

Structural Drivers and Constraints of Economic Competitiveness in Africa: A Dynamic Panel Analysis

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Abstract

This study empirically analyses the impact of institutions, infrastructure, higher education, innovation, and the regulation of information and communication technologies (ICT) on the improvement of the competitive framework in African countries. Based on a sample of 33 countries observed over 11 years, the study employs a dynamic panel data model estimated using the system GMM method. The findings indicate that institutions exert a positive yet non-significant influence, which may suggest that the effects of reforms are either indirect or subject to a time lag. Infrastructure has a significant negative effect, which is linked to issues of quality, maintenance, or misallocation. ICT regulation is slightly negative and non-significant, suggesting limited adoption and weak effectiveness. Higher education exerts a positive but modest impact, likely due to

skill mismatches, while innovation shows a negative and weakly significant effect, highlighting difficulties in translating efforts into competitive gains. These findings point to the need for more efficient infrastructure investment, better alignment between education and labor market needs, innovation strategies focused on commercialisation and diffusion, and deeper institutional and ICT reforms to strengthen long-term competitiveness.

Keywords: *Economic competitiveness, Innovation, Human capital, ICT regulations*

1. Introduction

As the global economy changes at pace, the parameters of what constitutes competitiveness have been fundamentally redefined. The World Economic Forum's Global Competitiveness Index defines competitiveness as "the set of institutions, policies, and factors that determine the level of productivity of a country," recognizing that productivity underlies long-term growth and living standards (WEF, 2024). More recently, African studies have emphasised that competitiveness depends not just on resource endowments or cost advantages but on the capacity to strengthen institutions, build technology and innovation systems, develop human capital, and improve infrastructure and regulatory environments. For example, Osei (2024) shows that digital infrastructure spurs innovation, especially where human capital is strong (Osei, 2024). Likewise, Kasongo & Makamu (2024) find a positive association between innovation indices and economic growth across 32 African countries (Kasongo & Makamu, 2024).

Recent literature identifies several foundational pillars of sustainable competitiveness. Studies such as Olyanga (2022), Kasongo (2024), and others provide empirical evidence in African contexts that innovation capacity, quality of institutions, human capital, ICT infrastructure/regulation, and physical infrastructure are strongly correlated with better competitive performance (Olyanga, 2022; Kasongo & Makamu, 2024).

However, there remains a gap: (a) the magnitudes of the effects of these pillars in dynamic settings (i.e., how past competitiveness interacts with current determinants) are not well established for many African countries; (b) it is still ambiguous how innovation and ICT regulation translate into competitive outcomes where infrastructure or institutional quality is weak; and (c) interactions among determinants (e.g. institutions $\times$ infrastructure $\times$ innovation) are seldom modeled explicitly. This study

aims to address these deficiencies by measuring the influence of the five pillars within a dynamic panel framework for 33 African nations between 2007 and 2017, thereby providing longitudinal and policy-orientated evidence. This research framework sets the stage for our central question:

To what extent do institutions, infrastructure, higher education, innovation, and ICT regulation shape competitiveness across African countries, given their structural heterogeneity and diverse development trajectories?

Based on past findings, we formulate the following hypotheses, each grounded in prior literature and stylised facts:

- H1: Better institutional quality (transparency, rule of law, regulatory effectiveness) has a positive and significant effect on competitiveness in African countries, consistent with findings that weak governance acts as a barrier to investment and firm productivity (Kasongo & Makamu, 2024).
- H2: Development of physical infrastructure (transport, energy, water, connectivity) significantly contributes to competitiveness, as many studies show large returns to infrastructure investments in Africa (Africa Finance Corporation, 2024).
- H3: Effective regulation of ICT (including policy frameworks, broadband regulation, and digital access) enhances competitiveness, especially when digital infrastructure is paired with favorable regulatory regimes (Osei, 2024).
- H4: High-quality higher education improves competitiveness by developing skills needed for innovation and productivity; human capital constraints reduce innovation effects when education quality is low (Awode et al., 2025).
- H5: Innovation capability (R&D, patents, technology adoption) is a key driver of longer-term competitiveness, though its effects may be muted where other fundamentals are weak (Kasongo & Makamu, 2024).
- H6: There are synergistic effects when institutions, infrastructure, and innovation interact—i.e., the effect of innovation on competitiveness is stronger when institutional quality is high or infrastructure is adequate; likewise, infrastructure investments are more effective when institutions are capable of managing them.

To test these, we employ a dynamic econometric model (system GMM) on panel data for 33 African countries over the period 2007-2017. This method allows us to capture persistence (lagged competitiveness) and account for endogeneity, while comparing how each of these determinants contributes to changes in competitiveness over time. The expected contribution of this research is both empirical (quantifying effects and interactions of these determinants) and policy-oriented: it can inform which levers African governments should prioritize, in what combinations, to accelerate sustainable competitiveness.

2. Empirical Literature Review

The notion of economic competitiveness is inherently multidimensional, drawing upon established paradigms within economic growth, institutional economics, and the field of innovation theory. The Global Competitiveness Index, among others, defines competitiveness as the set of institutions, policies, and factors driving productivity, which in turn underlies sustainable growth (IMF, 2018). Many studies show that emerging and developing economies aim to converge with advanced economies not merely through low factor costs or natural-resource endowments but by strengthening institutions, human capital, innovation, infrastructure, and regulatory environments (Aryeetey, 2022; Kasongo, 2024). In the African context, these dimensions appear as essential levers for inclusive growth and for raising competitiveness in a sustainable way. This section reviews empirical studies examining how structural pillars influence competitiveness, focusing on methodology, geographic scope, and findings, with attention to what is known in Africa and what isn't.

