Does institutional quality matter in the financial Development-Economic complexity Nexus? Empirical insights from Africa

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ABSTRACT

Purpose: This study examines the moderating role of institutional quality and its threshold in the African financial development-economic complexity nexus. This objective follows the argument that institutional quality influences the financial system's efficiency in allocating resources to innovative initiatives and activities that increase productivity knowledge and technical capabilities in an economy's production system to produce complex products and exports.
Design/methodology/approach: To achieve these objectives, this study adopts novel and robust approaches such as the system generalized method of moments (GMM), the Driscoll-Kraay nonparametric covariance matrix estimator (DK), the method of moments quantile regression, and a dynamic panel threshold to analyze the annual dataset of 29 African countries covering 1995–2020.
Findings: This study establishes robust and persistent evidence of interdependence, intertwining, and heterogeneity among African countries. Both mean-based (GMM and DK) and quantile regressions consistently demonstrate that financial development and institutional quality separately enhance Africa's economic complexity across quantiles. In contrast, institutional quality drains financial development's contribution to economic complexity when the coefficients are significant. The moment-quantile regression reveals that institutional quality complements financial development to support economic complexity from the 10th to 30th quantiles, but the coefficients are insignificant. The threshold estimation confirms nonlinearity and the institutional quality threshold estimate is 5.73 on the ordinal scale of 10. On average, only six African countries exceed the threshold, while others operate below the benchmark.
Research limitations/implications: Based on the findings, African financial systems operate within weak institutional frameworks. These phenomena allow rent-seeking, opportunism, corruption, and sharp practices, which divert financial resources from innovative activities and investments in research and development, human capital development, technology, high-tech infrastructure, and entrepreneurial innovation. As a result, Africa's institutional quality impairs the financial sector's ability to spur economic complexity upgrades. African economies need better institutional architectures to maximize financial development's benefits of upgrading economic complexity. The policy implications and recommendations of this study are more relevant to African settings and situations. Thus, other scholars are encouraged to conduct similar research for other continents to enrich the study's outcomes.
Originality/value: The following are the highlights of this study's novelties: 1.) To the best of the authors' knowledge, this is the first study to examine the moderating role of institutional quality in the financial development-economic complexity nexus in Africa using estimators that account for cross-sectional dependence, distributional effects, and heterogeneous effects (the Driscoll-Kraay nonparametric covariance matrix estimator (DK) and the method of moment quantile regression). 2.) Unlike earlier research, this study establishes a threshold of institutional quality in the financial development-economic complexity nexus. We propose that the institutional structures that govern Africa's financial systems be examined and trimmed. This move helps to phase out the inherent inadequacies that drain financial development's contributions to economic complexity.

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1. Introduction

The amount of productive knowledge and advanced capacities that a country materializes and acquires determines the level of sophistication and complexity of its production base (Inoua, 2023; Chu, 2020; Sakiru et al., 2022; Canh, Schinckus & Thanh, 2020; Stojkoski, Utkovski & Kocarev, 2016; Hidalgo & Hausmann, 2009). Economic complexity (EC) measures a country's technological advancement and knowledge capacities in its productive structure and manufacturing process to produce competitive exports (Oumbé, Djeunankan & Ndzana, 2023; Gnangnon, 2022; Avom, Keneck-Massil, Njangang & Nvuh-Njoya, 2022; Balland et al., 2022). EC leads to the structural transformation of an economy's productive system from simple technological production to a more complex one, which is the main thrust of economic complexity. It also determines the ability of firms in an economy to produce sophisticated products that can compete globally. It reflects this in the high quality, diversity, and widespread availability of the products it manufactures and exports. The level of economic complexity in a country's productive base influences the competitiveness of its products in the global economy. The depth of economic sophistication is a comprehensive and objective measure of a country's economic and industrial development (Ketu & Ningaye, 2023; Ajide, 2022a; Aslam et al., 2022; Nguyen & Su, 2021a & b; Lapatinas, 2019). The recent literature shows that the varying depth of economic complexity across economies is why some countries are more developed than others (Njangang & Nvuh-Njoya, 2023; Yu & Qayyum, 2023; Shahmoradi, Hafezi & Chiniforooshan, 2023; Antonietti & Franco, 2021; Avom, Keneck-Massil, *et al.,* 2022; Hartmann et al., 2017; Hidalgo & Hausmann, 2009). As a result, economic complexity is critical to the development agenda of any economy. On account of the importance of economic complexity to a country's development agenda, scholars, development experts, and policymakers have been driven to investigate the determinants of economic complexity. The factors that determine economic sophistication are multifaceted and multidimensional.

Several factors, such as innovation, institutional quality, foreign direct investment, human capital, natural resource abundance, remittances, income, government expenditure, etc., have been identified as determinants of economic complexity in the existing research. Meanwhile, it has been stressed that economic complexity and innovative products need high-powered technology and infrastructures, which require heavy capital investment (Njangang & Nvuh-Njoya, 2023). This emphasizes the critical roles of financial development in easing financial burdens by financing quality products, innovative activities, and R&D investments (Nguyen & Su, 2021; Karasoy, 2022; Avom, Kamguia & Ngameni, 2021; Kurt & Azazi, 2018), all of which stimulate economic sophistication improvements. Thus, the financial sector bridges the financial gap by mobilizing and channeling credits to finance activities that trigger advancement in the productivity knowledge that is materialized and embedded in the country's productive base. It has been asserted in previous studies that a higher level of financial development provides funds to the economic agents at lower costs, which enables them to produce better-quality products by increasing investment in research and development (R&D) and innovation (Njangang & Nvuh-Njoya, 2023), which are key ingredients to foster economic sophistication. As a result of these critical roles, empirical studies on the roles of financial sector development in economic complexity and sophistication have begun to increase, yielding mixed and contradictory results (Njangang & Nvuh-Njoya, 2023; Kamguia et al., 2023; Arooj & Sajid, 2022; Aslam et al., 2022; Kamguia et al., 2022; Avom, Keneck-Massil, *et al.,* 2022; Ajide, 2022a; Atasoy, 2021; Nguyen & Su, 2021a & b; Nguyen, Schinckus & Su, 2020; Can & Dogan, 2018; Sahin & Durmus, 2020; Avom & Ndoya, 2022; Njangang, et al., 2021).

Furthermore, despite the robust argument that financial development is an indispensable driver that spurs and provides the necessary impetus to improve economic sophistication, existing research implicitly assumes that higher financial development leads to better economic complexity. This hypothesis stresses "more finance, better economic sophistication." The current trend in the literature seems to be implicitly assumed that more finance will automatically translate to an improvement in economic complexity. This assumption might not be realistic. An economy's level of institutional development may impact how financial development influences economic sophistication. Economic sophistication's benefits from financial development may be contingent on the quality of institutions. Strong institutional frameworks and architectures tend to provide the necessary stimulus for credits to be channeled to economic complexity-enhancing activities such as investment in R&D and innovation. Good institutional apparatuses reduce opportunistic behaviour and rent-seeking in the financial system and facilitate efficient allocations of financial resources to yield deeper and better economic sophistication.

Weak institutions, on the other hand, accommodate loopholes and lapses in the financial system that facilitate rent-seeking, corrupt practices, opportunistic behaviour, and sharp practices (Olaniyi, 2022, Olaniyi & Oladeji, 2022 & 2021; Olaniyi & Adedokun, 2022 Valentine et al., 2023). As a result, financial sector resources may be diverted to nonproductive activities, undermining financial sector contributions to economic sophistication. Financial improprieties thrive in the financial system in the presence of weak or porous institutions, which thwart the process of channeling resources to activities that promote stronger economic complexity. This indicates that an economy is better financed to provide improved and enhanced economic sophistication only when finance is complemented by strong and efficient institutions, resulting in a considerable improvement in economic complexity. This sums up the fact that more finance in the absence of necessary and effective institutions may not result in deeper and more robust economic complexity (Aslam et al., 2022). Thus, the presumption is raised that "better finance, better economic complexity" is more appropriate. It suggests that sound and efficient institutions are precursors through which financial development could effectively and efficiently trickledown benefits to spur better and richer economic complexity.

Strong institutions generally facilitate efficient resource allocation (Olaniyi, 2022; Olaniyi & Oladeji, 2022, 2021; Olaniyi & Adedokun, 2022). Also, existing research has argued that the financial sector's ability to efficiently allocate economic resources to finance productive activities depends on the presence of strong institutions (Avom & Ndoya, 2022). It highlights the crucial role that institutions play in supporting a financial system in channeling financial resources to finance innovation, technology, and R&D investment, all of which are essential to spur an improvement in economic complexity (Nguyen & Su, 2021a & b). Therefore, this study argues that financial development embedded within a solid institutional framework is more important for economic complexity than just financial development. Strong institutions remove sharp practices, opportunism, and rent-seeking from the financial system, which hastens the pace of economic complexity improvement. This crucial position needs to be adequately addressed in the existing studies. Previous research has also found that effective institutional architecture encourages firms to invest in innovation and technology, which helps enhance export products' sophistication (Fan et al., 2015; Nguyen & Su, 2021a & b; Faruq, 2011). It shows that well-functioning institutions fundamentally enhance economic complexity (Sakiru et al., 2022; Vu, 2022; Hoang & Chu, 2022; Yalta & Yalta, 2021). Thus, from a theoretical perspective, an interplay between institutions and financial development may either accelerate or inhibit an improvement in economic complexity. It depends on the state of an economy's institutional development, whether weak or strong.

This research effort is the first study to look into the role of institutions in moderating the impact of financial development on economic complexity within the context of a more compelling argument that provides the necessary explanations for the roles of institutions in the nexus. The study also adopts more advanced econometric techniques that address econometric, analytical, and statistical pitfalls such as endogeneity, cross-sectional dependence, heterogeneity, and

conditional and distributional effects in the panel dataset. In many ways, the prevailing assumption in present research on the financial development-economic complexity nexus, which covertly posits that countries are economically independent of one another in the era of globalization, international links, and cross-border activities, appears superficial and impractical (Fosah et al., 2023; Olaniyi, 2022; Dada et al., 2022; Olaniyi et al., 2022). Many international trade and alliances, as well as cross-border financial resource flows, connect countries all over the world. In many instances, countries' financial systems are interconnected, and shocks are liable to transmit among countries, which might trigger actions and reactions in terms of policy instruments safeguarding their specific interests and matters.

Furthermore, there are sure to be technology transfer and spillover effects that tend to increase productivity knowledge and economic complexity as a result of cross-border foreign direct investment (FDI) and portfolio investment (Nguyen & Su, 2021a; Osinubi & Ajide, 2022), which could lead to countries' interdependence in the area of economic complexity. Hence, it aligns with socioeconomic realities to account for countries' interdependence in the analysis of the role of financial development in economic complexity. This component has been ignored in previous studies, and if the impact of countries' cross-sectional reliance on the finance-economic complexity nexus is not captured, the empirical findings and policy implications may be undermined (Uddin et al., 2023; Fosah et al., 2023; Olaniyi, 2023; Olaniyi, Young, *et al.,* 2022; Olaniyi, 2022; Olaniyi, Ojeyinka, *et al.,* 2023; Aluko et al., 2021). Hence, a nonparametric covariance matrix estimator proposed by Driscoll and Kraay (1998) is utilized to capture the cross-sectional dependence in the nexus. This estimator delivers robust standard errors unaffected by spatial or cross-sectional dependency, autocorrelation, or heteroscedasticity (Dada et al., 2022; Olaniyi, et al., 2022; Driscoll & Kraay, 1998; Hoechle, 2007; Lee & Olasehinde-Williams, 2022; Olaniyi, 2022; Olaniyi et al., 2023).

Furthermore, endogeneity issues in the finance-institution-economic complexity trilogy may distort estimates and lead to inaccurate policy implications (Hoang & Chu, 2022; Kamguia et al., 2022). A few studies have found evidence of two-way causality between financial development and economic complexity (Nguyen & Su, 2021). Examining the effect of financial development on economic complexity without accounting for the likelihood of a potential reverse causality may result in simultaneity bias, a cause of endogeneity, and provide erroneous results (Avom, Keneck-Massil, *et al.,* 2022; Ajide, 2022; Njangang, et al., 2021). The bias from omitted variables is another key source of endogeneity that could influence the estimations. Due to the proliferation of parameters, it is impossible to capture all of the factors that contribute to economic complexity in a single model. As a result, omitted-variable bias is anticipated and captured by addressing endogeneity concerns. Also, when there is a potential linear correlation between the error term and the independent variables, dynamic endogeneity occurs. Following the existing research (Kamguia et al., 2023; Hoang & Chu, 2022; Arooj & Sajid, 2022; Aslam et al., 2022; Kamguia et al., 2022; Avom, Keneck-Massil, *et al.,* 2022; Atasoy (2021), Nguyen, Schinckus & Su, 2020), the system generalized method of moments (GMM), an estimator that accounts for endogeneity in the analysis remains important for producing strong and accurate estimates.

Also, this study supplements the existing research by correcting another obvious methodological flaw that might have undermined the policy relevance of the empirical outcomes. Previous studies on the financial development-economic complexity nexus have neglected nonlinearity, the distributional and heterogenous effects, and paradigm shifts of estimates across different quantiles. Existing research covertly assumes that an average estimate explains the effects of financial development on economic complexity across quantiles. This supposition appears impractical, as it does not capture the likelihood of distributional and heterogeneous effects and paradigm shifts across quantiles (Jahanger, Hossain, Usman, & Onwe, 2023; Jahanger, Ozturk, Onwe, Joseph & Hossain, 2023). Unlike average estimates in the extant

literature, which produce mean effects, static views, and homogeneous policy dimensions across quantiles, this study accounts for nonlinearity, distributional heterogeneity, and paradigm shift, which accommodate distributional effects, the flexibility of estimates, and different and dynamic policy implications across quantiles (Musa, Sohag, Said, Ghapar & Ali, 2023; Awan, Abbasi, Rej, Bandyopadhyay & Lv, 2022). The method of moments quantile regression (MMQR) proposed by Machado & Santos Silva (2019) is adopted to address this methodological flaw. The quantile-based regression approach is robust and performs better in nonlinearity, heterogeneous and distributional effects, outliers, paradigm shifts, and normal and non-normal error distributions (Chu, 2023; Aluko, Opoku & Acheampong, 2022; Adebayo, Akadiri, Adedapo & Usman, 2022). This variant of quantile regression is more informative than mean-based regression, which provides restricted policy options (Somoye et al., 2023). This approach accommodates and extends the underlying principles of the dynamic generalized method of moments estimator (Machado & Santos Silva, 2019). As a result, it is more robust at taking care of endogeneity than other variants of quantile-based regression (Ajide et al., 2023). This estimator is advantageous because it stratifies financial development and institutions' distributional and heterogeneous effects on economic complexity into different quantile ranges (Aluko et al., 2022). As a result, the unique characteristics of each quantile, as well as the corresponding policy flexibility and options, are adequately captured. This study makes the first attempt in the empirical literature to capture the distributional and heterogeneous effects of financial development and institutional quality on economic complexity. This helps to account for varying effects and policy paradigm shifts across quantiles. Thus, this research provides more practical policy information and accommodates estimates' flexibility and varying policy options across quantiles in the financial development-economic complexity nexus.

