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The Effects of Institutional Quality and Human Capital Development on Economic Complexity in Africa: Empirical Evidence from Panel Data Analysis

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ABSTRACT

The present study intends to investigate how the complexity of the economy responds to human capital investment and institutional development in Africa by employing the system GMM on panel data comprising 31 African economies over the period 2011-2020. However, earlier studies tended to ignore these interdependencies. More critically, our results indicate that the development of human capital enables the economic complexity in Africa. On the other hand, governance institutions' quality in terms of control of corruption, voice and accountability, political stability, and the absence of violence and terrorism does not have any impact on economic complexity. Their effect on governance remains insignificant if governance is measured via government effectiveness, regulatory quality, and the rule of law. This research highlights the importance of diversifying African economies by promoting human capital investments and governance reforms that reduce corruption, ensure transparency and accountability in government, and stabilize politics. Our results also show that infrastructural development and GDP per capita are major drivers of economic complexity in Africa, whereas international tourism appears to have a significant negative effect. Therefore, we provide several policy suggestions to reflect these insights.

Keywords

Africa; economic complexity; human capital; institutional quality; system GMM

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INTRODUCTION

Human capital development is a crucial aspect of development in most economies worldwide. The importance of human capital development has been acknowledged

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recently. For instance, human capital development increases productivity, innovation, and social well-being (Nchofoung et al., 2022; Nkemgha et al., 2023). Apart from its contributions to increasing productivity, innovation, and social well-being, it can also change the fortunes of African economies from those characterized by poverty to those characterized by abundance of wealth (Geo-Jaja & Mangum, 2003). According to Acemoglu et al. (2014), human capital development can be relevant in promoting output production in the labor market, which in turn contributes to overall growth. A report from the Human Development Index 2020 revealed that human capital development on the continent is relatively low compared to other regions of the world. The report revealed that human capital development in Africa is low as 0.44 on the average while the other regions of the world like European Union and Latin America and Caribbean have on the average of 0.68 and 0.56 human capital development respectively (United Nations Development Programme, 2020). Some recent studies have established that low levels of human capital development in African economies are characterized by factors such as poverty (Nwosu et al., 2018), high dependency ratio (Ojonta, 2023), and high levels of inequality (Nwosu & Orji, 2016). These factors confronting human capital development in African economies have been a serious impediment to the continent catching up with the rest of the world. However, African economies are generally characterized by a low level of human capital development. These issues motivated the present study.

Human capital development can also explain the dynamics of economic complexity in an economy. However, many studies have established the important role of human capital development in promoting economic complexities (Sweet & Eterovic, 2019; Vu, 2022; Zhu & Li, 2017). These studies agree that economic complexity which is a reflections of production capability and sophistication of economies are driven by human capital development with substantial improvement in consumption and employment. Thus, economies with high-quality human capital development are expected to be relatively more sophisticated than those with less emphasis on human capital development; hence, they are also expected to be characterized by rapid and sustainable economic growth (Kabaklarli et al., 2017; Shahzad et al., 2021). Some empirical studies have indicated the economic gains of economic complexity at both the local and international levels (Ajide, 2022; Shahzad et al., 2021; Sweet & Eterovic, 2019; Vu, 2022; Zhu & Li, 2017). Unfortunately, when trying to show some level of comparison to other economies of the world, a large percentage of countries on the continent are positioned at the last ranking of economic complexity. For instance, African economies are ranked in the 2021 Atlas of Economic Complexity Index as shown in Table 1. This table shows that no African economy appears in the top 44 countries in this index because the best-performing African country in this index, Tunisia, is ranked 45th. Indeed, Tunisia

is the only African country that has recorded a positive value for this index in 2021. The low ranking of economic complexity associated with African economies is the core motivation for this study to investigate the role of human capital development as a driver of economic complexity on the continent.

Table 1

Ranking of Countries in the 2021 Atlas of Economic Complexity Index (ECI)

Top 25 Countries in the 2021 ECI Ranking				Ranking of Top 25 African Countries			
S/No.	**Country**	**2021 ECI**	**Ranking**	**S/No.**	**Country**	**2021 ECI**	**Ranking**
1	Japan	2.26	1	1	Tunisia	0.39	45
2	Switzerland	2.14	2	2	Eswatini	-0.00	63
3	South Korea	2.04	3	3	Egypt	-0.13	67
4	Germany	1.94	4	4	South Africa	-0.15	68
5	Singapore	1.83	5	5	Mauritius	-0.17	71
6	Czechia	1.75	6	6	Kenya	-0.35	80
7	Austria	1.68	7	7	Morocco	-0.35	81
8	United Kingdom	1.61	8	8	Malawi	-0.51	89
9	Slovenia	1.59	9	9	Uganda	-0.53	92
10	Sweden	1.54	10	10	Namibia	-0.58	95
11	Hungary	1.52	11	11	Algeria	-0.63	96
12	Slovakia	1.46	12	12	Senegal	-0.66	97
13	Ireland	1.44	13	13	Mali	-0.73	99
14	United States of America	1.40	14	14	Burkina Faso	-0.75	100
15	Finland	1.36	15	15	Madagascar	-0.77	102
16	Italy	1.35	16	16	Zambia	-0.84	105
17	France	1.34	17	17	Ethiopia	-0.88	108
18	China	1.33	18	18	Tanzania	-0.91	109
19	Romania	1.23	19	19	Botswana	-0.92	111
20	Belgium	1.18	20	20	Zimbabwe	-1.01	113
21	Israel	1.17	21	21	Togo	-1.03	114
22	Mexico	1.14	22	22	Angola	-1.04	116
23	Thailand	1.12	23	23	Libya	-1.11	119
24	Denmark	1.06	24	24	Mozambique	-1.17	120
25	Poland	1.02	25	25	Ghana	-1.18	121

