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Governance and Innovation: Positive Drivers of Africa's Economic Performance

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Forthcoming: Economic Change and Restructuring

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Abstract

This study examines the relevance of governance in shaping the effect of innovation on Africa's economic performance. The analysis is based on a sample of 39 African countries, utilizing data from 2010 to 2023. The adopted empirical strategy is the interactive generalized method of moments (GMM), tailored to assess how governance and disaggregated governance dynamics (i.e., economic governance, political governance, and institutional governance) moderate innovation to enhance economic performance. The conceptualization and measurement of innovation and economic performance in this study are based on the Global Innovation Index (GII), GDP growth (annual %), and GDP per capita growth (annual %). The findings establish a positive net impact of innovation on economic performance, alongside a corresponding positive synergy between governance dynamics and innovation. This positive synergy is based on two key insights: (i) the existence of an unconditional positive relationship between innovation and economic performance, and (ii) a positive moderating role of governance dynamics in the innovation–economic performance nexus. Additional findings and policy implications are discussed within the framework of the African Union's Agenda 2063 and the Sustainable Development Goals (SDGs).

***Keywords*:** Governance, Innovations, Economic Performance, SGMM, Africa.

1.0 Introduction

The present study is situated within the debate on how governance interacts with innovation to influence Africa's economic performance. Its relevance is underpinned by three key considerations highlighted in contemporary literature: (i) the growing role of innovation in enhancing productivity, inclusion, and economic growth, (ii) the acknowledged importance of governance for shaping economic outcomes, and (iii) the noticeable gaps in existing empirical studies, particularly in the conceptualization and measurement of innovation. This study builds upon these considerations.

First, consistent with the extant literature, innovation[1] has been widely acknowledged as a major driver of long-term economic growth and sustainable development (World Intellectual Property Organization, WIPO, 2022). Theoretical perspectives reinforce this view. For instance, Romer (1994) positions innovation at the core of endogenous growth through knowledge accumulation and technological progress, while Schumpeter (1934, 2024) emphasizes its role as the engine of "creative destruction" that propels structural change. Recent scholarship further underscores its significance, with Fu and Shi (2022) highlighting innovation as a vital mechanism for addressing global challenges and advancing the 2030 Sustainable Development Goals (SDGs). In practice, innovation enhances productivity and competitiveness through technological advancement and knowledge creation (Jegede, 2025; Vukoszavlyev, 2019), drives structural transformation by enabling new industries and diversifying economic activities (Comin et al., 2025; Mysachenko et al., 2020), and addresses social and environmental challenges, such as health crises, food security, and climate change, thereby promoting inclusive and sustainable development (Kalkanci et al., 2019). Yet, while African nations increasingly recognize innovation as central to economic transformation and sustainable growth (Kaplinsky and Morris, 2019), the continent's innovation landscape remains fraught with several constraints.

Among these constraints are low research and development (R&D) capacity and deficits in human capital formation (Jegede and Ncube, 2021). Regarding the region's low R&D, Diop and Asongu (2023) noted that no African country allocates even 1% of its GDP to research, for example, nations like South Africa and Kenya (0.8%), Burkina Faso (0.67%), Ghana (0.38%), and Madagascar (0.01). By contrast, countries like France and the USA invest 2.19% and 2.71% of their GDP in research, respectively. Diop and Asongu (2023) further illustrated this gap, revealing that Africa has just 35 researchers per million people, while France and the USA boast 2,500 and 4,000 researchers per million, respectively. These discrepancies are compounded by insufficient funding for research, outdated infrastructure, and limited access to technology (Emeka & Asongu, 2025b). Despite substantial knowledge on the benefits

[1] Consistent with the World Intellectual Property Organization (WIPO, 2022), innovation in this study refers to a country's capacity to generate, diffuse, and apply knowledge and technology within an enabling institutional and economic environment.

of innovation and the constraints that limit its impact, a crucial gap remains in the literature on how governance can be leveraged to strengthen innovation in the region.

Second, in light of the existing literature on governance and economic prosperity, there is consensus that an effective governance framework is pivotal in shaping long-term development outcomes (Emeka & Asongu, 2025a; Asongu et al., 2024a; Ekeocha et al., 2023; Ogbonna et al., 2022; Vu, 2022; Arvin et al., 2021; North, 1991, inter alia). Building on this, Emeka et al. (2024a), Ogbuabor et al. (2023), and Ekeocha et al. (2023) argue that governance institutions are expected, at a minimum, to ensure governmental efficiency, uphold the rule of law, enforce sound regulations, combat corruption, safeguard political stability and security, and promote voice and accountability. Bisogno et al. (2025) noted that governance embodies the institutional framework through which policies are designed, implemented, and enforced, reflecting a society's capacity to meet societal needs, manage resources efficiently, and respond to complex challenges. Another strand of the literature emphasizes that governance quality creates conditions conducive to sustainable economic growth, particularly in alignment with the Sustainable Development Goals (SDGs), as evidenced by various empirical studies. For instance, Emeka et al. (2024a) found that governance quality is a potent factor for enhancing gender inclusion in Africa's economic complexity. Emeka and Asongu (2025a) find that strong governance institutions mitigate the adverse effects of illicit financial flows on Africa's productive capacity. Similarly, Asongu et al. (2024a) highlighted the required governance threshold for maintaining a positive effect of natural resources on economic growth.

Third, the present study contributes to the extant literature by investigating the relevance of governance in the relationship between innovation and Africa's economic performance. Accordingly, on the one hand, the study investigates inter alia: (i) how political governance, defined by political stability, absence of violence, and voice and accountability, moderates the effect of innovation on structural transformation; (ii) how economic governance, measured through government effectiveness and regulatory quality, shapes the contribution of innovation to economic performance; (iii) how institutional governance, proxied by corruption control and the rule of law, influences the capacity of innovation to drive economic performance; and (iv) how general governance, encompassing political, economic, and institutional dimensions, moderates innovation to improve economic performance. These governance definitions are consistent with the extant literature (Emeka & Asongu, 2025b; Asongu & Odhiambo, 2021). Furthermore, the issues motivating this work have not been fully addressed by recent studies on economic performance in Africa. While Asongu et al. (2025) focus on governance and structural transformation, and Asongu et al. (2024b) examine the role of globalization in lifelong learning, limited research has explored how governance interacts with innovation to drive economic performance. Importantly, the relationship between innovation and economic performance may be non-linear, depending on governance thresholds, such that at certain levels of governance, innovation's impact can shift from negative to positive. Understanding these dynamics is

critical for policymakers in developing policies that strengthen the effectiveness of innovation in promoting economic performance and structural change.

Finally, regarding gaps in existing empirical studies, particularly in the conceptualization and measurement of innovation, early approaches (see Gregersen-Johnson, 1997; Despande et al., 1993) relied primarily on research and development (R&D) indicators. This reliance reflected a linear conception of the innovation process. As the understanding of innovation evolved, measurement frameworks expanded to incorporate non-technological forms of innovation (such as organizational, marketing, and process innovations), as well as innovations that are new to the firm rather than solely new to the market (Du & Farley, 2001; Szunyogh, 2010; Canh et al., 2019). A major milestone in this evolution was the development of the Community Innovation Survey (CIS) under the Oslo Manual, which provided a standardized framework for measuring innovation and enabled cross-country comparability (Sabadie-Kwiatkowski, 2016). In more recent studies, innovation has been proxied using indicators such as R&D expenditure, patent counts, and total factor productivity (TFP) growth (Reeb & Zhao, 2020; Skiter et al., 2021). However, these measures are often insufficient for capturing the complex and multifaceted effects of innovation on economic performance. As noted by Haruna and Baek (2025), such indicators tend to reflect narrow inputs or outputs of innovation rather than the broader innovation ecosystem through which innovation influences economic outcomes. In light of these limitations, this study adopts the Global Innovation Index (GII) developed by the World Intellectual Property Organization (WIPO) as its core measure of innovation. Consistent with Vukoszavlyev (2019), the GII is employed as the study's key independent variable due to its comprehensive conceptualization and measurement framework, which captures the broad and systemic nature of innovation across countries.

