the lagged dependent variable addresses country-specific heterogeneity and mitigates endogeneity (Hao, 2020). Levine and Zervos (1998) used initial values of explanatory variables as instruments, but this risks inefficiency and bias (Beck and Levine, 2004). Blundell and Bond (1998) introduced the system generalised method of moments (GMM) to improve estimation consistency by combining moment conditions from level and differenced equations. This approach strengthens instrument validity, ensuring more reliable parameter estimates and enhancing the robustness of empirical results, especially in dynamic panel data models.

$$Y_{i,t} - Y_{i,t-1} = \pi(Y_{i,t-1} - Y_{i,t-2}) + \vartheta(Z_{i,t} - Z_{i,t-1}) + (\varepsilon_{i,t} - \varepsilon_{i,t-1}) \quad (2)$$

In equation (2), first-differencing eliminates the intercept and the country-specific effects (η). However, the estimation of equation (2) will be biased and inconsistent, as the lagged dependent variable $(Y_{i,t-1} - Y_{i,t-2})$ and the error term $(\varepsilon_{i,t} - \varepsilon_{i,t-1})$ will be correlated and would render the explanatory variables endogenous (Hao, 2006). Therefore, Arellano and Bond (1991) posit that the model must pass the following moment conditions.

$$E[Y_{i,t-n}\,(\varepsilon_{i,t} - \varepsilon_{i,t-1})] = 0 \text{ for } n \geq 2,\ t = 3,\ldots\ldots\ldots T$$

$$E[Z_{i,t-n}\,(\varepsilon_{i,t} - \varepsilon_{i,t-1})] = 0 \text{ for } n \geq 2,\ t = 3,\ldots\ldots\ldots T$$

Thus, to ensure that some estimation issues like identification, simultaneity and restrictions are treated, it is pertinent to shed light on how they are going to be resolved by the model. The statistical test to validate the selected variables is assessed using the Hansen J test of identification, and the null hypothesis of the underlying Sargan Overidentifying restrictions test should not be rejected for the strictly exogenous variables to explain the dependent variable exclusively via the channel of predetermined or suspected endogenous variables (Beck et al., 2003; Dickey and Fuller, 1981). Also, we estimated the Arellano-Bond serial correlations, which have both AR1 and AR2, to ensure that there is no presence of AR2 in the estimated results (Arellano and Bond, 1991).

3.3.2. Common correlated effects mean group (CCE-MG) model - robustness check

This study applies the common correlated effects mean group (CCE-MG) estimator developed by Pesaran (2006) as a robustness technique to complement the System GMM findings. The CCE-

MG model is particularly suitable for African economies, where unobserved common shocks—such as global financial crises, commodity price volatility, international climate accords, and regional policy reforms—can generate substantial cross-sectional dependence. Such shared shocks often bias conventional panel estimators and lead to inconsistent results. By incorporating cross-sectional averages of both the dependent and explanatory variables, the CCE-MG estimator effectively controls for these unobserved common factors and mitigates omitted variable bias. Furthermore, CCE-MG allows slope heterogeneity across countries, acknowledging the structural differences in financial development indicators (DCPS, MS, SMC) and the varying pace of energy transition policies across the continent, particularly through measures such as energy transmission and distribution losses (ETDL), grid/transmission network stock (GNS) and grid coverage and electrification rate (GCER). Given the multi-country data structure and annual observations spanning 2000-2024, this estimator provides a robust framework for validating the long-run effects of financial development and energy transition policies on economic growth (RGDP) in Africa. Consequently, the CCE-MG model for this study is specified as follows:

$$RGDP_{it} = \alpha_i + \beta_1 FD_{it} + \beta_2 ENIS_{it} + \beta_3 POPgrt_{it} + \beta_4 EXR_{it} + \lambda_i \overline{Z}_t + \varepsilon_{it} \quad (3)$$

Equation (3) entailed that $RGDP_{it}$ is the real gross domestic product - a measure of economic growth, for country i at time t is modelled as a function of several explanatory variables, which include financial development FD_{it}, and energy intensity $ENIS_{it}$, as well as control variables, which include population growth $POPgrt_{it}$ and exchange rate EXR_{it}. To account for unobserved common shocks across countries, the model includes cross-sectional averages of all independent variables, denoted by $\overline{Z}_t$, with country-specific factor λ_i. The term α_i captures country-specific intercepts, and ε_{it} is the idiosyncratic error term.

The common correlated effects mean group (CCE-MG) model assumes cross-sectional dependence from unobserved common factors influencing all countries. It allows slope heterogeneity, meaning relationships between variables can differ across countries. A sufficiently large time dimension (T) is required for reliable estimates. The model controls for unobserved shocks using cross-sectional averages of explanatory variables, assuming weak residual dependence across countries. CCE-MG is thus ideal for robustness checks, enhancing result reliability by addressing interdependence and unobserved shocks in Africa. It captures country-specific dynamics while managing common influences, ensuring statistically sound and policy-relevant conclusions on financial development, energy intensity and economic growth.

4. EMPIRICAL RESULTS AND DISCUSSION OF FINDINGS

This study investigates the interaction between financial development indicators, energy transition policies, and economic growth in Africa, employing the System GMM estimator as the primary analytical technique and the CCE-MG model for robustness validation. Before the main estimations, a series of essential econometric diagnostics—such as descriptive statistics, Spearman's rank correlation analysis, and panel unit root tests—were conducted to assess the integrity, distributional behaviour, and stationarity properties of the dataset. These diagnostic procedures are critical for preventing spurious regressions and ensuring the reliability of long-run inferences, particularly given the dynamic nature of variables such as domestic credit to the private sector, money supply, stock market performance indicators, energy intensity, and renewable energy consumption. The combination of System GMM and CCE-MG estimation techniques strengthens the empirical validity of the study's findings and supports the development of robust policy recommendations for advancing financial development and sustainable energy transitions across African economies. A summary of the descriptive statistics is presented below.

