Income Inequality and Economic Complexity in Africa: The Moderating Role of Governance Quality

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Research Article

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Abstract

This study examines the effect of economic complexity on income inequality through the moderating role of governance factors. It is based on data obtained from 24 African countries from 2000 to 2018 and has employed systems GMM panel method of estimation. The findings show that economic complexity (without interaction term) has a significant positive effect on income inequality. However, the coefficient of the interaction term is negative and significant implying that the adverse (positive) effect of economic complexity on inequality is significantly offset by the inclusion of governance factors. The estimated results for disaggregated governance factors also indicate similar findings to that of the aggregate indicator. All governance indicators reduce income inequality when interacting with economic complexity. The overall result entails important policy implications in that improving governance quality will help reduce the deteriorating effect of economic complexity on income inequality. This calls for taking measures to improve the performance of governance factors to at least reduce the deteriorating effect of economic complexity on income inequality.

1. Introduction

The theoretical and empirical concept of economic complexity is a relatively recent phenomenon in economic analysis. It has created novel opportunities for the comprehensive investigation of countries' economic development processes. The concept tries to understand the productive structures of economies by constructing an index measure, the Economic Complexity Index (ECI), which captures the knowledge-based productive capabilities and the opportunities for economic diversification of countries (Allen & Bhorat 2021; Mealy & Teytelboym 2020; Mealy et al. 2019).

Economic complexity is a comprehensive and influential way of understanding the main challenges of the development process of countries. It uses dimensionality reduction techniques to create an index of economic sophistication whereby economic growth, technical change, inequality, spatial discrepancies, and resilience are evident outcomes of hidden systemic interactions (Balland et al. 2022; Balsalobre-Lorente et al. 2022; Hidalgo 2021; Bhorat et al. 2019). Its primary aim is to understand the nature of such interactions and examine how they define countries' social and economic development processes. Economic complexity aims at detecting the productive knowledge of countries (Sciarra et al., 2020). It helps users understand the development of productive structures of countries and trade partners, which allows for a richer understanding of large volumes of data to improve the quality of information readily available to decision-makers (Simoes and Hidalgo 2011).

Before getting into the role of economic complexity in influencing income inequality, it is logical to ask the question, ‘what factors determine economic complexity?’ and provide a brief insight. In this connection, recent empirical studies tried exploring economic complexity determinants. For instance, according to Gnangnon (2021), the productive capacity of countries determines their economic complexity; other studies such as Yalta & Yalta (2021), Caous & Huarng (2020), and Sadeghi et al. (2020) explored the role of human capital in influencing economic complexity and concluded that economic complexity depends
on human capital accumulation. Similarly, Mishra et al. (2020) and Sepehrdoust et al. (2019) found a positive link between financial globalization and trade liberalization with economic complexity. Another study by Di Clemente et al. (2021) tried to link economic complexity with urbanization. In all of these studies, the productive capacity of countries, technological knowledge, human capital accumulation, trade openness, and the urbanization process are essential determinants of the level of economic complexity of countries.

There is also a recent and renewed interest in the empirical literature to examine the role of economic complexity on countries' economic growth. In this regard, there are many empirical studies conducted in advanced and developing countries to examine the effect of economic complexity on countries' economic growth. Many of these works found that economic complexity has a significant positive effect on the economic growth of the countries (Lybbert & Xu 2022; Nuryartono & Pasaribu 2022; Mao & An 2021; Sayehmiri et al. 2021; Güneri 2019). The findings concluded that economically complex countries were found to be more prosperous; they belong to high-income groups and that the countries were seen to be engaged in building complex production structures and thus have experienced real economic gains from economic complexity. Besides, empirical research has witnessed that growth differences across countries can be explained by differences in their levels of economic complexity. For instance, Mealy et al. (2019) contended that economic complexity had shed new light on its empirical success in explaining cross-country differences in economic growth.

As highlighted above, the main interest of this study is to investigate the effect of economic complexity on income inequality through the moderating role of governance factors in selected African countries. As such, it is crucial first to highlight the concept of income inequality, the issue of what determines the country's level of inequality, and the significance of economic complexity in affecting inequality. Moreover, the interaction effect of governance quality with economic complexity- inequality nexus was reviewed.

Empirical studies on the relationship between economic complexity and income inequality are scant, and few existing ones provide mixed results. For instance, studies by (Chu & Hoang 2020; Lee & Wang 2021; Sepehrdoust et al. 2021; Chutimunt 2019) found that a high level of economic complexity is associated with a reduction in income inequality. These authors identified the mechanisms through which economic complexity influences income distribution and inequality. First, a high level of economic complexity implies a sophisticated economic structure that could offer more occupational choices with better pay, thereby leading to a more equitable system. Second, complex economies that produce sophisticated commodities have a greater possibility to possess an even occupational structure where workers can earn higher lifetime incomes. Finally, complex economies and their productive structures entail wider participation of workers in production activities characterized by higher productivity and increasing returns to scale.