2.1. Infrastructure and Competitiveness

Several African studies have found positive effects of infrastructure on competitiveness. For example, Aryeetey (2022) reports that infrastructure and good governance exert a significant influence on the competitiveness of the manufacturing sector in many African countries (Aryeetey, 2022). Empirical analysis by Aryeetey shows that improving a country's infrastructure base (e.g., electricity, water, transport, communication) is a precondition for a globally competitive manufacturing sector and that a better regulatory environment with good governance and strong institutions is needed to stimulate competitiveness. Similarly, Medeiros et al. (2019) find that infrastructure quality (transport, energy, and telecom),

along with macroeconomic stability, education, and innovation, are systemic determinants of competitiveness in developing countries, including those in Africa (Medeiros et al., 2019). Their cross-country analysis indicates that structural factors like market size and demand quality, together with “systemic” factors such as infrastructure, health, education/workforce training, and a sound macroeconomic environment, all play important roles in boosting the competitiveness of emerging economies. However, these studies also note potential diminishing marginal returns to infrastructure investment – initial improvements yield strong gains, but beyond a certain point, additional infrastructure produces smaller competitiveness boosts. There are also often internal disparities in infrastructure levels (e.g., better coverage in urban hubs versus rural areas) and quality issues (poor maintenance, unreliability) that reduce infrastructure’s effectiveness. In other words, while closing Africa’s infrastructure gap is essential, simply building more infrastructure is not a panacea; attention must also be paid to equitable access and infrastructure quality to realise its full competitiveness benefits. Notably, even countries that invested heavily in infrastructure have sometimes failed to see commensurate gains in manufacturing exports, due in part to such issues. Thus, infrastructure is an essential prerequisite that must be bolstered by sound governance and intelligent policy design to avoid the squandering of resources and to foster enduring competitive advantages.

2.2. Innovation and Competitiveness

Innovation plays a major role in competitiveness. Kasongo (2024) finds a strong positive relationship between innovation indicators and economic growth for 32 African countries over 2006–2017 (Kasongo & Makamu, 2024). In that study, an aggregate innovation index (incorporating R&D, patents, tech adoption, etc.) was a significant driver of higher GDP per capita, suggesting that more innovative economies tend to grow faster. This underscores that innovation – whether through technological adoption or new product development – can enhance productivity and competitive advantage in African contexts. Likewise, Olyanga (2022) shows that export competitiveness in East African countries correlates with innovation-related measures such as patent rights protection and innovation in exports (Olyanga et al., 2022). Using data from the East African Community (EAC), Olyanga and colleagues demonstrate that greater innovation output in the exporting country, as well as innovation in the destination (importing) country, are associated with higher export

performance; notably, stronger patent rights (intellectual property protection) have a significant positive impact on export competitiveness. Interestingly, they highlight that while internet usage represents digital access, it is not a sufficient driver of export success in the EAC, implying that the transition from simple connectivity to active innovation is essential for enhancing competitiveness. These studies emphasise that innovation's impact is greater when complemented by other enabling factors. For instance, openness to foreign direct investment (FDI) can facilitate technology transfer, magnifying the benefits of domestic innovation. Institutional support (such as R&D incentives and intellectual property enforcement) and decent infrastructure (like electricity and internet quality) also determine whether innovations can be effectively developed and commercialised. Where other fundamentals are lacking – e.g. a country with poor infrastructure or weak institutions – the impact of innovation on competitiveness is much weaker. In summary, innovation is a key pillar for competitiveness, but its positive effects materialize fully only in an environment that supports innovative firms and the diffusion of new technologies.

2.3. Education and Competitiveness

Studies outside Africa show that higher education quality, university–industry collaboration, and clustering of skills positively affect competitiveness. For example, research on European countries by Marčeta & Bojnec (2020) finds that the Global Competitiveness Index (GCI) is positively linked to innovation capacity and business sophistication, including active cooperation between universities and industry in R&D and the presence of industry clusters (Marčeta & Bojnec, 2020). In other words, economies that foster stronger links between academic institutions and the industrial sector, and where innovative clusters emerge, typically achieve higher rankings in terms of competitiveness. Likewise, Sain & Bozkurt (2023), examining OECD countries, show that higher education has a significant impact on national competitiveness (Sain & Bozkurt, 2023). Their panel causality analysis (2004–2018) finds a short-run causal link between various higher-education metrics and a country's GCI score, as well as a long-run cointegrating relationship, indicating that improvements in higher education (enrollment rates, tertiary quality, research output, etc.) translate into greater competitive performance over time.

However, in Africa, the empirical evidence on higher education and competitiveness is sparser. A few case studies suggest that investment in higher education does improve competitiveness – for instance, by supplying more skilled graduates and fostering innovation – but several issues dilute the potential impact. Common challenges include a mismatch between university curricula and labour market needs (skills mismatch), insufficient funding and resources for universities, and weak governance in the education sector. The struggle of many African graduates to secure relevant employment, coupled with the skill shortages cited by employers, reflects a structural misalignment between the output of educational systems and the practical requirements of the economy. Poor funding and infrastructure in universities (e.g., outdated laboratories, large class sizes) also hinder the quality of graduates. Governance issues such as inefficient management or lack of accountability in higher education institutions further reduce effectiveness. For example, Cole (2022) highlights that African higher education faces inadequate funding, governance challenges, and limited digital access, which all impede its contribution to economic development. Additionally, analysis by Kikasu et al. (2025) notes the prevalence of irrelevant or mismatched skills among graduates and calls for closer higher-education and industry collaboration to address this gap. In summary, human capital is critical for competitiveness—better education yields a more productive workforce and more innovation—but African countries must tackle the structural problems in their education systems to fully realise these gains.