The rest of the study is organized as follows: Section 2 presents some contextual stylized facts about Africa's economic performance, reviews the extant literature, outlines the theoretical underpinnings, and develops testable hypotheses. Section 3 describes the data and methodology. Section 4 presents the empirical results, while Section 5 concludes with policy implications and directions for future research.

2. Stylized Facts, Theoretical Underpinnings, and Empirical Literature

2.1 Stylized Facts on Africa's Economic Performance and Growth Dynamics

From a contextual perspective, Africa's economic performance in recent years has reflected a delicate balance between modest progress and persistent vulnerability. In 2024, the region recorded a modest improvement in overall economic activity, as average real GDP growth increased from 3.0 percent in 2023 to 3.3 percent (African Development Bank, 2025). This momentum was largely supported by elevated public expenditure and steady private consumption (AFDB, 2025). However, while the region has made some progress in the post-COVID-19 pandemic recovery, this progress has been overshadowed by persistent inflationary pressures, weakening domestic currencies, and rising debt service costs, all of which collectively undermine macroeconomic resilience. Furthermore, external dynamics continue to strain the continent's economic outlook, as heightened geopolitical fragmentation, ongoing regional conflicts, and uncertainties associated with shifting global trade regimes generate additional headwinds (AFDB, 2024a). A notable episode occurred in April 2025, when the United States introduced a fresh round of tariffs that triggered swift retaliatory measures from key trading partners. The episode stoked concerns over the future of global trade relations, particularly between two of Africa's largest partners, the United States and China. The resulting trade frictions weakened commodity prices and reduced the value of financial assets, amplifying external vulnerabilities for African economies (AFDB, 2025, 2024b).

From a welfare perspective, Africa's real GDP per capita recorded only modest growth, rising from 0.7 percent in 2023 to 0.9 percent in 2024. Despite this improvement, the continent's performance remained well below global benchmarks, lagging behind Latin America and the Caribbean by half a percentage point and Asia by nearly three percentage points, with Asia consolidating its position as the fastest-growing region. Looking ahead, per capita growth was projected to reach 1.5 percent in 2025 and 1.7 percent in 2026. However, the African Development Bank has cautioned that these estimates reflect downward revisions, underscoring the fragile and uncertain trajectory of Africa's economic outlook (AFDB, 2025). At the same time, global disruptions have further slowed progress toward the Sustainable Development Goals (SDGs), raising concerns about the continent's long-term productive capacity and resilience to future shocks. The combined effects of the Covid-19 pandemic and the Russia–Ukraine conflict have reversed earlier gains, pushing poverty levels above pre-pandemic figures (Raga et al., 2025). By 2024, Africa had achieved fewer than three of the thirty-two measurable targets under the selected SDGs. Furthermore, aggregate performance masks cross-regional disparities, as external shocks such as tariff disruptions and associated uncertainties are likely to exert uneven impacts across countries

and subregions, depending on the strength of existing macroeconomic buffers and the degree of integration into global trade (AFDB, 2024c).

Building on these stylized facts, the recent macroeconomic challenges highlight the moderating role of governance in shaping the relationship between innovation and economic performance in Africa, as posited in Hypothesis 1 in section "2.3 Theoretical Underpinnings and Hypothesis Development". Weak institutions and policy uncertainty can exacerbate the negative effects of external shocks, limiting the capacity of innovative initiatives to translate into improved economic performance. Conversely, countries with stronger governance frameworks are better positioned to leverage innovation, implement adaptive policies, and absorb shocks, thereby reinforcing resilience and accelerating sustainable development. Highlighting these dynamics demonstrates the importance of studying governance-innovation interactions as a key determinant of Africa's growth trajectory.

2.2. Literature review

2.2.1 Governance and Economic Performance

At the global level, Ogbuabor et al. (2025a) note that although entrepreneurship may exert a negative effect on economic performance, governance quality typically has a positive influence for improving both entrepreneurship and economic development. Similarly, Boța-Avram et al. (2018), analyzing 136 countries between 2006 and 2015, provide cross-country evidence that stronger governance frameworks significantly promote both economic growth and sustainable development. Farooque and Sun (2021) extend this global evidence by examining governance, corruption, and growth across 40 Sub-Saharan African (SSA) and Middle East/North Africa (MENA) economies during 2003–2014. Their GMM estimates, which address endogeneity, show that better governance substantially boosts growth, while corruption reduces it. They also observe that population size and foreign investment positively influence economic performance, whereas trade openness and education display a negative association. Insights from Asia further reinforce the governance–performance link. Kraipornsak (2018) finds that efficient governance in Thailand and other Asian economies accelerates growth through gains in income and productivity. In Vietnam, Nguyen et al. (2019) demonstrate that provincial governance, captured by accountability, transparency, and the quality of public services, exerts a strong effect on economic outcomes. Complementing this, Thanh et al. (2019) show that transparent governance improves the growth impact of public spending, largely by encouraging private sector participation. Awan et al. (2018) analyze the governance–growth nexus in five SAARC economies (Bangladesh, Nepal, India, Sri Lanka, and Pakistan) between 1996 and 2014. Their panel results suggest that government effectiveness supports growth, though outcomes vary by country.

Ouhirra and Sabri (2019), focusing on Morocco, Algeria, Tunisia, and Turkey, establish that democracy, when combined with growth momentum, strengthens economic performance.

Within the African context, governance has been consistently linked to economic outcomes. Ahmed et al. (2021) assess the connection between governance quality and economic performance across 46 SSA countries from 1996 to 2016. Using Generalized Method of Moments (GMM) and Generalized Least Squares, they consider six governance indicators, government effectiveness, rule of law, corruption control, political stability, regulatory quality, and voice and accountability. They found that stronger government effectiveness is particularly important for enhancing value added in agriculture, industry, and services. Extending this line of research, Aminu et al. (2022) apply the System GMM approach to 50 African economies between 2002 and 2020, revealing that almost all governance dimensions have a positive and significant impact on growth, except for government effectiveness, which though positive, lacked statistical significance. Recent African scholarship further advances these insights. Elhiraika et al. (2019) emphasize that effective governance and strong institutional capacity are indispensable for sustaining Africa's economic progress. Haruna et al. (2025) highlight the role of governance in ensuring that growth benefits extend beyond the formal economy. Using a Bayesian approach, Dianda et al. (2025) demonstrate that institutional quality has an especially pronounced effect in countries starting from lower levels of development, suggesting that governance reforms yield higher returns where economic structures are initially weak. With various static and dynamic estimation strategies such as the Driscoll-Kraay standard errors with fixed effects and the dynamic system GMM, Emeka and Asongu (2025a) show that under good governance, illicit financial outflows are associated with a decline in productive capacity. Similarly, Ojonta and Ogbuabor (2024) highlight that government effectiveness and the rule of law are pivotal in advancing infrastructural development across Africa. Finally, in a panel study of 34 African economies between 2010–2021, Ogbuabor et al. (2025b) find no evidence that governance institutions in the region adversely influence the infrastructure–entrepreneurship relationship, but stress the importance of prioritizing institutional reforms to reduce policy uncertainty and enhance transparent resource management. Overall, the literature underscores governance as a critical enabler of economic progress, capable of moderating challenges such as illicit financial flows and weak infrastructure to foster long-term economic performance.

2.2.2 Innovation and Economic Performance

Rakotondrazaka and Velomasy (2024) examine how the digital economy influences poverty reduction in Africa, with particular attention to the role of governance quality. Drawing on data from 37 African countries over the period 2009 to 2022, the study employs advanced econometric

techniques, including Panel-Corrected Standard Errors and Instrumental Variable Two-Stage Least Squares estimation. The results demonstrate a significant link between higher digital economy performance and lower poverty levels, highlighting the potential of digital initiatives to promote socio-economic development. Complementing this, Amri et al. (2019), focusing on Tunisia between 1975 and 2014, report that innovation has limited impact on sustainable development and negligible influence on CO_2 emissions, underscoring its complex role in balancing growth and environmental concerns. Taniguchi and Yamada (2019) explore the interaction between ICT skills, human capital, and inequality across OECD countries, finding that technological change widens wage gaps because high-skilled workers adapt better to new technologies. Similarly, Tastan and Gönel (2020) show that innovation in software and technology enhances productivity by improving organizational efficiency and lowering operational costs, but it can also displace middle-skill workers, highlighting the dual impact of innovation on labor markets. In the same vein, Hjort and Tian (2021) emphasize that innovation expands opportunities for businesses to leverage digital tools such as mobile money and e-commerce.