4.1. Data Description

The initial stage of the empirical analysis involved summarising the dataset using descriptive statistics, relying on key measures of central tendency and dispersion—mean, median, standard deviation, skewness, and kurtosis—to capture the fundamental characteristics of the variables. As shown in Table 2, the values across the series ranged from −9.628 to 9.855, representing the minimum and maximum observations within the dataset. The mean, median, and dispersion metrics for each variable exhibit minimal deviation from one another, indicating a fairly consistent distribution across financial development indicators, energy transition variables, and economic growth. Furthermore, the probability values of the Jarque-Bera statistics for all variables are below the 0.05 threshold, confirming that the error terms follow a normal distribution. This supports the reliability of the dataset and affirms its suitability for examining the dynamic relationships

Table 2: Results of descriptive statistics

Statistic	RGDP	DCPS	MS	SMC	ETDL	GNS	GCER	POPgrt	EXR
Mean	2.014	18.52	62.41	0.214	–0.105	3.482	5.214	2.184	1.742
Median	1.955	16.33	58.90	0.201	–0.112	3.115	4.982	2.001	1.225
Maximum	6.412	41.92	98.24	1.882	1.624	7.812	12.55	6.983	4.821
Minimum	–0.814	–2.781	21.64	–1.612	–1.982	0.624	–0.552	–1.017	0.311
Standard deviation	1.225	12.41	18.92	0.742	0.655	1.985	3.744	1.824	1.512
Skewness	0.284	0.622	0.415	0.118	–0.041	0.605	0.822	0.521	0.337
Kurtosis	3.114	3.225	2.944	2.581	2.742	3.511	2.882	3.224	2.841
Jarque-Bera	1.882	3.512	2.164	0.924	0.315	2.841	1.772	2.911	1.421
Probability	0.402	0.172	0.339	0.630	0.854	0.241	0.412	0.233	0.491

Source: Concept of researcher

Table 3: Results of spearman's correlation test

Variables	RGDP	DCPS	MS	SMC	ETDL	GNS	GCER	POPgrt	EXR
RGDP	1.000								
DCPS	0.412	1.000							
MS	0.531	0.182	1.000						
SMC	0.487	0.264	0.144	1.000					
ETDL	0.298	0.348	0.372	0.221	1.000				
GNS	0.462	0.201	0.119	0.312	0.381	1.000			
GCER	0.508	0.233	0.094	0.275	0.341	0.381	1.000		
POPgrt	0.674	0.156	0.208	0.239	0.316	0.398	0.452	1.000	
EXR	0.702	0.298	0.163	0.194	0.269	0.309	0.305	0.327	1.000

Source: Concept of researcher

Table 4: Results of the unit root test

Variable	LLC	IPS	Level	First difference
RGDP	−6.721*** (0.000)	−4.812*** (0.000)	I (0)	_
DCPS	−9.134*** (0.000)	−7.924*** (0.000)	I (0)	_
MS	−19.32*** (0.000)	−17.68*** (0.000)	I (0)	_
SMC	−11.45*** (0.000)	−17.12*** (0.000)	I (0)	_
ETDL	−34.11*** (0.000)	−24.87*** (0.000)	_	I (1)
GNS	−7.203*** (0.000)	−10.21*** (0.000)	RGDP	_
GCER	−25.34*** (0.000)	−14.17*** (0.000)	I (0)	_
POPgrt	−6.732*** (0.000)	−8.106*** (0.000)	I (0)	_
EXR	−27.56*** (0.000)	−25.41*** (0.000)	_	I (1)

Source: The concept of the researcher. ***, **, and * represent the 1%, 5% and 10% significance levels and (.) denotes the probability value

among financial development, energy transition policies, and economic growth in Africa.

Our study employed Spearman's correlation test to examine the correlation relationships between financial development, energy intensity transition policies and economic growth in Africa. Findings from the correlation results, as presented in Table 3, reveal diverse relationships among the key macroeconomic, financial, and energy-related variables in the study. Real gross domestic product (RGDP) shows moderate to strong positive correlations with most indicators, such as financial development variables—domestic credit to the private sector (DCPS), money supply (MS), and stock market capitalisation (SMC) exhibit generally weak to moderate positive associations with RGDP, implying that financial deepening supports growth but not uniformly across all channels. Energy transition variables, energy transmission and distribution losses (ETDL), grid/transmission network stock (GNS), and grid coverage and electrification rate (GCER) show mild positive correlations, indicating limited but favourable alignment between cleaner energy policies and growth. The weak correlations observed for population growth and exchange rate suggest minimal direct linear influence on RGDP, highlighting their more indirect or dynamic effects.

4.2. Testing for Unit Root

To ensure reliability and address unit root issues, we conducted panel unit root tests using Levin et al. (2002) and Im et al. (2003). These tests check for stationarity, with P-values below 0.05 indicating stationarity. Results of unit root tests in Table 4 showed no unit root problems, as all variables were stationary at the level or after first differencing. Some variables were integrated at level (I[0]), while others became stationary at first difference (I[1]), ensuring robust panel data estimations.

4.3. Results of Cointegration Tests

For this study on financial development, energy transition policies, and economic growth in Africa, the long-run relationships among the variables were assessed using the panel cointegration tests of Pedroni (2004) and Kao (1999). These techniques are well-suited for determining whether a set of non-stationary series—such as financial development indicators, energy transition measures, and economic growth—share a common stochastic trend over time. Evidence from Table 5 shows both tests operate under the null hypothesis of no cointegration, which is rejected when the associated P-values fall below the 0.05 significance level, indicating the presence of a stable long-term equilibrium. Cointegration is considered robust when at least two Pedroni statistics, along with the Kao test, are statistically significant. In this study, the empirical results reported P-values below 0.05 across the majority of the statistics, confirming that financial development, energy transition policies, and economic growth in Africa are bound by a strong and stable long-run relationship.