2.4. Competitiveness and Institutions

Institutional quality is widely recognised as a necessary condition for competitiveness. Aryeetey (2022) finds that governance-related factors – such as good governance practices, effective regulation, and control of corruption – are strongly linked to competitive manufacturing sectors in Africa (Aryeetey & Baffour, 2022). In the context of African manufacturing, Aryeetey’s study shows that improving governance (e.g., strengthening institutions, reducing corruption, and ensuring policy stability) has a significant positive effect on industrial competitiveness. The policy implication is that African governments need to improve the regulatory environment and institutional strength alongside infrastructure development to enable manufacturing-led growth. Medeiros et al. (2019) similarly emphasise that institutional quality interacts with other pillars (infrastructure, education, innovation) to enable countries to realise gains

in competitiveness (Medeiros et al., 2019). It is noted that "good institutions", characterised by reliable public services and sound governance, facilitate greater resource efficiency and bolster a country's competitive standing. In practice, strong institutions create a stable environment for businesses to thrive, ensure that infrastructure and human capital investments are put to productive use, and foster investor confidence. For example, clear property rights and efficient bureaucracy can enhance the returns on innovation and infrastructure by reducing transaction costs and uncertainty.

Nevertheless, some studies show mixed results for certain institutional dimensions. Not all aspects of governance have uniformly positive effects in every context. For instance, measures of political stability and of democratic participation (such as "voice and accountability") sometimes show weak or statistically insignificant effects on economic performance outcomes, depending on the country sample and timeframe. In some African cases, the absence of conflict and political stability is of course important for basic economic activity; but beyond a threshold, further gains in stability may not translate directly into competitiveness improvements, especially if other fundamentals are missing. Similarly, freedom of expression and accountability, despite their inherent societal value, do not always demonstrate a direct or unambiguous impact on short-term competitiveness metrics. One cross-country analysis found that the "voice and accountability" indicator had an ambiguous or insignificant relationship with economic growth and other development outcomes, with results varying widely by context. Another study on African governance noted that the coefficient for political stability was statistically insignificant in its effect on macroeconomic volatility, suggesting that stability alone, without broader institutional effectiveness, may not guarantee competitiveness gains. These nuances imply that while core institutional qualities like rule of law, regulatory quality, and corruption control consistently underpin competitiveness, other dimensions like political freedoms or stability need complementary conditions to have an economic payoff.

All the reviewed studies converge on the idea that no single pillar is sufficient: competitiveness depends on a combination of structural factors—institutions, innovation, infrastructure, human capital, and sound macroeconomic policies. Improvements in one area are most effective when other pillars are also strong (for example, innovation yields more dividends in the presence of good infrastructure and institutions). In the African literature, however, empirical studies often focus on one or two of

these pillars in isolation. There is a tendency in current literature to ignore both the interdependencies between pillars and the dynamic, longitudinal nature of competitiveness (e.g., lagged effects or path dependence). Thus, the existing knowledge is fragmented. There is a clear need for more comprehensive, comparative analyses (e.g., dynamic panel studies) that include all these pillars simultaneously for African countries. Such research could illuminate how the pillars reinforce each other or which sequence of improvements yields the best long-term competitiveness outcomes for African economies.

3. Data and Methodology

3.1. Data and Variable Selection

In this research, the selection of relevant variables is based on a review of previous literature on the relationship between economic competitiveness and its key determinants. Consequently, the selection of variables is informed by this empirical literature review and accounts for the specific structural characteristics of African economies. From this perspective, our dependent variable is represented by the Competition Framework Score, a composite index that reflects a country's ability to effectively mobilise its resources and institutions to ensure sustainable growth.

As for the explanatory variables, we selected one variable for each dimension identified as influencing economic competitiveness, namely:

Institutions: Represented by the variable INST, which corresponds to the "Institutions" index—one of the twelve pillars in the Global Competitiveness Index (GCI) developed by the World Economic Forum (WEF). It evaluates the quality of a country's institutional framework, which is essential for economic stability. This index incorporates aspects such as rule of law, transparency, public sector efficiency, security, and anti-corruption measures. A high score signifies an environment that facilitates investment, sustainable growth, and competitiveness through transparent regulations and reliable governance.

Infrastructure: Represented by the "Infrastructure" index, which measures the quality and extent of physical infrastructure essential to economic operations. It includes various components such as overall infrastructure quality, transportation networks, telecommunication infrastructure, electricity infrastructure, and access to basic services. This index is critical

for evaluating a country's competitive capacity, as efficient infrastructure reduces logistical costs, facilitates access to local and international markets, attracts foreign investment, and improves citizens' social well-being.

Innovation: Represented by the "Innovation Index," a composite indicator that measures a country's capacity to generate new ideas, technologies, and products. It includes R&D expenditures, the quality of scientific research, university-industry collaboration, and patent registration capacity. This index reflects a country's ability to support knowledge-based growth and, consequently, a more competitive economy.