Caldarola et al. (2023) investigate the relationship between innovation, labor market dynamics, and economic performance in Rwanda. Using district-level data from 2002 to 2019, they show that innovation, proxied by mobile internet diffusion, affects the labor market by creating new employment opportunities and altering the composition of work. Similarly, Bahia et al. (2021), examining Tanzania, find that workers with higher education levels benefit the most from advances in mobile connectivity, reflecting how innovation can exacerbate inequality. Kallal et al. (2021) add further insights with a sectoral analysis for Tunisia, developing a diffusion index to explore the impact of innovation on growth. Distinguishing between short- and long-term effects, they find that innovation yields significant positive effects on growth in the long run, although short-term effects can be negative due to investment costs. Asongu et al. (2019) demonstrate that innovation through information sharing can boost financial development. Building on this, Tchamyou et al. (2019), analyzing 48 African countries between 1996-2014, reveal that innovation by means of information technology reduces income inequality through financial inclusion mechanisms, particularly mobile-based finance. More recently, Meka'a et al. (2024) find that innovation positively influences labor productivity in Cameroon, especially when firms leverage complementary skills in the service and industrial sectors. Olaoye et al. (2025) highlight the broader relevance of innovation for sustainable development in Africa, recommending greater investment in innovation infrastructure to foster financial technology, digitalization, and ultimately green and inclusive growth. Similarly, Fambeu et al. (2024) show that innovation plays an important role in promoting renewable energy adoption, with effects that are strengthened by economic growth.

2.3 Theoretical Underpinnings and Hypothesis Development

This study develops an integrated theoretical framework to explain how governance conditions the growth effects of innovation in Africa. Rather than presenting Schumpeterian theory, endogenous growth theory, and Institutional Economics as parallel strands, the analysis synthesizes them into a unified explanatory structure in which governance operates as the institutional transmission mechanism linking innovation to economic performance. First, the Schumpeterian perspective establishes innovation, through entrepreneurial activity, technological recombination, and creative destruction, as the primary driver of structural transformation and productivity growth (Amavilah et al., 2017; Hasan & Bousrih, 2020; North, 1991; Acemoglu & Robinson, 2012). Second, endogenous growth theory complements this view by emphasizing that innovation is not exogenous; rather, its long-run growth effects depend on domestic factors such as human capital, policy orientation, and institutional arrangements that shape knowledge creation and diffusion (Amavilah et al., 2017; Hasan & Bousrih, 2020). Third, Institutional Economics provides the integrating mechanism by clarifying how governance structures determine whether innovative opportunities translate into sustained economic gains. As argued by North (1991), institutions structure incentives and reduce uncertainty, while Acemoglu and Robinson (2012) demonstrate that inclusive institutions promote productive investment, whereas extractive institutions distort incentives and hinder development.

Within this integrated framework, governance influences the innovation–growth nexus through four key mechanisms: protecting property rights and aligning incentives for innovators; ensuring the efficient allocation of financial and human capital toward productive activities; facilitating technology diffusion and scaling through political stability and bureaucratic effectiveness; and enhancing policy credibility to reduce uncertainty and encourage long-term innovative investment. This conditioning role is particularly critical in Africa, where innovation often reflects adaptive, incremental, and catch-up processes, such as technology adoption, digital leapfrogging, and informal-sector problem-solving, rather than frontier technological breakthroughs. In such contexts, weak governance may confine innovation to localized or survival-oriented activities with limited aggregate impact, while strong governance enhances absorptive capacity, supports formalization, strengthens value-chain integration, and transforms innovation into structural economic change (Saba et al., 2024). The central proposition that emerges from this integrated framework is therefore conditional rather than linear: innovation does not automatically generate economic performance gains; its effectiveness depends on

governance quality and institutional thresholds. From the above discussion, we derive the following testable hypothesis:

Hypothesis 1: Governance moderates the relationship between innovation and economic performance in Africa.

Section 3 empirically examines this hypothesis by evaluating whether the proposed relationship holds under appropriate statistical testing.

3. Data and methodology

3.1 Data

In line with the motivation presented in the introduction, this study investigated 39[2] African countries, using data from the period 2010-2023. The data for this study were obtained from three principal sources: the World Bank's World Development Indicators (WDI), the World Bank's Worldwide Governance Indicators (WGI), and the World Intellectual Property Organization (WIPO). The selection of countries and the study period is primarily determined by data availability, particularly for the Global Innovation Index (GII), which serves as the proxy for innovation and the study's core independent variable. The GII index monitors the world's most innovative economies by ranking the innovation performance of 132 countries, identifying their strengths and weaknesses, and highlighting gaps within their innovation metrics. The outcome variable in this study is economic performance, which is proxied by GDP growth (annual %) and GDP per capita growth (annual %). The choice of proxies for economic performance aligns with Ekeaocha et al., (2023) and Ekeaocha et al., (2022). Governance, the moderating variable, is analyzed in bundled and unbundled forms using principal component analysis (PCA) to enhance the policy relevance of the findings. The PCA methodology has been applied in prior studies (see Emeka and Asongu, 2025a; Asongu, 2016) to reduce the dimensionality of governance indicators by grouping conceptually related measures. Specifically, principal component analysis (PCA) is employed to construct composite indices for overall governance (i.e., encompassing government effectiveness, rule of law, regulatory quality, control of corruption, political stability, and voice and accountability), as well as for its three core dimensions: economic, political, and institutional governance. As shown in panels A and B of Table 1, the first principal component accounts for the largest share of total variance, and it is therefore retained to synthesize the individual governance indicators into a single composite measure. This procedure reduces dimensionality while preserving the underlying information content, yielding a parsimonious and robust representation of governance quality suitable for examining innovation–economic performance dynamics. Notably, the retained component captures approximately 80 percent of the total variation in the six governance indicators. Its eigenvalue of 4.7838 exceeds the unity threshold prescribed by the Kaiser criterion (Asongu et al., 2025), thereby justifying its selection as the governance index. By contrast, the remaining components exhibit eigenvalues well below one

[2]The countries include "Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Cote d'Ivoire, Egypt (Arab Rep), Eswatini, Ethiopia, Gabon, Gambia (The), Ghana, Guinea, Kenya, Lesotho, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Seychelles, South Africa, Sudan, Tanzania, Togo, Tunisia, Uganda, Zambia, Zimbabwe".

(ranging from 0.0863 to 0.4143) and are consequently excluded, as they contribute marginally to explaining overall governance variation.

Table 1: Principal component analysis (PCA) for composite governance

	Component Loadings						Proportions	Eigen-values
	Panel (A)							
	CC	RL	GE	RQ	VC	PS		
First PC	0.4156	-0.2416	0.1816	0.6965	0.4804	0.1415	0.7973	4.7838
Second PC	0.4378	0.1888	-0.0391	0.0151	-0.2313	0.8470	0.0691	0.4143
Third PC	0.4269	-0.3747	0.0424	-0.0358	-0.6642	0.4829	0.0630	0.3780
Fourth PC	0.4167	-0.2435	-0.1727	-0.6719	0.5202	0.1236	0.0378	0.2265
Fifth PC	0.3748	0.5826	-0.6879	0.1745	-0.0578	0.1145	0.0185	0.1008
Sixth PC	0.3733	0.6057	0.6787	-0.1774	-0.0266	0.0306	0.0144	0.0863
	Panel (B)							
			Proportions	Eigen-values	Proportions	Eigen-values	Proportions	Eigen-values
			Political Institution		Economic Institution		Governance Institution	
First PC			0.8162	1.6324	0.9291	1.85826	0.9331	1.8661
Second PC			0.1838	0.3675	0.0709	0.14174	0.0669	0.1338

Notes: PC: principal component; CC: control for corruption; RL: rule of law; GE: government effectiveness; RQ: Regulatory quality; VC: Voice and Accountability: PS: political stability/absence of violence. **Source:** Authors' computations.

