INVESTIGATING THE ROLE OF INSTITUTIONS IN THE FDI-ECOLOGICAL FOOTPRINT LINKAGE IN SUB-SAHARAN AFRICA: IS THERE A THRESHOLD FOR INSTITUTIONAL QUALITY?

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Abstract

This study employed the system generalised method of moment technique to examine the role of institutions in the Foreign Direct Investment – ecological footprint linkage for 40 Sub-Saharan African countries between 2004 and 2018. Some stylised facts about the level of exposure of Sub-Saharan African countries to environmental degradation and the rise in Foreign Direct Investment inflow into this part of the continent were provided. Empirical results showed that institutions in this area are weak and contribute to environmental degradation. Even though we found Foreign Direct Investment to improve the environmental quality, institutions create a negative link between Foreign Direct Investment and ecological footprint. This resulted in Foreign Direct Investment exerting an adverse effect on the environment. Likewise, findings showed that while economic growth contributes to the reduction of ecological footprint at low levels of growth, it increases ecological footprint at higher levels of growth. The study re-asserts the vital role of institutions in achieving a sustainable environment and suggests policy recommendations for strengthening institutions.

Keywords: Institutional Quality, Foreign Direct Investment, Ecological Footprint, Sub-Saharan Africa.

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Introduction

For the survival of businesses and economies across the globe, capital is needed. Foreign Direct Investment (FDI) is crucial in capital formation due to its direct and spill-over effects on the economy. FDI is essential to the growth and development of an economy, especially in situations in which the country's domestic savings are insufficient to meet the needs of the local investment market (Sokhanvar, 2019; Ahmad et al., 2020). FDI traditionally involves knowledge, management practices, and technology transfer from the home country to the host country (Nadia, 2020). The spill-over effects of FDI are felt through the diffusion of the transferred technologies and knowledge which are used in other sectors of the host economy. African countries have benefited immensely from foreign direct investment (FDI), owing to the capital-deficient nature of the region's economy. FDI flows have aided the continent's economic recovery and enabled African nations to stay on track to meet sustainable development goals (SDGs) (Adegboye et al, 2020). FDI flow to Africa attained a record high of 83 billion US$ in 2021, more than twice the figure observed in 2020, with Sub-Saharan African countries (SSA) accounting for over 88 per cent ($74 billion) of the inflow (UNCTAD, 2022). Over the last four decades, the inflow of FDI to SSA averaged US$12.5 billion from

1980 to 1989, US$40.2 billion from 1990 to 1999, US$20 billion from 2000 to 2009 and US$37.2 billion from 2010-2019 (World Bank, 2020; Duodu et al., 2021).

As FDI inflow to SSA economies continues to grow, there have been recent concerns about the impact these inflows have on the environment of the host communities. According to Adegboye et al. (2020b), most economies in sub-Saharan Africa (SSA) depend heavily on manufacturing, agricultural activities, and oil extraction as the main drivers of foreign direct investment from multinational corporations (MNCs). The excessive exploitation of these primary products contributes to pollution and environmental degradation and this exacerbates ecological footprint. A significant share of FDI flows to less developed nations (including SSA nations) to finance heavily polluting and environmentally less efficient production processes and infrastructure, many of which are contracted from developed nations (Jorgenson et al., 2007). Similarly, Copeland and Taylor (1994) noted that as the world becomes more globalised and trade becomes more liberalised, businesses with production processes that generate high levels of pollution tend to shift their production from rich countries where there are strict environmental regulations to poor countries with laxity in environmental regulations. The urge to increase foreign capital inflow to address the domestic capital shortages faced by the SSA countries has weakened regulatory actions on capital inflows and exposed the SSA economies to the predator FDIs.

Sub-Saharan Africa recorded over 500 per cent increase in Carbon (CO_2) emissions between 1960 and 2018, from 126,346 kiloton (kt) in 1960, to 506,944 kt in 1980, and over 823,427 kt in 2018 (Dingru et al., 2023; WDI, 2021). The inability of countries in Africa to fully embrace clean and renewable energy and heavy reliance on fossil fuels to meet the increasing energy demands, coupled with the excessive exploration of natural resources by multinational corporations have all contributed to the rising emission levels in the region. The increasing level of CO_2 is associated with many consequences ranging from warming and rising of ocean levels to drought, increased risk of cancer, mental health disorders and other health challenges. Osuagwu and Olaifa (2018) noted that oil and gas exploration in oil-rich African countries often leads to oil spillage which threatens the general terrestrial ecosystem including tourism and agriculture. Nigeria is a typical example of an oil-rich SSA country which has attracted FDI inflow into its oil and gas sector. According to Ayanlade and Proske, (2015) and Arogundade et al., (2022), foreign investment inflow into Nigeria's oil and gas sector has led to devastating environmental degradation in the Niger Delta community (a community that is blessed with abundant oil resources) in Nigeria resulting from extensive land reclamation, dredging of large rivers, flaring of gas and oil spillage with an estimated annual damage of US$750 million to the environment.