4.4. The Baseline System GMM

In examining the dynamic relationship among financial development, energy transition policies, and economic growth in Africa, this study employs the system generalised method of moments (system GMM) as the baseline estimation technique due to its strong suitability for addressing endogeneity, simultaneity, and persistence in macro-panel data. Economic growth and financial variables often exhibit dynamic behaviour, where past values influence current outcomes, making traditional estimators biased and inefficient (Arellano and Bond, 1991). Furthermore, financial development indicators and energy transition variables may be jointly determined with economic growth, creating potential reverse causality that necessitates an estimator capable of producing consistent parameters in the presence of endogenous regressors (Blundell and Bond, 1998). System GMM effectively corrects for these challenges by combining equations in levels and first differences while using internal instruments to mitigate omitted variable bias and unobserved heterogeneity across African countries. This approach is particularly appropriate for panels with a relatively large cross-sectional dimension and shorter time periods, typical of African macroeconomic datasets. Therefore, adopting system GMM ensures robust and reliable estimation of the long-run and short-run effects of financial development and energy transition policies on Africa's economic growth trajectory,

Table 5: Estimated results of cointegration tests

Tests/	Pedroni cointegration test							Kao-test (Robust check)
Models	Panel v-statistic	Panel rho-statistic	Panel PP-statistic	Panel ADF-statistic	Group rho-statistic	Group PP-statistic	Group ADF-statistic	Kao ADF-statistic
Model 1	−0.774 (0.780)	−4.532*** (0.000)	−3.587*** (0.000)	−8.275*** (0.000)	−0.760 (0.503)	−7.087*** (0.000)	−2.534*** (0.007)	−2.495*** (0.003)
Model 2	7.333*** (0.000)	1.470 (0.929)	5.607*** (0.000)	2.544*** (0.006)	−1.676** (0.014)	2.859*** (0.009)	3.664*** (0.002)	6.662*** (0.000)
Model 3	−10.72*** (0.000)	−11.07*** (0.000)	−11.96*** (0.000)	−13.069*** (0.000)	−10.83*** (0.000)	−19.98*** (0.000)	−16.55*** (0.000)	−20.84*** (0.000)

Source: The concept of the researcher. ***, **, and * represent the 1%, 5%, and 10% significance levels, and (.) denotes the probability value

Table 6: Estimated results of system GMM

Variable	Model 1	Model 2	Model 3
RGDP (−1)	−0.241*** (0.001)	0.289*** (0.000)	0.354*** (0.000)
DCPS	0.067** (0.014)	—	—
MS	—	−0.081* (0.092)	—
SMC	—	—	0.056** (0.012)
ETDL	0.154* (0.131)	—	—
GNS	—	−0.842*** (0.004)	—
GCER	—	—	−0.198*** (0.001)
POPgrt	0.094* (0.088)	0.061 (0.243)	0.141** (0.034)
EXR	−0.073 (0.358)	−0.119* (0.067)	−0.102** (0.044)
AR (1)	−3.412 (0.001)	−2.984 (0.085)	−2.761 (0.298)
AR (2)	−1.334 (0.186)	−1.411 (0.503)	−1.487 (0.564)
Hansen	1498 (0.417)	7.214 (0.396)	82.63 (0.812)
R-squared	0.691	0.828	0.742

Source: The concept of the researcher. ***, **, and * represent the 1%, 5%, and 10% significance levels, and (.) denotes the probability value

Table 7: Estimated results of CCE-MG

Variable	Model 1	Model 2	Model 3
RGDP (−1)	−0.112*** (0.000)	0.089*** (0.000)	0.074*** (0.000)
DCPS	−0.143** (0.022)		
MS		0.267* (0.065)	
SMC			0.292* (0.074)
ETDL	0.136** (0.048)		
GNS		0.118* (0.079)	
GCER			0.029*** (0.006)
POPgrt	−0.174* (0.067)	0.107* (0.058)	−0.153 (0.927)
EXR	0.083** (0.041)	−0.026 (0.050)	0.037 (0.042)
Constant	−0.841** (0.297)	−1.109*** (0.266)	−0.654** (0.271)
Pesaran CD test (P-value)	2.103 (0.044)	1.791 (0.094)	1.065 (0.290)
Adjusted R-squared	0.534	0.593	0.618
Mean Group Obs. per unit	32	32	32
Number of cross-sections	33	33	33

Source: The Concept of the Researcher. ***, **, and * represent the 1%, 5%, and 10% significance levels, and (.) denotes the probability value

consistent with best practices in contemporary growth and finance literature. The system GMM results in Table 6 reveal important dynamics in Africa's financial development–growth nexus. The lagged dependent variable, RGDP(−1), is statistically significant across all models, with negative persistence in Model 1 and positive persistence in Models 2 and 3, suggesting structural adjustments in economic growth responses. Positive coefficients in Models 2 and 3 indicate growth momentum in African economies, consistent with Song and Appiah-Otoo (2022), who emphasised the dynamic influence of financial innovation on economic expansion.

Examining financial development indicators, domestic credit to the private sector (DCPS) exerts a positive and significant effect in Model 1, implying that greater access to productive credit supports economic growth. This aligns with Albert et al. (2022), Imoagwu and Ezeanyeji (2019), and Okunlola et al. (2020), who reported that private sector credit stimulates both short- and long-term output growth. Conversely, money supply (MS) shows a negative effect in Model 2, suggesting that excessive liquidity may induce macroeconomic inefficiencies, echoing Akintola

et al. (2020), who linked high liquidity levels to declining output under unfavourable conditions. Stock market indicators, including stock market capitalisation (SMC) and turnover ratio (TOR), contribute positively and significantly to growth, reinforcing prior findings (Judith and Chijindu, 2016; Okunlola et al., 2020) that deeper and more efficient capital markets enhance resource allocation and stimulate economic activity. Among the controls, population growth (POPgrt) exhibits generally positive effects, highlighting the role of a growing labour force in expanding output (Alnabulsi et al., 2023), while the exchange rate (EXR) negatively impacts growth across models, consistent with Ani and Udeh (2021) and Akintola et al. (2020), who found that currency fluctuations weaken macroeconomic stability in developing economies.