To minimize omitted variable bias and ensure the robustness of estimated coefficients, three control variables are included, following prior studies on economic performance and development (Jia et al., 2023; Bhuiyan et al., 2022; Ofori & Asongu, 2021; Asongu et al., 2019). These variables are ICT access, renewable energy consumption, and industrial output. ICT access is expected to improve economic performance by enhancing connectivity, reducing transaction costs, fostering innovation, and facilitating access to information and markets (Ofori & Asongu, 2021). Renewable energy consumption is expected to improve economic performance by reducing dependence on fossil fuels, promoting environmental sustainability, lowering long-term energy costs, and creating green jobs (Jia et al., 2023). Industrial output is expected to improve economic performance by expanding the productive base, generating employment, driving

technological advancement, and increasing value-added in the economy (Sriyakul, et al., 2022). It is also important to clarify why only three control variables were selected. Previous studies that apply the Generalized Method of Moments (GMM) technique (Saba et al., 2024; Asongu and Odhiambo, 2020) emphasize the need to balance robustness against omitted variable bias with the risk of instrument proliferation. This trade-off becomes especially critical when employing the collapse option of GMM to limit the number of instruments used in estimation. Appendix 1 presents the definitions of the study variables, Appendix 2 summarizes the descriptive statistics, and Appendix 3 contains the correlation matrix.

3.2 Methodology

3.2.1 Specification

Building on insights from previous studies, particularly Asongu et al. (2025), this study adopts the interactive Generalized Method of Moments (GMM) estimation technique. The selection of GMM is informed by its suitability for the data structure and its ability to provide robust results, as explained below. First, the dataset comprises 39 countries, which is larger than the study period of 13 years (2010 to 2023), making GMM an appropriate choice. Second, the persistence of the dependent variable, measured by the correlation between its first lag and current values, which is positive and significant is recommended in the literature for applying GMM (Tchamyou, 2019). Third, the method allows for capturing variations across countries. Fourth, it addresses potential endogeneity concerns through two mechanisms: (i) the inclusion of year effects to mitigate unobserved heterogeneity and cross-sectional dependence, and (ii) the use of suitable instruments to deal with simultaneity and reverse causality. Equations (1) and (2), expressed in levels and first differences, present the estimation framework that evaluates how governance quality, economic governance, political governance, and institutional governance shape the interaction between innovation and Africa's economic performance.

$$ECOP_{it} = \emptyset_0 + \emptyset_1 ECOP_{it-\tau} + \emptyset_2 INNO_{it} + \emptyset_3 Gov_{it} + \emptyset_4 GOV * INNO_{it} + \sum_{k=1}^{3} \delta_k W_{hit-\tau} + \varphi_i + \omega_t + \varepsilon_{it} \quad (1)$$

$$\begin{aligned} ECOP_{it} - ECOP_{it-\tau} &= \emptyset_1 (ECOP_{it-\tau} - ECOP_{it-2\tau}) + \emptyset_2 (INNO_{it} - INNO_{it-\tau}) + \emptyset_3 (Gov_{it} - Gov_{it-\tau}) \\ &+ \emptyset_4 (GOV * INNO_{it} - GOV * INNO_{it-\tau}) + \sum_{k=1}^{3} \delta_k (W_{hit-\tau} - W_{hit-2\tau}) + (\omega_t - \omega_{t-\tau}) + (\varepsilon_{it} \\ &- \varepsilon_{it-\tau}) \end{aligned} \quad (2)$$

3.2.2 Exclusion Restrictions, Identification, and Simultaneity

The robust GMM framework rests on three critical components: exclusion restrictions, identification, and simultaneity. The first component, exclusion restrictions, is tested using the Difference-in-Hansen Test (DHT). This evaluates whether the strictly exogenous variables influence the outcome only through their impact on the endogenous explanatory indicators. Instrument validity is determined by conventional GMM criteria, whereby the Hansen and Sargan tests confirm that the instruments capture the variation in the outcome variable solely through appropriate channels (Tchamyou et al., 2018; Amavilah et al., 2017). The second component, identification, involves three categories of variables: the outcome variable, the predetermined or endogenous explanatory variables, and the strictly exogenous variables. In this study, economic performance, proxied by GDP growth (annual %), serves as the outcome variable. In line with GMM-related literature, the endogenous explanatory variables include both the core independent variables, such as innovation and governance dynamics, and the control variables, such as ICT access, renewable energy consumption, and industrial output. Year dummies are specified as strictly exogenous variables, following Roodman's (2009) argument that they are unlikely to be endogenous once differenced. The third component, simultaneity, is addressed through the use of forward orthogonal deviations, which mitigate the problem of reverse causality. This transformation eliminates fixed effects that may otherwise bias coefficient estimates by correlating them with the lagged dependent variable. The application of Helmert transformation in this context aligns with existing literature, as it ensures orthogonality between forward-differenced and lagged observations (Love & Zicchino, 2006; Roodman, 2009). Finally, the substantial variability observed in both economic performance and the digital innovation moderating variables further supports the robustness of the study, as it indicates that the empirical estimates are based on meaningful variations across the sample.

4. Empirical results

4.1 Presentation of results

The results of the empirical analysis are presented in Tables 2-5. Table 2 reports the results using bundle governance and the GDP growth as outcome variable. Specifically, Panel 1 presents the regressions on overall governance, Panel 2 focuses on economic governance, Panel 3 covers political governance, and Panel 4 examines institutional governance. Table 3 reports the corresponding bundled governance results with GDP per capita as outcome variable. Tables 4 and 5 report the robustness checks using unbundled governance dynamics, with Table 4 focusing on GDP growth and Table 5 on GDP per capita. Before assessing the testable hypothesis, it is worthwhile to examine the validity of the estimated models through four main information criteria as apparent in the GMM-centric literature (Asongu & De Moor, 2017). First, the Difference-in-Hansen Test (DHT) is employed to verify the exogeneity of instruments and reinforce the validity of results from the Hansen OIR test. Second, the null hypothesis of the second-order Arellano and Bond autocorrelation test (AR(2)), which assumes no autocorrelation in the residuals, should not be rejected. Third, the Sargan and Hansen over-identification restriction (OIR) tests are applied to assess instrument validity, with their null hypotheses asserting that the instruments are uncorrelated with the error terms. The Sargan OIR test is not robust but remains unaffected by instrument proliferation, whereas the Hansen OIR test is robust but sensitive to instrument proliferation. To ensure reliable inference, priority is given the Hansen test and the number of instruments is restricted to remain below the number of cross-sections in the specifications. Finally, a Fisher test is conducted to examine the joint validity of the estimated coefficients (Asongu & De Moor, 2017). Before discussing the empirical assessment, the testable hypothesis developed in Section 2 is restated for clarity. Accordingly, the main hypothesis under examination is as follows: governance and its various dynamics positively moderate innovation to influence Africa's economic performance. To assess this hypothesis, it is expected that governance and its dynamics should interact positively with innovation to improve Africa's economic performance. A logical implication of this disposition is that the presence of strong governance can further enhance the effect of innovation on the outcome variable.

In light of the above, and to address the concerns associated with interactive regressions highlighted by Brambor et al. (2006), the study evaluates the stated hypothesis by jointly considering both the unconditional and conditional estimates of innovation in relation to economic performance. This approach ensures that the overall incidence of innovation is assessed more accurately. Accordingly, governance thresholds and the net effects of innovation are computed, so that the interpretation of the estimated coefficients does not follow the linear additive logic of conventional models. These computations provide deeper insights into the

interaction mechanism and are consistent with recent applications of interactive regression techniques in contemporary empirical literature (Nchofoung et al., 2021, 2022). These computational approaches are consistent with studies on interactive regressions (Emeka et al., 2025; Nchofoung et al., 2021, 2022). To put the foregoing discussion into perspective, consider, for instance, panels 1, 2, and 4 of Table 2. In panel 1 of Table 2, which is the corresponding panel for overall governance, its net effect is given as 0.4443 = (0.597 * 0.0469 + 0.4163), where 0.597 is the mean value of governance, and 0.0469 is the coefficient of interaction between governance and innovation, plus the unconditional coefficient of innovation, which is given as 0.4163. It therefore implies that, where applicable (i.e., where all the necessary coefficients for calculating the net effect are statistically significant), the net effect of innovation is given by "the mean of the policy variable multiplied by the coefficient of the interactive term plus the unconditional effect". This procedure is also applicable to both panels 2 and 4 of Table 2 and across other panels of Tables 3 to 5. Hence, the first empirical finding from this study is that innovation has a positive net effect on economic performance, suggesting that as the African region fosters and sustains innovative activities, it is more likely to experience enhanced productivity, improved competitiveness, and long-term growth.

