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Effect of institutional quality and foreign direct investment on economic growth and environmental quality: evidence from African countries

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ABSTRACT

This study applies the method of the fully modified ordinary least squares (FMOLS) method and the vector error correction model (VECM) to explore whether institutional quality (IQ) and foreign direct investment (FDI) promoted economic growth (EG) and environmental quality (EQ) in oil-producing and non-oil-producing African countries from 1999 to 2017. The FMOLS findings demonstrate that IQ significantly promoted EG and improved EQ in the non-oil-producing countries, however it only improved EQ and showed no significant impact on EG in oil-producing countries. FDI significantly promoted EG to a higher extent in oil-producing countries than in non-oil-producing countries, but it presented no significant impact on EQ in both groups. The VECM results reveal that (i) two-way causation among IQ and EG, IQ and EQ, FDI and EG, and FDI and EQ was occurred in both groups, in the long-run. (ii) two-way causation among FDI and EQ and one-way causation from FDI to EG was observed in non-oil-producing countries in the short-run. Moreover, two-way causation among IQ and EG, and one-way causation from IQ to EQ were observed in non-oil-producing countries. To realize the sustainable development of economy and environment, a series of policy suggestions have been discussed.

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1. Introduction

The relationship between developing economy and protecting environment is quite complex. For example, incremental increase in energy use during economic growth cause elevated CO₂ emissions, contributing to climate change, and threatening human health and the environment. Therefore, coordinating economic development against

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environmental protection is a challenge to many countries which has been extensively studied in various academic and political contexts.

Some studies stipulate that the quality of a country's institutions is pivotal for promoting economic development and protecting environment (Abid, 2017; Xu et al., 2019). This is because the government can directly or indirectly macro-control the economic development and protect the environment. Specifically, institutional quality is associated with policies implemented by domestic institutions to establish legal and cultural rules under which socio-economic activities occur. The implementation of these policies can demonstrate political stability, lack of violence, quality of public services, and the ability of governments to formulate and impose policies and regulations (Canh et al., 2019). The rule of law is the most widely adopted element in governance and is pivotal in addressing environmental issues (Salman et al., 2019). Most large economies in Africa including oil-producing countries are resource-endowed, which attracts significant inflows of FDI to the country. However, non-oil-producing countries such as Ethiopia and Kenya have also attracted significant FDI in recent years. This indicates that the quality of institutions is important in sub-Saharan African (SSA) countries as they attract FDI, which can contribute to economic growth and environmental performance (Abid, 2016).

The influence of FDI flows on a country's economy and environment cannot be disregarded. In fact, FDI can yield capital funding to create positive externalities and facilitate economic growth utilizing spillover effects, transfer of technology, productivity gains, and the development of novel processes and managerial capabilities (Lee, 2013). Most countries are now encouraging green FDI, which focuses on economic growth while reducing the environmental emissions associated with industrial production (Demena & Afesorbor, 2020). However, an increase in FDI also leads to increasing emissions, promoting the hypothesis of pollution haven (He, 2006; Shahbaz et al., 2020). This hypothesis suggests that relatively flexible environmental regulations in developing countries might provide a comparative advantage for the production of pollution-intensive goods, which is advantageous for foreign investments from developed countries. Thus, FDI may damage the environment of developing countries through direct pollution (Sapkota & Bastola, 2017). In contrast, some scholars support the 'pollution halo hypothesis' and believe that FDI can improve the environmental quality of the host country through technology spillover effects and substitution effects (Saud et al., 2019; Udemba & Yalçıntaş, 2021). However, some scholars accept that the influence of FDI on the environment is mixed or non-significant (Haug & Ucal, 2019; Shaari et al., 2014). Although scholars have explored the connection between FDI and the environment, the results are often contradictory. The possible explanations are as follows: first, national conditions vary, and scholars from various countries may put forward different opinions from individual standpoints; second, the analysis methods and measurement models used by the researchers are different, and the selected data and research samples also vary significantly. Therefore, the objective of this paper is to explore the impact of institutional quality and FDI on economic growth while also exploring its impact on environmental quality in 24 African countries during the period 1996–2017.

Several studies investigate the factors affecting the emissions-growth nexus using different datasets, explanatory variables, and economies. Our study innovates in terms of set of countries and explanatory variables. This research notably adds to the literature by evaluating the correlations among institutional quality, FDI, economic growth as well as environmental quality. We applied panel unit-root tests and panel co-integration approaches to determine the stationary levels of all variables and their long-run correlation. The fully modified ordinary least squares (FMOLS) method was also applied to analyze the effect of institutional quality, FDI, economic growth as well as environmental quality in both oil-producing and non-oil-producing countries. Then, the short- and long-run causality links amid the variables were studied employing the VECM technique.

The rest of the paper is structured as follows. The literature review is presented in [Section 2](#). The methodology and data utilized are illustrated in [Section 3](#). Empirical results and discussion are presented in [Section 4](#). Finally, the conclusions and policy implications are provided in [Section 5](#).

2. Literature review

2.1. Research on institutional quality and economic-environment

The institutional economic theory establishes that institutions have the function of influencing and restricting organizational behavior. However, institutions are no longer an incentive and restraint mechanism related only to economic interests. They can be regarded as a type of technology that affects economic growth as an endogenous variable. In emerging countries, improvements in institutional quality trigger technology-upgrading outcomes in developed countries, creating total productivity gains (Jung, 2020). Thus, institutional quality seems to enhance economic growth (Boateng et al., 2021; Nair et al., 2021; Nguyen et al., 2020). Nonetheless, fixed institutions cannot promote growth not in the long-run, whereas they can only stimulate it in the short-run (Corriveau, 2021).

Most scholars are of the view that institutions are decisive for the economic-environment. Abid (2017) explored the influence of economic, financial, and institutional development on the environment. The research adopted the generalized method of moments (GMM) and reported that good institutions in EU countries affect not only economic development but also environmental quality. To explore whether institutional quality affects growth-emission, Salman et al. (2019) studied three East Asian countries over the period 1990–2016. They observed that effective and fair domestic institutions are conducive to simultaneous economic growth and reduction of CO₂ emissions. Institutional quality not only directly affects economic growth, but also indirectly affects it through CO₂ emissions, as reported by Lau et al. (2014). They investigated Malaysian and understood that high institutional quality was essential to manage emissions during economic development.

Institutional quality also reflects the overall regional economic and environmental conditions in many ways. Hosseini and Kaneko (2013) used a panel data model to investigate the impacts of the institutional quality of a country and its neighbors on CO₂ emission intensity from energy use of 129 countries/regions during 1980–2007.

They observed that the environmental quality of a country spread spatially to its neighbors through the spillover of national institutional quality. This finding was also applied to economic development. Xu et al. (2019) analyzed transnational data and observed that the quality of the institutions affected the local economy and peripheral economies from a spatial autocorrelation perspective, and the correlation between the two was U-shaped. Ibrahim and Law (2016) observed that institutional reform undoubtedly improved environmental quality and should, therefore, be implemented in countries with low institutional quality. Mavragani et al. (2016) investigated environmental performance by linking the environment with the macroeconomics and institutional quality of 75 countries. They observed that a country's economic growth, economic openness, institutional quality, and environmental performance were significantly positively correlated.

In the evaluation of institutional quality, scholars also use different proxy variables. For example, Butkiewicz and Yanikkaya (2006) evaluated the influence of democracy and the rule of law on the economy. They observed that both institutions promoted economic development, and democracy seemed especially vital for developing countries. Additionally, Uddin et al. (2017) investigated whether political stability affected economic growth using a sample of 120 developing countries over the period 1996–2014. The findings presented that political stability is vital for economic growth, especially in developing countries, while political risk is detrimental. Thus, the development of economic institutions in developing countries affects economic growth positively. Gherghina et al. (2019) also found that corruption control, regulation, effectiveness of government, accountability and voice, and the rule of law, positively affected economic growth. Nonetheless, the absence of violence/terrorism and the existence of a stable political situation were not statistically significant.