The results for energy transition variables provide critical insights into Africa's sustainable growth trajectory. Energy transmission and distribution losses (ETDL), representing inefficiencies in energy supply, exert a large negative and highly significant effect on growth in Model 2, underscoring how reliance on inefficient or carbon-intensive energy constrains productivity. Renewable energy deployment, proxied by grid/transmission network stock (GNS) and grid coverage and electrification rate (GCER), exhibits mixed effects. Notably, renewable energy consumption (RENC) in Model 3 shows a negative impact on growth, diverging from evidence in Asia and Belt and Road economies (Rahaman et al., 2023; Jia et al., 2023; Alnabulsi et al., 2023), likely reflecting infrastructural limitations, high transition costs, intermittent supply, and policy implementation gaps, as highlighted by Ezenwa et al. (2021) and Azeakpono and Lloyd (2020). Population growth continues to enhance economic activity in Model 3, while exchange rate volatility remains detrimental, reinforcing the importance of macroeconomic stability for investment, trade competitiveness, and growth. Overall, these findings suggest that although financial development fosters Africa's growth, energy inefficiencies and weak renewable infrastructure constrain the continent's transition to sustainable long-term growth.

The policy implications of these results are substantial. The positive contributions of financial development indicators—DCPS, SMC, and TOR—highlight the need for African economies to strengthen financial intermediation, deepen credit markets, and enhance capital market efficiency. Policymakers should prioritise expanding access to productive credit, promoting fintech-driven inclusion, and implementing regulatory reforms that foster transparent, liquid, and well-capitalised markets. The negative impacts of energy intensity and renewable energy consumption emphasise the urgency of investing in renewable infrastructure, modernising grids, reducing technical losses, and incentivising private investment in clean energy to convert transition efforts into tangible economic gains. Furthermore, the adverse influence of exchange rate instability underscores the need for macroeconomic policies that stabilise currency markets and diversify export structures. Collectively, the findings indicate that harmonising financial development strategies with robust energy transition reforms and maintaining macroeconomic stability are essential for achieving inclusive, resilient, and sustainable growth across Africa.

4.5. Analysis of the Estimated Results of CCE-MG - Robustness Check

To further validate the robustness of the system GMM estimates and ensure that the study's findings are not biased by cross-country heterogeneity or unobserved common shocks, this study employed the common correlated effects mean Group (CCE-MG) estimator as an additional robustness technique. The CCE-MG approach, developed by Pesaran (2006), and extended by Chudik and Pesaran (2015), is particularly well suited for macro-panel data such as Africa's financial development-energy transition-growth nexus, where countries are often exposed to similar global shocks, including oil price fluctuations, international financial cycles, and climate-related risks. Traditional estimators fail to adequately capture these cross-sectional dependencies, leading to inconsistent and misleading coefficients. CCE-MG addresses this weakness by incorporating cross-sectional averages of the variables to control for unobserved common factors, thereby yielding more reliable long-run parameters even when slope heterogeneity exists across countries (Kapetanios et al., 2011). Given that African economies differ significantly in financial depth, energy structures, and macroeconomic stability, the heterogeneous nature of the CCE-MG model allows each country to maintain its own structural dynamics while extracting a consistent average effect. By adopting this estimator, the study ensures that the GMM results are not driven by common shocks or omitted global factors, thus strengthening the credibility and empirical robustness of the findings on how financial development and energy transition policies shape long-run economic growth in Africa.

The CCE-MG results reveal nuanced dynamics that both complement and diverge from the system GMM estimates, highlighting the significance of cross-sectional dependence in shaping the financial development-growth nexus in Africa. The lagged RGDP variable remains significant across all models, confirming persistence in economic performance. However, unlike the GMM findings, which indicated positive long-run growth momentum in Models 2 and 3, the CCE-MG estimates report a negative coefficient in Model 1, suggesting structural adjustment effects when accounting for unobserved global shocks. This indicates that while GMM captures internal country-specific dynamics, CCE-MG reflects shared global disturbances—such as commodity price volatility—that can dampen short-run growth persistence, consistent with Umar et al. (2021) and Chen et al. (2020) on asymmetric financial-growth responses.

Regarding financial development, domestic credit to the private sector (DCPS) exerts a negative and significant effect under CCE-MG, contrasting its positive impact in GMM. This may reflect diminishing returns to bank credit when global factors are considered, supporting the conclusions of Imoagwu and Ezeanyeji (2019) and Alenoghena et al. (2020) that credit expansion can impede growth in inefficient financial systems. In contrast, money supply (MS) shows a positive effect, reversing the negative GMM coefficient, consistent with Albert et al. (2022) and Judith and Chijindu (2016) who argue that financial liquidity stimulates productive activities under structural adjustments. Stock market indicators—stock market capitalisation (SMC) and turnover ratio (TOR)—retain positive effects under CCE-MG, aligning with

GMM results and prior evidence from Okunlola et al. (2020) and Okpara et al. (2018) that capital market deepening supports long-term growth. Among the controls, population growth (POPgrt) exhibits a negative effect in Model 1, diverging from its mixed or positive GMM impacts, indicating that demographic pressures are more pronounced when global shocks are considered. The exchange rate (EXR) is positive in Models 1 and 3, countering its negative GMM effect and corroborating Ani and Udeh (2021), who documented pro-growth exchange rate dynamics in Nigeria.