Human Capital: Represented by the "Higher Education and Training" index, which assesses the quality of education and training—both basic and continuing. It includes enrollment rates, workforce skills, alignment of education with labour market needs, and vocational training policies. A high score indicates a strong stock of human capital capable of boosting productivity and innovation, thereby enhancing business competitiveness.

ICT Regulation: Represented by the "ICT Regulatory Tracker Index" (REGICT), developed by the International Telecommunication Union (ITU) to assess the maturity of regulatory frameworks in the information and communication technology (ICT) sector. The index is based on 50 indicators grouped under four pillars: regulatory authority, general regulatory framework, sector-specific regulation, and institutional tools. Scored from 0 to 100, the index reflects the extent to which a country has a regulatory environment that fosters innovation, competition, and digital inclusion. This serves as a pertinent indicator for assessing institutional performance in ICT and evaluating its potential contribution to the enhancement of economic competitiveness.

All these variables are drawn from the World Bank database and are presented as annual time series over a period of 11 years (2007–2017), forming a panel of 33 African countries. The choice of countries was limited by data availability. The variables are summarised in the table 1 below:

Table 1: Variables and data sources

Variable	Abbrev	Source	Dimension	Expected sign
Global Competitiveness Index	COMP	World Economic Forum (WEF) - WB	Overall Competitiveness	+
Institutions Index	INST	World Economic Forum (WEF) - WB	Institutions	+
Infrastructure Index	INFRA	World Economic Forum (WEF) - WB	Infrastructure	+
Higher Education and Training Index	HEDU	World Economic Forum (WEF) - WB	Human Capital	+
Innovation Index	INNOV	World Economic Forum (WEF) - WB	Innovation & R&D	+
ICT Regulatory Index	REGICT	International Telecommunication Union (ITU) - WB	ICT	+

3.2. Model Specification

This study employs an econometric framework to provide a dynamic assessment of the impact of institutions, infrastructure, human capital, innovation, and ICT on the economic competitiveness of African countries. The analysis relies on a dynamic panel data model estimated using the System Generalised Method of Moments (System GMM), as developed by Blundell & Bond (1998). This method is suitable for short time periods and large cross-sections, while correcting for potential endogeneity and unobserved individual effects.

By including the lagged dependent variable, the model creates a dynamic framework that assesses competitiveness as a function of the explanatory variables identified above. This approach allows for assessing the differentiated and evolving contributions of each determinant to the development of the competitive framework in Africa over the study period.

We estimate the following model using the System GMM method for dynamic panel data, as defined by Blundell and Bond (1998):

$$COMP_{it} = \beta_0 \cdot COMP_{i,t-1} + \beta_1 \cdot INST_{it} + \beta_2 \cdot INFRA_{it} + \beta_3 \cdot HEDU_{it} + \beta_4 \cdot INNOV_{it} + \beta_5 \cdot REGICT_{it} + \mu_i + \varepsilon_{it}$$

$COMP_{it}$: Competitiveness level of country i at year t

$COMP_{i,t-1}$: Lagged competitiveness to capture dynamic effects

$INST_{it}$	: Quality of institutions
$INFRA_{it}$	: Infrastructure level
$HEDU_{it}$	: Human capital, measured by the quality index of higher education and training
$INNOV_{it}$	: Innovation capacity
$REGICT_{it}$	: ICT regulatory index
μ_i	: Unobserved country-specific effects
ε_{it}	: Random error
$\beta_0, \beta_1, \beta_2, \beta_3, \beta_4, \beta_5$	: Model coefficients

This model makes it possible to assess the relationship between a given African country's competitiveness and both its past performance and its efforts in institutional governance, infrastructure, human capital development, innovation, and ICT regulation. The inclusion of the lagged dependent variable **$COMP_{i,t-1}$** reflects the persistence of competitiveness over time. Utilising the System GMM approach allows for the robust correction of endogeneity while simultaneously accommodating unobserved fixed effects inherent to each country in the sample.

Given the presence of the lagged dependent variable in the model, estimating it using Ordinary Least Squares (OLS) or fixed effects would result in biased and inconsistent estimates due to the correlation between this lagged variable and the unobserved country-specific error term μ_i . This bias is especially pronounced in panel datasets with a short time dimension (T) and a large cross-sectional dimension (N), which applies to our study.

To overcome this issue, we use the System Generalized Method of Moments (System GMM) proposed by Blundell and Bond (1998). This method allows us to:

Correct for endogeneity bias using internal instruments (lags of the dependent and explanatory variables),

Improve estimation efficiency compared to the difference GMM method of Arellano and Bond (1991), especially when the series are persistent.

Address problems of heteroskedasticity and autocorrelation in a robust manner.

The validity of the instruments will be tested using the Sargan-Hansen test for over-identifying restrictions and the Arellano-Bond autocorrelation tests (AR(1) and AR(2)) (Hansen, 1982; Sargan, 1958).

The inclusion of the lagged dependent variable $COMP_{i,t-1}$ helps capture the persistence effect in competitiveness levels, which is theoretically justified in the literature on growth and institutional performance.

This specification incorporates:

- Endogenous dynamics via the lagged dependent variable,
- Individual fixed effects (μ_i),
- The possibility for endogeneity was addressed by employing the GMM instrumentation approach, which ensures the consistency of the estimated coefficients .

4. Results

4.1. Model Estimation

The estimation of the dynamic competitiveness model using the robust two-step system GMM method reveals several important findings (see table2).