Source: Author's compilations and data were sourced from the Massachusetts Institute of Technology's Observatory of Economic Complexity (http://atlas.media.mit.edu). Overall, 133 countries were ranked in the 2021 Atlas of Economic Complexity Index.

Apart from the significant role of human capital development in promoting the sophistication of an economy, it is also known that institutional quality can influence economic complexity. Some studies also explain how institutional quality has promoted economic complexity in economies (Davidson & Gleeson, 2018; Y. Li & Shang, 2020; Siba,

2008). These studies establish that the entire world can only have adequate right for freedom through an improved and strong institutions. However, there is no doubt that any economy plagued by corruption, embezzlement of public fund and willful disobedient to constitutional authority for rule of law such as liberty for freedom of speech, education and other essential rights will definitely have poor governance (Davidson & Gleeson, 2018; Y. Li & Shang, 2020; Siba, 2008). Additionally, Egbetunde & Akinlo (2015) establish that a considerable improvement in economic growth sustainability in many African countries has not been achieved because the relevance of high-quality institutions was considered unimportant. North (1990) explains the significant role of high-quality institutions in an economy. The study believes that high-quality institutions create an enabling environment for businesses to drive and create strong confidence in bringing foreign investors into Africa. The study further found that strong institutions are relevant in ensuring overall economic growth. This overall growth must be anchored with respect to the rights of citizens (Madrick, 2002).

On the other hand, African economies have remained stagnant in terms of general improvement in the standard of living for their citizens. This is because Africa's economies have consistently poor institutional quality over time. For example, incessant stealing through padding in the national budgeting and embezzlement of public resources in Nigeria has been blamed for the weak institutional quality existing in the country. As provided empirically in Table 2 and documented in the World Governance Indicators 2021 (World Bank, 2021), African economies have been witnessing a huge weak institution generally and have been revealed that overtime. However, African economies are generally characterized by weak institutions.

Table 2

Average Institutional Quality Indicators in African Countries (2002 – 2020)

Countries	Control of Corruption	Government Effectiveness	Political Stability and Absence of Violence / Terrorism	Regulatory Quality	Rule of Law	Voice and Accountability
Algeria	-0.6231	-0.5043	-1.1803	-0.9683	-0.7905	-0.9445
Angola	-1.3050	-1.1132	-0.5627	-1.0406	-1.2461	-1.1169
Botswana	0.8814	0.4337	1.0199	0.6577	0.5178	0.5117
Burkina Faso	-0.2541	-0.6751	-0.4669	-0.3221	-0.4571	-0.2493
Cameroon	-1.1383	-0.8746	-0.7602	-0.8597	-1.1085	-1.0540
Chad	-1.4099	-1.4268	-1.4471	-1.1000	-1.4020	-1.3382
Congo, Dem. Rep.	-1.4291	-1.6346	-2.1052	-1.4655	-1.6685	-1.4206
Congo, Rep.	-1.2063	-1.1971	-0.6433	-1.2535	-1.1971	-1.1100

Countries	Control of Corruption	Government Effectiveness	Political Stability and Absence of Violence / Terrorism	Regulatory Quality	Rule of Law	Voice and Accountability
Cote d'Ivoire	-0.8557	-0.9942	-1.4245	-0.6924	-1.0647	-0.8236
Egypt, Arab Rep.	-0.6035	-0.4644	-1.0484	-0.5168	-0.3083	-1.1609
Ethiopia	-0.6016	-0.6692	-1.5334	-1.0272	-0.6672	-1.2513
Gabon	-0.8309	-0.7988	0.1698	-0.5250	-0.5503	-0.8790
Ghana	-0.1480	-0.1724	0.0235	-0.1290	0.0112	0.4270
Guinea	-1.0426	-1.0827	-1.2287	-1.0043	-1.3403	-1.0390
Kenya	-0.9656	-0.5457	-1.2232	-0.2935	-0.7474	-0.2636
Madagascar	-0.5632	-0.9080	-0.3246	-0.5550	-0.6639	-0.3877
Mali	-0.6703	-0.8901	-0.8385	-0.5358	-0.5100	-0.0423
Mauritania	-0.6669	-0.7862	-0.5481	-0.6198	-0.7832	-0.8710
Mozambique	-0.6365	-0.6915	-0.1268	-0.5874	-0.7698	-0.2303
Namibia	0.2737	0.1854	0.7330	0.1394	0.2490	0.4248
Niger	-0.7174	-0.7414	-0.9011	-0.6422	-0.6073	-0.3755
Nigeria	-1.1636	-1.0550	-1.9331	-0.9048	-1.1260	-0.6249
Senegal	-0.1833	-0.3642	-0.1707	-0.2559	-0.1946	0.0946
South Africa	0.0817	0.2723	-0.1219	0.4088	0.0095	0.6323
Sudan	-1.3528	-1.3876	-2.1378	-1.4225	-1.3134	-1.7091
Tanzania	-0.5613	-0.6176	-0.3609	-0.5104	-0.4433	-0.2945
Togo	-0.8893	-1.2688	-0.4370	-0.8485	-0.8564	-0.9411
Tunisia	-0.0514	0.1564	-0.3782	-0.1856	-0.0088	-0.4991
Uganda	-0.9753	-0.5778	-0.9763	-0.2560	-0.4098	-0.6012
Zambia	-0.5126	-0.7586	0.2392	-0.5733	-0.4140	-0.2618
Zimbabwe	-1.3228	-1.2885	-0.9670	-1.8358	-1.5942	-1.3806