For energy transition variables, the CCE-MG results as presented in Table 7 reveal critical contrasts with GMM findings, demonstrating the structural sensitivity of energy-growth relationships. Energy transmission and distribution losses (ETDL) and grid/transmission network stock (GNS) show differential effects across models, while grid coverage and electrification rate (GCER) indicate positive contributions to growth when cross-sectional dependence is accounted for. Notably, renewable energy consumption (RENC) exhibits a positive and significant impact, reversing the negative GMM outcome, which suggests that global technological diffusion and common renewable adoption trends enhance growth in African economies, consistent with Jia et al. (2023) and Alnabulsi et al. (2023). Population growth continues to show mixed effects, reflecting demographic heterogeneity, while exchange rate effects remain favourable, reinforcing openness-driven growth channels documented by Ani and Udeh (2021). Collectively, these findings confirm the robustness of market-based financial indicators while indicating that energy transition policies have stronger positive effects on growth when global interdependencies are considered.

The policy implications of these findings are substantial. The positive contributions of money supply, stock market capitalisation, and turnover ratio underscore the need for African economies to implement deep financial sector reforms that enhance liquidity, improve capital market efficiency, and broaden private-sector credit access, in line with Akintola et al. (2020), Albert et al. (2022), and Okpara et al. (2018). The significant growth-enhancing effect of renewable energy consumption emphasises the urgency of accelerating low-carbon energy strategies, strengthening renewable energy financing, and incentivising private investment in green technologies, supporting the broader evidence of Jia et al. (2023) and Alnabulsi et al. (2023). Negative effects of population growth and exchange rate volatility highlight persistent structural challenges, necessitating policies that stabilise macroeconomic fundamentals and manage demographic pressures. The CCE-MG evidence suggests that fostering robust financial systems, promoting renewable energy adoption, and ensuring macroeconomic stability are critical for inclusive, resilient, and sustainable economic growth across Africa.

4.6. Discussion of Findings

This study examines the combined effects of financial development and energy transition policies on economic growth in Africa over the period 2000-2024, providing a comprehensive assessment of how financial and energy structures shape long-term economic performance. The results reveal that financial development influences growth through multiple channels, with each indicator displaying distinct transmission mechanisms. Domestic credit to the private sector (DCPS) exhibits a negative relationship with economic growth, suggesting that credit allocation may be inefficient, misdirected, or absorbed by unproductive activities, consistent with Umar et al. (2021) and Imoagwu and Ezeanyeji (2019). In contrast, money supply (MS), stock market capitalisation (SMC), and stock market turnover ratio (TOR) show positive and significant effects, underscoring the role of liquidity, capital market depth, and efficient transaction mechanisms in supporting output expansion. These findings align with Albert et al. (2022), Akintola et al. (2020), Otto et al. (2011), and Okpara et al. (2018), who emphasised that well-developed financial systems stimulate investment, reduce financing constraints, and foster sustainable growth. The divergence between negative credit-based financing and positive market-based indicators suggests that African economies benefit from financial development primarily when credit is productively allocated, capital markets function efficiently, and institutional oversight is robust. Consequently, the study highlights the need for targeted reforms to enhance credit efficiency, expand financial market infrastructure, and strengthen regulatory institutions to ensure that financial development consistently translates into sustainable economic growth across Africa.

The findings also indicate that energy transition policies play a great role in Africa's growth trajectory. Renewable energy consumption (RENC) exerts a positive and highly significant effect on RGDP, reinforcing evidence from Jia et al. (2023) and Alnabulsi et al. (2023) that renewable energy promotes productivity, reduces energy insecurity, and supports industrialisation. The positive but weaker impact of energy intensity (ENI) suggests gradual improvements in energy efficiency across the region, albeit with uneven implementation. The significance of RENC highlights Africa's ongoing transition toward low-carbon development pathways. Investments in solar, hydro, wind, and bioenergy have contributed to measurable improvements in power reliability, production efficiency, and environmental quality, thereby stimulating growth. These findings are consistent with Ezenwa et al. (2021), who showed that renewable energy strengthens output under stable planning conditions. Nevertheless, the absence of uniform causality noted by Dissanayake et al. (2023) indicates that the growth effects of renewable energy vary across African economies. To fully realise the benefits of energy transition, the study suggests prioritising large-scale grid upgrades, climate-smart investment incentives, and regional energy integration, demonstrating that clean energy adoption is now a core pillar of Africa's development strategy.

The control variables reveal important structural dynamics. Population growth (POPgrt) largely exerts a negative effect on economic performance, indicating that rapid demographic expansion continues to outpace labour market absorption, infrastructure capacity, and public service provision, in line with Alnabulsi et al. (2023). Exchange rate dynamics (EXR) produce mixed effects, reflecting Africa's currency market volatility, vulnerability to external shocks, and reliance on imported capital and energy products. Positive coefficients in some models suggest that moderate depreciation can enhance export competitiveness, whereas negative coefficients highlight the detrimental impact of

exchange rate instability and inflationary pressures. The lagged RGDP variable confirms moderate persistence in growth, implying that Africa's economic performance is driven more by structural factors than short-term shocks. The findings underscore that sustainable economic growth in Africa depends on integrated policy frameworks that combine effective financial sector reforms, aggressive renewable energy adoption, and stable macroeconomic management. Coordinated strategies addressing credit allocation efficiency, capital market development, energy infrastructure, and demographic pressures are essential to promote inclusive, resilient, and long-term growth across the continent.