Besides, we put forward an argument that institutions may need to attain a certain threshold before they can spur financial development and deliver strong stimulus to improve the economic sophistication of an economy. The institutional quality before the threshold may need to be more potent to block loopholes and lapses in the financial system, thereby giving room for opportunistic tendencies that facilitate the wrong channelization of credit that could hamper improving economic sophistication. In contrast, institutions above the threshold will likely be powerful enough to provide the necessary impetus, reducing the inherent loopholes, checkmate opportunism, and rent-seeking inclinations of financial system operators. Institutions above the threshold point must strongly stimulate financial development to enhance economic complexity through various supports and financing for innovations and R&D investment. Determining the institutional quality threshold above which an institution becomes a powerful stimulus, thereby propelling financial development to spur better and stronger economic complexity, would help policymakers and stakeholders set appropriate policy priorities for institutional development. This is the first research effort to determine, if any, the threshold of institutional quality in the finance-economic complexity nexus. This study innovatively uses a dynamic panel threshold recently developed by Seo, Kim & Kim (2019) and Seo & Shin (2016) to accommodate the dynamism, flexibility, and behaviour of parameters before and after the threshold point. This dynamic panel threshold delivers more convincing policy dimensions.

Compared to existing literature, this study differs in the following areas: **One**, this study deviates from extant studies by incorporating a more practical issue of cross-sectional dependence into the financial development-institutional quality-economic complexity nexus. As discussed earlier, accounting for interdependence among countries in the nexus aligns with practical socioeconomic realities in the era of globalization, international alliances, high integration of financial systems across countries, and spillover effects of technological and knowledge transfers associated with economic complexity through cross-border transactions as a result of several inflows and outflows of foreign

direct investment and portfolio investment. **Two**, this study is the first attempt to examine the nonlinear, distributional, and heterogeneous effects of financial development and institutional quality on economic complexity. All existing studies employ mean-based regressions, which provide a restricted and static policy perspective across quantiles. We depart from previous studies by utilizing a more robust quantile-based regression (method of moment quantile regression). This method provides flexible estimates across quantiles to accommodate nonlinear, distributional, and heterogeneous effects of finance and institutions on economic complexity. These effects tend to vary policy options across quantiles. This approach has the edge over existing studies by allowing policy dynamism, shifts, and diversities across quantiles. This approach allows for more flexible, informed, and refined macroeconomic decisions and policies in the finance-institutions-economic complexity trilogy.

Three, we contribute to earlier research by examining institutional quality's impact on how financial development drives economic complexity. According to this study, improving economic complexity requires more than just financial development. Instead, an efficient institutional framework is needed to support financial development. More finance might not lead to greater economic complexity in the presence of weak institutions. Weak institutions can breed rent-seeking activities and opportunistic behaviour in the financial system, which might lead to the wrong channelization of resources to activity that impedes economic complexity. Thus, this study contributes to the general discussion by stressing that the role of financial development in enhancing economic complexity is contingent on institutional quality. **Four**, for the first time in the extant literature, we determine, if any, the threshold of institutional quality in the financial development-economic complexity nexus. Using a dynamic panel threshold, the determination of the threshold offers information on the level of institutions above which institutions are strong enough to produce the needed incentive for financial development to spur an improvement in economic complexity. Institutions below the threshold tend to be too weak. This situation exacerbates opportunistic tendencies and sharp practices in the financial system. Weak institutions' phenomenon thwarts and truncates the economic complexity's benefits of financial development.

This study examines African countries for the following reasons: 1.) African economic complexity is weaker than that of other continents. Almost all countries' economic complexity in Africa is negative. African economies have the lowest economic complexity in the world (Ketu & Ningaye, 2023; Observatory economic complexity, 2018). This hints that Africa's production system lacks the productive knowledge and technical capabilities to produce complex exports. It implies that understanding the main roots and determinants of Africa's performance in economic complexity is of practical importance for designing appropriate policy options. 2.) Evidence exists in the extant literature that Africa's financial systems are backward and underperforming compared to other continents worldwide. These situations might impede and weaken financial development's contributions to providing the necessary impetus to reduce finance costs, allocate resources, and provide technical support to promote initiatives and activities that increase economic complexity. 3.) Scholars have attributed the underperformance and unimpressive operations of African financial systems to the weak institutional quality within which they operate. Weak institutions and regulatory architectures might have opened loopholes and lapses in the financial system. There is a possibility that these conditions would allow corruption and sharp practices to flourish, thwarting the channeling of resources for the development of innovative activities in Africa to accelerate economic complexity upgrades. Thus, these peculiar circumstances in Africa present puzzles to unravel how financial development and institutional quality interplay to drive Africa's economic complexity. It will also necessitate the determination of the minimum level of institutional quality required to stimulate financial development and enhance economic complexity. This exercise will help the government and stakeholders set a target for institutional

development that is potent enough to facilitate financial development and enhance economic complexity in Africa.

The remainder of the work is sectionalized as follows: Section 2 provides a critical literature review from theoretical and empirical perspectives. Section 3 describes the data description and modeling strategies. Section 4 contains a presentation and discussion of empirical estimates, while Section 5 discusses the findings' practical contributions and policy implications. Section 6's key topics are the study's summary and conclusion. Section 7 concludes the analysis by identifying the study's limitations and recommending future research on the thematic subjects of the finance-institution-economic complexity trilogy.

2. The rationale for the study in Africa

African economies suffer structural weaknesses that impede their productive structure and development, making it crucial to upgrade the continent's economic complexity. Africa's productive structures lack sophistication and complex technical know-how. The evidence in the global ranking of countries in economic complexity reflects that African countries are overwhelmingly dominant in the last thirty countries. Furthermore, a study by Olasehinde-Williams & Oshodi (2021) states that African countries account for 75 % of the 20 bottom-ranked countries in the global economic complexity ranking. More recent statistics reveal that African countries performed badly in the economic complexity index with an average of −0.87 (Ajide, 2022a). The minimum and maximum values also stand at −2.80 and 0.51, respectively (Ajide, 2022a). The continent's economic complexity indicates that it lacks productivity expertise and advanced manufacturing capabilities to produce sophisticated products and exports (Tabash, Mesagan & Farooq, 2022). Countries with low EC are poor (Ajide & Osinubi, 2022; Mealy, Farmer & Teytelboym, 2019), as they tend to specialize in primary products. Production of these products requires less sophisticated technologies and productive capabilities, which are at the periphery of the product space (Ajide, 2022b). African countries mostly fall into this category. For instance, despite the abundance of her natural resources, Nigeria is ranked last in the EC, both in Africa and globally (Ajide, 2022a; Ajide & Osinubi, 2022). Average statistics over the study period 1995–2020, as presented in Fig. 1, indicate that Nigeria is the least complex economy in Africa. Also, countries such as Algeria and Libya operate in the primary stages of production. Their exports are mostly natural primary goods that lack global competitiveness. African products are unable to compete on the international markets partly due to inferior technology and knowledge capabilities which limit the countries to exports of primary commodities (Olasehinde-Williams & Oshodi, 2021). This situation could be responsible for why no African country has been listed among the top 50 most complex economies in the world over the years (see https://oec.world/en/rankings/eci/hs6/hs96). Existing literature also attests to Africa's deficiency in economic complexity by identifying the continent as the least innovative globally (Bekana, 2021; Cornell University, INSEAD, and WIPO, 2018; Ndubuisi, 2015). A study by Oluwatobi et al. (2015) also indicates that when compared to other parts of the world, African countries have a poor score for innovative output.

As of 2020, the most complex economy in Africa is Tunisia (the country ranks 54th globally). South Africa comes second on the continent (55th worldwide). Except for 2020, South Africa consistently ranks as the best-performing country in Africa. EC data for 2020 show that African countries make up 70 percent of the 20 bottom-ranked countries in the world. This record shows that 14 African countries are among the 20 least-ranked countries in EC (Nguea, Fotio & Baida, 2022). The statistics reveal that the continent is the least-performed in global rankings of economic complexity (Ogbuabor, Emeka, Orji, & Onuigbo, 2023; Njangang, Asongu, Tadadjeu & Nounamo, 2021). Most African countries rank at the bottom of the world in economic complexity (Ogbuabor, Emeka, Orji, & Onuigbo, 2023; Olasehinde-Williams & Oshodi, 2021). On average, it implies other continents outperform Africa in the
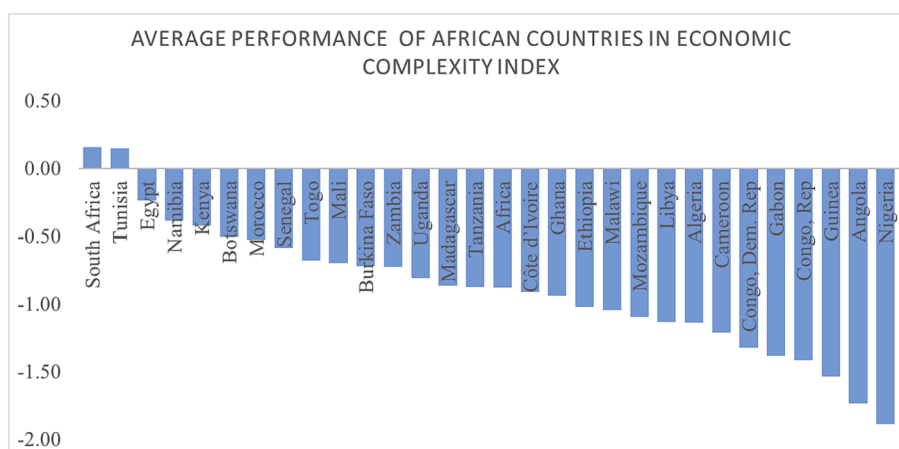
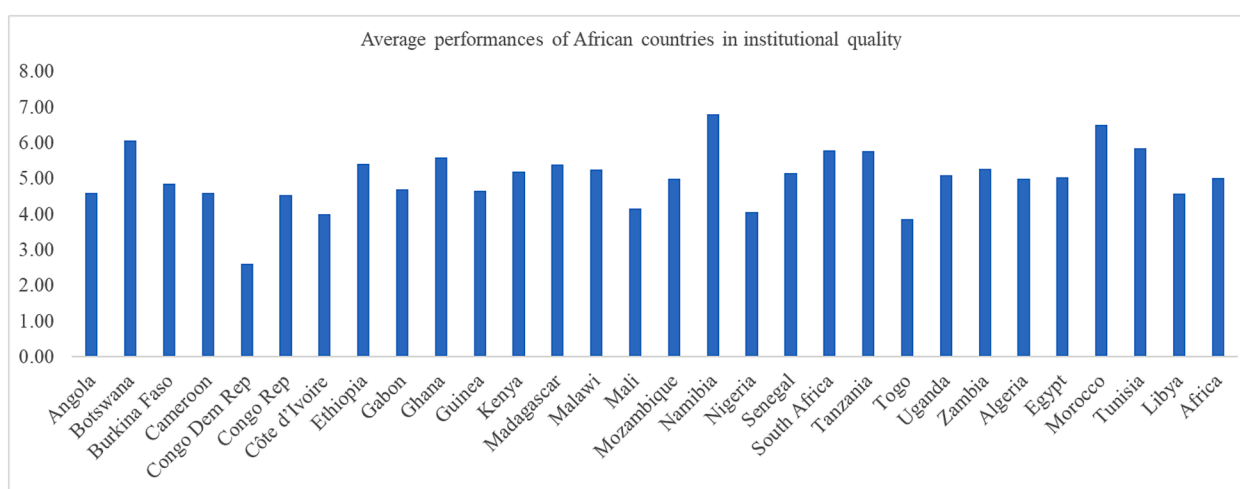**Fig. 1.** Average performance of African countries in economic complexity.

Fig. 2. Average performances of African countries in institutional quality.

economic complexity ranking. Sub-Saharan African countries export unsophisticated, uncompetitive, and poorly connected products to international markets (Abdon & Felipe, 2011). African countries are predominantly on the negative side of the economic complexity ranking compared to countries from other continents (Mesagan & Vo, 2023; Ajide & Dada, 2022; Ketu, Tchouto & Kelly, 2022). The average economic complexity index for African countries is −0.88. Of the 29 African countries sampled, only South Africa and Tunisia scored positively (see Fig. 1). This unimpressive overall performance indicates weak productive knowledge and capabilities in Africa's production system to produce complex exports. Economic complexity's performance in African countries presents several peculiar challenges. These issues need deep investigation for better and more refined policy options to spur economic complexity upgrades.

The phenomenon suggests that African economies lack advanced knowledge and capabilities in the productive structure for export-oriented goods and services. Thus, the state of EC in Africa requires serious empirical investigation to unravel the fundamentals explaining the weak performance of African economies in EC. The study's outcomes will highlight the inherent problems and the pathways to upgrading economic complexity in Africa. One of the factors stressed in the literature is financial development. Transitioning to higher economic complexity necessitates a sophisticated and complex production system. This process requires high-powered innovation, technology, sturdy infrastructure, and enormous R&D investment. These components of economic complexity necessitate consistent and substantial financial

resources and credit facilities, which are essential. Hence, a well-functioning and efficient financial system is critical in bridging the financial gap and sustaining peculiar ingredients such as investment in R&D, technology, and innovation, as well as entrepreneurial impulses that create an increase in economic complexity. (Olaniyi & Oladeji, 2021; Olaniyi, 2022) might have constrained their operations to provide sufficient stimulus and finance to enhance the continent's economic complexity. Statistics in recent studies show that SSA's financial system ranks the least developed in the global ranking (Allen et al., 2011, 2014; Demetriades & Fielding, 2012; Andrianaivo & Yartey, 2010; IMF, 2016; Olaniyi & Oladeji, 2022, 2021; Olaniyi & Adedokun, 2022; Olaniyi, 2022; Tyson, 2016; Kuada, 2016). According to the IMF's (International Monetary Fund) broad and comprehensive financial development index, African countries' performance between 1995 and 2020 was below average. With an average score of 0.48 out of a possible 1, South Africa performs the best in the continent. The continent performs on average at 0.13. More than 55 % of the countries in Africa fall below the average value for the whole continent (see Fig. 3 for further information). Although the continent's financial system is improving, yet unimpressive when compared to other regions across the globe (Asante, Takyi & Mensah, 2023; Olaniyi & Oladeji, 2021, 2022; Olaniyi & Adedokun, 2022; Olaniyi, 2022; Aluko & Ibrahim, 2020; Aluko & Ajayi, 2018).