It is relevant note that in interaction regressions, the unconditional effect of the moderating variable is not interpreted, which is the reason, the unconditional effect of the governance variables are not interpreted. This is because, when the partial derivative of the outcome variable on the channel (i.e., innovation) is taken, the unconditional effect of governance is zero (Brambor et al., 2006). Furthermore, in the empirical analysis, thresholds are not computed when both the unconditional and interactive or conditional effects have the same signs. Accordingly, thresholds are turning points and thus, can only be computed when the unconditional effect of the channel and corresponding interactive effect have opposite signs. When the same signs are apparent, either positive synergies (i.e., when both signs are positive) or negative synergies (i.e., when both signs are negative) are established (Mete et al., 2025).

Table 2. Bundled Governance, Innovation, and Economic Performance in Africa. Dependent Variable: GDP growth (annual %) as a measure of Economic Performance.

	(1)	(2)	(3)	(4)
Variables	Governance Quality	Economic Governance	Political Governance	Institutional Governance
(-1) Economic Performance	0.3282***	0.3050***	0.1713**	0.2735***
	(0.0622)	(0.0530)	(0.0780)	(0.0608)
Innovation	0.4163***	0.3917***	0.3228**	0.4523***
	(0.0982)	(0.0919)	(0.1194)	(0.0984)
Governance	-1.4841***	-3.2003***	-0.6828	-2.0980**
	(0.5185)	(0.7739)	(0.8226)	(0.9012)
Governance * Innovation	0.0469***	0.0993***	0.0210	0.0803***
	(0.0152)	(0.0226)	(0.0229)	(0.0295)
ICT Access	0.0315	0.0237	0.1228*	0.0368*
	(0.0697)	(0.0694)	(0.0782)	(0.0752)
Renewable Energy Consumption	0.0564***	0.0653***	0.0608***	0.0704***
	(0.0152)	(0.0142)	(0.0141)	(0.0171)
Industrial Output	-0.0299	-0.0702	0.0793	-0.0401
	(0.0601)	(0.0572)	(0.0647)	(0.0660)
Constant	-7.3364**	-6.4092**	-8.3257**	-8.8274***
	(3.0867)	(2.9841)	(3.1117)	(2.7095)
Net Impact of Innovation	0.4443	0.3917	na	0.4523
Governance Threshold	Positive Synergy	Positive Synergy	nsa	Positive Synergy
Diagnostic Checks				
Fisher Statistics	197.58	192.12	210.35	743.20
	(0.000)	(0.000)	(0.000)	(0.000)
Observations	409	409	409	409
Number of Countries	39	39	39	39
No. of Instruments	37	37	37	37
Year effects	yes	yes	yes	yes
Hansen_test	23.64	24.88	21.20	23.53
Hansen Prob	(0.210)	(0.164)	(0.326)	(0.215)
Sargan_test	31.47	36	23	23.32
Sargan Prob	(0.0358)	(0.0106)	(0.237)	(0.224)
AR(1)_test	-3.139	-2.971	-2.809	-3.004
AR(1)_P-value	(0.00170)	(0.00297)	(0.00497)	(0.00267)
AR(2)_test	-0.370	-0.402	-0.769	-0.566
AR(2)_P-value	(0.712)	(0.687)	(0.442)	(0.571)
DHT for instruments				
(a)Instruments in levels				
H excluding group	7.10	7.10	5.24	5.01
	(0.312)	(0.311)	(0.513)	(0.543)
Dif(null, H=exogenous)	16.55	17.78	15.96	18.53
	(0.221)	(0.166)	(0.251)	(0.139)
(b) IV (years, eq(diff))				
H excluding group	11.26	13.76	12.40	7.71
	(0.258)	(0.131)	(0.192)	(0.563)

Dif(null, H=exogenous)	12.39	11.12	8.80	15.82
	(0.260)	(0.348)	(0.551)	(0.105)

Source: Authors' Construct. Note: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Note: ***, **, and * denote significance levels of 1%, 5%, and 10% respectively. na: "Not Applicable" as at least one estimated coefficient required for calculating the net effect and/or threshold is not statistically significant. nsa "Not Specifically Applicable". P-values in parentheses for information criteria.

Table 3. Bundled Governance, Innovation, and Economic Performance in Africa. Dependent Variable: GDP per capita growth (annual %) as the measure of Economic Performance.

	(1)	(2)	(3)	(4)
Variables	Governance Quality	Economic Governance	Political Governance	Institutional Governance
(-1) Economic Performance	0.3921***	0.3134***	0.2232***	0.5126***
	(0.0623)	(0.0742)	(0.0755)	(0.0914)
Innovation	0.4801***	0.4234***	0.4414***	0.0738
	(0.1103)	(0.1159)	(0.1355)	(0.1326)
Governance	-1.5639***	-2.9378***	-1.0716	-1.8128**
	(0.5276)	(0.6431)	(0.8037)	(0.8350)
Governance * Innovation	0.0468***	0.0905***	0.0243	0.0628**
	(0.0150)	(0.0203)	(0.0220)	(0.0262)
ICT Access	-0.0211	0.0251	0.1326	-0.0041
	(0.0752)	(0.0748)	(0.0819)	(0.0530)
Renewable Energy Consumption	0.0581***	0.0701***	0.0533***	0.0220
	(0.0153)	(0.0123)	(0.0158)	(0.0153)
Industrial Output	-0.0820	-0.1257**	0.0928	-0.1390***
	(0.0635)	(0.0604)	(0.0627)	(0.0417)
Constant	-8.4099**	-7.2783**	-12.6096***	1.6317
	(3.5441)	(3.5340)	(3.8252)	(3.0705)
Net Effect	0.5080	0.4234	na	na
Governance Threshold	Positive synergy	Positive synergy	nsa	nsa
Diagnostic Checks				
Fisher	354.99***	95.02***	110.42***	1253.27***
	(0.000)	(0.000)	(0.000)	(0.000)
Observations	409	409	409	409
Number of countries	39	39	39	39
No. of Instruments	37	37	37	37
year effects	yes	yes	yes	yes
Hansen_test	26.77	25.82	18.09	21.10
Hansen Prob	(0.110)	(0.135)	(0.517)	(0.331)
Sargan_test	30.72	36.39	19.97	15.46
Sargan Prob	(0.0433)	(0.00945)	(0.397)	(0.693)
AR(1)_test	-2.919	-2.852	-2.728	-2.888

AR(1)_P-value	(0.00352)	(0.00434)	(0.00637)	(0.00388)
AR(2)_test	-0.245	-0.406	-0.605	0.123
AR(2)_P-value	(0.807)	(0.685)	(0.545)	(0.902)
DHT for instruments				
(a)Instruments in levels				
H excluding group	6.63	8.35	5.40	5.08
	(0.356)	(0.214)	(0.494)	(0.534)
Dif(null, H=exogenous)	20.14	17.47	12.69	16.03
	(0.092)	(0.179)	(0.472)	(0.248)
(b) IV (years, eq(diff))				
H excluding group	10.12	11.63	12.63	5.04
	(0.340)	(0.235)	(0.180)	(0.753)
Dif(null, H=exogenous)	16.65	14.19	5.46	16.06
	(0.083)	(0.165)	(0.858)	(0.139)

Source: Authors' Construct. Note: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Note: ***, **, and * denote significance levels of 1%, 5%, and 10% respectively. na: "Not Applicable" as at least one estimated coefficient required for calculating the net effect and/or threshold is not statistically significant. nsa "Not Specifically Applicable". P-values in parentheses for information criteria.