Bernauer and Koubi (2009) investigated the influence of political institutions on air quality by applying data from 107 cities in 42 countries/regions during 1971–1996. They observed that the degree of democracy had an independent positive influence on air quality, and in democratic countries, the presidential system was more conducive to air quality than the parliamentary system. Similar findings have been obtained for African countries. Using panel data on the income-emission-democracy nexus in 17 MENA countries from 1980 to 2005, Farzanegan and Markward (2018) assessed whether investing in the democratic development of these countries is an effective tool to allow the economic development in this region more environmentally compatible. The result indicated that improvements in the democratic development of the MENA countries helped to prevent environmental problems. Adams and Klobodu (2017) investigated 38 African countries, and observed that in the long-run, bureaucracy and democracy can effectively alleviate degradation of environmental quality. Qiang and Jian (2020) used provincial panel data of China from 2005 to 2018 and divided the institutional variables into degree of market resource allocation, degree of market openness, and degree of diversified property rights. They analyzed the relationship between these institutions and China's regional economic growth. Their results showed that a low level of market resource allocation led to a decline in economic growth performance. The low degree of property right diversification also

inhibited economic growth, whereas the improvement of market opening promoted economic growth.

Recent studies report that although institutions can boost economic activities, they can also decrease environmental quality. Godil et al. (2020) analyzed the impact of Pakistan's CO₂ emissions using the quantile autoregressive distribution lag model. They observed that the quality of institution and GDP could increase CO₂ emissions in the long-run when CO₂ emissions were already high. That is, if the quality of institution as well as GDP are improved, CO₂ emissions can also increase. Le and Ozturk (2020) explored the CO₂ emissions of 47 countries over the period 1990–2014, and they observed that institutional quality increased emissions. The reason may be that encouraging institutional quality can promote economic activities and attract more trades and investments through economic globalization, which in turn amplifies the scale effect of economic activities on emissions. Ali et al. (2020) explored the dynamic joint impact of trade opening, foreign direct investment (FDI), and institutional performance in the Organization of Islamic Conference (OIC) countries on environmental quality using the dynamic common correlation effect estimation method. They observed that trade openness, FDI, and environmental quality were significant factors, and a significant negative correlation was observed between institutional performance and environmental quality.

2.2. Research on FDI and economic-environment

The contribution of FDI to the economic-environment has been investigated from different perspectives by many studies. Several studies show that FDI influences the a nation's economy. For example, Akisik et al. (2020) found that FDI positively impacted economic growth in Anglophone and Francophone African countries. Muhammad and Khan (2019) analyzed 34 host countries and 115 Asian countries from 2001 to 2012 applying the GMM model. They investigated the factors that improved the economic growth and concluded that FDI inflow and outflow were essential for the growth of Asian economies. Also, Su et al. (2019) found a positive effect of FDI on economic growth in Vietnam. Hagan and Amoah (2020) observed that FDI inflows presented a slightly positive significant impact on economic development when the financial market is as fragile as Africa's.

Wu et al. (2020) discussed whether FDI promoted economic growth using data at the urban level in China. The study showed an inverted U-shaped correlation among FDI and GDP. Applying the simultaneous equation, Omri et al. (2014) studied the correlation among economic growth and FDI in 54 countries from 1990 to 2011. The findings indicated a two-way correlation among economic growth and FDI inflow. In contrast, Abdouli and Omri (2021) studied the link between economic growth and FDI inflows during 1990–2013 in the Mediterranean region. They observed that the causality between GDP and FDI inflows was one-way in European and Asian Mediterranean countries.

As for research on the impact of FDI on the environment, the conclusions of the existing studies are inconsistent, and there is substantial controversy. First, some scholars support the 'pollution haven hypothesis', believing that host countries

(usually developing countries) provide lenient environmental protection rules to attract foreign investment as well as high resource consumption and high pollution emission capacity investment in countries with stringent environmental controls (such as developed countries). Through this mechanism, FDI transfers environmental pollution to the host country, aggravating its environmental pollution. Shahbaz et al. (2015) used FMOLS methods to evaluate the connection between FDI and environmental pollution aggravation for low-, medium-, and high-income countries in a multiple framework. Their results confirmed the ‘pollution haven hypothesis’ and indicated that FDI contributed to environmental degradation. Shahbaz et al. (2020) explored the connection between public-private partnerships’ investment in energy sector and carbon emissions involving the use of technological innovations in emissions function for China. Their study emphasized that FDI increases carbon emissions, as well as reduces environmental quality, supporting the affirmation of the pollution haven hypothesis. Similarly, Opoku and Boachie (2020) also confirmed the hypothesis of pollution haven by examining the environmental influence of industrialization and FDI in 36 African countries from 1980 to 2014. In the Middle East, Abdouli and Hammami (2017) investigated the correlations among economic growth, FDI inflows, and environmental degradation during 1990–2012. They used the GMM method, and their findings demonstrated two-way causal relation between CO₂ emissions and FDI. It also confirmed that FDI inflow might create a pollution haven. Similar results have been obtained by Hakimi and Hamdi (2016) for Tunisia and Morocco. However, they observed two-way causal relation between emissions and FDI and suggested that inflows of FDI into these countries were not based on clean and sustainable technologies and practices.

In contrast, some scholars support the ‘pollution halo hypothesis’, believing that FDI can bring relatively advanced clean production technology and pollution control experience to the host country via technology spillover effects and substitution effects and improve the resource utilization and production efficiency of enterprises in the host countries, thereby enhancing its overall environmental quality. Saud et al. (2019) investigated environmental quality issues of 59 Belt and Road initiative countries during 1980–2016. They observed that the increase in FDI improved the environmental quality and the two-way causal relationship between them. This is because the increase in FDI inflow has brought about technological improvements and promoted research and development in these countries, consequently reducing CO₂ emissions and improving environmental quality. This conclusion is in line with the results of Shao (2018) from a study of 188 countries. Jiang et al. (2018) used the city-level data set of 150 cities in China in 2014 and constructed a spatial measurement model to investigate whether FDI in China led to environmental deterioration. They observed that FDI was negatively correlated with China’s air pollution, and spatial spillovers effect of FDI technology in the improvement of air quality proved the ‘pollution halo hypothesis’. This conclusion was verified by Hao et al. (2020), using panel data of 30 provincial units in China from 1998 to 2016. They investigated whether FDI impacted the country’s pollution of the environment and found that increasing FDI could reduce environmental pollution, which also confirmed the ‘pollution halo hypothesis’. Similarly, Udemba and Yalçın taş (2021) researched sustainable development and

environmental performance in Algeria from 1970 to 2018, employing nonlinear and long-run asymmetric cointegration. The study showed that, like the positive impact of FDI, the negative impact of FDI can also diminish carbon emissions and positively impact the environment. Again, this affirms the hypothesis of pollution halo.