Table 2: Estimation results using the GMM approach

Variable	Coef.	St. Err.	t-value	p-value
L1.COMP (Lagged Competitiveness)	1.391***	0.277	5.03	0.000
INST (Institutions)	0.551	0.388	1.42	0.155
INFRA (Infrastructure)	-0.727**	0.312	-2.33	0.020
REGICT (ICT Regulation)	-0.129	0.094	-1.37	0.169
HEDU (Human Capital)	0.574*	0.340	1.69	0.091
INNOV (Innovation)	-0.910*	0.488	-1.86	0.062
Constant	3.153	2.396	1.32	0.188

The coefficient of the lagged competitiveness variable (L1.COMP) is highly significant and greater than one (1.39; $p < 0.01$), indicating strong dynamic inertia: a country's current level of competitiveness strongly depends on its past level. This indicates a degree of structural rigidity in the development of competitiveness among the nations included in the study sample.

Institutions (INST) have a positive but non-significant effect on competitiveness, suggesting that institutional reforms may not yet be effective enough to produce measurable impacts or that their effects are indirect and long-term.

Infrastructure (INFRA) shows a significant and negative effect ($p < 0.05$), which may seem counterintuitive. This inverse relationship could be due to issues of quality, maintenance, or misallocation of infrastructure investments. It is also plausible that these investments require a significant period of time to elapse before their positive impact on competitiveness becomes evident.

ICT Regulation (REGICT) has a slightly negative but non-significant effect, suggesting that ICTs still have limited impact on competitiveness—potentially due to low technological adoption or inefficient usage.

Higher Education (HEDU) has a positive and weakly significant effect ($p < 0.10$), indicating that higher education can improve competitiveness, although its impact remains modest—possibly due to a mismatch between the skills developed and labor market demands.

Innovation (INNOV) has a negative and weakly significant effect ($p < 0.10$), which could indicate difficulty in translating innovation efforts into concrete competitive gains. This result may also reflect poorly targeted or undervalued innovation in the studied countries.

The highly significant coefficient for the lagged competitiveness variable (1.39; $p < 0.01$) reveals strong persistence and structural rigidity. This finding with the concept of competitive advantage as a path-dependent process, as proposed by Porter (1990), where current competitiveness is fundamentally shaped by historical investments and established capabilities. Similar evidence is reported in studies on institutional and structural persistence: Rodrik (2016) and Acemoglu et al. (2005) stress that competitiveness and productivity are strongly locked into historical trajectories, making rapid shifts unlikely. In the African context, Aryeetey (2022) also observed that past industrial performance and infrastructure conditions tend to “lock in” patterns of competitiveness, with reforms taking time to alter outcomes. Thus, your results align with the literature emphasizing inertia and the long-term nature of competitiveness transitions.

The positive but non-significant role of institutions suggests that reforms have not yet translated into measurable competitiveness gains. This aligns with findings by North (1990) and Acemoglu & Robinson (2012), who argue that institutional reforms exert effects only over the long term. In African studies, Medeiros et al. (2019) also note that institutional quality matters mainly through interactions with other factors such as infrastructure and education. The weak statistical impact in your results echoes Kasongo (2024), who observed that while governance improvements are essential, they often require complementary reforms in

innovation and human capital before competitiveness gains become visible.

The significant negative effect of infrastructure is counterintuitive, but similar paradoxes have been reported. Estache et al. (2012) argue that infrastructure investments in sub-Saharan Africa only generate positive returns when they are precisely targeted and supported by a robust governance framework. Poorly maintained or misallocated projects can create fiscal burdens without immediate competitiveness benefits. Aryeetey (2022) also stresses that while infrastructure is necessary, African economies often suffer from uneven access and weak quality, leading to inefficiencies. Therefore, the analysis points to a significant disconnect between the scale of infrastructure and its quality, illustrating that more investment is only effective if accompanied by sound governance, proper maintenance, and a clear focus on supporting productive economic activities

The slightly negative and non-significant effect of ICT regulation suggests that ICT reforms have not yet translated into competitiveness gains. This is consistent with Olyanga (2022), who found that in East Africa, internet usage alone was not a significant predictor of export competitiveness—only when ICT was linked to innovation and intellectual property rights did measurable impacts appear. The weak impact in your results likely reflects limited technological diffusion and inefficient regulation, a problem also raised by UNCTAD (2021), which noted that Africa's digital transformation remains constrained by affordability, uneven adoption, and policy fragmentation.

The positive and weakly significant effect of higher education is in line with international studies. Sain & Bozkurt (2023) show that higher education has causal effects on competitiveness, though with a lag. However, in Africa, mismatches between educational output and labor market needs reduce its impact, as noted by Cole (2022). The modest coefficient in your model supports this view: higher education matters, but its contribution is diluted by underfunding, governance issues, and lack of alignment with productive sectors.

The negative and weakly significant effect of innovation is perhaps the most surprising. However, it resonates with findings that innovation in many African countries remains input-driven rather than output-oriented. Kasongo (2024) found that innovation contributes positively to growth, but mainly in contexts with strong institutions and complementary infrastructure. Similarly, Rodrik (2016) observed that for innovation policies to succeed in developing economies, they must be fundamentally

linked to market demand, the process of commercialisation, and effective diffusion. Our results likely reflect the “innovation paradox”: African countries invest in innovation (e.g., R&D, patents), but weak institutional support and low absorptive capacity hinder its transformation into competitive advantage.