Many academics attribute Africa's financial sector's poor performance to the financial system's weak institutional base (Aluko & Ibrahim, 2020, 2021; Appiah-Otoo et al., 2022; Bekana, 2023; Kuada, 2016; Machado et al., 2021; Menegaki & Tugcu, 2016; Nsiah & Tweneboah,
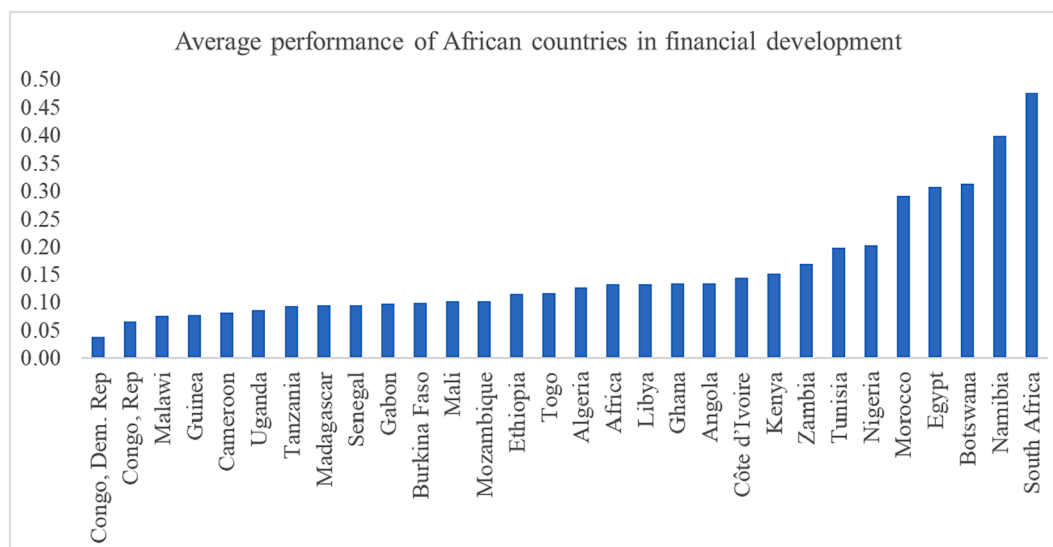
Fig. 3. Average performance of African countries in financial development.

2023; Olaniyi, 2022; Olaniyi & Oladeji, 2021; David et al., 2014; Anayiotos & Toroyan, 2009). The SSA financial system's weak institutional design may have resulted in corruption, rent-seeking, opportunistic behaviour, sharp practices, and political meddling. Africa's institutional and legal frameworks are inadequate for financial system supervision, regulation, and enforcement (Bekana, 2023), ensuring financial development provides the necessary finance and impetus to accelerate the transition from low to complex productivity, increasing technical capabilities and knowledge in productive structures for better manufacturing goods and exports. The institutional flaws in Africa's financial sector might thwart the process of upgrading economic complexity. As a result, it means that porous institutional frameworks may drain financial resources and services away from initiatives that support African economic complexity upgrading. Furthermore, according to the International Country Risk Guide's (ICRG) data, Africa's institutions are below average (Sanga & Aziakpono, 2023; Olaniyi & Oladeji, 2022, 2021). A more recent study affirms the weak institutions in Africa (Ogbuabor, Emeka, Orji & Onuigbo, 2023). As a result, Africa's deficient institutional development may stymie and diminish financial development's ability to support all of the ingredients that should increase the continent's economic complexity. The performances of African countries in institutional quality are average (see Fig. 2 for more information). These statistics underscore the complicated nature of how interactions between weak institutions and financial system underperformance can either expedite or inhibit economic complexity upgrades in Africa. The African triad problems of backward economic complexity, poor institutions, and underperforming financial systems present policymakers, stakeholders, and scholars with challenges to solve. Meanwhile, scholars have paid little or no attention to the empirical investigation of institutional quality's impact on how financial development promotes economic complexity. Thus, this study differs from others by unraveling how Africa's institutions moderate the financial development-economic complexity nexus.

3. Literature review

3.1. Theoretical proposition

The study's theoretical perspective has its roots in three theories: endogenous growth theory, the finance theory of innovation, and the law and finance theory. These theoretical propositions are woven and synthesized because no single theory explains all the dimensions of the financial development-institution-economic complexity trilogy, which

is the study's core focus. Theoretical exposition on economic complexity is an extension of endogenous growth theory (Hidalgo, 2021). Growth in knowledge and technological innovation is established as economic growth in endogenous growth theory (Hidalgo, 2021). In this context, an economy's economic complexity refers to the amount of productivity knowledge and technical capabilities embedded in its productive base that produces quality products and exports (Hidalgo & Hausmann, 2009). The level of sophistication and know-how capabilities in the productive structure determines export quality. In modern economic literature, this measure has also become a metric of economic development. A recent strand of literature suggests that the varying depth of economic complexity across economies explains why some countries are more developed than others (Chu, 2023; Njangang & Nvuh-Njoya, 2023; Shahmoradi, Hafezi, & Chiniforooshan, 2023; Antonietti & Franco, 2021; Avom, Keneck-Massil, *et al.,* 2022; Hartmann et al., 2017; Hidalgo & Hausmann, 2009). The theory opines that increased investment in R&D, innovation, technology, high-tech infrastructures, human capital development, and entrepreneurial inclinations are essential ingredients that enhance knowledge and technical capabilities in the productive structure to build a high-tech manufacturing process to produce a number, variety, and diversity of high-complexity products and exports that are globally competitive. The theoretical and empirical literature has shown that economic complexity depends on multidimensional factors. These factors include foreign direct investment, financial development, institutional quality, innovation, human capital, natural resource abundance, remittances, income, government expenditure, etc. The process of transitioning from low to complex technical capabilities and productive knowledge embedded in the production system requires substantial financial commitments and loan schemes. Thus, an efficient and well-functioning financial system is critical to providing the resources required to support these economic complexity components and initiatives.

Consistent with the financial theory of innovation as codified in Patrick's (1966) supply-leading hypothesis, which rests on Schumpeter's (1911) influential work that has its root in endogenous growth theory. It opines that an efficient financial system delivers the necessary technical support, finances, and other stimuli to spur the growth of technological innovation and knowledge intensity (Chu, 2020) to boost high-tech productivity and sophisticated production systems, which are instrumental in enhancing economic competitiveness. The theory posits that financial development is critical in redistributing resources from inefficient to productive sectors. The innovation theory of finance entrenched in endogenous growth theory supports the crucial role of the

financial system in propelling the required investments in R&D, innovations, technology, high-tech infrastructures, human capital development, entrepreneurial tendencies, and so on, which enhance economic complexity. Aside from theoretical expositions on the contribution of financial development to economic complexity, the effective and efficient role of the financial system in intermediating and directing resources to productive, innovative, and knowledge-based activities that could boost economic complexity is dependent on an economy's institutional quality. Financial development without corresponding institutional improvements may allow for opportunistic behaviour, rent-seeking tendencies, corruption, and political interferences, which may manifest as resource channeling and support for unproductive activities (Haini et al., 2023; Itaman, 2022; Olaniyi, 2022; Olaniyi & Oladeji, 2021, 2022; Olaniyi & Adedokun, 2022; Aluko & Ibrahim, 2020; Demetriades & Hook Law, 2006), slowing the rate of economic complexity upgrades. Thus, the theoretical tenet that bridges this inherent flaw leads to this study's contextualization within the law and finance theory proposed by La Porta, Lopez-de-Silanes, Shleifer, and Vishny (1998). The theory conceptualizes that a robust and efficient legal framework and institutional quality make financial system participants feel fair and secure. Efficient institutional structures provide an enabling environment for investors and savers to operate with confidence and trust. The institutionally enabled environment stimulates the financial system to mobilize and channel resources into productive initiatives, R&D, innovation, technology, high-tech infrastructures, entrepreneurial potentials, and growth-enhancing activities. Strong institutions protect stakeholders' interests in financial transactions. Sound institutions ensure reliable property and legal rights protections for existing and potential investors and savers on the financial markets. Law and finance theories suggest that efficient institutions build structures that protect against opportunism, rent-seeking, corruption, sharp practices, and political interference. Inefficient institutions, on the other hand, weaken the ability of the financial sector to give necessary support and finance to productive initiatives, productive knowledge, technical capabilities, and entrepreneurial potentials that help an economy climb the ladder to transition from a low to a complex production system and transform to a high-tech manufacturing process to produce quality products and exports. Covertly, law-and-finance theory indicates that institutions and legal architectures are critical to spurring economic complexity-enhancing benefits of financial development. As a result, this study assumes that institutional quality moderates financial development's contribution to economic complexity upgrades. Following this proposition, this study examines the moderating role of institutional quality in influencing economic complexity upgrades enabled by financial development in Africa.

3.2. Empirical evidence

Following the fledgling and expanding literature on the drivers of economic complexity, this study sectionalizes the empirical review into three areas to align with the trends in the existing body of knowledge. Since existing research predominantly examines the separate roles of good institutions and efficient financial system in driving economic complexity. Thus, we first present literature review on each before considering how the two factors interact to spur economic complexity upgrades. This process highlights the incentivizing roles of institutions and financial development's contribution in driving the amount of productivity knowledge and technological capabilities inherent in the production system to produce globally competitive exports. This provides information on the probable moderating influence of institutional quality as a factor driving the financial development-economic complexity nexus and highlight the study's novelties and contributions to previous research.

Financial development and economic complexity.

Economic complexity has continued to draw academic and policy interests from academics, policymakers, and government agencies, since

the influential study of Hidalgo & Hausmann (2009). Due to the importance of economic complexity upgrades to countries' developmental agendas worldwide (Yu & Qayyum, 2023), empirical studies have continued to examine its various determinants. Economic complexity upgrades require massive investments in R&D, innovation, technology, high-tech infrastructures, human capital, and entrepreneurial development. Therefore, a well-functioning financial system is necessary to spur improvements in these economic complexity components (Njangang & Nvuh-Njoya, 2023). Formal credit facilities and loan schemes targeted toward economic complexity upgrades are essential. This assertion implies that financial development is a driving factor in economic complexity improvements. Though the literature is still nascent on the critical role of financial development in upgrading economic complexity, few studies on the financial development-economic complexity relationship produce mixed and conflicting findings and policy implications.

Chu (2020) is one of the first to investigate the impact of financial development on economic sophistication in a panel study of 94 countries, employing a system generalized method of moments (GMM) estimator to account for endogeneity in the model. The findings show that financial development improves productive knowledge in all countries. Empirical analysis of the whole sample shows that stock markets and financial intermediaries positively influence economic sophistication. Stock markets have similar effects on productive knowledge and capabilities in both high- and middle-income countries. Meanwhile, financial intermediaries have more robust effects on productivity knowledge in high-income countries than in middle-income countries. The study attributes the differences in sub-group analyses to better institutional development in high-income countries compared to weak institutional quality in middle-income countries. In a panel analysis of 52 countries using diverse econometric estimators, Nguyen, Schinckus, and Su (2020) report heterogeneous effects of different components of financial development on economic complexity. The study indicates that overall financial development significantly increases economic complexity. Overall, financial institutions appear to play an insignificant role in driving economic complexity. Meanwhile, financial institution efficiency and depth contribute positively to productive knowledge and capabilities. Financial institutional access, on the other hand, significantly impedes economic complexity. Interestingly, all four components of financial market development led to greater economic complexity. It implies that bond and stock markets are more instrumental in propelling economic complexity. This process stimulates activities and initiatives such as innovative drives, R&D, technology, patent market development, and entrepreneurial potential. The dimension of results, however, changes with the long-run approach (ARDL-PMG). Financial development has no significant effect on economic complexity in the short run. In contrast, a long-run estimate of overall financial development inhibits economic complexity upgrades. Different aspects of financial institutions and markets reveal diverse impacts on economic complexity. Particularly, financial market and institution efficiency improve economic complexity, while financial depth and access impede productivity knowledge.

Meanwhile, Ha (2023) establishes that financial development improved economic complexity in the panel sample of European countries from 2011 to 2019. A study on Chinese data by Shoufu et al. (2023) also attests to evidence that affirms financial development's benefits to economic complexity. It contradicts the conclusion of Aslam et al. (2022), which established financial development as an insignificant factor in economic complexity. In some cases, financial development positively spurs economic complexity improvement, while in others, it becomes an inhibiting factor that weakens productivity knowledge. Financial development is also insignificant in some cases. In contrast, Nguyen & Su (2020a) found that financial development enhanced economic complexity in a panel study of 86 countries from 2002 to 2017. These findings persist across all financial development measures. It, however, appears that financial institutions contribute significantly

more to economic complexity than financial markets. Similarly, financial efficiency positively contributes more to economic complexity than financial depth and access.

The results appear similar in another Nguyen & Su's (2020b) study, which indicates that overall financial development contributes positively to upgrading economic complexity in a study of 128 countries from 1980 to 2014. These results are also obtained from the two sub-indices of financial development in lower-middle-income and high-income countries. The long estimates also corroborate that financial development stimulates high- and lower-middle-income countries' sophistication. Avom, Keneck-Massil, *et al.* (2022) likewise use the GMM estimator to establish that financial development promotes economic complexity in a panel analysis of 108 countries covering the period 1995–2017. Adopting the same estimator, Kamguia et al. (2022) and (2023) show that financial development spurs economic complexity improvement. Studies on the finance-economic complexity nexus attest to the critical role of financial sector development in fostering economic complexity upgrades. The favourable findings in the existing literature could be because financial systems are providing the necessary resources and technical support required to reduce the cost of financing and stimulate investments in innovation, technology, R&D, patent development, and entrepreneurial inclinations. These investments could spur knowledge intensity and technical capabilities to engender high-tech manufacturing processes and quality exports. Using the GMM technique, Njangang & Nvuh-Njoya (2023) empirically confirm that financial development significantly increases economic complexity. Similarly, to capture endogeneity and cross-sectional dependence, Njangang, et al., (2021) employed GMM and Driscoll-Kraay regression estimators to analyze 24 African countries. reported that financial development increases economic complexity. On the contrary, Aslam et al., (2022) adopt a system GMM estimator and establish that financial development is an insignificant factor in economic complexity in a panel analysis of 33 BRI participation countries. This may be a result of the financial systems in those countries not playing a major role in supporting the development of initiatives and programmes that enhance economic complexity.