Furthermore, some studies showed that the environmental impact of FDI is mixed, and others did not find any relation between them. For example, Marques and Caetano (2020) utilized the panel Autoregressive Distributed Lag to explore the impacts of FDI on the CO₂ emissions of 21 countries divided by income level from 2001 to 2017. The findings indicated that FDI decreased emissions in high-income countries while increasing them in the short-run in middle-income countries. Dhrifi et al. (2020) examined the causality between FDI, CO₂ emission, and poverty for a global panel of 98 developing countries employing the simultaneous-equations models (SEM's) from 1995 to 2017. The findings illustrated an inverted U-shaped correlation between FDI and CO₂ emission for Asian countries; in Latin America, a positive effect of FDI on CO₂ emission, and a negative impact in African countries. However, employing data of 15 countries, Shaari et al. (2014) explored whether economic growth and FDI influenced on CO₂ emissions. They found that FDI inflow, in the long-run, did not affect emissions, suggesting that increased FDI would not influence emissions, but increased economic growth would promote emissions. Similar results have been obtained by Haug and Ucal (2019) for Turkey, reporting that FDI had no statistically significant long-term effect on per capita CO₂ emissions.

It can be concluded from the studies quoted above that, although there is a certain theoretical consensus on the influence of institutional quality and FDI on the economic-environment, there are still areas worth further investigation. Few studies, especially for African countries, combine institutional quality and FDI with economic-environment into a unified research framework. Thus, this paper divides the studied African countries into oil-producing countries and non-oil-producing countries, and it uses FMOLS and VECM estimation techniques to consider the influence of institutional quality and FDI on economic growth as well as environmental quality. For that, factors affecting economic growth and environmental quality, such as trade openness, urbanization, and industrialization, were used as control variables.

3. Empirical methodology

3.1. Theoretical framework

Institutional quality and FDI are two important factors for a country's economic and sustainable environmental development. Therefore, it is of vital importance to clarify the theoretical relationship between them.

First, according to the theory of new institutional economics, institutional quality is the key factor determining the economic growth of a country (or region) (Shleifer & Vishny, 1993). Whether a country has a reasonable basic institution, institutional environment, institutional structure, and institutional trend directly affect its performance. In most developing countries, the institutional system is imperfect, corruption is a major problem, and inefficient institutions restrict economic growth potential. Myrdal and Sitohang (1957) realized early the impact of institutional factors on

developing countries and proposed that the theory of capital circulation accumulation could not explain the long-term low growth trap of underdeveloped countries. North (1990) believes that institutions are a series of game rules, and institutions, like population and savings are pivotal in economic development. Like other tangible resources, institutions also have high or low quality. A good institution quality is also a comparative advantage of a country or region, which can effectively improve the efficiency of resource allocation and promote economic growth. However, the impact of the institution on countries at different levels of development vary. Bouis et al. (2011) and Berggren (2015) pointed out that this may be related to the different development stages of the country.

At the same time, the institutional quality also reflects the region's overall development of environment and conditions and can affect the environmental conditions in many ways. A reasonable institutional arrangement can effectively promote the allocation and use of regional resources (Qiang & Jian 2020), while resource allocation improvement and use efficiency can positively impact the environmental quality.

Second, the role of FDI in economic growth of the host country mainly reflects in the role of FDI in various input factors (such as capital, labor force, technology, etc.) that promote economic growth. Rostow (1990) believes that capital accumulation was the first variable to eliminate the plight of economic backwardness for developing countries in the stage of economic take-off. Under the framework of neoclassical growth theory created by Solow (1956), if there is no exogenous technological change, the economy will converge to a stable state where the per capita income level remains unchanged. Under the new growth theoretical framework proposed by economists (Lucas, 1988; Romer, 1986), human resource capital, knowledge, and other factors are endogenous. Therefore, the return on capital can remain constant or even increase, and the per capita output can also theoretically increase indefinitely. Moreover, FDI influences economic growth in different ways. Specifically, FDI solves the capital shortage problem of the host country in the economic development process, relieves the bank stress, and stimulates the development vitality of enterprises. Additionally, enterprises in the host country can maintain contact with foreign enterprises through imitation, learning, or communication, and actively participate in the work of technological breakthrough, as well as process the improvement or innovation of foreign enterprises, which can promote the technology spillover of FDI to a large extent (Branstetter, 2006; Helpman, 2006) and human resource capital spillover effect (Zhuang, 2017), thus playing a key role in stimulating economic development in host countries.

Meanwhile, FDI also affects the country's environment. Therefore, FDI can affect environmental quality through various ways, including scale, structure, and technology effects (Chaudhuri & Mukhopadhyay, 2013; He, 2006; Levinson & Taylor, 2008; Smarzynska Javorcik, 2004). The scale effect is mainly reflected in the expansion of production input and the increase of pollution emissions. The structural effect is mainly manifested in that most developing countries are vigorously promoting the industrialization process, and most of the imported foreign capital flows into industries with high energy consumption and pollution emission levels, thus producing a negative structural effect on environment. This is not conducive for developing countries to improve the quality of their environment. Finally, the technology effect is

mainly manifested in the promotion of FDI, stimulating the economic development in host country. It also produces technology spillover to the host country via demonstration, imitation and correlation effect to improve the technical level and production efficiency and its environmental quality.

3.2. Model construction

In the reality of complex economic activities, the input factors of production activities are closely linked, and macroeconomic fluctuations will inevitably lead to changes in the activity of factors. In utilizing general panel data analysis methods, such as the general ordinary least squares (OLS) estimation method, it is basically difficult to avoid the endogeneity and sequence correlation problems of each input factor.

To solve this problem, Phillips and Hansen (1990) first proposed the fully modified least squares estimators (FMOLS) for the time series co-integration equation. On this basis, Pedroni (2000) improved and extended the FMOLS method to the heterogeneous panel co-integration. The semi-parameter estimation method of panel co-integration FMOLS can effectively eliminate the estimation bias caused by the endogeneity of dependent variables and the autocorrelation of disturbance terms and overcome the 'spurious regression' problem. It should be emphasized that panel FMOLS includes between- and within-dimension panel estimations, and Pedroni (2000) made a comparative analysis of these two estimation methods. Conclusively, between-dimension estimation is better than within-dimension estimation in terms of small sample size and operational flexibility. Therefore, the FMOLS panel co-integration coefficient estimation method was selected in this paper to study whether institutional quality and FDI have a long-run impact on economic growth as well as environmental quality in oil- and non-oil-producing African countries. Two models were considered to achieve this objective, as follows:

$$GDP_{it} = f(IQ_{it}, FDI_{it}, CO2_{it}, TO_{it}, URB_{it}, IND_{it}), \quad (1)$$

$$CO2_{it} = f(IQ_{it}, FDI_{it}, GDP_{it}, TO_{it}, URB_{it}, IND_{it}). \quad (2)$$

Then, logarithm of formula (1)-(2) can be obtained as follows:

$$\begin{aligned} \ln GDP_{it} = & \beta_0 + \beta_1 \ln IQ_{it} + \beta_2 \ln FDI_{it} + \beta_3 \ln CO2_{it} + \beta_4 \ln TO_{it} + \beta_5 \ln URB_{it} \\ & + \beta_6 \ln IND_{it} + \epsilon_{it}, \end{aligned} \quad (3)$$

$$\begin{aligned} \ln CO2_{it} = & \beta_0 + \beta_1 \ln IQ_{it} + \beta_2 \ln FDI_{it} + \beta_3 \ln GDP_{it} + \beta_4 \ln TO_{it} + \beta_5 \ln URB_{it} \\ & + \beta_6 \ln IND_{it} + \epsilon_{it}, \end{aligned} \quad (4)$$

where I and T represent countries and periods, respectively; β_0 is the intercept term; β_1 - β_6 is the co-integration coefficient; ϵ is error term; and GDP, IQ, FDI, CO₂, TO, URB, and IND are economic growth, institutional quality, foreign direct investment, CO₂ emissions, trade openness, urbanization, and industrialization, respectively.