Yet, other studies revealed that increasing economic complexity is associated with increased income inequality (Hasanvand et al., 2022; Banderira et al., 2021; Lee & Vu, 2020). This is because in developing
countries with less complex systems, there will be limited opportunities to get occupations with high productivity and returns which implies less effort to reduce income inequality.

It is well established in long-standing literature that deep-rooted and well-functioning institutions are the fundamental drivers of economic growth and are the sources of growth differences across countries, thereby reducing poverty and income inequality. The recent empirical studies on the relationship between inequality and institutional factors revealed that an improvement in indicators of institutional quality reduces income inequality (Huynh & Le 2022; Blancheton & Chhorn 2021; Zehra et al. 2021; Coccia 2021). However, Asamoah (2021) investigated the relationship between institutions and income inequality and found different results for World Governance and International Country Risk Guide indicators of institutions, where a Kuznets inverted U-shaped relationship between institutions and income inequality for both advanced and developing countries.

Generally, mixed empirical results were observed on the effect of economic complexities and institutional factors on income inequality studied distinctly. While improvements in institutional factors and economic complexities normally reduce income inequality (such as Prasetiya, 2021; Chu & Hoang, 2020) done separately, the effects of economic complexity on income inequality in the presence of governance as a moderating factor are not available. I have tried to figure out the most recent studies and to my knowledge, there are no empirical studies that have addressed the interaction effect of institutions on the economic complexity-inequality nexus.

This paper provides new insight into the existing literature on the relationship between economic complexity and income inequality by examining the moderating role of governance factors for the period between 2000 and 2018. The primary purpose is to examine the moderating role of institutional factors in the relationship between economic complexity and income inequality in selected African countries. Thus, it addresses the following questions ‘Does economic complexity affect income inequality? What are the roles of governance factors in moderating the effect of economic complexity on income inequality?’

The remaining part of this study is organized as follows. Section two reviews existing literature exploring the theoretical and empirical link between income inequality and economic complexity. Section three describes the data and presents the empirical estimation strategies used. Section four reports the main findings and makes a discussion of the findings. Finally, a conclusion and policy implications are provided in the last section.

2. Review of Literature

In earlier development-related theories, income inequality was primarily discussed in the context of the long-run growth path for developing countries, where economic growth and inequality involved a trade-off. The conclusions of such theories were primarily reflected by Kuznets’s inverted U-shape hypothesis, which in the end, served as a framework for understanding the changes in income inequality resulting from modern economic growth (Kuznet 1955). The development policy implication of such trade-off linkage was evident in that it emphasized growth-related issues in explaining inequality yet ignored
important distributional aspects of inequality. However, empirical studies that followed highly questioned the Kuznets hypothesis, where the findings could not justify the hypothesis in many cases. For instance, the studies of reverse causality (where income distribution affects growth) and differences in growth patterns across countries led to inconclusive results regarding the effect of growth on income inequality (Kanbur and Summer, 2012). The developments in analyzing determinants of income distribution and economic growth after Kuznets tell us that growth and income distribution are not mutually exclusive. This implies that policymakers cannot address growth and income distribution independently.

After the late 1990s, an increase in poverty at an alarming rate in developing countries drew attention to the importance of personal income distribution, where income inequality mattered for poverty reduction. As a result, faster economic growth and greater equality in the distribution of income were considered to be policy priorities for development. This has called for developing a pro-poor growth framework that brings the objectives of poverty reduction, equitable distribution, and acceleration of economic growth to be addressed jointly. In this framework, it was contended that faster economic growth, together with greater equality in the distribution of income, serves as means of reducing poverty (Essama-Nssah 2005; Kakwani et al. 2003; Kakwani & Pernia 2000).

However, starting from the early 2000s, the debates on pro-poor growth almost reduced, and the concept of inclusive growth gained much importance in the overall development circle (Doumbia 2019). The inclusive growth argument states that since the vast majority of the population is at the end tail of income distribution, there is a solid need to encompass a much broader segment of the population, and thus the benefits of growth will be shared broadly (Ranieri & Almeida 2013; Anand et al. 2013; Ianchovichina & Gable 2012). As a result, two critical issues of optimal policy mix came to the front for policymakers; the relationship between inequality and growth on the one hand and that between inequality and poverty on the other hand.

With a rise in income inequality in most developed and emerging economies after the 1980s, inequality and redistribution policy dominated academic and political debates and discussions. The debates were primarily on the causes and consequences of inequalities and distributional effects related to policies to resolve the problems. As a result, further exploration of determinants of income inequality and the question of what governments must do to improve citizens' collective welfare came to the frontline. Accordingly, some additional causes of income inequality were identified, such as trade globalization, financial liberalization, technological change, macroeconomic policies, and labour market policies (Dabla-Norris et al., 2015) were some to mention.