4.2. Model Validation

Several diagnostic procedures were carried out to evaluate the robustness and validity of the model estimated through the System GMM method, several diagnostic tests were conducted (Table 3). The Arellano-Bond test for first-differenced residuals confirms the absence of second-order autocorrelation (AR(2)), which is essential to ensure the validity of instruments based on lagged endogenous variables.

Additionally, instrument validity is assessed using over-identification tests by Sargan (1958) and Hansen (1982). The Hansen test, robust to heteroskedasticity, does not reject the null hypothesis of instrument validity ($p\text{-value} > 0.05$), confirming their statistical exogeneity. These results reinforce the credibility of the GMM estimator used, in line with the methodological standards of Hansen (1982) and Blundell & Bond (1998).

Table 3: Summary of GMM model validation tests

Test	Statistic	p-value	Interpretation
Arellano-Bond AR(1)	$z = -2.83$	0.005	Expected first-order autocorrelation
Arellano-Bond AR(2)	$z = -1.58$	0.115	No second-order autocorrelation
Sargan Test (non-robust)	$\chi^2(7) = 9.67$	0.208	Instruments are valid (no over-identification)
Hansen Test (robust)	$\chi^2(7) = 12.35$	0.090	Acceptable instruments (slightly close to threshold)
Diff-in-Hansen – GMM instruments (levels)	$\chi^2(1) = 0.83$	0.363	GMM instruments in levels are exogenous
Diff-in-Hansen – IV (INST, INFRA, etc.)	$\chi^2(5) = 10.98$	0.052	IV instruments are valid, but interpretation is cautious

5. Conclusion and Recommendations

The objective of this article was to empirically examine the impact of key determinants such as institutions, infrastructure, ICT regulation, higher education, and innovation on the improvement of the competitive framework across a panel of 33 African countries over an 11-year period.

Using a dynamic model estimated with the System GMM method (Arellano & Bond, 1991; Blundell & Bond, 1998), we tested a set of hypotheses linking these pillars to structural competitiveness dynamics on the African continent.

From this perspective, the econometric results provide a number of major insights. First, ICT regulation has a negative and non-significant effect on the competitive framework.

Second, the non-significant effects of institutions, higher education, and innovation suggest either inefficiencies in these levers within African contexts or delayed/indirect effects that are difficult to capture in a linear model (Aghion & Howitt, 2009). This calls for better integration of institutional quality, relevant education, and innovation environments into public policy.

Third, the negative and significant impact of infrastructure on competitiveness may appear counterintuitive. It could be explained by poor governance of public infrastructure investments, their misalignment with economic needs, or debt effects with no productive return, as noted by Estache et al. (2012) and Calderón & Servén (2014). This implies that the planning of infrastructure should adhere to a strategy of regional integration, ensuring it complements existing human capital and institutional frameworks.

Furthermore, the strongly significant lagged competitiveness variable confirms a hysteresis effect (H6), indicating that African countries' competitive trajectories are shaped by institutional and structural inertia (Rodrik, 2016; World Bank, 2023). This justifies the need for ambitious, coherent, and sustained reforms over time to break free from under-competitiveness traps.

Based on our empirical findings, we confidently confirm hypothesis H6, revealing inertia in Africa's competitiveness dynamics. Conversely, hypotheses H2 and H5 are rejected, suggesting that the effects of infrastructure and innovation may be conditional on institutional quality or sectoral adaptation. As for hypotheses H1 and H3, although theoretically robust, they are not empirically validated in our case—possibly due to governance gaps or incomplete reform implementation. In contrast, hypothesis H4 is partially confirmed, as the weakly significant effect of higher education deserves special attention. This suggests that the pillar could potentially enhance the African competitiveness framework, on the condition that it is more effectively aligned with prevailing economic demands.

Human capital plays a central role in strengthening national competitiveness, but its impact depends greatly on the quality, relevance, and adaptability of education and training systems. To begin with, education systems must be aligned with labor market needs. Universities, vocational schools, and technical institutes should design curricula in close collaboration with industries to ensure that students acquire skills demanded in competitive sectors such as ICT, renewable energy, and advanced manufacturing. Programmes such as internships and apprenticeships serve as a vital link, allowing individuals to translate academic concepts into workplace competencies and ensuring they are better prepared for the needs of the industry.

Improving competitiveness also requires a shift from focusing on the quantity of graduates to improving the quality of learning. Investments should target modernizing classrooms, upgrading laboratories, and enhancing teaching methods. Particular attention should be given to STEM fields—science, technology, engineering, and mathematics—while also nurturing soft skills such as problem-solving, communication, and teamwork, which are critical in competitive business environments. Continuous professional development programs are equally important to ensure that workers can adapt to technological change throughout their careers.

Another priority is to strengthen the link between human capital and innovation. Governments and universities should provide incentives for faculty and students to engage in applied research that directly supports national development and competitiveness goals. Innovation hubs, grants, and university–industry partnerships can help transform research outcomes into practical business applications. Such efforts can reduce the innovation paradox often observed in African economies, where investments in research do not always translate into measurable competitive gains.

Addressing skills mismatch and brain drain is also crucial. Many African economies are characterised by a paradox where university graduates remain unemployed at the same time as firms find it difficult to recruit suitably qualified staff. Regular labour market surveys can help identify emerging skill gaps and guide the adaptation of training programs. At the same time, retaining skilled professionals requires offering attractive career prospects and competitive conditions at home, while engaging the diaspora in knowledge-sharing and short-term exchange programs.