In another rigorous empirical examination of the finance-economic complexity nexus, Ndoya et al. (2023) report mixed findings across four different classes of countries. The study found that financial development improved economic complexity in classes 1, 2, and 4. Meanwhile, class 3 findings reveal that financial development impedes economic complexity upgrades, but its effect is insignificant. This study suggests that results may vary across different groups of countries. Countries' peculiar characteristics may influence the findings and infer policy implications. A Pakistani time-series analysis for 1990–2019 was carried out by Arooj & Sajid (2022) using the error-correction variant of the autoregressive distributed lag (ARDL) estimator. The study highlights that financial development contributes positively and significantly to enhancing economic complexity in the short and long run. This result is supported by Karasoy (2022), Kurt & Azazi (2018), and Can & Dogan (2018) in Turkey. Atasoy (2021) also uses the GMM estimator to analyze a panel study of 61 countries. The study's findings corroborate the position of existing studies that access to credit is a component of financial development that promotes and increases economic complexity. Following the same endogeneity-resolving technique, Avom & Ndoya (2022) also report that financial development spurs economic complexity upgrades in a panel study of 118 countries from 1995 to 2018. Ajide (2022a), Ajide & Osinubi (2023), Ketu, Tchouto & Kelly (2022), and Ndoya & Bakouan (2023) in a study of 32, 21, 27 and 29 African countries, respectively, likewise found that financial development produces economic complexity-enhancing benefits.

The following are the key findings from studies reviewed on the impact of financial development on economic complexity: Firstly, most research supports financial development as a beneficial driver of economic complexity. Secondly, only a few studies show that financial development reduces economic complexity. Thirdly, only a handful of studies have found financial development to be an insignificant factor in economic complexity. Aside from the main highlights identified, existing research hints that the financial sector's ability and efficiency in allocating scarce economic resources to innovative activities that promote productive knowledge and technical capabilities that spur countries to produce complex products depends on the presence of good institutions (Hoang, Chu & To, 2023; Avom & Ndoya, 2022; Chu, 2020). This study highlights that:

H_1 : Financial development plays a major role in enhancing Africa's economic complexity.

Institutional quality and economic complexity.

Institutions are human-created mechanisms that govern societal activity to ensure rational behaviour, efficiency, and fairness (Vu, 2022; North, 1990). Existing theoretical and empirical research posits that institutions are crucial predictors of economic complexity (Ndoya & Bakouan, 2023). An efficient institution fosters investment in human capital development, innovative activities, R&D, technological progress, patent development, and entrepreneurial inclinations. It also creates an environment to stimulate various productive activities and initiatives, thereby increasing economic complexity by strengthening productive knowledge and technical capabilities (Hoang & Chu, 2022). Creating quality high-tech products that are globally competitive requires strong institutions to allocate resources to the ingredients that will increase knowledge intensity and technical capabilities. Effective and well-performing institutions prevent rent-seeking, opportunism, corruption, and sharp practices by facilitating efficient resource allocation to enhance economic complexity. Due to the importance of institutions, many studies indicate that deeply entrenched institutional fundamentals may provide a more comprehensive explanation for persistent economic complexity differences across nations (Vu, 2022). Consistent with the critical role of well-performing and efficient institutions in upgrading economic complexity, scholars have begun to explore the institution-economic complexity nexus. Although studies on the economic complexity-institutional quality nexus are nascent and limited (Oumbé, Djeunankan, & Ndzana, 2023), most studies posit that institutional quality increases economic complexity, while others report adverse or insignificant effects.

In their contributions to existing research, Vu (2022, 2021), and Zhu & Fu (2013) report that institutional quality contributes positively to economic complexity by stimulating human capital development, entrepreneurial potentials, and incentivizing innovative activities. These findings align with the study by Hoang & Chu (2023), which uses the system GMM to analyze a panel of 98 countries from 2002 to 2017. The results consistently indicate that institutional quality improves economic complexity. Institutional components impact economic complexity in different ways, and the effects are heterogeneous across countries in various sub-regions. These findings imply that different groups of countries require different sets of institutions to spur economic sophistication. Ndoya & Bakouan (2023) also affirm the role of institutional development in fostering economic complexity. Khan *et al.* (2020) examine institutions' role in China's economic complexity. The findings highlight that Chinese institutional quality upgrades economic complexity. Ndoya et al. (2023) and Shahabadi & Pouran (2023) adopt various measures of institutional quality, and all of them can attest that institutions are fundamental to economic complexity. Similarly, Kamguia, Ndjakwa & Tadadjeu (2023) use the system GMM estimator to explain the influence of corruption control on economic sophistication in a panel of 45 African countries from 2003 to 2016. The study reveals that corruption control is a critical factor that improves Africa's economic complexity. In line with the empirical findings of Vu (2022), the study of Njangang & Nvuh-Njoya (2023) finds that institutional quality increases economic complexity by promoting efficient and functional systems, the creation of productive knowledge, innovation, and technological progress.

Another study by Ajide (2022a) that examines the effects of institutional quality on economic complexity focuses on 32 African

countries. The study establishes that institutional quality increases the depth of knowledge and technical capabilities that enhance Africa's economic complexity. Corroborating the trend in existing research, Nguyen, Schinckus, & Su (2022) also affirm the economic complexity-enhancing benefits of institutional quality in a panel analysis of 89 countries from 2006 to 2016. A panel analysis of 86 countries from 2002 to 2017 by Nguyen & Su (2021a & b) confirms that institutional improvements contribute positively to economic complexity upgrades. Gnangnon (2021) finds similar results through an endogeneity-resolving estimator, system GMM, in a sample of 126 countries covering 2002–2018. The study's findings affirm that institutional quality improves economic complexity. These findings are consistent with those of Lapatinas & Litina (2019), who find the institutional quality to be giving incentives and support to build up productivity knowledge and technical capabilities to produce highly complex products. All the studies reviewed found that institutional quality improves economic complexity by stimulating and incentivizing efficient resource allocation and technical support for human capital development, R&D, and innovative activities. However, a study by Yu & Qayyum (2023) found that institutional quality hinders economic complexity. This finding, however, stands incongruent with the study's outcomes by Dai & Jin (2014), which found that institutional quality improves export technical complexity in China. Kamguia et al. (2023) also corroborate the importance of institutions in stimulating economic complexity in 45 African countries over the period 2003–2016 via a system GMM estimator. Similar findings are reported in a similar African study of 32 countries by Ogbuabor, Emeka, Orji, & Onuigbo (2023), which uses the same estimation technique. The study highlights that institutional quality provides stimulus and incentives to spur Africa's economic complexity. This study posits that:

H_2 : Institutional quality matters in promoting and incentivizing Africa's economic complexity.

Institutions in the financial development-economic complexity nexus.

Studies on the institution-economic complexity nexus show that institutions play multifaceted and crucial roles in promoting and motivating economic complexity. As outlined in existing research, institutional factors are critical to the effective and efficient functioning of financial systems to channel resources to innovative activities, research and development, technology, patent market development, entrepreneurial potential and productive activities, all of which are influenced by the quality of institutions in an economy (Hoang, Chu, & To, 2023; Avom & Ndoya, 2022; Chu, 2020). It implies that institutional quality influences the financial sector's ability to cut down the cost of financing and channel resources efficiently to essential components and initiatives that increase productive knowledge and technical capabilities embedded in an economy's production system to produce highly complex exports. Efficient institutions are antidotes that reduce the extent of exploitation by opportunism, rent-seeking, and manipulative tendencies in financial markets and institutions. Thus, further financial sector expansion without institutional quality improvements may not deliver economic complexity upgrades. This situation is due to corruption, sharp practices, and financial improprieties in the financial system. These practices may divert resources from activities and initiatives that promote economic complexity upgrades. Consistent with this proposition, it should be of academic and policy concern to examine whether institutions matter in tilting how financial development contributes to economic complexity.

Despite the strong case for institutions' involvement in the finance-economic complexity nexus, research on how institutions influence financial development's contributions to economic complexity is sparse. Following an extensive literature review, the following highlights emerge: 1.) The bulk of existing research focuses on the direct and separate effects of institutions and finance on economic complexity without examining the implications of their interactions on economic complexity. The only study (Aslam et al., 2022) that examined the

moderating role of institutions in the nexus neglects the following fundamentals: (a) The study does not capture cross-sectional dependence and heterogeneity in its panel analysis of the financial development-institution-economic complexity trilogy. Recent advances in panel analysis have shown the necessity of cross-sectional dependence to avoid estimation pitfalls. The study also uses a mean-based regression (system GMM), which provides restrictive information and homogeneous policy dimensions across quantiles. A novel method of moment quantile regression is adopted in this study, making it different from others. This approach produces more information, flexible estimates and policy dimensions, and heterogeneous and distributional effects across quantiles in the trilogy. (c) The study focuses on 33 Belt and Road Initiative nations. Consequently, it excludes Africa's unique features and peculiarities. This restrictive information undermines the policy's relevance to countries on other continents. 2.) All existing studies ignore the possibility of a threshold for institutional quality in the financial development-economic complexity nexus. This study argues that institutions below the threshold might not be strong enough to curtail opportunism, rent-seeking, corruption, political interferences, and manipulative moves in the financial sector that might channel credits and resources to economic complexity-thwarting activities and unproductive. We, therefore, attempt to establish, if any, an institutional quality threshold in the finance-economic complexity nexus. Following these expositions, this study conjectures that:

H_3 : Institutional quality matters in the financial development-economic complexity nexus in Africa.

H_4 : institutional quality threshold matters in the financial development-economic complexity nexus in Africa.

4. Data information and modeling strategies

4.1. Description of data and sources

This study examines panel data from 29 African nations from 1995 to 2020. Table A in the appendix has a complete list of African countries. The availability of data primarily dictates the sample size of the study. We excluded some countries from the analysis due to insufficient data for the studied years. Meanwhile, all of the African continent's sub-regions, including West Africa, East Africa, Southern Africa, North Africa, and Central Africa, are well represented in this study. As a result, the sample is representative and accounts for all of Africa's distinctive traits. This study harvests data on variables such as foreign direct investment (fdi), net inflows (% of GDP), real gross domestic product per capita (rgdppc) (constant 2010 US$), and total population (pop) from World Development Indicator, WDI, (The World Bank, 2021). This study follows a class of studies on determinants of economic complexity by using population as a proxy for the human capital factor in economic complexity (Arpaci-Ayhan, 2023; Kamguia et al., 2022; Gnangnon, 2021; Sweet & Maggio, 2015). It also helps to examine the implications of the African population surge on the amount of productivity knowledge embedded in the continent's production system to produce sophisticated products and exports. Similarly, data on it are readily available for all the countries in the study. We glean the data on the broad-based financial development index (fd) from International Monetary Fund (IMF) financial statistic Database. This financial development index is more robust as it captures all dimensions of the performance of the financial market and institutions. It explains financial markets' and institutions' efficiency, access, and depth.

This study gleans the data on five institutional quality measures such as (1) law and order, (2) corruption control, (3) democratic accountability, (4) bureaucratic quality, and (5) government stability from International Country Risk Guide (ICRG). The last two measures of institutions are on 0–4 and 0–12 scales, respectively, whereas the first three (1–3) are on the ordinal scale of 0–6. In tandem with the position of extant studies (Olaniyi, Young, *et al.,* 2022; Olaniyi & Oladeji, 2022, 2021; Law et al., 2018, 2013; Aluko & Ibrahim, 2020 & 2021; Muye &

Muye, 2017; Olaniyi, 2022; Olaniyi & Adedokun, 2022; Tang et al., 2020), all five institutional indicators have been resized to 0–10, thus allowing for consistent interpretations and comparisons. The institutional measures are interconnected and strongly tied to one another. Thus, treating them independently of others might not accurately reflect overall institutional development in an economy. Furthermore, institutional measures are closely related and tied to one another (Olaniyi, 2022; Olaniyi & Adedokun, 2022). Studies have shown that these institutional measures work hand in hand to ensure overall institutional development in an economy. The institutional indicators are very intertwined with one another. As a result, examining each institutional quality metric independently of one another may not produce the overall institutions' role in controlling how financial development fosters economic complexity in Africa. Consistent with the existing research (Law et al., 2018a,b; Law et al., 2013; Olaniyi & Adedokun, 2022; Olaniyi, 2022), after rescaling, to calculate the institutional quality index, we average the five institutional measures to arrive at an ordinal scale ranging from 0 to 10. Values of 10 imply flawless institutions, while a value approaching 0 signifies weak institutions (Demetriades & Hook Law, 2006; Olaniyi, 2022; Olaniyi & Oladeji, 2022 & 2021, Olaniyi & Adedokun, 2022; Olaniyi, Young, et al., 2022; Tang et al., 2020; Gazdar & Cherif, 2015).

The Observatory of Economic Complexity at MIT Media Lab provides improved economic complexity index (ECI) data (https://oec.world/en/rankings/eci/hs6/hs96). The statistics on economic complexity used international trade data, which connects countries to the products they export. According to Hausmann and Hidalgo (2011), ECI is not just a measure of knowledge capability; it also captures far more growth-relevant data than traditional indicators of competitiveness, education, and institutions.

4.2. Modelling strategies and procedures

Following the existing research such as Njangang & Nvuh-Njoya (2023), Kamguia et al. (2023), Arooj & Sajid (2022), Aslam et al. (2022), Kamguia et al. (2022), Avom, Keneck-Massil, et al. (2022), Ajide (2022a), Atasoy (2021), Nguyen & Su (2021a & b), Nguyen, Schinckus & Su (2020), Can & Dogan (2018), Sahin & Durmus (2020), Avom & Ndoya (2022), and Njangang et al. (2021), which examine the direct effects of financial development on economic complexity, we specify the model and augment it to accommodate relevant control variables. We, therefore, specify the economic complexity model as follows:

$$eci_{it} = \varnothing_0 + \varnothing_1 eci_{it-1} + \varnothing_2 fd_{it} + \varnothing_3 inst_{it} + \varnothing_4 fdi_{it} + \varnothing_5 gdppc_{it} + \varnothing_6 pop_{it} + u_{it} \tag{1}$$

where $eci, fd, inst, fdi, gdppc,$ and pop are defined as economic complexity, financial development indicator, institutional quality, foreign direct investment, real GDP per capita and population. i and t are the cross-sectional units and the period covered in the study, respectively. Also, $\varnothing_0$ denotes the intercept of the model, while $\varnothing_1, \cdots, \varnothing_6$ represent the parameters that explain each variable. Lastly, u_{it} is the stochastic error term.