In relatively recent studies, countries’ economic complexity, governance (institutional) quality, structural transformation, and productive structures were also found to be significant determinants of income inequality. In the next part of this study, a review of the recent empirical literature on the relationship between economic complexity and income inequality is provided in detail. The role of governance quality in enhancing inequality reduction role of economic complexity was also provided.
Khanzadi et.al (2022) investigated the effect of economic complexity on income inequality in Iran. Their findings showed that economic complexity in Iran exerted a negative and significant effect on income inequality. According to their study, economic complexity reflects production sophistication resulting from the improvement in the knowledge and skills of a country's manpower. This will help to achieve a higher level of expertise by using diverse and unique product knowledge and producing more advanced and sophisticated products. The higher specialization and product sophistication resulting from economic complexity will in turn increase the income in society thereby contributing to the reduction of income inequality through increasing productivity and products with high rates of return.

Another study by Hasanvand et al. (2022) in Iran investigated the relationship between economic complexity and income inequality by using a simultaneous equation modelling approach. Their study argued that economic complexity is an important concept that infers the role of knowledge in production and economic growth which plays an important role in changing income inequality. The results show that increasing income inequality had raised economic complexity, but an increase in economic complexity has reduced inequality. An increase in economic complexity is the result of the development of knowledge and skills in production which leads to industrialization which ultimately reduced income inequality. Therefore, their studies recommended increasing the quality of education and industrial development to promote knowledge-based production and increase GDP to enjoy the benefits of economic complexity effectively.

Sepehrdoust et al. (2022) examined the effect of macroeconomic variables on income inequality in developing countries using data from 2000 to 2019. They applied the panel-VAR model and found that income inequality decreases with an increase in economic complexity above a certain threshold. In their studies, they used economic complexity as one of the macroeconomic factors representing productive capabilities and thus leading to economic growth. The economic complexity reflects the productive capabilities and determines the level of economic growth and development of the countries. Thus, investment in knowledge and human capital, and the resulting increase in the capabilities of economic agents create complex economies. They recommended that developing countries be able to move towards economic complexity by utilizing technical knowledge and producing technology, based export products, thereby increasing per capita income and more equal income distribution.

Similarly, Bandeira et al., (2021) examined the role of economic complexity in influencing income inequality in Brazil using panel data for Brazilian states. The study aimed to look at whether differences in regional productive structures (regional economic complexities) affect income inequality among the states. Their findings revealed that the relationship between economic complexity and income inequality has an inverted U-shape, indicating that increasing levels of complexity first worsen and then improve the income distribution in Brazilian states. The study showed the role of urbanization and the resulting improvement in regional economic structure leading to the reduction of income inequality. Thus, the degree to which regional productive structures are characterized by diversity in terms of industries and occupations promoted income growth thereby reducing inequality. Besides, the problems of inequality are pronounced in less developed states with a more rural character. All in all, the findings confirmed the
important role that economic complexity plays in creating product and occupational diversification that drive improvements in income distributions.

Using a two-group finite mixture method, Lee and Wang (2021) analyzed the nexus between economic complexity, income inequality, and country risk using balanced data for 43 countries from 1991 to 2016. It was found that country risk has exerted effects on the complexity-inequality nexus. Specifically, while an increase in economic complexity brings equal income distribution in countries with low country risk, it was not found to reduce inequality in countries with high economic risk.

Lee & Vu (2020) conducted a cross-country analysis of the relationship between income inequality, economic complexity, and human capital using OLS regression and system GMM techniques. Their findings revealed that countries with an economic structure of complex products are associated with less inequality and that human capital magnifies this relationship but with an indirect interaction effect. However, the systems dynamic GMM result indicated that increased economic complexity leads to higher income inequality.

A study by Chu & Hoang (2020) examined the relationship between economic complexity and income inequality using panel data obtained from eighty-eight countries spanning from 2002 to 2017. They identify whether the changes in the nature of this relationship are conditional on the evolution of other economic and social factors. The finding concluded that economic complexity significantly positively affects income inequality; that is, economic complexity worsens inequality in income distribution. Besides, they have tried to see this relationship conditional on other economic and social factors where the study showed that when education level, government spending, and trade openness reach a certain threshold level, they are likely to facilitate the beneficial effect of increasing economic complexity on reducing income inequality. On the other hand, in situations with less education, ineffective government spending, and low economic openness, economic complexity fails to reduce income inequality. Therefore, they recommended developing a knowledge-based economy to enhance economic complexity and reduce inequality.

Chutimunt (2019) has assessed the international experiences in the analysis of the relationship between inequality in income distribution and the complexity of economies in different countries. The study compared the economic complexity and sectoral data on wage inequality at the inter-country level. Based on the assessment, most research findings concluded that advanced countries with a high per capita GDP have low sectoral wage income inequality rates.

Using a dynamic panel threshold model, Asamoah (2021) has investigated whether institutional quality exerts a threshold effect on income distribution. He employed data from a panel of advanced and developing countries from 1995 to 2017. His finding revealed that the inequality reduction effect of institutional quality is uneven with two different results. First, institutional indicators of governance quality showed a quadratic effect for advanced countries but a monotonic negative effect for developing countries. Similarly, the institutional quality measures of the International Country Risk Guide revealed an inverted U-shape relationship between income inequality and institutional quality for both groups of
countries. However, the threshold values are higher for developing countries compared to advanced countries under investigation.