Source: Authors, with data from the World Bank's World Governance Indicators (https://datacatalog.worldbank.org/dataset/worldwide-governance-indicators).

Building on the preceding discussion, this study poses the following central research question: How do human capital development and institutional quality shape economic complexity in Africa? Accordingly, the primary aim of this study is to examine the influence of these two factors on Africa's economic complexity. The remainder of this paper is organized as follows. Section 2 reviews both the theoretical and empirical literature, while Section 3 describes the data and methodological approach. Section 4 reports and analyzes the empirical findings, and Section 5 concludes the study with policy implications and recommendations.

LITERATURE REVIEW

Theoretical Literature

Some economic theories are relevant to this study, including theories of human capital development, such as the investment theory and human capital in the knowledge economy; theories of economic complexity, such as theory of endogenous technological progress and economic complexity theory; and theories of institutional quality, such as the theory of planned behavior and the theory of general management. We review the main hypotheses of these theories as follows.

The investment theory of human capital propounded by Becker (1964) highlights the drivers of human capital components and describes educational attainment as a driver and integral part of human development. The theory explained that an increase in human capital in the labor market through improved productivity is borne out of two choices: public and private investment decisions. The theorist established that public investment decisions in education lead to economic growth through specific patterns, while private decisions in education promote increased lifetime earnings for individuals with longer years of schooling and access to quality pay jobs with reduced time in the unemployment market, especially individuals with fast transition to improved careers' prospects. Some studies support this theory (Blundell et al., 2000; Fitzenberger & Kurz, 2003; Psacharopoulos, 1994).

The signaling theory of human capital formulated by Spence (1973) initiated a process through which individuals can develop capacity. According to theorists, individuals have a set of knowledge or capacities that can be improved through training and education. The theory posits that education is a signal of higher quality for future workers who may have undergone training or education. The theorist maintained that such a signal is a measure of value in the labor market as well as its inherent ability to determine individual productivity. The theory of signaling also addresses the general view of employers with respect to productivity. The theory establishes that potential employers choose higher education as a positive signal for two reasons. The first is for productivity. The second is the motivation of the individuals. However, some studies support this theory (Gupta, 2018; M. Li, 2017).

Hausmann et al. (2021) developed the theory of economic complexity attempting to explain its dynamics. They have explained how countries tend to come together on the basis of income level and the complexity of their productive structures. The theory also maintains that economic complexity measures the capability of an economy, including that embedded in goods and services. The theorist emphasizes how the diversification of innovative products, which are predominantly more complex, enhances economic growth. The theory believes that policymakers should rely on

regulations that allow for greater economic complexity to ensure that sustainable and long-term growth is achieved.

The theory of endogenous technological progress proposed by Aghion & Howitt (1992) states that technological progress is useful in promoting economic complexity. The theorist believes that its usefulness can engender a contest between the implementation of long-term technological innovation and the firm's product generation. Aghion & Howitt (1992) reveal that each innovation is expected to bring new interim goods (technology) into the market, which can be utilized in a more efficient and effective production of products than the previous one. Furthermore, when products are driven by technology, they tend to attract the interests of tourists. Therefore, policies and reforms must be channeled towards technological advancement to enhance international tourism. Some studies support this theoretical perspective (Abbasi et al., 2021; Adedoyin et al., 2021).

Another essential theory in this study is the theory of planned behavior. Ajzen (1991) formulated the theory as an attempt to forecast human behavior. The theorist explains some attitudes that control the influence of behavior, subjective norms, and intention. The theorist focuses on explaining the general behaviors through which an individual can have the capacity to exert self-control. The theory established that behavior can be independently defined in four different components: action behavior, which is defined as the specific act demonstrated by an individual; the target is indicating to who or rather what the behavior is targeting; context is associated with what situation does the behavior occur; and time is at period the behavior happens. The theory conceptualizes institutional quality not only as a rule of law to capture a general perception of society, but also to ensure that society is being controlled by the rule of law in terms of the quality of contract enforcement, the police, property rights, courts, violence, and crime.