Equation (1) only evaluates the direct effects of institutions and financial development. It does not capture how institutional quality influences economic complexity-enhancing benefits of financial development, which is the study's main goal. Following the argument in the earlier section, we incorporate the interactive term to account for how institutions and finance interplay to determine economic complexity. Equation (1) is modified to take care of the moderating effects as follows:

$$eci_{it} = \varnothing_0 + \varnothing_1 eci_{it} + \varnothing_2 fd_{it} + \varnothing_3 inst_{it} +$$
$$\cap fd^*_{it} inst_{it} + \varnothing_4 fdi_{it} + \varnothing_5 gdppc_{it} + \varnothing_6 pop_{it} + u_{it} \tag{2}$$

Consistent with the moderating role in Equation (2), we make an effort

to obtain the marginal effect of financial development on economic complexity given a level of institutional quality. Following the process in existing research (Olaniyi & Adedokun, 2020; Olaniyi, 2021; Olaniyi, Young, et al., 2022; Olaniyi & Oladeji, 2021), we perform the partial derivative of Equation (2) with respect to fd to establish the marginal effect of economic complexity-enhancing benefits of financial development taking cognizance of institutional quality. This process translates into Equation (3) as follows:

$$\frac{\partial eci_{it}}{\partial fd_{it}} = \varnothing_2 + \cap inst_{it} \tag{3}$$

Equation (3) is important in explaining the institutional quality's role in moderating how financial development contributes to economic complexity. Economic interpretations of Equation (3) depend on the signs, magnitudes, and statistical significance of the parameters, $\varnothing_1$ and $\cap$. Previous studies (Olaniyi, Young, et al. 2022; Ehigiamusoe & Lean, 2020; Olaniyi & Oladeji, 2021, 2022; Olaniyi & Adedokun, 2022; Ehigiamusoe & Samsurijan, 2021; Gazdar & Cherif, 2015) highlight four possible interpretations of Equation (3) as follows:

a. If $\varnothing_2 > 0$ and $\cap > 0$; it explains that as the financial sector channels credit to finance and supports initiatives and programmes that enhance the productive knowledge and technical capabilities inherent in the economy's production system, institutional quality also complements the process and makes the effect stronger.

b. If $\varnothing_2 > 0$ and $\cap < 0$; it implies that as financial development spurs an increase in investment in R&D, innovation, technological expertise, and entrepreneurial inclinations, which promote economic sophistication, the institutions thwart the process, thereby constituting a drag in the financial system that drains the positive effect.

c. If $\varnothing_2 < 0$ and $\cap > 0$; it highlights that financial development impedes economic complexity by thwarting the process of upgrading investment in R&D, knowledge, and technological abilities in the economy's productive structure, whereas institutional quality mitigates the negative effects of the financial system.

d. If $\varnothing_2 < 0$ and $\cap < 0$; it suggests that financial sector development impedes the upgrade of economic complexity, and institutional quality exacerbates the adverse effect by creating loopholes and abetting corruption, opportunistic behavior, and rent-seeking in the financial sector.

Furthermore, the possibility of an institutional quality threshold in Equation (3), above which financial development strongly spurs economic complexity upgrades, exists if the two parameters, $\varnothing_1$ and $\cap$, are significant and have different signs (Olaniyi, 2021; Olaniyi, Young, et al. 2022; Gazdar & Cherif, 2015). Thus, the institutional quality threshold in the finance-economic complexity nexus is obtained by setting Equation (3) equal to zero. The process is simplified as follows:

$$inst_{it} > \left(-\frac{\varnothing_2}{\cap}\right) \tag{4}$$

Recent advances and innovations in econometrics have highlighted pitfalls in the static threshold obtained in Equation (4), as it does not capture the reality of robust dynamism in threshold determination. We follow the influential works of Seo & Shin (2016) and Seo et al. (2019) to capture dynamism, endogeneity, and simultaneity bias in panel threshold (Bolarinwa et al., 2021; Olaniyi, 2022; Olaniyi, Young, et al., 2022). The approach outperforms the static threshold in that it explains the behavior of the variables both before and after the threshold. Equation (5) defines the dynamic panel threshold model as follows:

$$eci_{it} = (1, z'_{it})\gamma_1 1\{inst_{it} \leq \beta\} + (1, z'_{it})\gamma_2 1\{inst_{it} > \beta\} + u_{it} u_{it} = \omega_i + \varphi_{it} 1$$
$$= 1, \cdots, n; t = 1, \cdots, T \tag{5}$$

where eci_{it} is the explained or endogenous variable (economic complexity in this case). The vector of control variables, including the lag of the explained variable (eci_{it-1}) is proxy by z_{it}. 1{} stands for the functional indicator for lower and upper regimes. The parameters γ_1 and γ_1 are the estimates that describe regimes 1 and 2 or lower and upper regimes' estimates. These parameters give explanations of how variables behave before and after the threshold is reached. The threshold estimates of institutional quality (*inst*) is defined by β. The stochastic error term is u_{it}, which includes time-invariant individual-specific fixed effects, ω_i, and the time-variant zero mean idiosyncratic random disturbance, φ_{it}.

The dynamic panel threshold model developed by Seo et al. (2019) adheres to the principles of Arellano & Bond's (1991) first-difference generalized method of moments. This method is preferable because it allows the covariates of the endogenous variables and the threshold variable to follow a conventional asymptotic distribution. This research builds on the work of Seo et al. (2019), who created a statistically robust bootstrap technique for the nonparametric bootstrap introduced by Seo and Shin (2016). The significance of a bootstrapped p-value based on the maximum statistic attests to the threshold confirmation. Aside from using the dynamic panel threshold to determine the institutional quality's threshold in the financial development-economic complexity nexus, this study discusses other procedural techniques to account for endogeneity cross-sectional dependence.

The main estimators and their modeling strategies.

This study examines a series of preliminary to validate that appropriate estimators are used. These include: cross-sectional dependence tests and slope homogeneity test. We use an array of estimators, such as the system generalized method of moments (GMM), the Driscoll-Kraay nonparametric covariance matrix estimator, and a method of moment quantile regression. These estimators account for diverse dimensions of econometric pitfalls to deliver correct and more accurate estimates for better-informed policy perspectives to address practical socio-economic realities in examining the roles of institutional quality in the financial development-economic complexity nexus in Africa. GMM produces more reliable and efficient estimates in the presence of inherent endogeneity in the model. Also, Driscoll & Kraay's (1998) regression approach is robust to cross-sectional dependence, spatial correlation, and heterogeneity in the nexus. It should be highlighted that these two estimators do not capture distributional and heterogenous effects of the interplay between financial development and institutional quality on economic complexity across quantiles. This study adopts the moment quantile regression (MM-quantile regression) approach, introduced by Machado & Santos Silva (2019), to produce flexible estimates across quantiles that account for nonlinearity by incorporating the heterogeneous and distributional effects of financial development and institutional quality on economic complexity.

This method generates deeper information, and its estimates are resistant to outliers in the panel data distribution (Aluko et al., 2022; Chernozhukov & Hansen, 2008). The approach also generates consistent and efficient estimates that are robust to non-normal and normal error distribution (Koenker & Bassett, 1978). The quantile regression is developed by Koenker & Bassett (1978) and the model is expressed as:

$$Z_{it} = U_{it}'\gamma_\theta + \varepsilon_{it}; Q_\theta(Z_{it}/U_{it}) = U_{it}'\gamma_\theta \tag{6}$$

where U' denotes a vector of independent variables or regressors; ε stands for the vector of residuals and $Q_\theta(Z_{it}/U_{it})$ explains the θth conditional quantile of Z given U. Meanwhile, due to the limitations of Koenker & Bassett's (1978) variant of quantile regression, Machado & Santos Silva (2019) propose a new variant called the method of moment quantile regression. This method produces non-crossing estimates in quantile regression, which empirical studies do not take into account in empirical analysis (Aluko et al., 2022). Similar to the variant of Koenker & Bassett (1978), the approach estimates a conditional location-scale

model. The conditional location-scale model to estimate conditional quantiles $Q_Z(\in/U_{it})$ of Machado & Santos Silva (2019) is given as follows:

$$Z_{it} = U_{it}'\gamma_\theta + (\varepsilon_i + Q_{it}')V_{it}, \tag{7}$$

where the probability is $P\{\varepsilon_i + Q_{it}'\omega > 0\} = 1$. $(\alpha, \gamma', \varepsilon, \omega')'$ are estimation parameters. $(\alpha_i, \varepsilon_i), i = 1, \cdots, n$, stand for the individual fixed effects and Q is the k-vector of known components of U, which are differentiable transformations with element m given by

$$Q_m = Q_m(U), m = 1, \cdots, k \tag{8}$$

U_{it} follows the assumption independently and identically distributed (*i.i.d*) for any known cross-sectional unit and it is independent across time (t). V_{it} is equally *i.i.d* across each cross-sectional unit (i) over time and they are orthogonal to U_{it}. These are normalized to meet the moment conditions stated by Machado & Santos Silva (2019), which among other things do not indicate strict exogeneity. The following could be deduced from Equation (14)

$$Q_Z(\in/U_{it}) = (\alpha_i + \varepsilon_i q(\in)) + U_{it}'\gamma + Q_{it}'\omega q(\in) \tag{9}$$

where U_{it}' in Equation (16) is a vector of regressors. $Q_Z(\in/U_{it})$ is the quantile distribution of Z_{it}, which is conditional on the location of U_{it}. $\alpha_i(\in) = \alpha_i + \varepsilon_i q(\in)$ is the scalar parameter that highlights the quantile $\in$ fixed effect for individual i. Different from the individual fixed effect in the least squares regression, the individual fixed effect in the moment quantile regression does not represent an intercept shift. The time-variant coefficients are allowed to vary across quantiles of the conditional distribution of Z. $q(\in)$ is the $\in th$ sample quantile, which is estimated by finding the solution to the optimization problem.

$$\min_q \sum_i \sum_t \varphi_\in (\varepsilon_i + Q_{it}'\omega)q, \tag{10}$$

$\varphi_\in(A)$ is the check function, which is equivalent to $(\in - 1)AI\{A \leq 0\} + \in AI\{A > 0\}$

5. Discussion of findings

5.1. Descriptive statistics

We examine the descriptive properties and features of the variables to set the study in the proper perspective. The summary of the descriptive statistics is presented in Table 1. We compare standard deviation and mean estimates to check the extent to which the mean values of the variables reflect the features of the actual data. The actual data of economic complexity (*eci*), financial development (*fd*), and foreign direct investment (*fdi*) significantly spread from their respective mean values. On the contrary, the averaged values of other variables represent their respective actual data to a reasonable extent. The statistics reveal that the actual data of variables such as institutional quality (*inst*), natural logarithms of the population (*lpop*), and real GDP per capita (*lrgdppc*) cluster around their mean values to a large extent. The implication is that inst, lpop, and lrgdppc are stable and less volatile. The widespread out of the data on economic complexity and financial development from their averaged values signals the importance of accounting for heterogeneous effects in the nexus.

The computed coefficients of variations also reaffirm the status of the variables on their volatility and stability. Similarly, variables such as eci, inst, and lpop are negatively skewed, while others follow positive skewness. The data distribution of the variables is examined through the coefficients of Kurtosis. This hints that three variables (fd, inst and fdi) are leptokurtic while the others (eci, lrgdppc, and lpop) are platykurtic. None of the variables appear to follow the exact attributes of mesokurtic. Thus, there appears to be asymmetric data distribution in all the variables. Also, Jarque-Bera statistics indicate that all the variables except

Table 1
Descriptive statistics.

	eci	fd	inst	fdi	lrgdppc	lpop
Mean	−0.876	0.161	5.003	3.141	7.257	16.607
Median	−0.866	0.110	5.020	2.033	7.130	16.679
Maximum	0.509	0.638	8.400	40.167	9.398	19.067
Minimum	−2.778	0.017	2.330	−8.703	5.212	13.897
Standard Deviation.	0.540	0.125	0.934	4.875	1.032	1.122
Coefficient of variation (%)	61.598	77.777	18.665	155.192	14.217	6.754
Skewness	−0.118	1.825	−0.139	3.947	0.270	−0.396
Kurtosis	2.978	5.626	3.653	25.225	2.053	2.820
Jarque-Bera	1.558	562.053	14.003	15460.170	33.023	18.342
Probability	0.459	0.000	0.001	0.000	0.000	0.000
Observations	754	754	754	754	754	754

eci (economic complexity) follow the path of non-normality in the data distribution. It suggests that data distributions asymmetrically and heterogeneously spread across cross-sectional units in the panel dataset.

As part of the preliminary analysis, this study examines the correlation matrix among the variables (see Table 2). The results show that financial development, institutional quality, and real GDP per capita positively and significantly correlated with economic complexity. In contrast, foreign direct investment and population correlate negatively with economic complexity. All the coefficients of the correlation matrix do not suggest the threat of multicollinearity among the explanatory variables. Aside from the correlation matrix, we examine a further multicollinearity test. This test is essential, as the presence of multicollinearity in a multivariate regression has the likelihood of producing inaccurate results. Strong linear correlations between the independent variables cause multicollinearity, which inflates the regression coefficient standard errors. The Variance Inflation Factor (VIF) test is adopted to test the presence of multicollinearity. To validate that the multicollinearity problem is not severe, the rule of thumb is that the VIF value must be at most ten, and the tolerance value must be at least 0.1 (Miles, 2014). Consistent with the study of Studenmund (2011), five is used as the threshold point for the VIF value. All the VIF values are below two, and the tolerance values exceed 0.1 (see Table 3). As a result, severe multicollinearity does not seriously threaten the reliability of regression estimates in this analysis.

5.2. Slope homogeneity and cross-sectional dependence tests

Two dimensions of CD tests are adopted to deliver robust empirical estimates, findings, and well-polished decisions. We adopt both the CD tests in the series and regression. This study explores four variants of CD tests in the series such as Baltagi *et al.* (2012), Breusch & Pagan (1980), Pesaran (2021), and Pesaran *et al.* (2008) to reveal the presence of CD in each of the series. The results of CD in the regression and series (see Tables 4 and 5) confirm robust interdependence and intertwining among the cross-sectional units in the panel dataset. The rich outcomes of CD tests attest to robust evidence of interdependence and intertwining

Table 3
VIF test.

Variable	VIF		Tolerance	
fd	1.970	1.404	0.508	0.492
lrgdppc	1.900	1.378	0.525	0.475
lpop	1.380	1.175	0.726	0.274
inst	1.350	1.162	0.739	0.261
fdi	1.020	1.010	0.984	0.016
Mean VIF	1.520			

among African countries (Fosah et al., 2023). CD in the dataset implies heavy cross-bordered trades, international alliances, and transactions among African countries. It is a pointer that African countries' financial systems are highly integrated, and there are spillover effects and shock transmission on the continent (Uddin et al., 2023). Hence, macroeconomic decisions and policies of one African country could cause reactionary moves and impacts on other countries within the economic bloc. It also implies that technology and knowledge transfers in a country could spill over to African countries. These could spur an improvement in economic complexity due to the accrued benefits of cross-bordered international transfers and trade in Africa.

Aside from CD in financial development and economic complexity, it is confirmed that institutional architectures in the countries are interconnected to spill over both negative consequences and positive benefits. The robust evidence of CD attests to its important role of accounting for CD in the finance-institutions-economic complexity trilogy. These findings highlight that extant studies which neglect CD in their empirical analyses might have overestimated their respective models. Following the confirmation of CD, we examine the slope homogeneity test using Pesaran & Yamagata (2008). Table 6 summarizes the test results. The findings confirm the presence of slope heterogeneity across African countries. It suggests that there is a need to capture slope heterogeneity in the analysis of the financial development-institutional quality-economic complexity trilogy.

Table 2
Correlation matrix.