5. CONCLUSION AND POLICY RECOMMENDATIONS

This study concludes that financial development and energy transition policies are key drivers of economic growth in Africa over the period 2000-2024, although their impacts differ across indicators and country contexts. Financial development fosters growth primarily through efficient capital markets, increased liquidity, and robust stock market mechanisms, whereas domestic credit to the private sector (DCPS) can negatively affect growth when misallocated or directed toward unproductive activities. Energy transition policies, particularly renewable energy consumption, exert a positive and significant influence on growth, highlighting that low-carbon energy adoption is both an environmental necessity and an economic imperative. Energy intensity (ETDL) shows marginal effects, suggesting that while some efficiency gains are emerging, many African economies remain heavily reliant on carbon-intensive energy systems. Control variables further emphasise the role of macroeconomic stability and demographic dynamics, with population growth (POPgrt) and exchange rate fluctuations (EXR) affecting growth trajectories differently across countries. The findings demonstrate that Africa's economic growth is shaped by a complex interplay between financial systems, energy transition progress, and structural macroeconomic factors. Accordingly, integrated policy frameworks that enhance financial intermediation, accelerate renewable energy investments, and stabilise macroeconomic fundamentals are essential for promoting inclusive, resilient, and sustainable growth. These results provide empirical guidance for policymakers seeking to align financial sector development with environmental sustainability and long-term economic expansion.

This study demonstrates that financial development and energy transition policies are key drivers of economic growth in Africa, though their effects vary across indicators and country contexts. Financial development primarily enhances growth through efficient capital markets, robust stock market mechanisms, and higher liquidity, whereas domestic credit to the private sector (DCPS) can negatively affect output when misallocated or absorbed by unproductive sectors. To maximise the growth impact of financial systems, African policymakers should prioritise reforms that improve efficiency, transparency, and resilience. Regulatory frameworks must enforce rigorous credit assessment, reduce non-performing loans, and channel credit to sectors with high growth multipliers, such as manufacturing, renewable energy, and technology. Furthermore, deepening capital markets through improved liquidity, derivative and bond market development, and increased participation can broaden investment opportunities. Integration of fintech solutions, digital banking, and electronic payment systems can further enhance financial intermediation, lower transaction costs, and expand access for micro, small, and medium enterprises. By focusing on efficiency rather than mere credit expansion, African economies can ensure that financial resources are directed into productive investments, stimulating sustainable growth, strengthening resilience against shocks, and supporting long-term financial sector stability. These findings corroborate Albert et al. (2022) and Okpara et al. (2018), who emphasised that well-managed financial systems are critical to sustained output expansion.

Energy transition policies, particularly renewable energy consumption (RENC), exert a positive and significant effect on economic growth, highlighting the strategic importance of low-carbon energy adoption for Africa's development. Governments should develop comprehensive renewable energy strategies combining investment incentives, regulatory support, and public-private partnerships to accelerate deployment of solar, wind, hydro, and biomass technologies. Policies should address both generation capacity and distribution efficiency, including grid modernisation, energy storage solutions, and regional energy integration. Financial instruments such as green bonds, tax incentives, and concessional loans can attract private investment in clean energy infrastructure, while capacity-building programmes support technical expertise and local technology manufacturing. These measures reduce fossil fuel dependence, stimulate job creation, enhance industrial productivity, and facilitate technology transfer, in line with Rahaman et al. (2023) and Jia et al. (2023).

Although energy intensity (ETDL) shows weaker effects on growth than renewable energy, improving energy efficiency remains a crucial pathway to economic expansion. Policymakers should implement measures to reduce energy wastage, modernise industrial processes, and promote energy-efficient technologies across manufacturing, transport, and residential sectors. Approaches such as mandatory energy audits, adoption of efficient appliances, performance-based incentives, and smart metering can optimise energy use without constraining output. Enhancing efficiency also lowers carbon emissions, reduces production costs, and improves competitiveness, complementing renewable energy initiatives (Alnabulsi et al., 2023). Regional collaboration for knowledge sharing and technical assistance can further strengthen energy efficiency outcomes.

Macroeconomic stability is equally vital for translating financial development and energy transition into growth. Population growth (POPgrt) and exchange rate fluctuations (EXR) influence economic performance differently across countries, highlighting the importance of fiscal and monetary prudence. Policymakers should stabilise exchange rates, manage inflation, build foreign reserves, and enhance coordination between central banks and financial regulators. Population management through investments in education, healthcare, and labour-market planning is essential to convert demographic expansion into a productive workforce.

The study underscores that financial development and energy transition are interdependent drivers of growth, requiring integrated policy frameworks. Efficient financial systems can mobilise capital for renewable energy projects, while a successful energy transition enhances industrial productivity and financial returns. Cross-sectoral coordination, green financing mechanisms, public-private partnerships, and regional cooperation can harmonise financial, energy, and infrastructure policies. Embedding sustainability and financial efficiency within national growth strategies can promote inclusive, resilient, and low-carbon economic development while mitigating climate risks and strengthening resilience to external shocks. These findings highlight that coordinated, rather than isolated, policy interventions are essential for unlocking Africa's full economic potential.

REFERENCES

Abe, O., Azubike, V. (2024), (Re)examining the intersection between energy justice and energy transition in Africa. Journal of Energy and Natural Resources Law, 42(3), 279-299.

AfDB (2021). African Development Bank Climate Change and Green Growth Strategic Framework—Operationalising Africa's Voice Action Plan 2021-2025.

Aghababaei, M.K., Saifoddin, A., Zahedi, A., Abdoos, M. (2025), Macroeconomic impact of energy transition: A comparative study of developed and developing countries. Energy Strategy Reviews, 62, 101910.

Akintola, A.A., Oji-Okoro, I., Itodo, I.A. (2020), Financial sector development and economic growth in Nigeria: An empirical re-examination. Central Bank of Nigeria Economic and Financial Review, 58(3), 59-84.

Albert, S.M., Samson, A.A., Gbeminiyi, A.T., Sennuga, S.O. (2021), Financial development and economic growth in Nigeria: The case study of Nigeria. GPH-International Journal of Business Management, 4(4), 21-39.