On this basis, the analysis method of panel data was adopted for this research. First, a test of unit root was used for all variables. If each variable had the same unit root, then the panel co-integration test was performed. The establishment of a co-integration relationship implied a long-run relationship between variables. The FMOLS method was used to overcome the potential interiority and sequence correlation among regression variables and accurately estimate the long-run co-integration relationship (Pedroni, 2000).

Further causality can be detected by the FMOLS panel co-integration data. However, the variables with a co-integration correlation must be able to undergo the vector error correction model (VECM) test, which considers not only the short-run causal connection between variables examined in a traditional causal relationship test, but also the long-run causal connection between them (Engle and Granger, 1987). More importantly, it can also reflect the correction mechanism of short-run deviation from long-run equilibrium. Therefore, VECM inspection is a stable and reliable model that can reflect both long- and short-run relationships.

To clarify the relationship between variables, this study conducted long- and short-run Granger causality tests based on VECM. The model is presented as follows:

$$\begin{aligned} \Delta \text{GDP}_{it} = & \beta_{10} + \sum_{k=1}^P \beta_{11} \Delta \text{GDP}_{it-k} + \sum_{k=1}^P \beta_{12} \Delta \text{IQ}_{it-k} + \sum_{k=1}^P \beta_{13} \Delta \text{FDI}_{it-k} \\ & + \sum_{k=1}^P \beta_{14} \Delta \text{CO2}_{it-k} + \sum_{k=1}^P \beta_{15} \Delta \text{TO}_{it-k} + \sum_{k=1}^P \beta_{16} \Delta \text{URB}_{it-k} \\ & + \sum_{k=1}^P \beta_{17} \Delta \text{IND}_{it-k} + \beta_{18} \text{ect}_{it-1} + \epsilon_{1it} \end{aligned} \quad (5)$$

$$\begin{aligned} \Delta \text{CO2}_{it} = & \beta_{20} + \sum_{k=1}^P \beta_{21} \Delta \text{CO2}_{it-k} + \sum_{k=1}^P \beta_{22} \Delta \text{IQ}_{it-k} + \sum_{k=1}^P \beta_{23} \Delta \text{FDI}_{it-k} \\ & + \sum_{k=1}^P \beta_{24} \Delta \text{GDP}_{it-k} + \sum_{k=1}^P \beta_{25} \Delta \text{TO}_{it-k} + \sum_{k=1}^P \beta_{26} \Delta \text{URB}_{it-k} \\ & + \sum_{k=1}^P \beta_{27} \Delta \text{IND}_{it-k} + \beta_{20} \text{ect}_{it-1} + \epsilon_{2it} \end{aligned} \quad (6)$$

$$\begin{aligned} \Delta \text{IQ}_{it} = & \beta_{30} + \sum_{k=1}^P \beta_{31} \Delta \text{IQ}_{it-k} + \sum_{k=1}^P \beta_{32} \Delta \text{FDI}_{it-k} + \sum_{k=1}^P \beta_{33} \Delta \text{GDP}_{it-k} \\ & + \sum_{k=1}^P \beta_{34} \Delta \text{CO2}_{it-k} + \sum_{k=1}^P \beta_{35} \Delta \text{TO}_{it-k} + \sum_{k=1}^P \beta_{36} \Delta \text{URB}_{it-k} + \sum_{k=1}^P \beta_{37} \Delta \text{IND}_{it-k} \\ & + \beta_{38} \text{ect}_{it-1} + \epsilon_{3it} \end{aligned} \quad (7)$$

$$\begin{aligned}
\Delta FDI_{it} = & \beta_{40} + \sum_{k=1}^P \beta_{41} \Delta FDI_{it-k} + \sum_{k=1}^P \beta_{42} \Delta IQ_{it-k} + \sum_{k=1}^P \beta_{43} \Delta GDP_{it-k} \\
& + \sum_{k=1}^P \beta_{44} \Delta CO2_{it-k} + \sum_{k=1}^P \beta_{45} \Delta TO_{it-k} + \sum_{k=1}^P \beta_{46} \Delta URB_{it-k} + \sum_{k=1}^P \beta_{47} \Delta IND_{it-k} \\
& + \beta_{48} \text{ect}_{it-1} + \epsilon_{4it}
\end{aligned} \tag{8}$$

$$\begin{aligned}
\Delta TO_{it} = & \beta_{50} + \sum_{k=1}^P \beta_{51} \Delta TO_{it-k} + \sum_{k=1}^P \beta_{52} \Delta IQ_{it-k} + \sum_{k=1}^P \beta_{53} \Delta FDI_{it-k} \\
& + \sum_{k=1}^P \beta_{54} \Delta GDP_{it-k} + \sum_{k=1}^P \beta_{55} \Delta CO2_{it-k} + \sum_{k=1}^P \beta_{56} \Delta URB_{it-k} \\
& + \sum_{k=1}^P \beta_{57} \Delta IND_{it-k} + \beta_{58} \text{ect}_{it-1} + \epsilon_{5it}
\end{aligned} \tag{9}$$

$$\begin{aligned}
\Delta URB_{it} = & \beta_{60} + \sum_{k=1}^P \beta_{61} \Delta URB_{it-k} + \sum_{k=1}^P \beta_{62} \Delta IQ_{it-k} + \sum_{k=1}^P \beta_{63} \Delta FDI_{it-k} \\
& + \sum_{k=1}^P \beta_{64} \Delta GDP_{it-k} + \sum_{k=1}^P \beta_{65} \Delta CO2_{it-k} + \sum_{k=1}^P \beta_{66} \Delta TO_{it-k} \\
& + \sum_{k=1}^P \beta_{67} \Delta IND_{it-k} + \beta_{68} \text{ect}_{it-1} + \epsilon_{6it}
\end{aligned} \tag{10}$$

$$\begin{aligned}
\Delta IND_{it} = & \beta_{70} + \sum_{k=1}^P \beta_{71} \Delta IND_{it-k} + \sum_{k=1}^P \beta_{72} \Delta IQ_{it-k} + \sum_{k=1}^P \beta_{73} \Delta FDI_{it-k} \\
& + \sum_{k=1}^P \beta_{74} \Delta GDP_{it-k} + \sum_{k=1}^P \beta_{75} \Delta CO2_{it-k} + \sum_{k=1}^P \beta_{76} \Delta TO_{it-k} \\
& + \sum_{k=1}^P \beta_{77} \Delta URB_{it-k} + \beta_{78} \text{ect}_{it-1} + \epsilon_{7it}
\end{aligned} \tag{11}$$

where Δ represents a first-order difference operator, P denotes the lag period, and ECT denotes residual term. A significant ECT coefficient indicates a long-run relationship between variables. ϵ represents random perturbation; GDP, CO₂, IQ, FDI, TO, URB, and IND represent economic growth, environmental quality, institutional quality, foreign direct investment, trade openness, urbanization, and industrialization, respectively.

Table 1. Summary of descriptive statistics.

Variable	Mean	Median	Max	Min	Std. Dev.
lnGDP	23.78332	23.55497	27.06627	21.11608	1.307983
lnCO ₂	2.077642	1.686399	6.092429	-0.916291	1.606278
lnIQ	4.018028	4.041295	4.343805	3.063391	0.161300
lnFDI	19.97517	20.01933	23.17238	13.96454	1.597219
lnTO	-0.451284	-0.462787	0.267668	-1.670966	0.343658
lnURB	3.766046	3.765470	4.488636	2.779006	0.374404
lnIND	3.293171	3.253945	4.349163	2.421639	0.367842

Source: calculations, authors with STATA.