Vocational and technical training should be expanded as a complementary pathway to higher education. These programmes provide

practical skills for middle-level jobs that are essential to industrial development and competitiveness. Integrating entrepreneurship training and digital literacy within vocational curricula would empower graduates to create businesses and adapt to evolving job markets.

Finally, competitiveness depends on the capacity of individuals to learn continuously. Lifelong learning programmes, including adult education and online platforms, should be promoted to enable workers to reskill and upskill as industries evolve. Governments can support this process by offering tax incentives or subsidies to firms that invest in employee training and by recognising non-formal and informal learning through certification systems. Regional and international collaboration further strengthens these efforts. Student and faculty exchanges, harmonised qualification frameworks, and active participation in initiatives like the African Continental Free Trade Area (AfCFTA) can help African countries benchmark their human capital policies against successful international models while tailoring them to local contexts.

References

- Acemoglu, D., Johnson, S., & Robinson, J. A. (2001). The Colonial Origins of Comparative Development: An Empirical Investigation. *THE AMERICAN ECONOMIC REVIEW*, 91(5).
- AfDB. (2022). Climate Investor 2 Fund's Environmental and Social Management System (ESMS) and Safety Management System (SMS) Assessment Report. In *The Europa Directory of International Organizations 2022* (24e éd.). Routledge.
- Aghion, P., Chérif, R., & Hasanov, F. (2021). Competition, Innovation, and Inclusive Growth. International Monetary Fund.
- Aghion, P., & Howitt, P. (2009). *The Economics of Growth* (Vol. 1). The MIT Press.
<https://EconPapers.repec.org/RePEc:mtp:titles:9780262012638>
- Ahodode, B. G. C. (2023). Evolution of innovation systems, economic growth, and sustainable competitiveness in Africa. *African Journal of Science, Technology, Innovation and Development*, 15(3), 362-375.
<https://doi.org/10.1080/20421338.2022.2115605>
- Arellano, M., & Bond, S. (1991). Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. *The Review of Economic Studies*, 58(2), 277. <https://doi.org/10.2307/2297968>

- Aryeetey, E., & Baffour, P. T. (2022). African Competitiveness and the Business Environment: Does Manufacturing Still Have a Role to Play? *Journal of African Economies*, 31(Supplement 1), i33–i58.
- Barro, R. J. (1990). Government Spending in a Simple Model of Endogenous Growth. *Journal of Political Economy*, 98(5, Part 2), S103-S125. <https://doi.org/10.1086/261726>
- Barro, R. J. (2001). Human Capital and Growth. *American Economic Review*, 91(2), 12-17. <https://doi.org/10.1257/aer.91.2.12>
- Blanchard, O. J., & Summers, L. H. (1986). Hysteresis and the European Unemployment Problem. *NBER Macroeconomics Annual*, 1, 15-78. <https://doi.org/10.1086/654013>
- Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*.
- Calderón, C., & Servén, L. (2008). Infrastructure and Economic Development in Sub-Saharan Africa.
- Calderon, C., & Servén, L. (2014). Infrastructure, Growth, and Inequality : An Overview. <https://openknowledge.worldbank.org/entities/publication/2ab4001c-e411-5914-842f-55be49e33ad3>
- Cole, L. (2022). Some Issues with Higher Education in Africa. *Hungarian Journal of African Studies*, 16(3), 61–77.
- Costantiello, A., & Leogrande, A. (2024). The impact of voice and accountability in the ESG framework in a global perspective. *Academy of Accounting and Financial Studies Journal*, 28(2), 1–19.
- Commission de l'Union africaine & OCDE. (2023). Dynamiques du développement en Afrique 2023 : Investir dans le développement durable. OECD. <https://doi.org/10.1787/b0920649-fr>
- David, O. O. (2024). ICT Diffusion and Economic Growth in Southern African Development Community (SADC) Countries. 223-241. Scopus. https://doi.org/10.1007/978-3-031-49951-7_16
- Dutta, S., Lanvin, B., Rivera León, L., & Wunsch-Vincent, S. (2023). Global Innovation Index 2023 : Unknown. <https://doi.org/10.34667/TIND.48220>
- Estache, A., Perrault, J.-F., & Savard, L. (2012). The Impact of Infrastructure Spending in Sub-Saharan Africa : A CGE Modeling Approach. *Economics Research International*, 2012, 1-18. <https://doi.org/10.1155/2012/875287>
- Hansen, L. P. (1982). Large Sample Properties of Generalized Method of Moments Estimators. *Econometrica*, 50(4), 1029. <https://doi.org/10.2307/1912775>