	1	2	3	4	5	6
eci (1)	1					
fd (2)	0.593***	1				
	(0.000)					
inst (3)	0.436***	0.463***	1			
	(0.000)	(0.000)				
fdi (4)	−0.118***	−0.074*	−0.009	1		
	(0.002)	(0.058)	(0.809)			
lrgdppc (5)	0.167***	0.558***	0.267***	−0.080**	1	
	(0.000)	(0.000)	(0.000)	(0.039)		
lpop (6)	−0.053	−0.001	−0.194***	−0.058	−0.392***	1
	(0.170)	(0.989)	(0.000)	(0.138)	(0.000)	

***, **, and * denote 1, 5 and 10 percent levels of significance, respectively.

Table 4

Cross-sectional dependence tests (in the series).

CD Tests	eci	fd	inst	fd_inst	lrgdppc	fdi	lpop
Breusch-Pagan LM	1296.036***	2321.277***	1683.846***	1602.596***	5429.173***	822.007***	9298.607***
Pesaran scaled LM	31.234***	67.213***	44.844***	41.992***	176.279***	14.599***	312.069***
Bias-corrected scaled LM	30.575***	66.554***	44.185***	41.333***	175.620***	13.940***	311.410***
Pesaran CD	1.045	37.433***	21.879***	13.916***	52.321***	11.525***	96.429***

Note: *** implies that null hypothesis of no cross-sectional dependence is rejected at 1 percent level of significance.

Table 5

Cross-sectional dependence tests (in the regression).

Model	eci = f(fd,inst,[fd]^*inst,fdi,lrgdppc,lpop)
Tests	Statistic
Breusch-Pagan LM	1210.435***
Pesaran scaled LM	28.230***
Pesaran CD	0.701

Note: *** implies that null hypothesis of no cross-sectional dependence is rejected.
at 1 percent level of significance.

Table 6

Pesaran and Yamagata (2008) slope homogeneity test.

Model	Δ~	Δ~_adj
eci = f(fd,int,[fd]^*inst,fdi,lrgdppc,lpop)	−29.568***	−20.908***

Note: *** stands for 1 percent level of significance.

5.3. Empirical analysis of the moderating role of institutional quality in the finance-economic complexity in Africa

After examining the necessary preliminary analyses, which reveal the fundamental features of the variables and the dataset, the emphasis now shifts to an empirical examination of the findings on the moderating role of institutions in the financial development-economic complexity nexus. To make informed policy recommendations based on econometric results, we present and discuss them in two phases. We first present and examine the direct effects of financial development and institutional quality on economic complexity. In the second phase, we explore the interactions of the two variables to reveal institutions' moderating roles. This process highlights how institutions influence financial development to enhance or improve economic complexity. To obtain rigorous, consistent, reliable, and flexible estimates, this study adopts a system generalized method of moments (GMM), a Driscoll-Kraay nonparametric covariance matrix estimator, and a method of moment quantile regression. These estimators help to address the multidimensional econometrics pitfalls detected in the panel dataset. We use the system GMM to deal with the problem of endogeneity inherent in the variables in the estimated model. Driscoll-Kraay regression handles cross-sectional dependence and heterogeneity, which we observed in the preliminary analyses. Also, this study utilizes a method of moment quantile regression to capture distributional and heterogeneous effects and estimates flexibility and diverse policy options across quantiles. These estimators can deliver more polished and enhanced policy options and perspectives. Before applying moments quantile regression, which allows for estimates flexibility, heterogeneous distributions, and distributional effects across quantiles, we discuss mean-based regressions (GMM and Driscoll-Kraay).

Consistent with the results of the system GMM estimation presented in Table 7, the coefficients of the Hansen test suggest the validity of the instrumental variables. It implies that the instrumental variables do not correlate with the error terms. The number of groups is more than the number of instruments, which follows the conventional principle. Also, the findings reveal that the estimates are free from serial correlation. The GMM estimates indicate that the previous performance of economic

Table 7

System GMM and Driscoll and Kraay Estimators' Results.

Dependent variable: eci (Economic complexity) Variables	System GMM Estimator		Discroll and Kraay Estimator	
eci (-1)	0.4512***	0.4825***		
	(0.0237)	(0.0234)		
fd	2.1628***	3.4838***	2.9945***	3.8955*
	(0.2731)	(1.0971)	(0.2310)	(2.1343)
inst	0.0619***	0.1058***	0.10001***	0.1203*
	(0.0068)	(0.0308)	(0.0207)	(0.0604)
fdi	−0.0025**	−0.0001	−0.0112***	−0.0112***
	(0.0012)	(0.0012)	(0.0022)	(0.0022)
lrgdppc	−0.1433***	−0.1738***	−0.1757***	−0.1800***
	(0.0261)	(0.0243)	(0.0417)	(0.0528)
lpop	−0.0099	0.0029	−0.0755***	−0.0815***
	(0.0092)	(0.0103)	(0.0216)	(0.0250)
fd*inst		−0.2982		−0.1550
		(0.2036)		(0.3827)
Constant			0.7058	0.7243
			(0.4695)	(0.5075)
Specification tests				
Number of groups	29	29		
Number of instruments	21	25		
P-value of AR(1) test statistics	0.0003	0.0001		
P-value of AR(2) test statistics	0.9161	0.9944		
Hansen tests	0.2265	0.3419		

Note: ***, ** and * stand for 1%, 5% and 10 % levels of significance respectively. Robust standard error values are in ().

complexity in Africa is a positive and significant driver for the current economic complexity. These results persist in models with and without interactions. According to the empirical findings, previous investment in R&D, innovative activities, and technological progress contributed to the current economic complexity enhancement. Specifically, these findings show that prior improvements in EC serve as a motivating factor for stronger and better current EC (Chu, 2020). It also indicates that there should be a positive dynamism of dogged determination and tenacity in crafting policies that instil the habit of persistently pursuing movements that improve EC from one period to the next in people, government agencies, and parastatals in African countries. It also emphasizes that current improvements in EC could lead to improved EC in the future. This result reveals robust evidence of persistence in EC in Africa (Ndoya & Bakouan, 2023; Nguea, Fotio & Baida, 2022; Lapatinas, 2019). These findings are congruent with those of Kamguia et al., and (2022), Ndoya & Bakouan (2023) Nguyen & Su (2021a & b), Atasoy (2021), Gnangnon (2021), and Chu (2020) who used the system GMM to investigate the determinants of EC in the existing literature.

The coefficients of financial development in both the GMM and Discroll-Kraay (DK) estimators (with and without interactive terms) are positive and statistically significant at conventional levels (see Table 7). These findings support the theoretical exposition that an economy requires a well-functioning and efficient financial system to provide funding and technical impetus to finance investment in R&D, technology, innovative activities, and other ingredients of economic complexity. Africa's financial development improves economic

complexity by giving the necessary assistance and incentives to firms through investment in R&D and innovation (Nguyen & Su, 2021b). These moves enable firms to produce high-tech quality goods and services that are globally competitive. Despite the weak average financial system's performance in Africa, financial development still enhances productivity knowledge and advances capabilities embedded in the production process of goods exported. Thus, developing Africa's financial sector is critical to reaping more economic complexity-enhancing benefits through innovation financing of firms to produce high-tech products and exports. More developed financial sector development in Africa tends to spur a stronger sophistication of African economies through the finance of knowledge-intensive and high-tech products, which need substantial investments in R&D, technology, and innovation. Better financial development in African countries will allow a reduction in the cost of borrowing, better management of asymmetric information phenomena in the financial system, more efficient allocation of resources, and better risk management. All these positive roles of financial development are necessary ingredients that catalyze a stronger economic complexity. These findings corroborate the research outcomes of previous studies by Ndoya & Bakouan (2023), Ha (2023), Kamguia et al., (2023), Njangang & Nvuh-Njoya (2023), Ajide (2022a), Neagu, Neagu & Gavurova (2022), Nguyen & Su (2021b), Atasoy (2021), Njangang, Asongu, Tadadjeu & Nounamo (2021) and Chu (2020). These studies find that financial development supports the ingredients which enhance economic complexity. Meanwhile, it contradicts the findings of Aslam et al. (2022), which establish financial development as an insignificant factor in economic complexity.

These positive effects of financial development on economic complexity in mean-based regressions (GMM and Driscoll-Kraay) persist in the flexibility estimates obtained in the method of moment (MM) quantile regression, which account for distributional, heterogeneous, and nonlinear effects across quantiles. Financial development remains a potent tool for boosting economic complexity. Meanwhile, the magnitudes of financial development coefficients vary from one quantile to another. In the MM-quantile regression without the interaction, FD coefficients decline as we progress from lower to upper quantiles. It implies that FD's effect on EC is the strongest in the 1st quantile, while it is

the least in the 13th quantile. These findings indicate that FD impacts on EC are more felt in the lower than upper quantiles. The coefficients of FD remain positive in the model, where finance and institutions interact to boost EC. The coefficients of FD across quantiles are still positive, but as we move from the lower to higher quantiles, the coefficients keep increasing. The changes in FD estimate variability across quantiles might not be unconnected to the effects of interactions in quantile regression. According to these findings, interacting finance with institutions have significant implications for improving EC in Africa through financial development. The critical roles of FD to drive or determine Africa's EC in the presence of the institution's moderating role become stronger; as we move from lower to upper quantiles. The graphical illustrations of the MM-quantile regressions, as presented in Figs. 4 and 5, attest to the robust findings explained. Another critical factor of EC emphasized in this study is institutional quality.

The results of mean-based regressions for the system GMM and Driscoll-Kraay estimators, with and without interactive elements, persistently affirm institutional quality's critical role in enhancing Africa's EC at conventional levels. These findings follow the theoretical standpoint that well-functioning and efficient institutions promote necessary incentives to spur an upgrade in structural transformation, innovation, technology, productive knowledge, and capabilities which are instrumental in the production of a variety of diverse, competitive, and sophisticated goods and exports. In this sense, the institutional development of Africa provides necessary incentives, and a business-friendly environment for innovations and allows firms to enhance their technical know-how, productive knowledge, and advanced economic capabilities. These related activities spur an increase in productive knowledge and advanced technical capabilities embedded in the production system. As Africa's institutional development further develops, it will be possible to achieve these essential drives and ingredients for improving its economic complexity. These research outcomes also indicate that further improvement in Africa's institutional quality provides essential incentives. These incentives boost the efficient allocation of resources to fund economic complexity-enhancing activities such as entrepreneurial inclinations and ideas, investment in R&D, innovation, and technological advancements. The findings reveal that
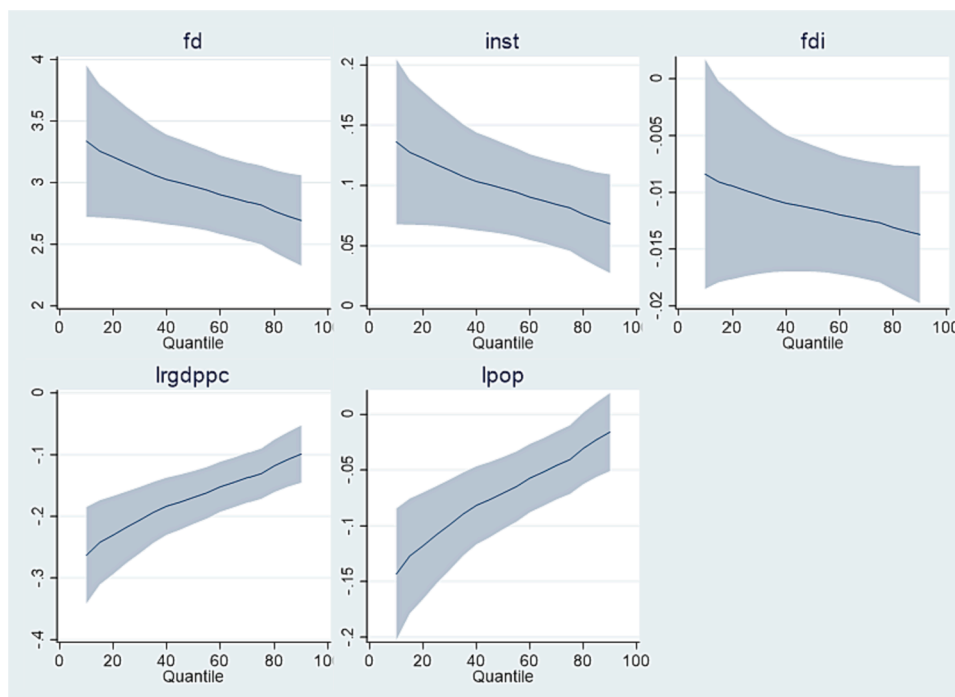

Fig. 4. Distributional coefficients of the method of moments quantile regression (without the interaction).
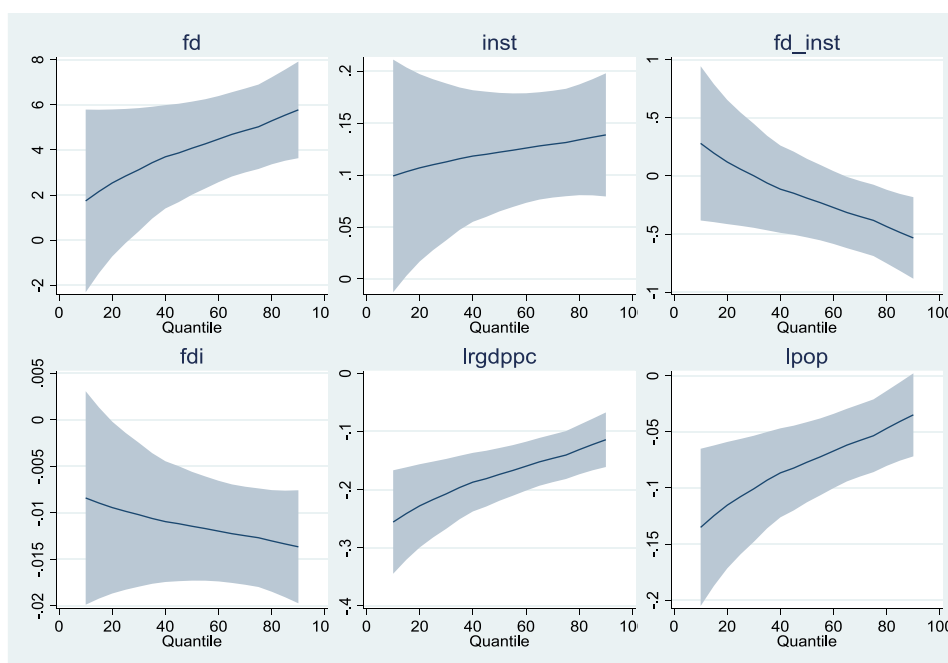
Fig. 5. Distributional coefficients of the method of moments quantile regression (with the interaction).

the productive capacity of the African economy depends on existing institutional quality. From a policy perspective, African countries should prioritize the development of institutional quality to foster and enhance productive knowledge and capabilities. In addition, they should prioritize further development of technological capacity in the manufacturing process to produce quality and competitive goods and exports. These findings reaffirm the earlier studies of Kamguia, Ndjakwa & Tadadjeu (2023), Njangang & Nvuh-Njoya (2023), Ndoya et al., (2023), Hoang & Chu (2022), Vu (2022), Ajide (2022a), Nguyen, Schinckus & Su (2022), Nguyen & Su (2021b &b), Gnangnon (2021), Lapatinas & Litina (2019), which establish institutional quality as a key factor in EC that provides incentives for knowledge creation, productive capabilities, investment in R&D, development of the patent market, innovative activities and increasing the quality of human capital. Meanwhile, it contradicts the research outcomes of Yu & Qayyum (2023) which finds that institutional quality impedes an economic complexity upgrade.