3.3. Data source and variable selection

In this study, panel data from 1999 to 2017 for 24 African countries were used. The data for GDP per capita, CO₂ emissions, trade openness, FDI, urbanization, and industrialization were provided from the World Bank database. Institutional quality data were collected from the Heritage Economic Freedom Index. Carbon dioxide emissions as a proxy variable of environmental quality (measured in metric kilograms per capita) were used, and GDP per capita was represented economic growth, both as dependent variables. The independent variables were institutional quality and FDI. Institutional quality represents economic freedom based on 12 quantitative and qualitative factors, divided into four pillars, namely the efficiency of the regulatory, the size of government, the rule of law, and the open market. The control variables were trade openness, urbanization, and industrialization. Trade openness was measured as the proportion of imports and exports to GDP. Industrialization was represented as the added value of industrial output as a percentage of gross domestic product. Finally, urbanization was measured as a percentage of the total national population living in urban environments. Table 1 presents the summary of descriptive statistics.

4. Results and discussion

4.1. Panel unit root test

To avoid a false regression, the stability of the panel data should be verified before the regression analysis. In this study, the Levin-Lin-Chu (LLC) and the Im-Pesaran-Shin (IPS) test methods were adopted to determine the stability of the panel data. The null hypothesis of both test methods is that they contain unit roots. Thus, the LLC and IPS tests were conducted on GDP, CO₂ emissions, institutional quality, FDI, trade openness, urbanization, and industrialization of 24 African countries from 1995 to 2017.

The results of unit root test presented that GDP, CO₂, URB, IND were not stationary at level (Table 2). However, the variables became stationary after the first difference. Under the LLC and IPS tests, all variables were statistically significant in the first difference. Thus, the unit root does not exit.

4.2. Panel co-integration results

We used the Kao and Pedroni tests to conduct a co-integration test for panel data. The results are displayed (see Table 3). According to Pedroni (1999), if Panel ADF and Group ADF have the best test effect, and Pane V and Group Rho have the worst

Table 2. Results of unit root test.

Variable	LLC		IPS	
	Level	1 st difference	Level	1 st difference
lnGDP	-5.39765***	-5.57912***	0.23150	-6.92871***
lnCO2	-3.56448***	-7.87399***	2.68989	-8.46810***
lnIQ	-1.41644*	-5.75545***	-1.99042**	-7.98977***
lnFDI	-2.42939***	-7.23179***	-1.41832*	-8.89259***
lnTO	-1.61927*	-0.76876	-5.46983***	-6.86691***
lnURB	-9.80498***	-1.33279*	-0.80189	-4.26147***
lnIND	-0.86925	-6.64026***	-0.59440	-7.61711***

Note. ***, **, and * mean significance at the level of 1%, 5%, and 10%, respectively.
Source: calculations, authors with STATA.

Table 3. Pedroni co-integration test results.

Alternative hypothesis: common AR coefs. (within-dimension)	
Panel v-Statistic	-3.048458 (0.9988)
Panel rho-Statistic	6.351105 (1.0000)
Panel PP-Statistic	-3.179505*** (0.0007)
Panel ADF-Statistic	-3.764087*** (0.0001)
Group rho-Statistic	7.713340 (1.0000)
Group PP-Statistic	-6.663066*** (0.0000)
Group ADF-Statistic	-2.436482*** (0.0074)

Note. ***, **, and * mean significance at the level of 1%, 5%, and 10%, respectively.
Source: calculations, authors with STATA.

test effect, the data can pass the significance test. From Table 3, at the significance level of 1%, panel ADF and Group ADF reject the hypothesis of null, indicating panel co-integration relationship exists. In summary, the long-run co-integration relationship between each variable and economic growth as well as CO₂ emissions existed, so the analysis of panel data was performed.

4.3. Panel FMOLS regression results

The results of the co-integration test of panel data indicated a long-run stable connection among various influencing factors, economic growth, and environmental quality. Therefore, the magnitude and direction of action between variables should be quantitatively examined. For that, the OLS method is widely used by scholars, but it may lead to invalid conclusions. In this study, the methods reported in Phillips and Hansen (1990) and Pedroni (2000) were used with the FMOLS to estimate the equation coefficients and parameters. Panel co-integration FMOLS using the semi-parameter estimation method can effectively eliminate the estimation errors caused by the endogeneity of dependent variables and the autocorrelation of disturbance terms. It can also overcome the false regression problem. Therefore, panel FMOLS was used to co-integrate the economic growth model and environmental quality model (see Table 4).

Table 4. Panel FMOLS results for African countries.

Variable	Model 1 lnGDP	Model 2 lnCO ₂
lnGDP		0.187*** (3.796)
lnCO ₂	0.262*** (3.974)	
lnIQ	0.141 (0.930)	-1.172*** (-6.709)
lnFDI	0.109*** (11.923)	-0.004 (-0.354)
lnTO	-0.208*** (-3.761)	0.366*** (6.944)
lnURB	4.924*** (27.116)	1.073*** (3.330)
lnIND	0.303*** (2.752)	-0.335*** (-4.175)

Note. ***, **, and * mean significance at the level of 1%, 5%, and 10%, respectively.

Source: calculations, authors with STATA.

As the empirical results of the African sample as a whole, institutional quality does not affect on economic growth, but it significantly influences CO₂ emissions with a coefficient of -1.172 . Our results indicate that a 1% improvement in quality of institution led to a CO₂ reduction of 1.172%. Therefore, this study confirms the existing literature and demonstrates the importance of institutions in improving environmental quality (Ibrahim & Law, 2016; Mavragani et al., 2016). Meanwhile, FDI had a significant influence on economic growth, and its coefficient was 0.109, but no impact on CO₂ emissions was observed. This study showed that a 1% expansion in FDI could cause the economic growth to increase by 0.109%. This effect may be because FDI brings capital, technology, and other factors of production to African countries, which promotes local economic growth.

Moreover, CO₂ emissions are positively associated with economic growth, and the coefficient is 0.262. This implies that in terms of CO₂ emissions, a 1% increase in emissions would be associated with economic growth by 0.262%. Economic growth has contributed significantly to CO₂ emissions, with a coefficient of 0.187. Therefore, a 1% growth in the economy would result in an increase of 0.187 in CO₂ emissions. This may be because economic growth requires more inputs and inevitably increases the consumption of resources, making the intensity of CO₂ emissions increase as output increases.

Trade openness inhibited economic growth, and promoted CO₂ emissions. A 1% increase in trade openness led to an 0.208% reduction in economic growth as well as a 0.366% increase in CO₂ emissions. This may be because in the selected sample, a large number of the countries have imported more than exported, their exchange rates have fallen, and the influence of trade opening on economic development has worsened. However, in terms of the environment, trade opening has the effect of attracting developed countries to transfer pollution-intensive enterprises and turning Africa into a pollution paradise. Therefore, trade opening at this stage has deteriorated environmental quality.

In contrast, industrialization promoted economic growth and suppressed CO₂ emissions. A 1% increase in industrialization led to an economic growth increase of 0.303% and lowered CO₂ emissions by 0.335%. It can be seen that industrialization is an important means of economic development. Therefore, industrial restructuring can effectively reduce pollution emissions (Zhou et al., 2013). Although urbanization has promoted economic growth, it has also increased CO₂ emissions. In terms of urbanization, an increase of 1% causes an economic growth increase of 4.924% and

Table 5. Panel FMOLS results for oil-producing and non-oil-producing countries.