Not much has been documented about the role played by institutions in facilitating FDI flows in SSA and the resulting impact on both the economy and the environment. The quest to attract more FDI to the region often involves the government embarking on numerous reforms and extensive policy changes aimed at appeasing foreign investors without regard to the associated externalities of such policies on the environment. According to Godfrey (2016), institutions in highly indebted less-developed countries are weakened by global governance institutions, which encourage these countries to adopt measures aimed at creating a favourable environment for multinational corporations and foreign investors. These measures (which include relaxation of labour laws, reduction of taxes, and creation of exemptions to environmental laws aimed at protecting the environment from indiscriminate extractive activities) ultimately result in pollution of the environment (Grimes and Kentor, 2003).

From the literature, it is observed that the political institutions in SSA are weak and suffer from bureaucracy, corruption, political instability, and legal complications, which have affected the FDI flow to the region. However, studies on this subject (Li and Resnick, 2003; Chan and Mason, 1992) largely focused on the institution's role in attracting FDI without recourse to the role of institutions in managing FDI externalities upon the environment. With this in mind, this study contributes to knowledge in the following ways: First, what is mostly seen in the extant literature on the FDI-environmental degradation nexus in SSA is that CO_2 emission is used to capture environmental degradation because it made up a larger percentage of greenhouse gas and the easy accessibility of its data. However, when it comes to the stock of resources like mining, oil, forests and soil, CO_2 emissions may be a weak signal and therefore is not a comprehensive assessment of environmental degradation. Therefore, an aggregate indicator of environmental degradation is required if we are to make progress toward sustainable development (Muhammad et al, 2019; Solarin and Bello, 2018). On this account, a suitable measure that adequately depicts environmental degradation is the Ecological footprint (EF). It symbolises a complete measure of the adverse effect of the actions of human beings on the quality of the environment (Muhammad, 2023). Since it accounts for CO_2 as well as mining, tree felling and all the various uses of land, researchers believe that EF is the ideal proxy when taking account of CO_2 emissions. As a result, the EF can provide more accurate and useful results when used as a stand-in for pollution levels in the environment (Alola et al, 2019; Sharif et al, 2021). Hence, this study makes use of EF as a proxy for environmental degradation for SSA. Second, this study extends its analysis by capturing the variation in the mediating role institutions play in the FDI-EF nexus in each of the Sub-regions of SSA (that is West, East, Southern and Central Africa). According to the International Monetary Fund (IMF), SSA sub-regions have structural differences and this has implications for the pursuit of policy objectives. As such, we can better understand the driving forces of Environmental degradation for the entire sample by splitting the sample into analytical subgroups. Furthermore, performing distinct estimations for each sub-region is important to ensure the robustness of findings (Zoaka and Güngör, 2023). Lastly, this study established a threshold for institutions above which institutions will exert some influence on FDI to improve the quality of the environment. This threshold is important for policy objectives in the SSA region.

Stylise facts

According to the World Bank, SSA are largely vulnerable to environmental degradation and climate change as they negatively affect life and health quality there. High levels of environmental degradation have implications for socio-economic life and health quality of the region. Figures 1 and 2 show the average trend of Ecological footprint in SSA and the Ecological footprint by sub-region.

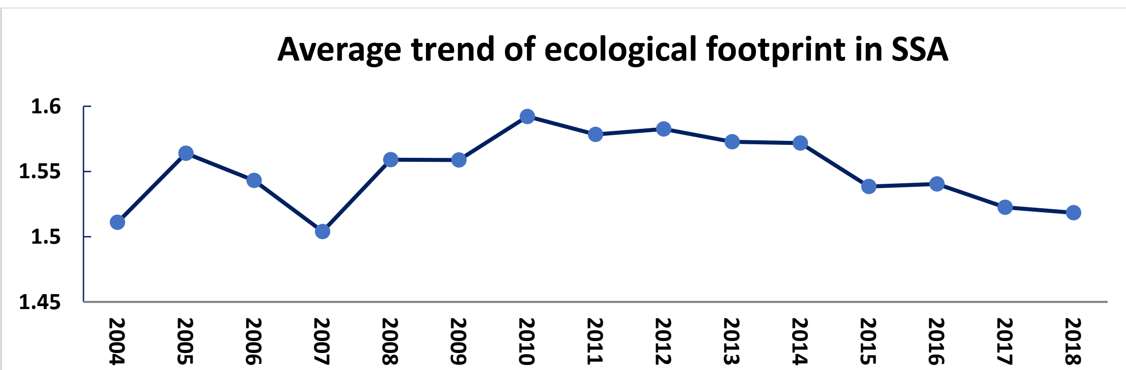

Figure 1: The trend of Ecological Footprint (source: own chart)

As shown in Figure 1, the overall trend in ecological footprint has been fluctuating mildly over time for the SSA region. On average, this variation has been between approximately 1.5 and 1.6 global hectares per person for the region and this has vital implications for the region's pursuit of environmental sustainability.