Zehra et al. (2021) have examined the importance of institutional quality in reducing inequality and its effectiveness in improving income distribution. They used panel data from 114 countries from 1984 to 2018 under different political regimes. Institutional measures such as government stability, corruption index, bureaucratic quality, law and order, and democratic accountability were used for the analysis. Moreover, the ‘governance index’ and its different dimensions were all used as proxy indicators of the quality of institutions. By employing the two-stage least square pooled regression and systems GMM methods, the researchers found that the improvements in institutional quality generally reduce income inequality. However, the magnitude of the effect depends on the type of indicator. The indicators of the governance index were found to have a significant adverse effect except for voice and accountability. Moreover, institutional quality across political regimes revealed that income inequality is negatively related to solid democratic institutions but moves positively with the autocratic nature of democratic institutions.

Coccia (2021) conducted a study to examine the effect of institutional quality as measured by governance indicators on income inequality and reduction of poverty for 191 countries. His main finding indicated that suitable governance parameters support the reduction of poverty and income inequality. The finding further showed that the level of reduction in poverty and inequality is higher in stable and advanced countries than in emerging and fragile states. He recommended the countries focus on institutional improvements in governance effectiveness and the rule of law to reduce inequality. Similarly, Lee et al. (2021) have investigated the consequence of political institutions on income inequality based on perceived distributional fairness and the ability of citizens to participate in politics effectively. Based on data from the fourth wave of the Asian Barometer Survey (2014–2016), their finding suggested that political efficacy is linked to how people perceive fairness/unfairness in the distribution of income and the resulting expected role of government in the redistribution policies/programs.

Kunawotor et al. (2020) conducted a study to identify the drivers of income inequality in Africa and tried to check whether institutional quality matters in reducing income inequality. They applied a dynamic GMM technique with robust standard error for a panel dataset from 1990 to 2017 and found no significant effect of aggregate institutional quality parameters on income inequality. In connection with this, the governance indicators of corruption control and enforcement of the rule of law reduced income inequality. But other indicators such as government effectiveness, voice and accountability, regulatory quality, and political stability are not statistically significant in influencing income inequality. They suggested more emphasis specifically to be given to control of corruption and adherence to the rule of law, but in general overall institutional development is suggested in the context of Africa, where there are weak institutions.

3. Methodology
This section describes the methodology of the study. Specifically, it provides a brief explanation of the types and sources of data, a description of the variables used in the analysis, and a specification of the econometric models employed.

### 3.1. Data sources and description

The primary purpose of this study is to examine the effect of economic complexity on income inequality. Specifically, it empirically addresses the moderating effect of governance quality on the relationship between economic complexity and income inequality. To achieve this objective, the annual data on income inequality, economic complexity, governance quality, and other control variables are needed and obtained from different official sources for African countries under this study. But due to the unavailability of a complete set of data for all countries, the study has made a limited choice of only 24 African countries (for which we can get a complete dataset). The list of countries included in this study along with their 18 years’ average values of economic complexity, income inequality, economic growth and the aggregate governance index computed using principal component analysis is provided in annex Table 1 (see table for the annex section).

The dependent variable, income inequality, is measured by the Gini index. The Gini coefficient ranges from 0 to 100 per cent, with zero being perfect equality and 100% perfect inequality in income distribution. The Gini index data is obtained from the latest version of the Standardized World Income Inequality Database (SWIID V.9.2) developed by Solt (2020). The SWIID data includes comparable indices of the Gini coefficient of inequality for 198 countries worldwide from 1960 to the present. However, because of the limited data span in developing countries, only the period from 2000 to 2018 was considered. Moreover, due to the scarcity of the complete Gini index data for some countries under investigation, a few missing years were estimated using linear interpolation techniques.

The Economic Complexity Index (ECI) is one of the explanatory variables of interest in this research. Economic complexity is the composition of a country’s productive output and it reflects the structures holding the combined knowledge. Knowledge is accumulated, transferred and preserved if it is embedded in networks of individuals and organizations that put this knowledge into productive use (Hausmann et al., 2014; Hidalgo, 2021). It reflects the amount of productive knowledge that is combined and used in a country’s productive structure. Economic complexity is a measurement of the sophistication of a country’s productive structure that reflects the country’s capabilities. ECI is obtained by using the information on countries’ product diversity and ubiquity. Complex economies combine vast quantities of relevant knowledge and interact across large networks of individuals, to produce diverse and mixed knowledge-intensive products, while simpler economies, on the other hand, have a narrower base of productive knowledge and thus produce fewer and simpler products, requiring smaller networks of interaction. Economic complexity matters a lot because it explains differences in the income level of countries and predicts their economic growth.
Practically, economic complexity metrics were originally discovered using international trade data and validated by their ability to predict future economic growth. Globally, in the year 2020, Japan, Switzerland, Chinese Taipei, Germany and South Korea are the top five countries with the highest complexity index with Japan scoring the highest of all (2.19) and Nigeria having the lowest economic complexity index (-1.86). Among African countries, Tunisia and South Africa have a positive and relatively higher level of economic complexity which is indicated as 0.2049 and 0.1466 respectively (See table 4).