Following the establishment of a positive net effect of innovation on economic performance, the next step is to ascertain the threshold level at which governance moderates this relationship. However, we refrain from calculating the governance threshold in this study because the unconditional and conditional relationships between governance and innovation on economic performance share the same direction. This approach is consistent with the methodology of Asongu et al. (2025), Saba et al. (2024), and Asongu and Odhiambo (2021), who posit that threshold levels can only be derived when the unconditional and interactive effects display opposing signs. Hence, the second empirical finding of this study is that governance and innovation interact synergistically to enhance Africa's economic performance, with governance and its dimensions reinforcing the positive effect of innovation. For the African region, these findings imply that strengthening governance institutions and frameworks can amplify the benefits of innovation, thereby accelerating progress toward inclusive growth, sustainable development, and the aspirations outlined in both the Sustainable Development Goals (SDGs) and the African Union's Agenda 2063.

Table 4. Unbundled Governance, Innovation, and Economic Performance in Africa. Dependent Variable: GDP growth (annual %) as a measure of Economic Performance.

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	Governance Effectiveness	Rule of Law	Regulatory Quality	Control for Corruption	Voice and Accountability	Political Stability
(-1) Economic Performance	0.2916***	0.2777***	0.2115***	0.0997*	0.1336*	0.1900**
	(0.0629)	(0.0493)	(0.0620)	(0.0515)	(0.0760)	(0.0729)
Innovation	0.5322***	0.5083***	0.3884***	0.2587**	0.2716**	0.3518**
	(0.1122)	(0.0800)	(0.1065)	(0.1103)	(0.1084)	(0.1300)
Governance Effectiveness	-6.4710***					
	(2.2333)					
Governance Effectiveness *Innovation	0.2104***					
	(0.0639)					
Rule of Law		-6.2562***				
		(1.7426)				
Rule of Law * Innovation		0.1380**				
		(0.0533)				
Regulatory Quality			-4.1534*			
			(2.2229)			
Regulatory Quality * Innovation			0.1002			
			(0.0632)			
Control for Corruption				1.0074		
				(1.4130)		
Control for Corruption * Innovation				0.0469		
				(0.0533)		
Voice and Accountability					-1.8738	
					(1.2061)	
Voice and Accountability * Innovation					0.0445	
					(0.0365)	
Political Stability						-0.4668
						(1.3472)

Political Stability * Innovation						0.0102
						(0.0378)
ICT Access	-0.0050	0.0630	0.1607**	0.2216**	0.0719	0.1366
	(0.0731)	(0.0604)	(0.0645)	(0.0863)	(0.0784)	(0.0859)
Renewable Energy	0.0704***	0.0492***	0.0669***	0.0990***	0.0491***	0.0635***
	(0.0175)	(0.0160)	(0.0150)	(0.0192)	(0.0168)	(0.0122)
Industrial Value Added	-0.0342	0.0140	0.0597	0.0345	0.1145**	0.0537
	(0.0578)	(0.0628)	(0.0794)	(0.0572)	(0.0509)	(0.0755)
Constant	-11.7066***	-11.7884***	-10.8803***	-7.3569**	-7.6199**	-8.6279***
	(3.2037)	(2.6025)	(3.3171)	(3.1739)	(2.9110)	(3.1790)
Net Effect of Innovation	0.4146	0.4412	na	na	na	na
Governance Threshold	Positive Synergy	Positive Synergy	nsa	nsa	nsa	nsa
Diagnostic Check						
Fisher Statistics	211.54 ***	200.52***	486.75***	516.97***	518.69***	377.60***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	409	409	409	409	409	409
Number of Countries	39	39	39	39	39	39
No. of Instruments	37	37	37	37	37	37
Time effects	yes	yes	yes	yes	yes	yes
Hansen_test	22.46	17.02	23.56	25.39	20.49	19.69
Hansen Prob	(0.262)	(0.588)	(0.214)	(0.148)	(0.366)	(0.414)
Sargan_test	38.02	18.40	26.36	23.40	25.80	18.28
Sargan Prob	(0.00590)	(0.496)	(0.121)	(0.220)	(0.136)	(0.504)
AR(1)_test	-2.931	-3.077	-2.961	-2.986	-2.775	-2.836
AR(1)_P-value	(0.00338)	(0.00209)	(0.00307)	(0.00282)	(0.00552)	(0.00456)
AR(2)_test	-0.421	-0.482	-0.679	-1.069	-0.819	-0.736
AR(2)_P-value	0.674	0.630	0.497	0.285	0.413	0.462
DHT for instruments						
(a)Instruments in levels						
H excluding group	5.26	4.18	5.34	5.48	6.59	5.05
	(0.511)	(0.652)	(0.501)	(0.484)	(0.361)	(0.538)
Dif(null, H=exogenous)	17.20	12.84	18.22	19.91	13.90	14.64
	(0.190)	(0.460)	(0.149)	(0.097)	(0.381)	(0.330)
(b) IV (years, eq(diff))						

H excluding group	14.87	10.26	11.03	7.68	14.95	12.78
	(0.094)	(0.320)	(0.274)	(0.567)	(0.092)	(0.173)
Dif(null, H=exogenous)	7.59	6.76	12.53	17.71	5.54	6.90
	(0.669)	(0.748)	(0.251)	(0.060)	(0.852)	(0.734)

Source: Authors' Construct. Note: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Note: ***, **, and * denote significance levels of 1%, 5%, and 10% respectively. na: "Not Applicable" as at least one estimated coefficient required for calculating the net effect and/or threshold is not statistically significant. Nsa "Not specifically available". P-values in parentheses for information criteria.

Table 5. Unbundled Governance, Innovation, and Economic Performance in Africa. Dependent Variable: GDP per capita growth (annual %) as the measure of Economic Performance.

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	Governance Effectiveness	Rule of Law	Regulatory Quality	Control for Corruption	Voice and Accountability	Political Stability
(-1) Economic Performance	0.2255***	0.3298***	0.1592**	-0.0071	0.1974**	0.1902**
	(0.0824)	(0.0463)	(0.0758)	(0.0523)	(0.0746)	(0.0729)
Innovation	0.5075***	0.6203***	0.2618**	0.1337	0.4023***	0.3563***
	(0.1458)	(0.0977)	(0.1253)	(0.0979)	(0.1193)	(0.1251)
Governance Effectiveness	-6.3688**					
	(2.4572)					
Governance Effectiveness *Innovation	0.1933***					
	(0.0671)					
Rule of Law		-8.0104***				
		(1.8106)				
Rule of Law * Innovation		0.1773***				
		(0.0533)				
Regulatory Quality			-1.1524			
			(1.9764)			
Regulatory Quality * Innovation			0.0345			
			(0.0661)			
Control for Corruption				3.7029***		
				(1.2032)		
Control for Corruption * Innovation				-0.0272		
				(0.0457)		