Variable	Oil producing countries		Non-oil producing countries	
	lnGDP	lnCO ₂	lnGDP	lnCO ₂
lnGDP		0.324*** (6.601)		0.037 (0.419)
lnCO ₂	0.376*** (3.155)		0.139*** (2.962)	
lnIQ	-0.076 (-0.333)	-0.587** (-2.880)	0.379* (1.925)	-1.810*** (-6.246)
lnFDI	0.113*** (9.662)	-0.005 (-0.658)	0.104*** (7.340)	-0.002 (-0.082)
lnTO	-0.221* (-2.476)	0.422*** (6.449)	-0.194*** (-3.102)	0.303*** (3.624)
lnURB	4.637*** (18.140)	0.106 (0.311)	5.238*** (20.324)	2.128*** (3.738)
lnIND	0.329* (1.735)	-0.723*** (-8.742)	0.274*** (2.727)	-0.0189 (-0.130)

Note. ***, **, and * mean significance at the level of 1%, 5%, and 10%, respectively.

Source: calculations, authors with STATA.

CO₂ emissions increase of 1.073%. This may be because more people living in cities can help improve labor productivity and economic development. In contrast, improving urbanization level will promote production and consumption growth and increase CO₂ emissions, which is not conducive to improving environmental quality.

To understand whether institutional quality and FDI show heterogeneity in economic growth and environmental quality, African countries were divided into oil-producing and non-oil-producing countries (see Table 5).

The results demonstrate that institutional quality present no significant influence on the economic growth in oil-producing countries, but it promotes the economic growth in non-oil-producing countries. Therefore, institutional quality increased by 1% could cause a 0.379% increase in the economy only in non-oil-producing countries. This result differs from the findings of Salman et al. (2019) for three East Asian countries, Shah et al. (2020) for eight developing countries, and Qiang and Jian (2020) for a provincial panel data of China. These studies report that improvement in institutional quality promotes economic growth. This discrepancy may reflect differences in national samples and research methods. In addition, the restraining influence of institution on emissions was greater in non-oil-producing countries than in oil-producing countries. For a 1% improvement in institutional quality, the CO₂ emissions of non-oil-producing countries decreased by 1.810% and that of oil-producing countries by 0.587%. This implies that strengthening the institutions, especially in the areas of government size, rule of law, regulatory efficiency, and open markets, can effectively reduce CO₂ emissions and promote the environmental improvement. This results cohere with Pushak et al. (2007) and Abid (2016)'s findings.

FDI promoted more economic growth in oil-producing countries than in non-oil-producing countries. Our result indicate a 1% improvement in FDI causes an economic growth improvement of 0.113% in oil-producing countries and 0.104% in non-oil-producing countries. This may result from the comparison between non-oil- and oil-producing countries, indicating that the latter have abundant oil resources, which can reduce the production cost of enterprises and stimulate the enthusiasm of enterprises for production. This is an important factor in attracting foreign investment and achieving economic growth. However, in a statistical sense, FDI had no significant impacts on CO₂ emissions both in oil-producing and non-oil-producing countries.

Control variables, such as economic growth, only boosted CO₂ emissions in oil-producing countries. Specifically, boosting economic growth by 1% would increase CO₂ emissions by 0.324% in oil-producing countries. In addition, CO₂ emissions

contributed more to economic growth in oil countries than that in non-oil countries. A 1% increase in CO₂ emissions was associated with economic growth of 0.376% in the oil-producing countries and 0.139% in non-oil-producing countries. This may be because oil-producing countries have more economic activity than non-oil-producing countries, and the higher the proportion of fossil fuel consumption, the higher the carbon emissions. Concurrently, as a main part of the energy consumption structure, oil is also the key source of CO₂ emission. Urbanization promoted economic growth in non-oil-producing countries to a higher extent compared to oil-producing countries. For a 1% increase in urbanization, economic growth increased by 4.637% and 5.238% in oil- and non-oil-producing countries, respectively. Thus, the advancement of urbanization can quickly activate the economy and stimulate economic growth. In addition, it contributed to CO₂ emissions only in non-oil-producing countries; a 1% expansion in urbanization led to a 2.128% increase in CO₂ emissions. This may be because these countries are basically in the initial stage of urbanization development, which has driven the construction and use of infrastructure, resulting in a sharp increase in energy consumption demand and increased intensity of CO₂ emission.

Trade openness inhibited economic development, significantly promoting CO₂ emissions in oil-producing countries compared to non-oil-producing countries. For oil-producing countries and non-oil-producing countries, an increase in trade openness of 1% would lead to a 0.221% and 0.194% reduction in economic growth, as well as 0.422% and 0.303% increases in CO₂ emissions, respectively. The key reason is that in oil- and non-oil-producing countries, the economic development level is relatively low. Consequently, they cannot resist the international competition from multinational corporations of developed countries; therefore, it is difficult to benefit from trade openness. Additionally, the weak absorption capacity also restrains the technology spillover effect. Furthermore, trade openness significantly promoted CO₂ emissions of oil- and non-oil-producing countries. This is consistent with previous research results (Khoshnevis Yazdi & Golestani Dariani, 2019).

In addition, industrialization promoted economic growth in oil-producing countries more than non-oil-producing countries, and it presented significant inhibitory effects on CO₂ emissions only in oil-producing countries. A 1% increase in industrialization led to an economic growth increase of 0.329% and 0.274% in oil-producing countries and non-oil-producing countries, respectively; and a CO₂ emissions decrease of 0.723% in oil-producing countries. This may be because oil-producing countries have abundant resource advantages in developing industrialization, which provides an impetus for economic growth. However, maintaining a sustainable environment is always a huge challenge for oil-producing countries with higher oil consumption, especially in the transport sector, leading to higher CO₂ emissions (Alkhatlan & Javid, 2015).

4.4. Panel granger causality

Although the estimated results of FMOLS can explain the degree and direction of interaction between variables, they do not reveal the causal relationship between them. Thus, the test of panel granger causality was performed to determine the causal

Table 6. Panel granger causality results.