The data on this variable is obtained from the observatory economic complexity (OPEC) of Harvard’s Growth Lab (Simoes & Hidalgo, 2011). It measures the knowledge-created capacity of countries using techniques of dimensionality reduction or principal component analysis. It is calculated from export data of countries with a comparative advantage and combines both ubiquity and diversity of the products of countries. Accordingly, complex countries are those that export sophisticated and diversified products.

Another variable of interest in this study, governance quality, and other control variables are obtained from the World Bank open database. Specifically, the governance indicators are from the

World Governance Indicator’s Database and others from the World Bank’s World Development Indicator Database.

The governance indicators as defined by (Kaufman et al.2009) and applied by different scholars under different contexts as summarized below (Beyene 2022; Dickson et al. 2021; Seppo 2020). Voice and accountability are defined to capture the perception of citizens’ participation in voting for their government, access to free media, and the freedom of association and the press. Political stability measures the probability that the government can be destabilization due to unconstitutional acts of violence and terrorism. Government effectiveness captures people's perception of the public service quality, capacity, independence from political forces, and values related to better policy formulation and implementation. Regulatory quality measures the capability of the states to design and implement sound policies and regulations to promote private sector development. The rule of law captures the perceptions of the citizens’ confidence to accept and follow the rules of society, the enforcement of property rights, the confidence and reliability of security forces, and the related danger of criminality. Finally, corruption control measures the degrees to which the power of the government is used for private advantages, containing both minor and magnificent forms of corruption. The indicators' governance scores range from − 2.5 to 2.5, with zero at the centre. Higher positive values are indicators of better governance quality. Besides, the composite governance index (CGI) was estimated using PCA and included in the model from these six governance factors.

3.2. Econometric model specification

To investigate the effects of economic complexity and its interaction with governance quality on income inequality, a two-step system dynamic GMM estimator was applied. The systems GMM method of estimation helps account for potential endogeneity problems. The original model is given as follows;
\[ Gini_{it} = \alpha EC_{it} + \beta GQ_{it} + \delta Z_{it} + \mu_i + \varepsilon_i \]  \hspace{1cm} (1) \]

Where \( i \) represents the cross-sectional units, \( t \) the time dimension, \( Gini_{it} \) is a variable representing income inequality, \( EC_{it} \) is economic complexity index, \( GQ \) represents factors of governance quality, \( Z_{it} \) is a vector of control variables. The coefficients \( \alpha, \beta \) and \( \delta \) are parameters to be estimated. \( \mu_i \) is a country-specific unobserved effect and \( \varepsilon_{ii} \) is the usual error term.

As Arellano and Bond (1991) show, the dynamic GM model takes the first difference to control for country-specific unobserved effects. As a result, Eq. (1) can be re-written as:

\[ \Delta Gini_{it} = \alpha \Delta EC_{it} + \beta \Delta GQ_{it} + \delta \Delta Z_{it} + \Delta \mu_i + \Delta \varepsilon_i \]  \hspace{1cm} (2) \]

where \( \Delta \) is the first difference operator.

The empirical investigation of Eq. (1) helps us to identify the influence of economic complexity on income inequality, but to bring the interaction effect of governance quality in the relationship between inequality and economic complexity, Eq. (1) is modified as given below following Lee et al. (2020) and Gazdar & Cherif (2015).

\[ Gini_{i,t} = \phi Gini_{i,t-1} + \alpha_0 EC_{i,t} + \alpha_1 (EC_{i,t} \times GQ_{i,t}) + \sigma_i GQ_{i,t} + \delta_i Z_{i,t} + \mu_i + \varepsilon_{i,t} \]  \hspace{1cm} (3) \]

Equation (3) allows us to check if economic complexity affects income inequality, and whether the inclusion of governance quality indicators will change the economic complexity-inequality relationship. The current lagged value of the inequality is included to introduce dynamism into the model. The parameters \( \alpha_0 \) and \( \alpha_1 \) capture the direct and conditional effect of economic complexity respectively. We can estimate four aspects of the hypothesis based on these parameters as follows:

- First, if \( \alpha_0 > 0 \) and \( \alpha_1 > 0 \), economic complexity will positively affect income inequality and governance indicators will further enhance that positive effect. This means, that economic complexity increases inequality and the presence of governance quality parameters will worsen the income distribution.
- Second, if \( \alpha_0 > 0 \) and \( \alpha_1 < 0 \), economic complexity will enhance (increase) income inequality but the governance factors affect that positive effect adversely. In other words, economic complexity increases inequality, but that positive effect will be weaker when governance factors exist.
- Third, if \( \alpha_0 < 0 \) and \( \alpha_1 > 0 \), economic complexity reduces income inequality, and the existence of governance factors will mitigate that negative effect. That is, economic complexity reduces income inequality, and governance factors will further decrease this effect.
- Finally, if \( \alpha_0 < 0 \) and \( \alpha_1 < 0 \), economic complexity negatively affects income inequality and governance conditions, which will further aggravate the negative effect. In other words, economic complexity improves income distribution and this effect is more robust in the presence of governance factors.
Two specification tests were conducted to check for the overall validity of the instruments for the GMM estimator: second-order serial correlation of disturbances and the Sargan over-identifying restrictions tests (Arellano and Bond 1991). A failure to reject the null of the Sargan test indicates the validity of instruments and of course the correct specification of the model. Similarly, to justify the absence of second-order serial correlation in disturbances, we should accept the absence of second-order serial correlation (AR2).

4. Findings and discussion

4.1. Descriptive Statistics

The descriptive analysis of 19 years’ average data on the main variables included in this research is provided in Table 1. As seen from the table, the average data on the income inequality index for the region as a whole has only slightly improved from 45.56 in 2000 to 45.35 in 2018 as a region. Based on the dataset, Namibia has the highest Gini coefficient which is about 0.661 (66.1 per cent) followed by South Africa at 0.628 (62.8 per cent). Ethiopia registered an average Gini index of 0.329 (32.9 per cent). This is the lowest Gini value in the African region reflecting the presence of a relatively more equitable distribution of income in Ethiopia.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs.</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gini Coefficient</td>
<td>456</td>
<td>45.502</td>
<td>8.088</td>
<td>32.6</td>
<td>66.1</td>
</tr>
<tr>
<td>Economic Complexity</td>
<td>456</td>
<td>-0.805</td>
<td>0.564</td>
<td>-2.337</td>
<td>0.513</td>
</tr>
<tr>
<td>Composite Governance Index</td>
<td>456</td>
<td>2.70e-09</td>
<td>1.000</td>
<td>-1.931</td>
<td>2.50</td>
</tr>
<tr>
<td>GDP Growth</td>
<td>456</td>
<td>4.784</td>
<td>3.209</td>
<td>-7.70</td>
<td>18.30</td>
</tr>
<tr>
<td>Inflation</td>
<td>456</td>
<td>8.722</td>
<td>18.807</td>
<td>-8.238</td>
<td>324.996</td>
</tr>
<tr>
<td>Population Growth</td>
<td>456</td>
<td>2.338</td>
<td>0.781</td>
<td>0.055</td>
<td>3.789</td>
</tr>
<tr>
<td>Public Expenditure</td>
<td>456</td>
<td>23.760</td>
<td>8.118</td>
<td>9.760</td>
<td>55.801</td>
</tr>
</tbody>
</table>

Similarly, the average economic complexity index is -0.805 in the region, with a minimum value of -2.34 found in Nigeria and a maximum value of 0.513 (in Tunisia). The composite governance index is estimated from six governance factors by using the Principal Component Analysis (PCA). The average values of other control variables used are also reported in the same table. The computed index number ranges from −1.93 (minimum) to 2.50 (maximum), with the highest value representing countries with better governance systems.
4.2. Empirical Findings and Discussion

One major problem in panel data is the existence of country-specific unobserved heterogeneity effect. A two-step GMM estimator is applied to control for such effects where we introduce the lagged values of the dependent and pre-determined variables as instruments. However, the validity of the instruments is checked by using both Sargent and Hansen tests. Moreover, the second-order autocorrelation test of the disturbance terms is also included in Table 2 along with the estimated coefficients. As shown in the table, the Arellano-Bond test for the first-order autocorrection AR (1) is statistically significant implying that we need to use a dynamic panel model in the context of our study. On top of this, the Arellano-Bond test for the second-order autocorrection AR (2) is insignificant as required for the validity of instruments. Similarly, both Sargent and Hansen tests are insignificant and the instruments as reported in the table are not as so large (65/64). Therefore, the test results confirm that the instruments used in the analysis are valid.

Table 2 reports the empirical results of the three models; the first model is estimated based on only economic complexity indicator (along with control variables excluding CGI), the second model is estimated using only composite governance index (excluding ECI), and the final model is estimated considering the interaction effect of economic complexity on income inequality through the moderating role of composite (aggregate) governance indicator. The estimated results in models 1 and 2 (Table 2) reveal that both economic complexity and governance quality are positively related to income inequality. In other words, the ECI and CGI deteriorate income distribution or increase inequality in the study area. This finding is consistent with empirical studies of (Hasanvand et al., 2022; Banderira et al., 2021; Lee & Vu, 2020), but against the findings of Khanzadi et.al (2022), Hasanvand, et.al. (2022).