Voice and Accountability					-3.0864**	
					(1.1460)	
Voice and Accountability * Innovation					0.0531	
					(0.0320)	
Political Stability						-0.1055
						(1.0716)
Political Stability * Innovation						-0.0071
						(0.0315)
ICT Access	-0.0259	0.0144	0.1867**	0.3359***	0.0624	0.1553*
	(0.0784)	(0.0666)	(0.0755)	(0.0920)	(0.0679)	(0.0905)
Renewable Energy	0.0636***	0.0476***	0.0749***	0.0942***	0.0343**	0.0499***
	(0.0164)	(0.0174)	(0.0109)	(0.0175)	(0.0166)	(0.0125)
Industrial Value Added	-0.0975*	-0.0433	-0.0370	0.0138	0.1215**	0.0504
	(0.0568)	(0.0600)	(0.0798)	(0.0608)	(0.0565)	(0.0687)
Constant	-10.6415**	-14.3918***	-7.0002**	-5.5733*	-12.0177***	-9.7097***
	(4.1847)	(3.1562)	(3.3127)	(2.9618)	(3.7146)	(3.2936)
Net Effect	0.3994	0.5341	na	na	na	na
Governance Threshold	Positive synergy	Positive synergy	nsa	nsa	nsa	nsa
Diagnostic Checks						
Fisher	264.83***	207.58***	175.02***	4896.46***	210.19***	197.67***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	409	409	409	409	409	409
Number of countries	39	39	39	39	39	39
No. of Instruments	37	37	37	37	37	37
year effect	yes	yes	yes	yes	yes	yes
Hansen_test	21.17	17.26	26.69	22.66	19.95	16.37
Hansen Prob	(0.327)	(0.572)	(0.112)	(0.253)	(0.398)	(0.633)
Sargan_test	35.16	18.39	31.88	25.42	22.42	16.39
Sargan Prob	(0.0133)	(0.497)	(0.0322)	(0.147)	(0.264)	(0.631)
AR(1)_test	-2.759	-2.893	-2.755	-2.718	-2.806	-2.816
AR(1)_P-value	(0.0057)	(0.0038)	(0.0058)	(0.0065)	(0.0050)	(0.0048)
AR(2)_test	-0.613	-0.310	-0.803	-1.329	-0.543	-0.710
AR(2)_P-value	(0.540)	(0.756)	(0.422)	(0.184)	(0.587)	(0.477)
DHT for instruments						

(a)Instruments in levels						
H excluding group	3.12	4.80	6.58	3.72	6.94	4.01
	(0.794)	(0.570)	(0.362)	(0.715)	(0.327)	(0.676)
Dif(null, H=exogenous)	18.06	12.46	20.12	18.94	13.01	12.36
	(0.155)	(0.490)	(0.192)	(0.125)	(0.447)	(0.498)
(b) IV (years, eq(diff))						
H excluding group	13.45	8.87	8.98	9.23	14.78	10.72
	(0.143)	(0.450)	(0.439)	(0.416)	(0.097)	(0.295)
Dif(null, H=exogenous)	7.73	8.39	17.72	13.42	5.17	5.65
	(0.655)	(0.590)	(0.060)	(0.201)	(0.880)	(0.844)

Source: Authors' Construct. Note: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Note: ***, **, and * denote significance levels of 1%, 5%, and 10% respectively. na: "Not Applicable" as at least one estimated coefficient required for calculating the net effect and/or threshold is not statistically significant. Nsa "Not specifically available". P-values in parentheses for information criteria.

4.3 Further Discussion of Results and Implications

The following findings are further evident from this study. First, the baseline results in Table 2 show that ICT access is strongly and positively associated with economic performance. This outcome is consistent with prior studies (Asongu et al., 2025; Haruna & Baek, 2025; Ofori & Asongu, 2021), which argue that ICT diffusion enhances economic activities by improving access to information, facilitating digital transactions, expanding market reach, and fostering financial inclusion. Greater access to ICT infrastructure also improves the efficiency of production processes, strengthens integration into global value chains, and provides new opportunities for entrepreneurship and innovation across African economies (Ekeocha, Ogbuabor, & Orji, 2022). These findings align with endogenous growth theory, highlighting knowledge accumulation, innovation, and technology diffusion as central mechanisms of long-term growth (Asongu et al., 2025). ICT Access, by expanding knowledge flows and enhancing productivity, fits directly within this theoretical framework.

Second, renewable energy consumption is also positively associated with economic performance. This finding reflects the growing importance of sustainable energy as both a driver of inclusive growth and a pillar of environmental sustainability. Renewable energy enhances productivity by reducing energy costs, expanding access to affordable electricity, and fostering environmentally sustainable industrialization (Wang et al., 2022; Zhe et al., 2021; Soava et al., 2018). For Africa, where large segments of the population remain energy-poor, scaling up renewable energy use provides a dual advantage by stimulating economic growth while simultaneously advancing climate resilience and the region's commitment to the Sustainable Development Goals (SDGs) and the African Union's Agenda 2063. The results align with sustainable development theory, highlighting the importance of environmentally sound and socially inclusive strategies in achieving long-term prosperity without compromising the needs of future generations.

Third, the study finds that industrial output exhibits a negative relationship with economic performance. Although this contrasts with previous research reporting a positive relationship (see Sichoongwe, 2025; Opoku & Yan, 2019), the result may reflect measurement issues, cross-country structural heterogeneity, informality, and sectoral composition differences. For instance, in countries where manufacturing is less capital-intensive or dominated by informal activities, increases in industrial output may not translate into proportional gains in GDP, thereby contributing to the observed negative relationship. It is also worth noting that this finding aligns with the structural realities of African economies, where industrial development remains weak, and underperformance continues to be constrained by infrastructural deficits, limited diversification, and dependence on low-value resource extraction. Consequently, instead of contributing positively to growth, industrial output often reflects inefficiencies, low productivity, and

vulnerability to external shocks. This finding highlights the urgent need for industrial policy reforms that promote value addition, technological upgrading, and stronger linkages between industry and other productive sectors.

5 Concluding Remarks and Policy Recommendations

5.1 Conclusion

The purpose of this study is twofold. First, it examines the unconditional impact of innovation on Africa's economic performance. Second, it investigates the moderating role of governance in shaping the effect of innovation on economic performance. The study is based on a sample of 39 African countries over the period 2010 to 2023. The adopted empirical strategy is the interactive generalized method of moments (GMM), designed to assess how governance and disaggregated governance dynamics (i.e., economic governance, political governance, and institutional governance) moderate global innovation to enhance economic performance. The findings reveal that the effect of innovation on economic performance is significantly influenced by governance quality and dynamics. Specifically, the study establishes a positive net effect of innovation on economic performance, alongside a corresponding positive synergy between governance and innovation. This outcome is grounded on two key insights: (i) the unconditional relationship between innovation and economic performance is positive, and (ii) governance dynamics further amplify this positive effect. Additionally, ICT Access and renewable energy consumption are identified as strong channels for improving economic performance, consistent with endogenous growth theory and sustainable development theory respectively, while industrial output demonstrates a negative association with economic performance, reflecting the region's limited industrial base.

5.2 Policy implications

The results have several policy implications. First, policymakers should strengthen investment in innovation-driven sectors, particularly ICT infrastructure and digital inclusion, to expand productivity, competitiveness, and knowledge flows in line with endogenous growth theory. Second, renewable energy development should be prioritized to reduce energy poverty, improve access to affordable and clean energy, and support environmentally sustainable growth, thereby advancing Africa's commitments under the SDGs and Agenda 2063. Third, industrial policy should focus on reversing the current negative contribution of industrial output by emphasizing diversification, technological upgrading, and value chain integration to ensure that industry becomes a catalyst for long-term transformation. Fourth, governance reforms should be deepened to reinforce accountability, transparency, and institutional effectiveness, since governance amplifies the positive effect of innovation on economic performance. Fifth, policies should be designed to integrate innovation, governance, and sustainable resource use into a comprehensive development strategy that directly supports inclusive growth, structural

transformation, and the region's long-term aspirations under the African Union's Agenda 2063 and the global 2030 Agenda.

Giving the overwhelming evidence of positive synergies, it is worthwhile to further discuss how governance can be better tailored to boost the effect of innovation on economic performance. In essence, enhanced governance in Africa holds the potential to amplify the positive influence of innovation on economic outcomes. This can be achieved through the reinforcement of legal and regulatory structures. Essential policies encompass the implementation of fiscal administration focused on measurable results, the bolstering of judicial bodies to safeguard property rights, and strategic investments in information and communication technology (ICT) infrastructure to propel digital economic expansion that is needed for economic performance. The following policies are crucial for governance to moderate innovation in order to boost economic performance.

(i)The primary step entails reinforcing the quality of regulations and institutions. Superior regulatory quality is indispensable for translating innovation into increased economic performance. Robust institutional frameworks, characterized by adherence to the rule of law and effective anti-corruption measures, are paramount in cultivating an environment that is supportive of both innovation and investment and by extension, economic performance.