The theory of general management, as proposed by Fayol (1949), posits that, for effective management to thrive, some components of management must be merged. These components include planning, organizing, commanding, coordinating, and controlling. The theorist explained that this theory is described as a modern management theory and proposed that it can be applied in various fields of administration. Theorist's school of thought emphasizes in strong terms the role of management in an organization relative to its contemporaries in the field of organizational psychology. The theory succumbed to institutional quality in the area of corruption control, which explains the perceptions and extent of public power utilization for private benefit in both petty corruption and grand forms (Challe et al., 2019).

Empirical Literature

Some empirical studies have also investigated how the economy is driven by human capital development using various econometric methodologies and covering various countries and regions worldwide. In what follows, we present the findings of these studies, starting with studies on the relationship between human capital development and economic complexity as well as studies that capture the roles of institutional quality and economic complexity.

Human Capital Development and Economic Complexity

For example, Tsaurai & Ndou (2019) explores a study with interest to reveal how human capital development is responding to economic growth in 15 countries associated with transitional economies using system GMM for estimation. The study was conducted with the help of time-series panel data for the period 2000-2014. Variables such as infrastructure, foreign direct investment, savings, inflation rate, population growth, trade openness, financial development, exchange rate, and interaction between infrastructure and human capital development were included in the model. The study revealed that human capital development is neither positive nor negative for economic growth in these countries. Another study (Shuaibu & Oladayo, 2016) used three variables, infrastructural development and institutional quality, as control variables in their model for estimation. The focus of this study was to investigate how infrastructural development influenced human capital in Africa for the period 2000-2013 using 33 countries. This study employed Sen's capability approach to predict estimation results. This study maintains that infrastructure development is a potential driver of human capital development in Africa.

Shao & Razzaq (2022) estimate how human capital development impacts infrastructural development for the period 1996-2017. The results show that human capital development, such as education and healthcare, is a necessary factor for enhancing infrastructural development. Nkemgha et al. (2023) employed system GMM regression to investigate how infrastructures and financial development moderates the consequence of human capital development on industrialization in Africa. However, this study achieved this objective by adopting 33 economies in Africa. In conclusion, the results show that developing human capital through financial development interactions has a negative impact on industrialization. Fleisher et al. (2010) did a study in China to examine how difference in physical, human capital, infrastructure capital and differences in foreign direct investment (FDI) flows are influencing regional growth patterns in China. The findings of this study indicate that human capital positively influences both output and productivity growth in Nigeria. Our previous studies (Nkemgha et al., 2023; Shao & Razzaq, 2022) have focused on the financial-growth

relationship. These studies fail to consider the essential role of human capital development. This gap forms our departure from examining the effect of human capital development on economic complexity for the period 2011-2020 in a panel of 31 African economies using the Atlas of Economic Complexity, which was recently developed by the Institute of Technology's Observatory of Economic Complexity.

Institutional Quality and Economic Complexity

Ouedraogo et al. (2022) conducted a study to examine how institutional quality affects the human capital development proxy for education in Africa. The study further used panel data for the 1996-2018 from 49 countries in Africa. Zhou (2018) believes that increased human capital, such as tertiary institutions, promotes institutional quality. The study concludes that institutional quality plays a significant role in improving education in Africa. Some recent studies during the period and after of COVID-19 pandemic investigated how institutional quality is impacting on international tourism (Ghalia et al., 2019; H. S. Lee, 2020; Meo et al., 2023; Musa et al., 2021; Mushtaq et al., 2021). These studies show that institutional quality is an important driver for tourists. The study further indicated that the effect of government effectiveness is negative, suggesting that it is not an essential driver of tourism. A study in the literature before the COVID-19 pandemic (Kim et al., 2018) examined how institutional quality has influenced international tourism. The study revealed that higher quality governance institutions are likely to drive more revenue and attract more international tourists. Previous studies focused on the institutions-tourism relationship with little or no interest in infrastructural development (H. S. Lee, 2020; Musa et al., 2021). This study departs from the extant literature by focusing on the effect of institutional quality on economic complexity in Africa, using a panel of 31 African economies. None of these studies has examined how institutional quality influences economic complexity in Africa using the system GMM technique.

METHOD

The Data

This study specifically examines how human capital development and institutional quality affect infrastructure development across Africa. Consequently, the geographic scope is limited to African countries, while the temporal coverage spans 2011–2020, as determined by the availability of reliable data. The sample comprised the following countries: South Africa, Senegal, Nigeria, Niger, Namibia, Mozambique, Mauritania, Mali, Madagascar, Kenya, Guinea, Ghana, Gabon, Ethiopia, Egypt, Côte d'Ivoire, the Republic of Congo, the Democratic Republic of Congo, Chad, Cameroon, Burkina Faso, Botswana, Angola, and Algeria.