Based on the statistical significance of the estimated coefficients across quantiles, MM-quantile regression results (Tables 8 and 9) support institutional quality as a significant contributor to EC. Results reveal robust heterogeneous and distributional effects of institutions on economic sophistication. These findings highlight the importance of accounting for flexibility of estimates, paradigm shifts, and policy diversities in the institution quality-economic complexity nexus across quantiles. In the MM-quantile regression's results without an interactive component, all coefficients of institutional quality across the quantile are positive and significant at conventional levels. More importantly, coefficient magnitude and size decline as we move from the lower to upper quantiles. The effect is strongest in the first quantile, while the 13th quantile has the least coefficients. Table 9 shows the policy implications and importance of interacting finance with institutions in modeling economic complexity. These results show that the coefficients behave differently across quantiles when finance and institutions interact. The coefficients increase in size as we move from the lower to the upper quantiles. Institutional quality effects are not evenly distributed but heterogeneously dispersed across quantiles (See Fig. 3). Financial development and institutional quality foster stronger economic complexity across quantiles. Thus, it is more practical for policy makers to rely on MM-quantile regression that allows estimates and policy flexibility. When analyzing Africa's economic complexity, experts

should allow finance and institutions' effects to vary. Each quantile's idiosyncrasies should be treated with relevant and distinct policy alternatives. It highlights the advantages of MM-quantile regression over mean-based techniques in existing studies. The scale and location parameters equally support the significant positive roles of finance and institutions in upgrading Africa's economic complexity. After discussing the direct and independent effects of financial development and institutions on Africa's economic complexity, we look at how the two macroeconomic factors interact to improve or hinder the continent's productive capacity to produce quality goods and exports.

Based on the system GMM and Driscoll-Kraay estimators (mean-based regressions), the interactive term's coefficients between financial development and institutional quality are persistently negative and significant. The significance of the estimates implies that institutional quality moderates financial development's influence on economic complexity in Africa. Meanwhile, the negative signs of the estimates highlight that institutional quality leaks out some economic complexity-enhancing benefits of financial development in Africa. Although institutional quality and financial development independently improve the sophistication, knowledge, and technical capacities embedded in the productive structures of African economies, the continent's institutional quality creates loopholes and opportunistic tendencies in the financial sector, which drain and weaken the potency of financial development to boost economic complexity. These findings suggest that, as financial development provides strong impetuses to boost activities such as investment in R&D, entrepreneurial and innovative inclinations, and allocation of resources to enhance the quality of goods and exports, the extant institutions in Africa constitute a drag that diminishes and thwarts the process through which financial development culminates in enhancing the continent's economic complexity.

The practical implications of these research outcomes indicate that Africa's institutional framework creates loopholes and lapses. These loopholes breed opportunistic behaviour, rent-seeking, corrupt practices, and sharp practices in the financial system. These activities, which emerge from the interplay of the financial system and institutions, abet the moves that thwart some effective allocations of resources and strategic assistance from the financial sector. These allocations are meant to spur economic complexity improvement in Africa. The findings reveal that regulatory apparatuses and institutional frameworks guiding

Table 8
Method of Moments Quantile Regression Estimation Results.

Dependent Variable: Economic Complexity Variables	Location	Scale	Quantiles 0.10	0.20	0.25	0.30	0.40	0.50	0.60	0.70	0.75	0.80	0.90	0.95	0.99
fd	2.9945*** (0.1772)	-0.2001* (0.1131)	3.3370** (0.3128)	3.2089*** (0.2535)	3.1591*** (0.2323)	3.1136*** (0.2148)	3.0256*** (0.1855)	2.9702*** (0.1720)	2.9024*** (0.1626)	2.8451*** (0.1613)	2.8187*** (0.1630)	2.7681*** (0.1698)	2.6938*** (0.1869)	2.6424*** (0.2028)	2.5706*** (0.2332)
inst	0.1000*** (0.0197)	-0.0212* (0.0126)	0.1362*** (0.0349)	0.1226*** (0.0323)	0.1174*** (0 0.0259)	0.1126*** (0.0240)	0.1033*** (0.0207)	0.0974*** (0.0192)	0.0903*** (0.0181)	0.0842*** (0.0180)	0.0815*** (0 0.0182)	0.0761*** (0.0189)	0.0683*** (0.0209)	0.0628*** (0.0226)	0.0553** (0.0260)
fdi	-0.0112*** (0.0029)	-0.0017 (0.0019)	-0.0084 (0.0084)	-0.0095** (0.0042)	-0.0099*** (0.0038)	-0.0102*** (0.0035)	-0.0110*** (0.0031)	-0.0114*** (0.0028)	-0.01120*** (0.0026)	-0.0125*** (0.0027)	-0.0127*** (0.0027)	-0.0131*** (0.0028)	-0.0137*** (0.0031)	-0.0141*** (0.0033)	-0.0147*** (0.0038)
lrgdppc	-0.1757*** (0.0225)	0.0511*** (0.0143)	-0.2630*** (0.0398)	-0.2304*** (0.0323)	-0.2177*** (0 0.0295)	-0.2061*** (0.0274)	-0.18360*** (0.0236)	-0.1695*** (0.0219)	-0.15219*** (0.0207)	-0.1376*** (0.0206)	-0.1308*** (0.0208)	-0.1179*** (0.0217)	-0.0990*** (0.0237)	-0.0859*** (0.0255)	-0.0675** (0.0306)
lpop	-0.0755*** (0.0170)	0.0396*** (0.0108)	-0.1433*** (0.0300)	-0.1179*** (0.0243)	-0.1081*** (0.0223)	-0.0991*** (0.0207)	-0.0816*** (0.0178)	-0.0706*** (0.0165)	-0.0572*** (0.0156)	-0.0459*** (0.0155)	-0.0406*** (0.0152)	-0.0306* (0.0164)	-0.0159 (0.0178)	-0.0057 (0.0192)	0.0085 (0.0232)
constant	0.7058* (0.4014)	0.5687** (0.2562)	1.6790** (0.7091)	1.3150** (0.5747)	1.1736** (0 0.5265)	1.0442** (0.4873)	0.7942* (-0.4207)	0.6367 (0.3898)	0.4442 (0.3687)	0.2812 (0.3660)	0.2062 (0.3699)	0.0623 (0.3854)	-0.1487 (0.4229)	-0.2948 (0.4579)	-0.4988 (0.5317)

Table 9
Method of Moments Quantile Regression Estimation Results.

Dependent Variable: Economic complexity Variables	Location	Scale	Quantiles 0.10	0.20	0.25	0.30	0.40	0.50	0.60	0.70	0.75	0.80	0.90	0.95	0.99
fd	3.8955*** (1.1015)	1.2810* (0.7554)	1.7380 (2.0649)	2.5334 (1.6617)	2.8340* (1.5167)	3.1210*** (1.3924)	3.6930*** (1.1681)	4.0750*** (1.0521)	4.4768*** (0.9735)	4.8587*** (0.9488)	5.0227*** (0.9543)	5.2884*** (0.9838)	5.7724*** (1.0921)	6.1639*** (1.2229)	6.9074*** (1.5613)
inst	0.1203*** (0.0305)	0.0125 (0.0209)	0.0991* (0.0571)	0.1069*** (0.0459)	0.1099*** (0.0419)	0.1127*** (0.0385)	0.1183*** (0.0323)	0.1220*** (0.0291)	0.1259*** (0.0269)	0.1297*** (0.0262)	0.1313*** (0.0264)	0.1339*** (0.0272)	0.1386*** (0.0302)	0.1424*** (0.0339)	0.1497*** (0.0427)
fd*inst	-0.1550 (0.1805)	-0.2583** (0.1238)	0.2800 (0.3384)	0.1196 (0.2723)	0.0579 (0.2485)	0.0012 (0.2282)	-0.1141 (0.1915)	-0.1911 (0.1724)	-0.2722* (0.1596)	-0.3491** (0.1556)	-0.3822* (0.1565)	-0.4358** (0.1613)	-0.5333*** (0.1789)	-0.6123*** (0.2003)	-0.7622*** (0.2576)
fdi	-0.0112*** (0.0031)	-0.0017 (0.0021)	-0.0084 (0.0059)	-0.0094*** (0.0047)	-0.0098*** (0.0043)	-0.0102*** (0.0039)	-0.0109*** (0.0033)	-0.0114*** (0.0030)	-0.0120*** (0.0028)	-0.0125*** (0.0027)	-0.0127*** (0.0027)	-0.0130*** (0.0028)	-0.0136*** (0.0031)	-0.0141*** (0.0035)	-0.0151*** (0.0044)
lrgdppc	-0.1780*** (0.0242)	0.0449*** (0.0166)	-0.2557*** (0.0454)	-0.2278*** (0.0365)	-0.2170*** (0.0333)	-0.2072*** (0.0306)	-0.1871*** (0.0257)	-0.1737*** (0.0231)	-0.1596*** (0.0214)	-0.1462*** (0.0209)	-0.1405*** (0.0210)	-0.1311*** (0.0217)	-0.1142*** (0.0239)	-0.1004*** (0.0268)	-0.0744*** (0.0350)
lpop	-0.0815*** (0.0131)	0.0319** (0.0131)	-0.1352*** (0.0358)	-0.1154*** (0.0288)	-0.1078*** (0.0263)	-0.1008*** (0.0241)	-0.0865*** (0.0202)	-0.0770*** (0.0182)	-0.0670*** (0.0169)	-0.0575*** (0.0165)	-0.0535*** (0.0166)	-0.0469*** (0.0171)	-0.0348* (0.0189)	-0.0251 (0.0211)	-0.0066 (0.0274)
constant	0.7243* (0.4216)	-0.5802* (0.2891)	1.7015** (0.7900)	1.3413** (0.6357)	1.2026** (0.5801)	1.0751** (0.5331)	0.8160* (0.4472)	0.6430 (0.4026)	0.4610 (0.3728)	0.2880 (0.3635)	0.2137 (0.3656)	0.0934 (0.3769)	-0.1258 (0.4174)	-0.3032 (0.4670)	-0.6399 (0.6006)

Africa's financial system to provide incentives for economic complexity improvement should be thoroughly monitored and checked. Some governmental initiatives and supports and activities inhibit Africa's economic complexity. This corroborates the argument that higher financial development without an efficient and effective institutional framework might not translate to economic complexity improvement. In the African context, both institutional and financial development should be pursued simultaneously to spur economic complexity improvements. Further development of the financial sector without institutional quality improvement might not deliver improved economic complexity on the continent. Thus, the earlier proposition that "more finance, better economic complexity" appears invalid in Africa. Africa needs "better finance, better economic complexity". Institutional quality must complement the financial sector to stimulate Africa's economic complexity.

Africa's situation indicates that institutions leak out the economic complexity-enhancing benefits of financial development, revealing that the continent's institutions are not strong enough to correct the structural flaws in the financial system that allow rent-seeking and opportunistic behaviour. Hence, institutions need to be strengthened to prevent improprieties and corruption in the financial system. Weak institutional quality drains financial development's ability to enhance economic complexity. These findings highlight that institutional quality may need to reach a certain threshold. Beyond that, it can consistently stimulate financial development in Africa to improve economic complexity. African legal and regulatory frameworks do not complement financial sector development to spur economic complexity improvement; rather, they thwart the process by creating opportunities for the diversion of credits to activities that are not strengthening the technical knowledge and capabilities embedded in the manufacturing of quality goods and exports. The findings highlight that financial development and institutional quality are not complementing each other to boost and enhance African productive structures. Institutions and finance separately promote the economy's sophistication. Meanwhile, instead of strengthening the financial system to spur investment in R&D, innovation, entrepreneurial activities, and other economic complexity-enhancing drives in Africa, institutions weaken the financial sector's ability to channel resources adequately to promote technological abilities and knowledge in the productive structure. All governmental and non-governmental financial regulatory and institutional organizations and parastatals that guide Africa's financial system, especially in the area of encouraging and supporting research and development investments, technological capabilities, innovation, and entrepreneurial skills, which are fundamentals to spur an increase in the continent's economic complexity, should be carefully examined and pruned. These institutions and agencies must undergo scrutiny and monitoring. This move will help to detect and block all the inherent loopholes and opportunistic tendencies that impede economic complexity-enhancing benefits of financial development. This study stands in contrast to the study of Aslam et al., (2022) which establishes that institutional quality complements financial development to upgrade and enhance economic complexity.

Aside from the mean-based regression outputs of the system GMM and Driscoll-Kraay estimators, the MM-quantile regression results produce some results that validate the necessity of adopting the approach to capture the practical realities (distributional and heterogeneous effects, and nonlinearity) of socioeconomic conditions and varying research outcomes across quantiles. The findings vary across all quantiles. The interactive term's coefficients between institutional quality and financial development are persistently positive but insignificant in the lower quantiles (Q.10, Q.20, Q.25, and Q.30). The coefficients turn negative but remain insignificant at the Q.40 and Q.50 quantiles. However, the coefficients become significantly negative at the Q.60, Q.70, Q.75, Q.80, Q.90, Q.95, and Q.99 quantiles. These results reveal that institutional quality plays an insignificant role in moderating the impact of financial development on Africa's economic complexity at the lower quantiles. Meanwhile, institutions become strong factors that moderate financial

development's influence on economic complexity at the upper quantiles. It is, however, evident that institutional quality only drains financial development's economic complexity-enhancing benefits when it is significant.

African institutional structures in the upper quantiles weaken financial development's ability to provide incentives to the financial system to enhance economic complexity. The negative and significant coefficients become stronger as we move from Q.60 to Q.99. These results imply that the significant negative coefficients keep increasing as we move from Q.60 to Q.99. The deteriorating role of institutions to puncture and weaken the ability of the financial system to provide stimulus to upgrade economic complexity becomes more pronounced as we move to the upper quantiles. These findings validate the essence of accounting for distributional and heterogeneous effects in the finance-institution-economic complexity trilogy. Earlier studies adopted diverse variants of mean-based regressions, which neglected distributional and heterogeneous effects. Leaving out these important aspects might have undermined their research findings for making effective policy recommendations to upgrade and improve economic complexity. Furthermore, Estimates based on scale and location confirm that institutional quality deteriorates and seeps out the economic complexity-enhancing benefits of financial development. However, the coefficient of location shift is not significant.