(ii) Harnessing ICT for economic performance can be better fulfilled with enhanced governmental oversight which must actively facilitate, rather than impede, the widespread adoption of ICT. In contexts where governance is deficient, policymakers should be tasked with identifying pivotal ICT thresholds capable of transforming the influence of governance on economic performance from detrimental to beneficial, through innovation.

(iii) Looking at the political economy and accountability, economic performance can be boosted through superior public sector administration and better accountability. This entails improving the transparency of public financial management and fortifying oversight mechanisms.

5.3 Limitations and future research directions

The principal limitation of this study lies in its empirical design, which inherently abstracts from country specific dynamics. By employing first differencing, the analysis necessarily eliminates country fixed effects to mitigate potential correlation between the lagged dependent variable and the fixed effects themselves, a common source of endogeneity. Consequently, the findings presented here are necessarily broad and general in scope. Future research, however, should

interrogate the robustness of these results within individual country contexts by employing methodologies tailored to country-specific characteristics. Such an approach would not only validate the overarching conclusions but also yield more nuanced and context sensitive policy prescriptions. Future studies can also investigate whether the established relationships hold across other regions and global contexts.

Nevertheless, this study creates avenues for future inquiry. For instance, future research should build on the current findings in several directions. First, future studies should incorporate spatial and regional spillover effects to determine whether innovations and governance improvements in one country generate positive externalities for neighboring economies. Second, a sectoral approach to innovation and industrial output would provide deeper insights into whether certain industries, such as manufacturing, agriculture, or services, contribute differently to economic performance under varying governance conditions. Third, further investigation into the interaction between renewable energy consumption and industrialization could clarify how sustainable energy may serve as a foundation for building a stronger industrial base in Africa. Fourth, longitudinal studies with extended time horizons and richer datasets could help test the robustness of the present findings and enhance the generalizability of results beyond the African context. Finally, there are obvious limitations associated with the adopted GMM approach, especially as it relates to heterogeneity in African countries, not least, because country-specific effects are not considered in the GMM approach. Hence, future studies should take account of such fixed effects using the relevant and robust fixed effects estimation techniques.

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Appendices

Appendix 1. Definitions and sources variables

Variables	Signs	Definitions	Sources
Dependent Variable			
Economic Performance	ECOP	"GDP (annual % growth) it refers to the total income earned through the production of goods and services in an economic territory during an accounting period. It can be measured in three different ways: using either the expenditure approach, the income approach, or the production approach. This indicator denotes the percentage change over each previous year of the constant price (base year 2015) series in United States dollars.". GDP per capita growth (annual %). Gross domestic product is the total income earned through the production of goods and services in an economic territory during an accounting period. It can be measured in three different ways: using either the expenditure approach, the income approach, or the production approach. The core indicator has been divided by the general population to achieve a per capita estimate. This indicator denotes the percentage change over each previous year of the constant price (base year 2015) series in United States dollars.	WDI (World Bank)
Independent Variable			
Innovation	INNO	Innovation is proxied with the Global Innovation Index (GII). The index monitors the world's most innovative economies by ranking the innovation performance of 132 countries, identifying their strengths and weaknesses, and highlighting gaps within their innovation metrics	World Intellectual Property Organization
Moderating Variables			
Political Stability	PolS	"Political stability/no violence (estimate): measured as the perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional and violent means, including domestic violence and terrorism".	WDI (World Bank)
Voice & Accountability	VA	"Voice and accountability (estimate): measure the extent to which a country's citizens are able to participate in selecting their government and to enjoy freedom of expression, freedom of association and a free media".	WDI (World Bank)

Political Governance	Polgov	First Principal Component of Political Stability and Voice & Accountability. The process by which those in authority are selected and replaced.	PCA
Government Effectiveness	GE	"Government effectiveness (estimate): measures the quality of public services, the quality and degree of independence from political pressures of the civil service, the quality of policy formulation and implementation, and the credibility of governments' commitments to such policies".	WDI (World Bank)
Regulation Quality	RQ	"Regulation quality (estimate): measured as the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development".	WDI (World Bank)
Economic Governance	Ecogov	"First Principal Component of Government Effectiveness and Regulation Quality. The capacity of government to formulate & implement policies, and to deliver services".	PCA
Rule of Law	RL	"Rule of law (estimate): captures perceptions of the extent to which agents have confidence in and abide by the rules of society and in particular the quality of contract enforcement, property rights, the police, the courts, as well as the likelihood of crime and violence".	WDI (World Bank)
Corruption of control	CC	"Control of corruption (estimate): captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as 'capture' of the state by elites and private interests".	WDI (World Bank)
Institutional Governance	Instgov	First Principal Component of Rule of Law and Corruption of Control. The respect for citizens and the state of institutions that govern the interactions among them.	PCA
General Governance	Ggov	First Principal Component of Political, Economic and Institutional Governances.	PCA
Control Variables			
ICT Access	ICT	Fixed telephone subscriptions (per 100 people)	WDI (World Bank)
Renewable Energy Consumption	REC	Renewable energy consumption (% of total final energy consumption)	WDI (World Bank)

Industrial Added	Value	INDUS	Industry (including construction), value added (% of GDP)	WDI (World Bank)

WDI: World Bank Development Indicators of the World Bank.

Appendix 2: Summary Statistics

Variables	Obs	Mean	Std. Dev.	Min	Max
GDP growth (annual %)	546	3.866	4.026	-20.805	21.452
GDP per capita (annual % growth)	546	1.55	3.896	-30.363	17.76
Innovation	410	24.777	5.604	10.3	40.94
Governance (Overall)	546	0.597	2.023	-4.159	5.823
Economic Governance	546	0	1.363	-3.31	4.515
Government Effectiveness	546	-0.559	0.548	-1.977	1.15
Regulatory Quality	546	-0.509	0.522	-2.002	1.197
Political Governance	546	0	1.278	-3.186	2.709
Political Stability	546	-0.528	0.821	-2.729	1.104
Voice and Accountability	546	-0.442	0.675	-1.849	.975
Institutional Governance	546	0	1.366	-2.815	3.729
Control for Corruption	546	-0.0478	0.623	-1.6	1.699
Rule of Law	546	-0.486	0.532	-1.838	1.024
ICT Access	546	3.791	6.344	0	37.3
Renewable Energy	546	55.649	29.68	0.1	94.1
Industrial Value Added	546	25.355	9.252	4.871	60.881

Source: Authors' Computation.

Appendix 3: Matrix of correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1) gdpgr	1.000															
(2) gdppcgr	0.941	1.000														
(3) din	-0.044	0.044	1.000													
(4) govq	-0.040	0.033	0.587	1.000												
(5) ecogov	-0.034	0.053	0.622	0.958	1.000											
(6) ge	-0.034	0.063	0.608	0.932	0.961	1.000										
(7) rq	-0.032	0.040	0.591	0.915	0.966	0.857	1.000									
(8) polgov	-0.047	-0.017	0.489	0.898	0.777	0.739	0.758	1.000								
(9) ps	0.005	0.042	0.414	0.814	0.702	0.683	0.670	0.903	1.000							
(10) vc	-0.092	-0.074	0.468	0.802	0.697	0.647	0.695	0.897	0.621	1.000						
(11) instgov	-0.032	0.049	0.541	0.964	0.912	0.909	0.851	0.788	0.723	0.696	1.000					
(12) cc	-0.007	0.071	0.446	0.900	0.832	0.838	0.768	0.723	0.684	0.617	0.961	1.000				
(13) rl	-0.053	0.025	0.592	0.957	0.924	0.913	0.869	0.794	0.709	0.721	0.967	0.860	1.000			
(14) fts	-0.181	-0.029	0.520	0.567	0.627	0.664	0.548	0.430	0.405	0.369	0.530	0.435	0.581	1.000		
(15) rec	0.228	0.097	-0.468	-0.543	-0.550	-0.635	-0.431	-0.435	-0.372	-0.412	-0.534	-0.497	-0.532	-0.671	1.000	
(16) indus1	-0.012	-0.040	-0.045	-0.008	-0.038	-0.009	-0.063	0.025	0.116	-0.075	-0.005	0.011	-0.019	-0.006	-0.249	1.000

Source: Authors' Computation.