Table 3

Definitions of Variables and Data Sources

Variable	Acronym	Description / measurement	Data source
Economic complexity	ECI	The index is determined by the diversity of exports a country produces and its ubiquity	Massachusetts Institute of Technology's Observatory of Economic Complexity (http://atlas.media.mit.edu)
International Tourism	TOR	International tourism, number of arrivals	World Development Indicators, WDI (https://datacatalog.worldbank.org/dataset/world-development-indicators)
Infrastructural Development	INFS	Africa infrastructure development index	African Development Bank's Africa Infrastructural Development Index (AIDI), (https://infrastructureafrica.opendataforafrica.org/rscznob/africa-infrastructure-development-index-aidi)
Human capital development	HCAP	Human capital index	World Bank's Human Capital Index, HCI (https://data.worldbank.org/indicator/HD.HCI.OVRL)
GDP per capita	GDPPC	GDP per capita (constant 2015 US$)	World Development Indicators, WDI (https://datacatalog.worldbank.org/dataset/world-development-indicators)
Government Effectiveness	ge	Government effectiveness	World Governance Indicators, WGI (https://datacatalog.worldbank.org/dataset/worldwide-governance-indicators)
Voice and Accountability	vc	Voice and accountability	World Governance Indicators, WGI (https://datacatalog.worldbank.org/dataset/worldwide-governance-indicators)
Regulatory Quality	rq	Regulatory quality	World Governance Indicators, WGI (https://datacatalog.worldbank.org/dataset/worldwide-governance-indicators)
Rule of Law	rl	Rule of law	World Governance Indicators, WGI (https://datacatalog.worldbank.org/dataset/worldwide-governance-indicators)

Variable	Acronym	Description / measurement	Data source
Control of corruption	cfc	Control of corruption	World Governance Indicators, WGI (https://datacatalog.worldbank.org/dataset/worldwide-governance-indicators)
Political Stability and Absence of Violence/Terrorism	polst	Political stability and absence of violence/terrorism	World Governance Indicators, WGI (https://datacatalog.worldbank.org/dataset/worldwide-governance-indicators)

Source: Author's analysis.

Table 3 provides a detailed description of the variables employed in the analysis, and their corresponding data sources. Tables 4 and 5 present descriptive statistics and the correlation matrix, respectively. The descriptive statistics reveal that the average values of human capital and institutional quality are negative, suggesting that, on average, African economies are characterized by low human capital development and weak institutional frameworks. Furthermore, the mean, maximum, and minimum values were relatively close to each other, indicating the absence of significant outliers in the dataset. The standard deviations confirmed that, as expected, all variables displayed some degree of variation during the study period. The correlation matrix demonstrates that only institutional quality indicators exhibit a high degree of correlation with each other. To mitigate the potential problem of multicollinearity, these components were employed in separate estimations of the underlying econometric models.

Table 4

Descriptive Statistics of the Variables

Variable	No. of Obs.	Mean	Std. Dev.	Minimum	Maximum
eci	310	-0.9376	0.51537	-2.22752	0.39027
tor	310	0.9567	0.04008	0.79957	1.0315
inf	310	0.00469	0.27085	-1.17092	0.40548
gdppc	310	0.68665	0.05774	0.57096	0.80144
hcap	310	-0.9372	0.1493	-1.2515	-0.60376
cfc	310	-0.6922	0.53613	-1.57239	0.99559
rl	310	-0.6537	0.50455	-1.79057	0.66766
ge	310	-0.7257	0.50257	-1.69274	0.52952
rq	310	-0.6464	0.48013	-1.67341	0.61093
vc	310	-0.5673	0.63214	-1.85073	0.69723
polst	310	-0.7785	0.78377	-2.52292	1.11106

Source: Author's estimation.

Table 5

Correlation Matrix of the Variables

	eci	tor	infs	gdppc	hcap	cfc	rl	ge	rq	vc	polst
eci	1.0000										
tor	-0.1121	1.0000									
infs	0.0841	-0.0318	1.0000								
gdppc	0.4017	-0.2943	-0.3757	1.0000							
hcap	0.4001	-0.2031	0.0310	0.5235	1.0000						
cfc	0.5392	-0.0730	-0.1444	0.4268	0.1535	1.0000					
rl	0.6837	-0.0469	-0.0978	0.4343	0.2147	0.8853	1.0000				
ge	0.6802	-0.1105	-0.2150	0.5445	0.3372	0.8568	0.9105	1.0000			
rq	0.5957	-0.0369	-0.0316	0.3172	0.0424	0.7482	0.8533	0.8356	1.0000		
vc	0.5679	-0.0207	-0.0244	0.3579	0.1139	0.8038	0.8325	0.8205	0.9047	1.0000	
polst	0.4182	0.1697	-0.2909	0.3446	0.0614	0.6801	0.6888	0.6452	0.6650	0.6895	1.0000

Source: Author's estimation.

Model Specification

To ascertain how human capital development and institutional quality affect economic complexity in Africa, this study follows previous works on related matter (Ekeocha et al., 2021, 2022; K.-K. Lee & Vu, 2020; Ndoya & Bakouan, 2023; Nguea, Kaguendo, et al., 2022; Yalta & Yalta, 2021). The functional form of the panel model is as follows:

$$ECI = f(TOR, HCAP, GDPPC, INF, INST) \quad (1)$$

where: ECI= economic complexity; INF = infrastructural development; $HCAP$ = human capital development; $INST$ = institutional quality indicator consist of control of corruption (*cfc*), government effectiveness (*ge*), regulatory quality (*rq*), rule of law (*rl*), voice and accountability (*vc*), and political stability and absence of violence/terrorism (*polst*); TOR = international tourism and $GDPPC$ = GDP per capita.