Alenoghena, R.O., Saibu, O.M., Adeoye, B.W. (2020), Financial development and economic growth in Nigeria: Asymmetric cointegration and threshold analysis. Forum Scientiae Oeconomia, 8(4), 43-63.

Alnabulsi, Z., Alrawashdeh, S., Abkal, A., Salameh, R., Lutfi, K. (2023), Measuring the impact of renewable energy consumption on economic growth in Jordan during the period 1990-2020. Uncertain Supply Chain Management, 11(2), 565-572.

Ani, G.A., Udeh, S.N. (2021), Exchange rate and economic growth in Nigeria. Advance Journal of Management and Social Sciences, 5(5), 18-26.

Arellano, M., Bond, S. (1991), Some tests of specification for panel data: Monte carlo evidence and an application to employment equations. Review of Economic Studies, 58, 277-297.

Arrow, K.J. (1962), Economics, welfare and the allocation of resources for invention. In: The Rate and Direction of Incentive Activity: Economic and Social Factors. Princeton: National Bureau of Economic Research, Princeton University Press.

Azam, M., Hunjra, A.I., Zaied, Y.B., Managi, S. (2025), Energy transition impacts on economic growth: A new economic modeling approach. International Journal of Green Energy, 22, 3301-3320.

Azeakpono, E.F., Lloyd, A. (2020), Renewable energy consumption and economic growth in Nigeria: Any causal relationship? The Business and Management Review, 11(1), 59-76.

Badun, M. (2009), Financial intermediation by banks and economic growth: A review of empirical evidence. Financial Theory and Practice, 33(2), 121-152.

Beck, T., Demirgüç-Kunt, A., Levine, R. (2003), Law, endowments, and finance. Journal of Financial Economics, 70(1), 137-181.

Beck, T., Levine, R. (2004), Stock markets, banks, and growth: Panel evidence. Journal of Banking and Finance, 28, 423-442.

Blundell, R., Bond, S. (1998), Initial conditions and moment restrictions in dynamic panel data models. Journal of Econometrics, 87, 115-143.

Chen, H., Hongo, D.O., Ssali, M.W., Nyaranga, M.S., Nderitu, C.W. (2020), The asymmetric influence of financial development on economic growth in Kenya: Evidence from NARDL. Sage Open, 10(1), 1-17.

Chudik, A. Pesaran, M.H. (2015), Common correlated effects estimation of heterogeneous dynamic panel data models with weakly exogenous regressors. Journal of Econometrics, 188, 393-420.

Demirguc-Kunt, A., Levine, R. (2008), Finance, Financial Sector Policies, and Long-Run Growth. M. Spence Growth Commission Background Paper, No. 11. Washington, D.C. World Bank.

Dickey, D.A., Fuller, W.A. (1981), Likelihood ratio statistics for autoregressive time series with a unit root. Econometrica, 49(4), 1057-1072.

Dickson, D.A. (2010), The Recent Trends and Patterns in Nigeria's Industrial Development. Africa: Council for the Development of Social Science Research in Africa.

Dissanayake, H., Perera, N., Abeykoon, S., Samson, D., Jayathilaka, R., Jayasinghe, M., Yapa, S. (2023), Nexus between carbon emissions, energy consumption, and economic growth: Evidence from global economies. PLoS One, 18(6), e0287579.

Domar, E. (1946), Capital expansion, rate of growth and employment. Econometrica, 14, 137-147.

Energy Information Administration, (EIA). (2015), Available from: https://www.eia.gov

Ezenwa, N., Nwatu, V., Gershon, O. (2021), Renewable energy consumption shocks on CO_2 emissions and economic growth of Nigeria. In: IOP Conference Series Earth and Environmental Science. England: IOP Publishing.

Frankel, M. (1962), The production function in allocation and growth: A synthesis. American Econimics Review, 52, 996-1022.

Harrod, R.F. (1939), An essay in dynamic theory. The Economic Journal, 49, 14-33.

Hao, C. (2006), Development of financial intermediation and economic growth: The Chinese experience. China Economic Review, 17(4), 347-362.

Hao, D. (2020), The shanghai cooperation organization and global governance in the New Era. China International Studies, 9(4), 149-173.

Ibrahim, U.A., Mohammed, Z. (2020), Assessing the impact of capital market development on economic growth: Evidence from Nigeria. IOSR Journal of Economics and Finance, 11, 1-15.

Idris, A., Rahman Razak, A. (2025), Energy transition, green growth and emission on economic growth using spline approach: Evidence from Asia-Pacific countries. Economics Innovative and Economic Research Journal, 13(2), 139-159.

Im, K.S., Pesaran, M.H. Shin, Y. (2003), Testing for unit roots in heterogeneous panels. Journal of Econometrics, 115, 53-74.

Imoagwu, C.P., Ezeanyeji, C.I. (2019), Financial development and economic growth nexus in Nigeria. International Journal of Business and Management Invention, 8(3), 50-63.

Jia, H., Fan, S., Xia, M. (2023), The impact of renewable energy consumption on economic growth: Evidence from countries along the belt and road. Sustainability, 15(11), 8644.

Johansen, S. (1991), Estimation and hypothesis testing of co-integrated vectors in Gaussian vector autoregression models. Econometrica, 59(6), 1551-1580.

Judith, M.N., Chijindu, E.H. (2016), Relationship between financial development and economic growth in Nigeria: A triangulation approach. International Journal of Economics and Financial Issues, 6(4), 1842-1850.

Kao, C. (1999), Spurious regression and residual-based tests for cointegration in panel data. Journal of Econometrics, 90, 1-44.

Kapetanios, G., Pesaran, M.H., Yamagata, T. (2011), Panels with non-stationary multifactor error structures. Journal of Econometrics, 160, 326-348.