Having discussed the key variables of the study, we shift attention to some other factors identified as determinants or control variables of economic complexity in previous research. All the coefficients of foreign direct investment (FDI) in all the regressions (mean-based and MM-quantile regressions) predominantly affirm a strong negative role of FDI in economic complexity at conventional levels. These findings indicate that foreign direct investment (FDI) inflows to African countries impede the continent's economic complexity upgrade. The continent's productive knowledge and ability are hindered by FDI inflows, making it harder to produce and manufacture highly complex goods for export. According to these findings, multinational corporations' operations in Africa essentially revolve around maximizing the size of the continent's market at the expense of developing domestic knowledge productivity and technical capabilities in the core production of sophisticated products for export. It can also suggest that competition between local investors/entrepreneurs and the handlers of foreign direct investment in Africa stifles and hinders their innovative ventures. This phenomenon may have inhibited Africa's drive for innovation to advance the productive knowledge necessary for producing sophisticated goods and exports. Despite the theoretical expectation of the accrued benefits associated with inflows of FDI to developing countries, such as technological and skill transfers and spillovers to transform the productive base of the economy, FDI is supposed to come with better productive knowledge and capabilities to upgrade the quality of manufacturing goods and exports in African countries. The reverse is true, as FDI inflows weaken the continent's economic complexity. These findings corroborate the earlier proposition in previous studies that FDI net inflows might not always benefit the host countries (Nguyen & Su, 2021a; Demena & Afesorgbor, 2020). The situation might imply that most of the FDI net inflows to African countries are from those with low technologies and innovations that merely exploit the rich extractive industries, especially natural resource rents, on the continent (Nguyen & Su, 2021a; Ndikumana & Sarr, 2019; Arvanitis, 2005) to aggravate economic complexity. These results show that African countries have not attracted the right foreign direct investment that could spur economic complexity improvement. African countries need to design appropriate strategies, policies, and incentives to attract the right FDI inflows. This move is capable of enhancing productive knowledge and capabilities in the continent's manufacturing and export sectors. The findings confirm the studies' outcomes of Neagu, Neagu & Gavurova (2022), and Nguyen & Su (2021a) that FDI weakens economic complexity but opposes Nguéda & Kelly's (2022) and Kamguia, Tadadjeu, Miamo & Njangang's (2022) conclusion that FDI increases it.

institutional quality score is 5.00 (see Table 1). As a result, it implies that Africa's institutional quality is too weak to combat foul play and manipulative tendencies in the financial system. These circumstances could obstruct and undermine the financial development benefits of strengthening the continent's economic complexity. When the average country-specific institutional performance is compared to the threshold, twenty-three African countries fall short of the required minimum to ensure that the financial sector's financial resources and expertise are used to promote and increase the productive knowledge and technical capabilities inherent in Africa's productive structure. The remaining six African countries studied (Botswana, Namibia, South Africa, Tanzania, Morocco, and Tunisia) are marginally above the threshold. Although these countries meet the benchmark on average, their institutional performance is inconsistent. To increase Africa's economic complexity, these inconsistencies make it difficult for the institution to provide necessary and effective financial development support. Inconsistencies in institutional development could impede the financial sector's ability to channel funds to initiatives that enhance productive knowledge and technical capabilities entrenched in Africa's production system. This would allow for the manufacture of quality goods and exports. For African countries to reap the benefits of financial development, which increases economic complexity, they must prioritize the development of a consistent institutional development strategy. Africa's prospects for increasing economic complexity depend on the development of its financial and institutional infrastructure. More than financial development policies and actions are required to improve Africa's economic complexity. Rather, it is financial development within a sound regulatory framework.

Another intriguing finding from the study is that three of the six countries that exceed the threshold are from Southern Africa (Botswana, Namibia, and South Africa). Morocco and Tunisia are both in North Africa, while Tanzania is in East Africa. The study's findings show that, on average, all West and Central African countries fall below the threshold. These institutional performances of African countries illustrate the continent's sub-regional ranks. Inconsistencies in institutional development promote rent-seeking and opportunism in the financial system and drain the economic complexity-enhancing benefits of financial development. Institutional development must remain consistently above the threshold for the financial sector to effectively channel resources and provide the required impetus to increase Africa's economic sophistication.

The coefficient of financial development is negative in the lower regime. This follows the argument raised earlier that the effect of financial development on economic complexity is either insignificant or negative. It implies that institutional quality below the threshold is too weak to prevent corruption and political interferences and it opens up lapses and loopholes in the financial sector which drain the economic complexity-enhancing benefits of financial development. The financial development effect of economic complexity in the upper regime becomes significantly positive. This demonstrates that institutional quality above the threshold becomes a strong factor that enables financial development to support and finance investment in research and development, innovation and technology, and entrepreneurial initiatives, which are essential to foster and upgrade economic complexity.

6. Practical contributions and policy implications of the study

This section presents the study's highlights regarding the contributions to existing research and the resulting policy implications and options. These two dimensions focus on the criticality and interplay of institutional quality and financial development in driving Africa's economic complexity. Its practical contributions include: One, unlike earlier studies, this study unravels institutional quality's role in influencing financial development's contribution to economic complexity (increase the depth and amount of productive knowledge and technical capabilities inherent in an economy's productive structure). Two, this

study opens up discussion and empirical investigation on the threshold of institutional quality. Beyond this threshold, institutions become potent tools that enable financial development to strongly contribute to economic complexity upgrading. Three, unlike previous research, this study controls for the econometric pitfall of cross-sectional dependence in the analysis of the finance-institution-economic complexity trilogy. Four, we also augment the extant literature by accounting for estimates' flexibility, nonlinear, heterogeneous, and distributional effects of institutional quality and financial development on economic complexity across quantiles. We use the method of moment-quantile regression to achieve this and it allows flexible and diverse policy options across the quantiles.

Aside from the study's practical contributions to existing research discussed above, we highlight the policy implications and inferred recommendations for government, agencies, and parastatals from the empirical outcomes. We highlight the informed policy implications and recommendations as follows: One, Efforts to upgrade economic complexity must be persistent and continuous over time in Africa. For the economy's production system to transition from low to complex and enhanced productivity capabilities, efforts should gear toward investments in R&D, innovation, technology, and entrepreneurial ideas. This policy implication is necessary because the findings show that previous economic complexity has positively and significantly boosted the current functional knowledge and technological capabilities inherent in the productive system. Two, stakeholders and governmental agencies should prioritize the development of the African financial system to improve economic complexity. Stakeholders and policymakers should incentivize and monitor the financial system to channel more resources and technical expertise toward increasing innovation and sophisticated technology in firms' productive structures and manufacturing processes. Also, African financial institutions and markets should focus more on providing finances and strategic services to firms that use high-tech and knowledge-intensive mechanisms to produce quality products and exports.

Three, the research outcomes reveal that institutional quality incentivizes, strengthens, and promotes activity and initiatives, such as resource allocation to investment in R&D, innovation, technology, and entrepreneurial inclinations. These efforts enhance Africa's productive knowledge and technical capabilities. Therefore, there should be massive and progressive moves to improve African countries' institutional architecture. Also, African institutional structures aimed at upgrading economic complexity need to be strengthened to enhance performance in fostering high-tech manufacturing processes and quality exports to other countries worldwide. Four, the research findings show that Africa's institutional architecture constitutes a drag on the economic complexity-enhancing effects of financial development. The implication is that the institutions driving the continent's financial sector to increase economic sophistication are ineffective. Instead, it undermines the process by allowing opportunistic tendencies and rent-seeking to thrive, leading to sharp practices and corruption in the financial system. These phenomena divert resources and promote initiatives and activities that restrict or slow the financial development's contribution to economic complexity in Africa. Thus, the institutional framework and architecture driving the African financial system to support and enhance economic complexity need total overhauling, pruning, and monitoring for them to be functional. From a policy perspective, further development of Africa's financial system without corresponding improvements in institutional quality may not deliver economic complexity upgrades.

Five, the findings highlight the heterogeneous and distributional effects of institutions and finance on economic complexity across quantiles. Thus, diverse and varying policy options across quantiles compared to static policy views stressed in extant studies are more suitable to address socioeconomic realities on the contribution and interactions of institutions and finance in explaining economic complexity upgrades. The flexible, distributional, and heterogeneous effects

identified allow policy dimensions and implications to highlight quantiles where interactions between financial development and institutional quality are potent in driving economic complexity and where they are ineffective.

Six, the findings indicate that economic complexity declines as income rises in Africa. The implication is that as income increases in Africa, more incomes are channelled to promote traditional production techniques. This is at the expense of innovative initiatives, human development, R&D investment, technological progress, and entrepreneurial inclinations, which are intended to enhance economic complexity. Thus, there should be massive public awareness and campaigns in African countries on the importance of channelling higher levels of income to initiatives aimed at increasing the amount of knowledge, productivity, and technical capabilities embedded in the production system to produce globally competitive products. These findings highlight that Africans do not specifically value the promotion of improvement in economic complexity. Seven, the findings reveal that foreign direct investment inflows (FDI) repress economic complexity. It implies that the continent only attracts FDI with low- and backward-technologies. These FDI inflows transfer weak production systems to African countries, draining the amount of productivity knowledge and technical capacities embedded in the production system. As a result, African countries must aggressively and deliberately design policies, incentives, and strategies to attract the right FDI inflows that have advanced technologies and sophisticated manufacturing complexities to transfer modern production techniques to produce products that have global competitiveness.

7. Summary and conclusion

Economic complexity improvements require significant investments in R&D, innovation, technology, patent development, and entrepreneurial activity. A well-performing and developed financial sector is crucial for mobilizing funds and bridging the financial gap. However, financial development without improvements in institutional quality may not increase economic complexity, as weak institutions can breed rent-seeking and opportunism, affecting financial development's contributions to economic complexity. A well-performing and developed financial sector is crucial for mobilizing funds and bridging the financial gap. However, financial development without improvements in institutional quality may not increase economic complexity, as weak institutions can breed rent-seeking and opportunism, affecting financial development's contributions to economic complexity. Previous studies assumed that institutions did not influence financial development's contributions to economic complexity. However, this assumption may be unrealistic due to corruption and financial improprieties. Also, existing studies do not consider cross-sectional dependence in the trilogy, which is crucial for understanding socioeconomic and modern macroeconomic realities. Unlike existing research, this study examines the heterogeneous, distributional, and nonlinear effects of the interaction between financial development and institutional quality on economic complexity. This novel perspective allows estimates' flexibility by accounting for allowing policy options to vary across quantiles. This study uses moments quantile regression to determine the moderating role of institutional quality in the financial development-economic complexity nexus in Africa from 1995 to 2020. Similarly, this study differs from existing research by determining the institutional quality threshold, which is the point at which institutions become potent to stimulate financial development and enhance Africa's economic complexity.

The findings highlight strong evidence of interdependence and intertwining among African countries. The implication is that there are heavy cross-border activities, integrations, international trades and alliances, and inflows and outflows of foreign direct investment among African countries. These have significant impacts on African productive structure sophistication. It implies that ignoring cross-sectional

dependence in the empirical analysis of the finance-institution-economic complexity trilogy might bias the estimates and undermine the study's policy relevance. This finding validates the argument raised earlier that CD matters in the nexus. The research outputs indicate that both financial development and institutional quality have separate and strong positive impacts on economic complexity in Africa. These results are robust and consistent across all three dimensions of econometric analysis. These findings hold in both analyses with and without the interactions. These findings indicate that each of these two factors individually provides the essential stimulus and incentives to support initiatives and activities that promote economic complexity in Africa.

Meanwhile, the findings on the roles of the interplay between institutions and finance in economic complexity show that institutional quality does not complement financial development to increase Africa's sophistication of productive knowledge and technical capabilities embedded in the production system. Institutions instead drain financial development's contribution to Africa's economic complexity upgrade. As a result, it creates room for rent-seeking and opportunistic behavior that drains and weakens the financial sector's financial intermediation ability to channel financial resources to promote various initiatives that enhance economic complexity in Africa. The implication is that Africa's institutional architecture leaks out the financial development benefits of boosting economic complexity. These findings attest that institutional structures create loopholes, inadequacies, and imperfections in Africa's financial system. These intricacies divert resources and credit facilities to activities that reduce financial development potency to foster economic complexity. Policy-wise, it suggests all stakeholders and governmental agencies devise strategies and monitor them to prune all the institutional frameworks and mechanisms that guide the operations of the African financial system, which are supposed to enhance and upgrade economic complexity. These processes will help curb sharp practices, corrupt tendencies, and political interferences that diminish the potency of financial development to spur an increase in economic complexity. Similarly, the findings highlight that most African countries perform below the institutional quality threshold. Beyond that, institutions become potent tools to stimulate financial development to enhance economic complexity. These underperformances could be the reason institutions are not strong enough to tame corruption and financial improprieties in Africa's financial system that inhibit financial development to yield maximum benefits from enhancing economic complexity. Thus, building up institutional development is an antidote and mechanism to spur the financial sector to give necessary support to initiatives and activities such as increased investment in R&D, innovations, technology, and entrepreneurial inclinations that are liable to improve the weak economic complexity in Africa.

8. Limitations and suggestions for future research efforts

The study provides novel insights and perspectives into the finance-institution-economic complexity trilogy. It explores the function of institutions in affecting the financial development-economic complexity nexus. In addition, it employs more advanced methods to identify relevant econometric pitfalls. These methods add more policy options that are practical and flexible in addressing socioeconomic concerns. Aside from these novelties, other aspects remain unexplored which should be the focus of future research efforts. This study focuses on African countries. Thus, the policy implications are restricted to the African context. To enrich the empirical content and policy relevance of the existing literature, scholars should consider cases of continents different from Africa. Also, a country-specific analysis is critical, as panel and cross-country studies might not be adequate to address the peculiarities of each country, taking into account the different stages of development in the financial sector, institutional quality, and economic complexity across countries. Despite the robust asymmetric phenomenon in the financial system's transactions and operations, existing research has ignored the probable asymmetric effect of financial

development on economic complexity. Also, other researchers should examine the probable asymmetric causal relationship between financial development and economic complexity, which has remained unexplored in previous research. It will also be innovative to examine asymmetric structures in the heterogeneous and distributional effects of finance and institutions on economic complexity within the context of moments-quantile regression. Future research efforts should consider classifying African countries into low-income, lower-middle-income, and upper-middle-income countries to provide another dimension of empirical outcomes and policy views.

CRediT authorship contribution statement

Clement Olalekan Olaniyi: Conceptualization, Methodology, Software, Data curation, Formal analysis, Writing – original draft, Project administration. **Nicholas Mbaya Odhiambo:** Supervision, Visualization, Writing – review & editing, Investigation, Software, Validation, Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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