Several reasons may be implied for the existence of such positive relationships. First, it may be related to the existing status of economic complexity and governance qualities in these countries (which are very weak) and the link depends on and is reinforced by other factors. For instance, the overall low governance quality in these countries is reflected by the low level of governance indicator (negative for most countries) and poor governance systems in education, ineffective government spending, corruption as well a low level of openness (lack of export diversification), which may all contribute to such positive association. Second, the country's level of risk and political instability issues together wit institutional systems such as poor labour market conditions may also add to low levels of employment and income distribution patterns which lead to inequitable distribution of income.

Third, the relation may also depend on the effort and the ability of countries to generate employment in manufacturing and sophisticated services sectors. This is because most African countries are unable to produce knowledge-based and diverse commodities. As a result, their economies are characterized by a very low level of complexity which fails to generate such type of complex economic structure and more rewarding employment systems thereby leading to positive relationships. In this regard, the governments are expected to intervene to strengthen institutional and governance drawbacks to create knowledge-based and diverse production systems.
However, the result of model 3 (now with the moderating role of governance factors) given in the same table, shows that the coefficient of the interaction term is negative and statistically significant. This supports the second hypothesis in our model specification, which states that economic complexity positively affects inequality, but its interaction with governance factors will reverse the relationship (that is, $\alpha_0 > 0$ and $\alpha_1 < 0$). In other words, while economic complexity alone increases inequality (Model 1), that increase is offset by the inclusion of the governance factor (Model 3). This calls for the need for considering the interaction role of governance factors to realize the inequality reduction benefit of economic complexity.
Table 2
Empirical results with and without moderating effect

<table>
<thead>
<tr>
<th>Dependent variable (Gini)</th>
<th>Model 1 (with ECI only)</th>
<th>Model 2 (with CGI only)</th>
<th>Model 3 (ECI*CGI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gini Coefficient (-1)</td>
<td>1.0092***</td>
<td>.003097</td>
<td>1.0062***</td>
</tr>
<tr>
<td>Economic Complexity Index</td>
<td>.22801***</td>
<td>.0419858</td>
<td></td>
</tr>
<tr>
<td>Composite Governance Index</td>
<td>.05919*</td>
<td>.0353643</td>
<td></td>
</tr>
<tr>
<td>ECI*CGI</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDP growth</td>
<td>.00267</td>
<td>.0050412</td>
<td>-.00038</td>
</tr>
<tr>
<td>Inflation Rate</td>
<td>.00179**</td>
<td>.0007135</td>
<td>.00129*</td>
</tr>
<tr>
<td>Financial Institution Index</td>
<td>-1.3245***</td>
<td>.2015946</td>
<td>-.99874***</td>
</tr>
<tr>
<td>Population Growth Rate</td>
<td>-.06561***</td>
<td>.0203965</td>
<td>-.08192***</td>
</tr>
<tr>
<td>Public Expenditure</td>
<td>.00045</td>
<td>.0011531</td>
<td>-.00186</td>
</tr>
<tr>
<td>_cons</td>
<td>-.23324***</td>
<td>.073971</td>
<td>-.25121***</td>
</tr>
</tbody>
</table>

| Arellano-Bond test AR (1) | P-value = 0.000         | P-value = 0.000         | P-value = 0.000    |
| Arellano-Bond test AR (2) | P-value = 0.319         | P-value = 0.405         | P-value = 0.487    |
| Sargan test (P-value)     | (0.125)                 | (0.291)                 | (0.282)            |
| Hansen test (P-value)     | (0.282)                 | (0.350)                 | (0.313)            |
| Instruments               | 22                      | 22                      | 22                 |

[Table 2 here]

To sum up, the income distribution effects of the governance quality and economic complexity reveal that the factors when used individually will degrade income distribution, but when the governance factor was allowed to moderate the relationship, their interaction will tend to make the positive effect weaker. The result has important policy implications in that, for economic complexity to have a weaker positive
effect on income inequality, it should be accompanied by an improvement in the governance factors rather than doing alone.

Regarding the effects of the control variables, we can see from the table that, the financial system development is negative and statistically significant at 1%. This is consistent with existing theories because the development and proper functioning of the financial sector accelerate economic growth through its role in allocating and channelling finance to various productive investments. This will play a significant role in creating employment opportunities and thereby contributing towards reducing income inequality. Inflation in all three cases and GDP growth in the case of the interaction model (model 3) significantly deteriorate income distribution, but public expenditure as a percentage of GDP even if insignificant in the first two models, exerts a negative significant effect on inequality.