Group	Dependent variable	Independent variable										Long run ECT	
		Short run											
		InGDP	InCO ₂	InIQ	InFDI	InTO	InURB	InIND					
All countries	InGDP	0.749 (0.945)	8.702* (0.069)	11.957** (0.017)	2.423 (0.658)	8.706* (0.069)	9.264* (0.054)	2.658 (0.616)	0.824*** (0.000)				
	InCO ₂	15.627*** (0.003)	7.178 (0.126)	3.450 (0.485)	11.836** (0.018)	3.014 (0.555)	0.406 (0.982)	0.921 (0.922)	-1.393*** (0.000)				
	InIQ	14.097*** (0.007)	6.721 (0.151)	1.304 (0.860)	1.986 (0.738)	5.717 (0.221)	5.353 (0.252)	5.493 (0.240)	-0.225 (0.000)				
	InTO	2.956 (0.565)	5.533 (0.236)	2.036 (0.729)		11.816** (0.018)	0.475 (0.975)	8.655* (0.070)	-1.249*** (0.000)				
	InURB	11.571** (0.020)	5.837 (0.211)	2.411 (0.660)	12.196** (0.015)	1.989 (0.737)	0.842 (0.932)	1.195 (0.878)	0.335*** (13.881)				
	InIND	5.157 (0.271)	7.078 (0.131)	6.706 (0.152)	1.597 (0.809)	5.755 (0.218)	4.588 (0.332)	1.616 (0.805)	-0.090** (0.010)				
	InGDP		6.581** (0.037)	0.438 (0.803)	4.804* (0.090)	1.593 (0.450)	6.853** (0.032)	0.264 (0.875)	-0.254*** (0.000)				
Oil producing countries	InCO ₂	0.278 (0.870)	0.915 (0.632)	0.321 (0.851)	23.334*** (0.000)	3.498 (0.173)	6.054** (0.030)	1.359 (0.506)	-1.339*** (0.000)				
	InIQ	3.944 (0.139)	5.110* (0.077)	0.297 (0.861)	0.285 (0.866)	4.174 (0.124)	0.689 (0.708)	0.784 (0.675)	0.138*** (0.000)				
	InFDI	1.500 (0.472)	2.456 (0.292)	2.916 (0.232)	1.706 (0.426)	2.373 (0.305)	0.945 (0.623)	5.658* (0.059)	-0.569** (0.040)				
	InTO	0.242 (0.885)	1.054 (0.590)	1.537 (0.463)	0.009 (0.995)	0.549 (0.759)	0.460 (0.794)	2.916 (0.232)	0.225*** (0.001)				
	InURB	7.226** (0.027)	0.554 (0.757)	6.609** (0.036)	2.454 (0.293)	0.333 (0.846)	0.502 (0.777)	3.115 (0.210)	-0.142** (0.031)				
	InIND	2.298 (0.316)	18.800*** (0.004)	11.427* (0.076)	8.405 (0.209)	13.874** (0.031)	21.438*** (0.001)	4.389 (0.624)	0.099 (0.201)				
	InGDP								0.860*** (0.000)				
Non-Oil producing countries	InCO ₂	7.294 (0.294)	8.857 (0.181)	12.702** (0.048)	10.592 (0.101)	6.071 (0.415)	2.838 (0.828)	3.948 (0.683)	-0.957*** (0.000)				
	InIQ	20.215*** (0.002)	10.509 (0.104)	4.317 (0.633)	13.892** (0.030)	4.196 (0.650)	14.646** (0.023)	9.874 (0.130)	-0.253*** (0.000)				
	InFDI	11.078* (0.086)	6.641 (0.355)	1.249 (0.974)	8.017 (0.236)	6.024 (0.420)	8.357 (0.213)	5.054 (0.536)	-1.731*** (0.000)				
	InTO	8.017 (0.236)	8.089 (0.231)	8.804 (0.184)	6.507 (0.368)	2.900 (0.821)	1.251 (0.976)	1.251 (0.976)	0.379*** (0.000)				
	InURB	4.243 (0.643)	23.058*** (0.000)	6.627 (0.356)	1.736 (0.784)	11.072 (0.082)	8.370 (0.212)	2.327 (0.887)	-0.114** (0.024)				
	InIND	9.395 (0.152)							-0.258*** (0.000)				
	InGDP												

Note. ***, **, and * mean significance at the level of 1%, 5%, and 10%, respectively, and *p*-values are in parenthesis.

Source: calculations, authors with STATA.

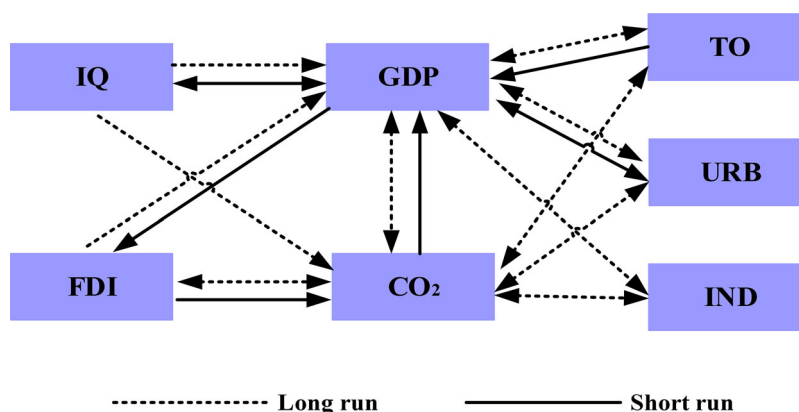


Figure 1. Causality relations for African countries.
Source: Self-formulated.

relationship among each variable. The results for the short- and long-run were shown (see Table 6). The samples were analyzed as a whole (all African countries), and as oil-producing and non-oil-producing African countries. The respective short- and long-run links between the variables are shown in Figures 1–3.

In the analysis of all African countries, in the short-run, the results present that there was two-way causation between the quality of institution and economic growth was observed, and there was one-way causation from trade openness to economic growth. In the long-run, the results presented that institutional quality had one-way causation with CO₂ emissions as well as economic growth. However, there was two-way causation between FDI and CO₂ emissions, similar to the causation among industrialization and economic growth, industrialization and CO₂ emissions, trade openness and economic growth, and trade openness and CO₂ emissions, and urbanization and CO₂ emissions. Moreover, both in the short- and long- run, two-way causation between urbanization and economic growth occurred.

For oil-producing African countries, in the short-run, the results demonstrate that there was one-way causation from FDI to economic growth. However, there was two-way causation between FDI and CO₂ emissions. One-way causation was observed from urbanization to CO₂ emissions. Meanwhile, there was two-way causation between economic growth and urbanization. In the long-run, the results demonstrate that there was two-way causation among: institutional quality and economic growth, FDI and economic growth, urbanization and economic growth, trade openness and economic growth, and causation among these variables and CO₂ emissions. There was one-way causation from industrialization to CO₂ emissions as well as economic growth.

For non-oil-producing African countries, in the short-run, the results demonstrate that there was two-way causation among institutional quality and economic growth, and one-way causation from institutional quality to CO₂ emissions. In addition, there was one-way causation from economic growth to FDI, from trade openness to economic growth. In the long-run, the results demonstrate that there was two-way causation among some variables (institutional quality, FDI, trade openness, urbanization) and economic growth. Also, the same is true of these variables in relation to CO₂ emissions.

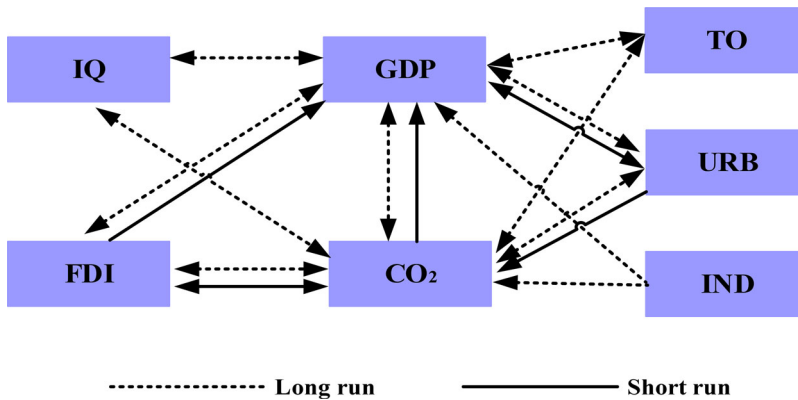


Figure 2. Causality relations for oil-producing African countries.

Source: Self-formulated.

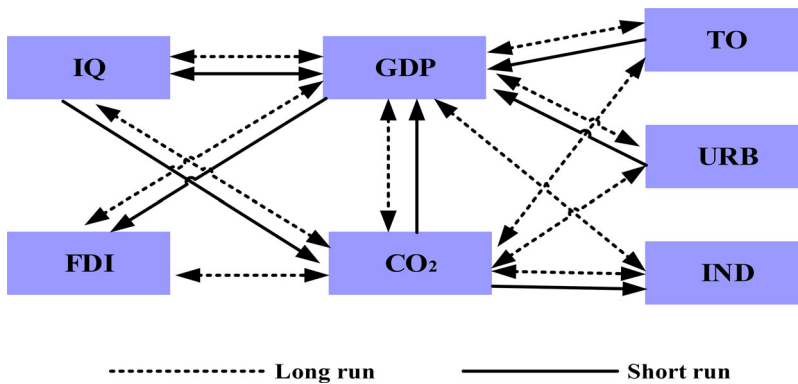


Figure 3. Causality relations for non-oil-producing African countries.

Source: Self-formulated.