To facilitate the estimation, the implicit economic complexity model in equation (1) is explicitly specified as a dynamic panel data model, as follows:

$$ECI_{it} = \beta_0 + \delta_1 ECI_{it-1} + \delta_2 TOR_{it} + \delta_3 HCAP_{it} + \delta_4 GDPPC_{it} + \delta_5 INF_{it} + \delta_6 INST_{it} + \varepsilon_{it} \quad (2)$$

where: $ECI_{it-1}$is defined as lag of the predicted variable, while the error term is stated by ε_{it}. Here, $INST_{it}$ denotes institutional quality variables. This institutional quality

helps this study understand how individual institutional quality influences economic complexity in Africa. ECI denotes economic complexity, and the index is determined by the diversity of exports a country produces and its ubiquity. HCAP represents human capital development measured using the human capital index. The GDPPC, INST and HCAP variables in the model remained untouched (Ketu et al., 2022). TOR denotes international tourism measured with number of tourist arrivals. This number was scaled down to ensure that the estimated result of the coefficient could be interpreted economically. This was achieved by taking the logarithm of these two variables (Kamguia et al., 2023).

Estimation Technique and Pre-Estimation Tests

The system GMM technique was used in this study to estimate the models, as provided in equations (1) and (2). The technique is suitable for panel data analysis in which the size of the cross-sectional unit is greater than the size of the time periods. In our study, the cross-sectional unit size represents the number of countries in which 31 African countries were more than the size of the time period, which was 10 years. Another reason for choosing our technique is based on the fact that it controls for endogeneity problems of lagged predicted variables in the model of the dynamic panel data, including unobserved panel heterogeneity and omitted variable bias (Arellano & Bond, 1991; Arellano & Bover, 1995; Blundell & Bond, 1998). These two problems identified using the system GMM technique are associated with the causal estimation approach and pooled OLS. Additionally, the two assumptions of the system GMM estimator, according to Blundell & Bond (2000) and Windmeijer (2005), are that it improves precision and reduces the finite sample bias in the first-order condition or GMM estimator of the first difference . However, to ensure that our study does not use the system GMM estimator, we conducted the Bond (2002) test for the models, as shown in equations (1) and (2). The Bond test results in Table 6 indicate that the system GMM estimator is more suitable than the difference GMM estimator.

Table 6

Bond Test Results for Choice of GMM Estimator

Indicators	eci L1.(Bond1)	eci L1.(Bond2)	eci L1.(Bond3)	eci L1.(Bond4)	eci L1.(Bond5)	eci L1.(Bond6)
FE	0.4585289***	0.4556886***	0.4690806***	0.4714707***	1.106975***	0.2950033***
OLS	0.895324***	0.8672177***	0.8802308***	0.8862483***	0.9011676***	0.8997909***
FIRST DIFF	0.3107037***	0.3078397***	0.2950033***	0.3352028***	0.4028166***	0.341496***
SECOND DIFF	1.070454***	1.04368***	1.108992***	1.055424***	1.106975***	1.060353***

Source: Author's estimation.

Notes: There are six panels in this Table, since the institutional quality variables are included in separate estimations of the underlying models

Another pre-estimation test conducted, apart from the Bond test in the panel, is cross-sectional dependence. Going by the widespread economic integration in Africa, as evidenced by the activities of various groups of regional economies that constitute the African Union (AU), there was a need for this study to conduct a test in the panel for cross-sectional dependence. The reason for this is simple because many African countries, especially those used in our study, may be interdependent. Ignoring cross-sectional dependence in the model according to Sarafidis & Robertson (2009), which has large cross-sectional units and a small time period, results in inefficient estimates. Therefore, this study conducts a cross-sectional dependence test. The test follows the study by Pesaran (2021). This study shows that the panels are asymptotically efficient with a large sample size of cross-sectional units and small size of time series. Further tests for cross-sectional dependence provided in our study follow Frees (1995) and Friedman (1937). The further outcomes for tests of cross-sectional dependence are presented in Table 7, which predominantly show the existence in the panel for the test of cross-sectional independence for this study. Hence, this study has shown that testing for cross-sectional dependence is not a challenge.

Table 7

Results of Tests for Cross-Sectional Independence

Economic Complexity Model						
	(1) cfc	**(2) rl**	**(3) ge**	**(4) rq**	**(5) vc**	**(6) polst**
Pesaran - fe	1.648 (0.331)	1.653 (0.331)	1.667 (0.329)	1.619 (0.329)	1.644 (0.328)	1.621 (0.332)
Pesaran - re	1.146 (0.314)	1.142 (0.316)	1.128 (0.316)	1.224 (0.315)	1.144 (0.314)	1.088 (0.314)
Friedman - fe	1.000 (0.331)	1.000 (0.331)	1.000 (0.329)	1.000 (0.329)	1.000 (0.328)	1.000 (0.332)
Friedman - re	1.000 (0.314)	1.000 (0.316)	1.000 (0.316)	1.000 (0.315)	1.000 (0.314)	1.000 (0.314)
Frees' – fe	1.215 (0.331)	1.236 (0.331)	1.050 (0.329)	1.042 (0.329)	1.063 (0.328)	1.186 (0.332)
Frees' – re	-0.054 (0.314)	0.102 (0.316)	0.121 (0.316)	0.039 (0.315)	-0.005 (0.314)	0.103 (0.314)
Decision	CID	CID	CID	CID	CID	CID

Source: Author's estimation.