[Table 3 here]
Table 3
Disaggregated effect of governance quality on income inequality

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1 (with CC)</th>
<th>Model 2 (with GE)</th>
<th>Model 3 (with PS)</th>
<th>Model 4 (with RQ)</th>
<th>Model 5 (with RL)</th>
<th>Model 6 (with VA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gini (-1)</td>
<td>1.0077***</td>
<td>1.0175***</td>
<td>1.0059***</td>
<td>1.0067***</td>
<td>1.0205***</td>
<td>1.096***</td>
</tr>
<tr>
<td>GDP Growth</td>
<td>.00167</td>
<td>.00256</td>
<td>-.0028</td>
<td>.0019</td>
<td>.0056</td>
<td>.0061</td>
</tr>
<tr>
<td>Inflation</td>
<td>.00263***</td>
<td>.0026***</td>
<td>.0018**</td>
<td>.0030***</td>
<td>.0027***</td>
<td>.0026***</td>
</tr>
<tr>
<td>ECI*CC</td>
<td>-.1667***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ECI*GE</td>
<td></td>
<td>-.18433***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ECI*PS</td>
<td></td>
<td>-.0512***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ECI*RQ</td>
<td></td>
<td></td>
<td>-.1660***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ECI*RL</td>
<td></td>
<td></td>
<td></td>
<td>-.1655***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ECI*VA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-.2462***</td>
<td></td>
</tr>
<tr>
<td>Financial Institution Index</td>
<td>-1.1186***</td>
<td>-1.0964***</td>
<td>-.9075***</td>
<td>-1.0507***</td>
<td>-1.267***</td>
<td>-1.333***</td>
</tr>
<tr>
<td>Population Growth</td>
<td>-.0694***</td>
<td>-.0643***</td>
<td>-.1022***</td>
<td>-.0746***</td>
<td>-.0909***</td>
<td>-.0748***</td>
</tr>
<tr>
<td>Public Expenditure</td>
<td>-.0007</td>
<td>-.0005</td>
<td>-.0021*</td>
<td>.0006</td>
<td>.0005</td>
<td>.0024*</td>
</tr>
<tr>
<td>Constant</td>
<td>-.2787***</td>
<td>-.2867***</td>
<td>-.1779**</td>
<td>-.2866***</td>
<td>-.3683***</td>
<td>-.3651***</td>
</tr>
<tr>
<td>Arellano-Bond test AR (1)</td>
<td>Pv-0.000</td>
<td>Pv-0.000</td>
<td>Pv-0.000</td>
<td>Pv-0.000</td>
<td>Pv-0.000</td>
<td>Pv-0.000</td>
</tr>
<tr>
<td>Arellano-Bond test AR (2)</td>
<td>Pv-0.441</td>
<td>Pv-0.418</td>
<td>Pv-0.396</td>
<td>Pv-0.520</td>
<td>Pv-0.423</td>
<td>Pv-0.707</td>
</tr>
<tr>
<td>Sargan test (P-value)</td>
<td>(0.150)</td>
<td>(0.190)</td>
<td>(0.484)</td>
<td>(0.391)</td>
<td>(0.164)</td>
<td>(0.123)</td>
</tr>
<tr>
<td>Hansen test (P-value)</td>
<td>(0.678)</td>
<td>(0.648)</td>
<td>(0.899)</td>
<td>(0.898)</td>
<td>(0.787)</td>
<td>(1.000)</td>
</tr>
<tr>
<td>Instruments</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>22</td>
</tr>
</tbody>
</table>

Pv is the p-value

The results for the interaction effects of the disaggregated governance indicators are provided in Table 3. As shown in the table, the disaggregated indicators generally follow a similar pattern to that of the
composite governance index. The interaction terms in all of the models are negative and significant which indicates that when economic complexity interacted with each governance factor, it reduced income inequality. This implies that these factors mitigate the adverse effect of economic complexity on income inequality. The financial development index and population growth are negatively related to income inequality, while GDP growth and public expenditure are statistically insignificant.

5. Conclusions

Several conclusions and policy implications can be drawn from the findings. First, the study concludes that economic complexity positively predicts income inequality. That is, economic complexity alone (without interaction effect) has deteriorated income distribution or increased the level of income inequality in the study area.

Second, a positive and significant effect of economic complexity on inequality (model 1) and a statistically significant negative effect of the interaction term (model 3) revealed that, while economic complexity increases inequality, that increase is offset by the mediating role of governance factors. The overall finding concluded that governance factors are likely to weaken the positive effect of economic complexity. The result has an important policy implication in that, for economic complexity to contribute to the reduction of income inequality, improvements in governance quality must be accompanied. The effects of control variables gave additional valuable insight to policymakers. For instance, higher inflation will reduce the purchasing power of citizens and thereby worsen income distribution.

Third, the results of disaggregated effects provide similar information to that of the composite governance index. The interaction terms of economic complexity with each governance factor are all negative and statistically significant. The implication for policymakers is evident in that measures taken to improve the governance factors will significantly reduce the adverse effects of economic complexity on income inequality.

Declarations

Competing interest – as an author I declare that there are no competing interests

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Authors’ contribution – Not applicable because there are no other authors.

Acknowledgement – Not applicable

Availability of data and materials:

The datasets analyzed during the current study are available from the following sources.

✓ World Bank Database (World Development Indicators)
References


**Supplementary Files**

This is a list of supplementary files associated with this preprint. Click to download.

- AnnexTable1.docx