In summary, for oil-producing African countries, there was only two-way causation among institutional quality and economic growth, institutional quality and CO₂ emissions in the long-run. Thus, improving institutional quality can boost economic growth and CO₂ emissions in the long-run. In turn, the acceleration of economic development and the large amount of CO₂ emissions caused by economic activities forces the further perfection of institutions. On the other hand, in non-oil-producing African countries, there was two-way causation between the quality of institution and economic growth in the short- and long-run, and one-way causation from institutional quality to CO₂ emissions in the long-run. This shows that in the short and long periods, improving institutional quality in non-oil-producing African countries can promote economic growth. In turn, the acceleration of economic growth drives the improvement of institutions, but the increase in CO₂ emissions can only force institutional improvements in the long run.

In oil-producing African countries, there was one-way causation from FDI to economic growth, two-way causation among FDI and CO₂ emissions in the short-run, and two-way causation among FDI and economic growth, and FDI and CO₂ emissions in the long-run. This implies that the expansion of FDI can stimulate local

economic growth, but it can also cause more CO₂ emissions to be released in the short- and long-run. In contrast, in the long-run, economic growth can attract more FDI, while the large increase of CO₂ emissions can be a factor attracting FDI in the short- and long-run. However, in non-oil-producing countries, there was two-way causation among FDI and economic growth, and FDI and CO₂ emissions in the long-run, and one-way causation from economic growth to FDI in the short-run. This implies that FDI in non-oil-producing African countries will only accelerate economic growth and lead to a significant increase in CO₂ emissions in the long-run. This finding supports the results of Al-Mulali and Tang (2013) for Gulf Cooperation Council countries; Omri et al. (2014) for Latin America, the Caribbean, African countries (such as the sub-Saharan Africa and North Africa), and the Middle East; and Bildirici and Gokmenoglu (2020) for nine countries. This similarity might be because countries with abundant energy resources attract foreign investment more easily than countries with energy endowment. FDI brings new technologies and skills to accelerate resource allocation and promote domestic economic growth (Bajo-Rubio et al., 2010). Meanwhile, FDI is not based on clean technologies, which cause an increase in pollution emissions (Hakimi & Hamdi, 2016).

5. Conclusions and policy implications

The effectiveness of institutional implementation and FDI attraction in balancing economic growth and environmental protection is a hotly debated topic among scholars. In this context, this study explored whether the institutional quality and FDI influenced economic growth as well as environmental quality in 24 African countries from 1996 to 2017 using FMOLS and VECM estimation techniques. The countries were divided into oil- and non-oil-producing countries for comparative analysis.

The FMOLS results demonstrated that (i) for Africa as a whole, institutional quality had no influence on economic growth, whereas it significantly curbed CO₂ emissions. Conversely, FDI showed a positive influence on economic growth, whereas it showed no influence on CO₂ emissions. Economic growth contributed significantly to CO₂ emissions. Trade openness inhibited economic growth and promoted CO₂ emissions. Industrialization promoted economic growth and suppressed CO₂ emissions. Urbanization promoted economic growth and increased CO₂ emissions. (ii) Comparing oil-producing and non-oil-producing countries, institutional quality had no significant influence on economic growth in oil-producing countries but promoted it in non-oil-producing countries. Institutional quality had a greater constraint on emissions in non-oil-producing countries than in oil-producing countries. FDI had more positive influences on economic growth in oil-producing than in non-oil-producing countries. However, it had no significant influences on CO₂ emissions in either group of the sample countries. Other variables such as economic growth have boosted CO₂ emissions only in oil-producing countries. As a result, CO₂ emissions contributed more to economic growth in oil-producing countries than in non-oil-producing countries. The positive effect of urbanization on economic growth was greater in non-oil-producing countries than in oil-producing countries. However, it only contributed to CO₂ emissions in non-oil-producing countries. In addition, trade

openness inhibited economic growth, significantly promoting CO₂ emissions in oil-producing countries than in non-oil-producing countries. In addition, industrialization had more positive effects on economic growth in oil-producing countries than in non-oil-producing countries. However, it only had significant inhibiting influences on the emissions of oil-producing countries.

The VECM granger causality test results showed that (i) for all studied countries, there was two-way causation among institutional quality and economic growth in the short-run, and institutional quality had one-way causation with economic growth and CO₂ emissions in the long-run. There was two-way causation in the long-run between: FDI and economic growth, FDI and CO₂ emissions, industrialization and economic growth, and industrialization and CO₂ emissions. One-way causation from trade openness to economic growth was observed in the short-run, but two-way causation among trade openness and economic growth, and trade openness and CO₂ emissions were observed only in the long-run. Two-way causation between urbanization and economic growth was shown in the short- and long-run, while two-way causation among urbanization and CO₂ emissions was only shown in the long-run. (ii) In oil-producing African countries, in the short-run, one-way causation from FDI to economic growth, from urbanization to CO₂ emissions, and two-way causation among FDI and CO₂ emissions, as well as urbanization and economic growth, were observed. In the long-run, institutional quality, FDI, trade openness, urbanization had two-way causation with economic growth as well as CO₂ emissions, respectively. At the same time, industrialization had one-way causation with economic growth as well as CO₂ emissions. (iii) In non-oil-producing African countries, two-way causation between institutional quality and economic growth, one-way causation from institutional quality to CO₂ emissions, and one-way causation from economic growth to FDI, from trade openness to economic growth, and from industrialization to economic growth were observed in the short-run. Institutional quality, FDI, trade openness, and urbanization have two-way causation with economic growth, and these variables also have two-way causation with CO₂ emissions in the long-run.

The results of this paper provide crucial policy implications. First, improving the institutions is essential to improve economic development and protecting the environment. Therefore, it is important to strengthen institutional construction, especially those that strengthen the rule of law, improve regulatory efficiency, expand the size of government, and open markets, reduce the negative impact of official corruption and other institutional problems, and effectively establish institutional construction to promote sustainable development. In the long-run, the oil-producing African countries should establish a strong system and exert its effectiveness to reduce pollution without affecting the stable development of their economy. Furthermore, the existence of strong institutions creates the need for better environmental standards and can improve the efficiency of environmental regulation. To this end, local governments should raise public awareness to establish strong institutions and low pollution emissions. Whether in the short or long term, the improvement of institutional quality can promote economic development, also improve environmental quality. The message to policymakers in non-oil-producing African countries is that regulating and improving the role and efficiency of domestic institutions can lead to green and sustainable growth in the future.

Second, oil-producing African countries should aim to increase capital and technology spillover through foreign capital to accelerate economic development, reduce pollution and improve energy efficiency by using clean technology FDI. Through improving foreign investment introduction policy, the supervision system and other relevant measures can be improved to achieve high-quality FDI inflow. Moreover, non-oil-producing African countries should improve investments aimed at environmental protection by implementing differentiation strategies. For example, by strengthening education, and improving its infrastructure construction, the ability to absorb FDI to attract foreign capital can be expanded (Wang et al., 2020). Besides, it can lead foreign capital enterprises toward green, environmental protection, and energy-saving investments.

Lastly, both oil- and non-oil-producing African countries should accelerate the allocation of population and resources, especially the flow of production factors such as physical capital and labor force. Green and new urbanization should be further promoted to realize coordinated urbanization development, economic growth, and environmental protection. In terms of trade openness, all countries should improve their industrial development and optimize their trade structure. In particular, emission-oriented imports should be controlled through reforms that do not restrict trade and aim at reducing CO₂ emissions (Khan et al., 2020). In terms of perfecting industrialization, oil-producing African countries with rich natural resources and non-oil-producing African countries with high energy demand during industrialization should continuously improve the level of low-carbon technology and the efficiency of energy use in order to promote the progress of green technology so that natural resources can be changed from the ‘curse’ of green development to the ‘Gospel’.

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