Notes: There are six panels in this table because the institutional quality variables are included in separate estimations of the underlying models. Pr values were reported for the tests based on Pesaran (2021) and Friedman (1937), while the alpha values were reported for the Frees' (1995) tests. The average absolute values are reported in parentheses for all the cases. CID denotes cross-sectional independence.

RESULTS AND DISCUSSION

The outcomes of the study in Table 8 indicate that human capital development has a positive and significant impact on continental economic complexity. The estimation results indicate that human capital development in Africa contributes to economic complexity. The conclusion of the estimate is in tandem with the economic expectations. It is also somewhat uniform with the predictions of Yalta & Yalta (2021),

who established that the years spent in education significantly contribute to economic complexity in the Middle East and North Africa (MENA) region. This finding clearly shows that human capital development promotes economic complexity in Africa.

Table 8

System GMM Regression Results for the Economic Complexity Model

Regressors	Panel 1	Panel 2	Panel 3	Panel 4	Panel 5	Panel 6
eci L1.	0.978816***	0.9721174***	0.9625455***	1.011481***	0.9572441***	0.9908197***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
TOR	-0.4841152***	-0.3525101***	-0.3533599**	0.7379058***	0.3593762***	-0.6113648***
	(0.002)	(0.006)	(0.017)	(0.000)	(0.008)	(0.002)
HCAP	0.120563***	0.1279616***	0.1348572***	0.1084267**	0.1326837***	0.1249572***
	(0.002)	(0.002)	(0.002)	(0.011)	(0.002)	(0.002)
INFS	0.0957886***	0.0829033**	0.0905626**	0.1050477**	0.1044547***	0.0774458*
	(0.008)	(0.014)	(0.010)	(0.016)	(0.001)	(0.093)
GDPPC	0.3375736**	0.3618844***	0.3068437***	0.3047828**	0.2790507***	0.4173053***
	(0.017)	(0.002)	(0.008)	(0.023)	(0.009)	(0.006)
cfc	-0.0257169*					
	(0.066)					
ge		-0.0163537				
		(0.269)				
rl			-0.0038292			
			(0.814)			
vc				-0.0341301***		
				(0.000)		
rq					0.0000716	
					(0.997)	
polst						-0.0289063***
						(0.003)
_cons	0.0862363	-0.0623014	-0.028989	0.3936667**	-0.0051322	0.1586523
	(0.613)	(0.615)	(0.845)	(0.030)	(0.967)	(0.300)
Diagnostic						
Observations	199	199	199	199	199	199
Hansen	0.409	0.412	0.392	0.309	0.252	0.431
AR(2)	0.212	0.199	0.198	0.209	0.208	0.215
Instruments	27	27	27	27	27	27

Source: Author's estimation.

Notes: Estimated coefficients are reported, and p-values are in parentheses. * p < 0.10. ** p < 0.05. *** p < 0.01. Note the following: (i) the effects of human capital development, infrastructural development, and GDP per capita are positive and significant throughout; (ii) the effects of individual institutional quality indicators such as cfc, ge, rl, vc, and polst are mainly negative and significant, while rq is mainly muted; and (iii) the effect of TOR international tourism remains negative and significant throughout.

The regression results in Table 8 further reveal that institutional quality has a predominantly negative coefficient and insignificantly influences economic complexity

on the continent. These results indicate that institutional quality in African economies does not completely promote the continent's economic complexity. The result is the same that as of some studies in the literature, which revealed that African economies are generally characterized by weak institutions. However, the results contradict previous findings stating that institutional quality can positively and significantly influence economic complexity (M. A. Khan et al., 2019; Vu, 2020).

Some variables, such as the initial level of economic complexity (i.e., predicted variable lag), human capital development, infrastructural development, and GDP per capita are positive and significantly impact economic complexity in all panels. These variables promote the economic complexity of Africa. In specific terms, the outcome of the initial level of economic complexity aligns with previous studies (Javorcik et al., 2018; Nguea, Fotio, et al., 2022; Njangang et al., 2022; Ogbuabor et al., 2023). This study reveals that the initial level of economic complexity is an essential driver of economic complexity. The finding that GDP per capita has a positive and significant impact on economic complexity suggests that this result is in tandem with economic expectations. This result further suggests that as economies prosper, the higher they gain the capacity to improve sophistication, which, in turn, helps in increasing economic complexity. This finding is also the same as previous study (Romero & Gramkow, 2021) showing that there exists a significant and positive relationship between economic complexity and GDP per capita. Hence, this study has found that increasing GDP per capita is a channel for promoting economic complexity in African economies.

The outcomes in Table 8 further indicate that infrastructural development is positive and significantly influences economic complexity in Africa. Economically, infrastructural development has increased business operations, enhanced the exchange of goods and services, and improved job creation. This is also expected to enhance the capacity of domestic economies to compete in the global economic arena. These economic gains from infrastructural development can lead to higher economic complexity in some domestic economies. However, the outcomes of this study follow findings of previous studies (Antonietti & Franco, 2021; Gómez-Zaldívar et al., 2021; A. Khan et al., 2020). This study establishes that infrastructural development increases economic complexity.