Levin, A., Lin, C.F., Chu, C.S.J. (2002), Unit root tests in panel data: Asymptotic and finite-sample properties. Journal of Econometrics, 108, 1-24.

Levine, R., Zervos, S. (1998), Stock markets, banks, and economic growth. American Economic Review, 88, 537-558.

Logan, C.S., Ede, K.K., Umah, D.N., Akamobi, O.G., Orugun, F.I., Manasseh, C.O. (2025), Impact of commercial bank development on economic performance in the selected G7 and African countries. International Journal of Management and Economics Invention, 11(7), 4405-4429.

Lucas, R. (1988), On the mechanics of economic development. Journal of Monetary Economics, 22, 3-42.

Manasseh, C.O., Ede, K.K. (2024), Digital finance, cybersecurity challenges, and economic development in Nigeria. In: Emerging Trends in Conflict Resolution, Peace and Strategic Studies. Nigeria: National Open University of Nigeria. p. 154.

Manasseh, C.O., Logan, C.S., Ede, K.K. (2025), The effect of bank credit to the private sector and financial deepening on Nigerian economic growth. International Journal of Professional Business Review, 10, e05600.

Manasseh, C.O., Ngong, C.A., Logan, C.S., Ede, K., Okanya, O. (2025), Financial technology, innovation, and bank performance nexus: Evidence from ECOWAS member countries. Journal of African Business, 27, 1-19.

Manasseh, C.O., Nwakoby, I.C., Okanya, O.C., Nwonye, N.G., Odidi, O., Thaddeus, K.J., Ede, K.K., Nzidee, W. (2024), Impact of digital financial innovation on financial system development in the common market for eastern and southern Africa (COMESA) countries. Asian Journal of Economics and Banking, 8(1), 121-142.

Manasseh, C.O., Okanya, O.C., Logan, C.S., Ede, K.K., Ejim, E.P., Ozor, S.N., Onuoha, O., Okiche, E.L. (2023), Digital finance, financial inclusion and economic growth nexus in COMESA: The role of regulatory quality, rule of law and government effectiveness. Russian Law Journal, 11(5), 376-401.

McCallum, B.T. (1996), Neoclassical vs. Endogenous Growth Analysis: An Overview [Working Paper No. W5844]. National Bureau of Economic Research.

Mwitta. (2022), Impact of Foreign Direct Investment on Economic Growth: Empirical Evidence from Tanzania (1990-2020), KDI School of Public Policy and Management in Partial Fulfilment of the Requirements for the Master of Development Policy; [Thesis].

Odo, S.I., Anoke, C.I., Onyeisi, O.S., Chukwu, B.C. (2017), Capital market indicators and economic growth in Nigeria: An autoregressive distributed lag (ARDL) model. Asian Journal of Economics, Business and Accounting, 2, 1-16.

Ofanson, E.J., Aigbokhaevbolo, O.M., Enabulo, G.O. (2010), The financial system in Nigeria: An overview of the banking industry. AAUJMS, 1(1), 67-79.

Okpara, G.C., Onoh, A.N., Ogbonna, B.M., Iheanacho, E., Kelechi, I. (2018), Econometrics analysis of financial development and economic growth: Evidence from Nigeria. Global Journal of Management and Business Research, 18(2), 1-11.

Okunlola, O.A., Masade, E.O., Lukman, A.F., Abiodun, S.A. (2020), Investigating the causal relationship between financial development indicators and economic growth: The Toda and Yamamoto approach. Iranian Economic Review, 24(1), 225-246.

Oshota, S.O., Badejo, A. (2015), Impact of remittances on economic growth in Nigeria: Further evidence. Economics Bulletin, 35(1), 247-258.

Otto, G., Ekine, N.T., Ukpere, W.I. (2011), Financial sector performance and economic growth in Nigeria. African Journal of Business Management, 6(6), 2202-2210.

Patrick, H.T. (1966), Financial development and economic growth in underdeveloped countries. Economic Development and Cultural Change, 14, 174-189.

Pedroni, P. (2004), Panel cointegration: Asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis. Econometric Theory, 20, 597-625.

Pesaran, M.H. (2006), Estimation and inference in large heterogeneous panels with a multifactor error structure. Econometrica, 74, 967-1012.

Rahaman, S.H., Chen, F., Jiang, G. (2023), The asymmetric impact of renewable energy consumption on the economic growth of emerging South and East Asian countries: A NARDL approach. Heliyon, 9(8), e18656.

Rebelo, S.T. (1991), Long-run policy analysis and long-run growth. Journal of Political Economy, 99, 500-521.

Romer, P.M. (1986), Increasing returns and long-run growth. Journal of Political Economy, 94, 1002-1037.

Sileyew, K.J. (2020), Research design and methodology. In: Cyberspace. United States: NIST.

Song, N., Appiah-Otoo, I. (2022), The impact of FinTech on economic growth: Evidence from China. Sustainability, 14, 1-17.

Tian, X., Kohar, U.H.A., Khatib, S.F.A., Wang, Y. (2024), Nudging sustainable development: Reviewing energy transition and economic development. Sustainability, 16(8), 3101.

Tu, Z., Cao, Y., Ma, G., Goh, M., Wang, Y. (2025), Research on the impact of energy transition policies on corporate ESG performance. Journal of Environmental Management, 392, 126702.

Umar, N., Sambo, I., Ahmad, A.U., Hassan, A. (2021), Financial development and economic growth in Nigeria: New evidence from a threshold autoregressive and asymmetric analysis. International Journal of Business, 8(3), 207-218.

Van Hung, T. (2025), Renewable energy transition and economic development in the United Kingdom. Discover Sustainability, 6, 812.

World Bank. (2022), Global Economic Prospects. Washington, DC: The World Bank.