- Hanushek, E. A., & Woessmann, L. (2008). The Role of Cognitive Skills in Economic Development. *Journal of Economic Literature*, 46(3), 607-668. <https://doi.org/10.1257/jel.46.3.607>
- Hryhorash, O., Bocharov, D., Korneyev, M., Rudyanova, T., & Hryhorash, T. (2022). The quality of higher education and its funding in countries with different levels of socio-economic development. *Knowledge and Performance Management*, 6(1), 49-61. [https://doi.org/10.21511/kpm.06\(1\).2022.05](https://doi.org/10.21511/kpm.06(1).2022.05)
- IMF (2018). *A Competitive Africa: Institutions, Policies, and Productivity*.
- Kasongo, A., & Makamu, P. (2024). Impact of Innovation and Trade Participation on Economic Growth Among Selected African Countries. *Scientific Annals of Economics and Business*, 71(4), 491–513.
- Krstić, M., Filipe, J. A., & Chavaglia, J. (2020). Higher Education as a Determinant of the Competitiveness and Sustainable Development of an Economy. *Sustainability*, 12(16), 6607. <https://doi.org/10.3390/su12166607>
- López-Rubio, P., Chaparro-Banegas, N., Mas-Tur, A., & Roig-Tierno, N. (2025). The road to national competitiveness is paved with innovation and entrepreneurship: A qualitative comparative analysis. *Policy Studies*, 46(3), 415-436. <https://doi.org/10.1080/01442872.2024.2306971>
- Lucas, R. E. (1988). On the mechanics of economic development. *Journal of Monetary Economics*, 22(1), 3-42. [https://doi.org/10.1016/0304-3932\(88\)90168-7](https://doi.org/10.1016/0304-3932(88)90168-7)
- Marčeta, M., & Bojnec, Š. (2020). Drivers of Global Competitiveness in the European Union Countries in 2014 and 2017. *Organizacija*, 53(1), 37-52. <https://doi.org/10.2478/orga-2020-0003>
- Medeiros, V., Godoi, L. G., & Teixeira, E. C. (2019). Competitiveness and its determinants: a systemic analysis for developing countries. *CEPAL Review*, No. 129, pp. 7–26.
- Nelson, R. R., & Rosenberg, N. (1993). Technical Innovation and National Systems. *National Innovation Systems*, 3-22. <https://doi.org/10.1093/oso/9780195076165.003.0001>
- North, D. C. (1990). *Institutions, Institutional Change and Economic Performance*. Cambridge University Press. <https://doi.org/10.1017/CBO9780511808678>
- Olyanga, A. M., Shinyekwa, I. M. B., Ngoma, M., Nkote, I., Esemu, T., & Kamya, M. (2022). Innovativeness and export competitiveness in the

- East African Community. Modern Supply Chain Research and Applications, 4(3), 177–201.
- Radović, M., Zugic, R., & Milovic, N. (2013). Economic institutions and competitiveness of economy with emphasis on montenegro. 9.
- Rexhepi, G., Sharif, A., Najmi, A., & Dincă, G. (2024). Factors Deriving Sustainable Oriented Innovation Capability for Firm Competitiveness : Findings from the Family Businesses of an Emerging Countries. *Journal of Family and Economic Issues*. <https://doi.org/10.1007/s10834-024-09993-5>
- Rodrik, D. (2008). The Real Exchange Rate and Economic Growth. *Brookings Papers on Economic Activity*, 2008(2), 365-412.
- Rodrik, D. (2016). An African Growth Miracle? *Journal of African Economies*, jafeco;ejw027v1. <https://doi.org/10.1093/jae/ejw027>
- Rodrik, D. (2018). Populism and the economics of globalization. *Journal of International Business Policy*, 1(1-2), 12-33. <https://doi.org/10.1057/s42214-018-0001-4>
- Romer, P. M. (1986). Increasing Returns and Long-Run Growth. *Journal of Political Economy*, 94(5), 1002-1037. <https://doi.org/10.1086/261420>
- Romer, P. M. (1990). Endogenous Technological Change. *Journal of Political Economy*, 98(5), S71-S102.
- Sain, K., & Bozkurt, K. (2023). Transformation of Knowledge into Economic Value in Higher Education and Global Competitiveness : A Panel Causality Analysis on OECD Countries. *Educational Policy Analysis and Strategic Research*, 18(3), 223-251. <https://doi.org/10.29329/epasr.2023.600.11>
- Sargan, J. D. (1958). The Estimation of Economic Relationships using Instrumental Variables. *Econometrica*, 26(3), 393. <https://doi.org/10.2307/1907619>
- Struk, O. (2023). The role of institutions in shaping state competitiveness : The evidence from the European countries. *Reality of Politics*, 25(3), 145-162. <https://doi.org/10.15804/rop2023308>
- UNCTAD. (2019). Digital Economy Report 2019. https://unctad.org/system/files/official-document/der2019_en.pdf
- Vu, K. M. (2011). ICT as a source of economic growth in the information age : Empirical evidence from the 1996-2005 period. *Telecommunications Policy*, 35(4), 357-372. <https://doi.org/10.1016/j.telpol.2011.02.008>

- Weymouth, S., & Feinberg, R. (2011). National Competitiveness in Comparative Perspective: Evidence from Latin America. *Latin American Politics and Society*, 53(3), 141-159. <https://doi.org/10.1111/1/j.1548-2456.2011.00128.x>
- Word Bank. (2023). Digital Progress and Trends Report 2023.
- World Bank. (2021). Morocco Economic Monitor : Building Momentum for Reform. World Bank. <https://www.worldbank.org/en/country/morocco/publication/morocco-economic-monitor-building-momentum-for-reform>
- Yogo, U. T., & Verdier-Chouchane, A. (2015). Enhancing North Africa's Infrastructure for Improved Competitiveness. *African Development Review*, 27(3), 274-287. <https://doi.org/10.1111/1467-8268.12146>
- Zantsa, M. N., Avom, D., & Bigna, F. (2022). Effect of Governance on Macroeconomic Instability in Sub-Saharan Africa. *Regional Economic Development Research*, 3(2), 160–179.