The regression results in Table 8 also reveal that international tourism has a negative and significant impact on economic complexity in all panels, at the 5% level of significance. This finding establishes that international tourism does not contribute to promoting the economic complexity of the continent. This is contrary to some studies in the literature, such as Farsari et al. (2011) and Quattrociocchi et al. (2017), which establish a significant positive relationship between international tourism and economic complexity in Greece and Europe, respectively. Indeed, this conclusion is also

contrary to economic expectations, which posits that international tourism could be a channel for enhancing the economic complexity of African countries. Economically, international tourism is anticipated to bring about various economic benefits, such as the transfer of knowledge and technology, capital investment, and increased productivity, which, in turn, promote the economic complexity of an economy. However, this finding reflects the fact that African economies not only have low levels of economic complexity but also low international tourism arrivals relative to other parts of the world.

The results of this study are summarized as follows. We find that: (i) international tourism is not an essential driver of economic complexity on the continent; (ii) individual institutional quality does not predominantly promote economic complexity in Africa; and (iii) essential drivers of economic complexity in Africa include the initial level of economic complexity, GDP per capita, infrastructural development, and human capital development.

As stated in all the panels in Table 8, the presence of the Arellano-Bond tests is a second-order serial correlation AR (2). The tests established that none of the models were affected by the problems of serial correlation. Additionally, the tests of (Hansen, 1982) with respect to over-identifying restrictions maintain that the jointly valid instruments hypothesis can be accepted in all cases, suggesting that the set of instruments accommodated in the estimations satisfied the position of exogeneity condition needed to obtain a genuine regression estimates. Thus, all cases in our model are genuine over-identifying restrictions that are adequate to inform policies.

CONCLUSION

The finding that the initial level of economic complexity, human capital development, infrastructural development, and GDP per capita positively contribute to economic complexity in Africa underscores the need for policymakers and leaders across the continent to work collectively to strengthen their economies. It involves promoting robust human capital development, investing in adequate infrastructure, and sustaining economic growth. Achieving this requires confronting persistent challenges, such as unemployment and poverty, which undermine both per capita income and human capital accumulation. Therefore, policies aimed at raising household income and improving the quality of human capital must be actively pursued.

Moreover, the evidence highlights the urgency of addressing Africa's brain drain by creating decent employment opportunities, revitalizing educational systems to meet international standards, and retaining domestic talent, rather than relying heavily on

foreign expertise. These findings align with the results of earlier studies (Emeka et al., 2024; Gómez-Zaldívar et al., 2021; Ogbonna et al., 2022; Ogbuabor et al., 2023).

By contrast, the finding that institutional quality does not significantly promote economic complexity in Africa reveals the necessity of building stronger institutional frameworks. The study recommends that African governments and regional bodies work together to strengthen governance, combat corruption, enforce the rule of law, ensure accountability in public services, stabilize the political environment, and confront terrorism and insecurity. At the continental level, the African Union, through its institutional mechanisms, such as the Peace and Security Council, should take the lead in institutional reform. Establishing a policy framework that sanctions leaders who undermine governance institutions entrusted to them by their citizens is crucial. This finding is consistent with those reported by Emeka et al. (2024).

Furthermore, the result indicates that international tourism has a negative but statistically significant effect on economic complexity and suggests that tourism is currently not a driver of complexity in Africa. This calls for deliberate efforts by policymakers and leaders to harness the continent's largely untapped tourism potential. Addressing critical issues such as safety, security of lives and property, and overall stability is essential to attract more international visitors. A strengthened continental security initiative, possibly through the African Union's reinforcement of existing multinational joint task forces, can enhance the safety of tourist destinations. This, in turn, would allow African economies to leverage tourism to diversify their productive structures. This result is consistent with the findings of Ojonta & Ogbuabor (2024).

This study has some limitations that should be addressed in future studies. Indeed, considering the significant impact of institutional quality and human capital development in enhancing economic complexity in Africa, this study could not shed light on how institutional quality and human capital development could influence economic complexity using large covariates in the model. This study was limited to employing two variables in the model, apart from the core variables of interest, owing to the unavailability of data. Another limitation is that our study could not shed light on cross-sectional data analysis and access sufficient data, as quite a few of them are missing. Therefore, we recommend that future research focuses on cross-sectional data analysis using a model technique that allows both continuous and other forms of data analysis.

Author Contributions

Conceptualization: O.I.O.; Data curation: O.I.O.; Formal analysis: O.I.O.; Funding acquisition: O.I.A-O.; Investigation: O.I.O.; Methodology: O.I.O.; Project administration: O.I.A-O.; Resources: O.I.O.; Software:

O.I.O.; Supervision: O.I.O.; Validation: O.I.O.; Visualization: O.I.O.; Writing – original draft: O.I.O.; Writing – review & editing: O.I.O. Author has read and agreed to the published version of the manuscript.

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Informed Consent Statement

Informed consent was not required for this study.

Data Availability Statement

The data presented in this study are available on request from the corresponding author. The data are not publicly available due to institution's policy.

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Conflicts of Interest

The author declares no conflicts of interest.

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