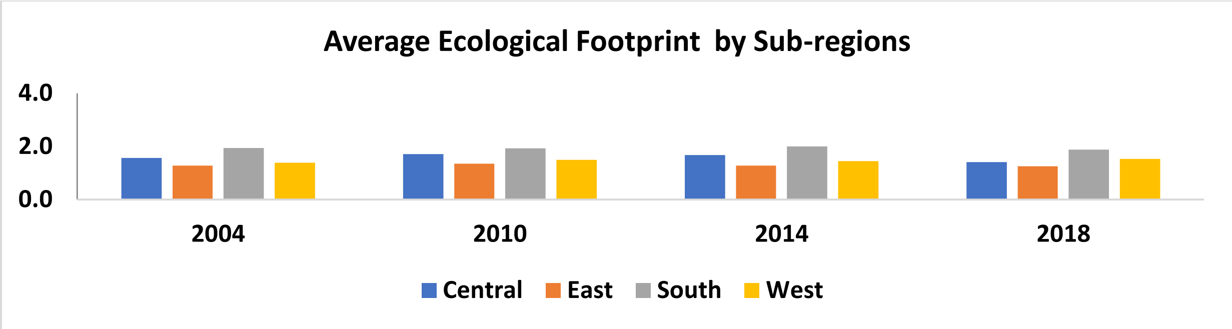

Figure 2: Ecological Footprint by Sub-Regions (source: own chart)

It is observable from the various sub-regions that Southern Africa has the highest ecological footprint followed by Central, West and East Africa respectively. For the observed period, the ecological footprint in Southern Africa has been approximately 2.0 global hectares per person while Central, West, and East African regions have approximately 1.5, 1.3 and 1.2 global hectares per person respectively. This number may seem small but the decline in the region's biocapacity is degrading the SSA environment. A lower human footprint than the Earth's biocapacity is a prerequisite for long-term environmental sustainability. After all, exploiting the environment too much is only conceivable in the short term. There is a general ecological deficit in Africa, as the continent's production footprints exceed its biocapacity. This means that more carbon dioxide and other pollution mechanisms are being released into the atmosphere than the continent's natural resources can absorb, and this gives rise to an ecological deficit as the region's biocapacity has been on the decline since 1960 (Yang et al, 2022).

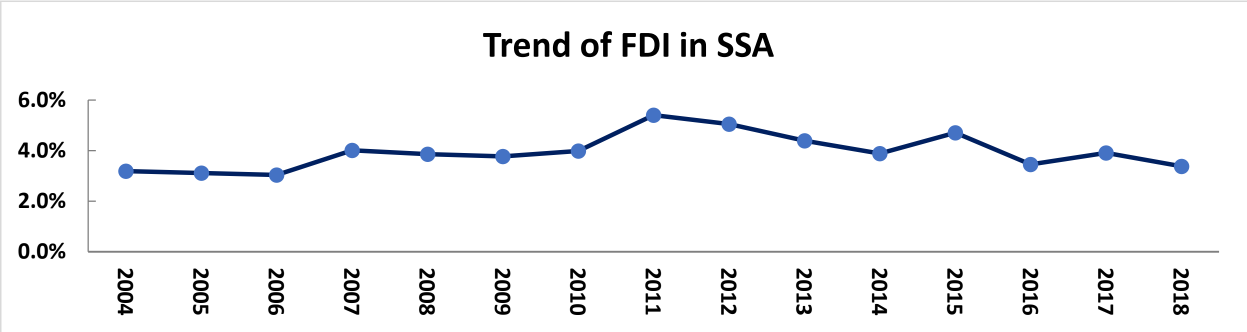

Figure 3: Overall trend of FDI in SSA (source: own chart)

FDI as a percentage of Gross Domestic Product (GDP) has over time hovered between 3 per cent and 6 per cent in SSA. In monetary terms, in 2021, foreign direct investment (FDI) into Africa was at its highest of 83 billion US dollars, a little over twice the figure documented in 2020, with Sub-Saharan African (SSA) countries receiving more than 88 per cent ($74 billion) of the total. Foreign direct investment (FDI) into SSA has fluctuated between $12.5 and $40 billion over the past four decades ((UNCTAD, 2022; World Bank, 2020).

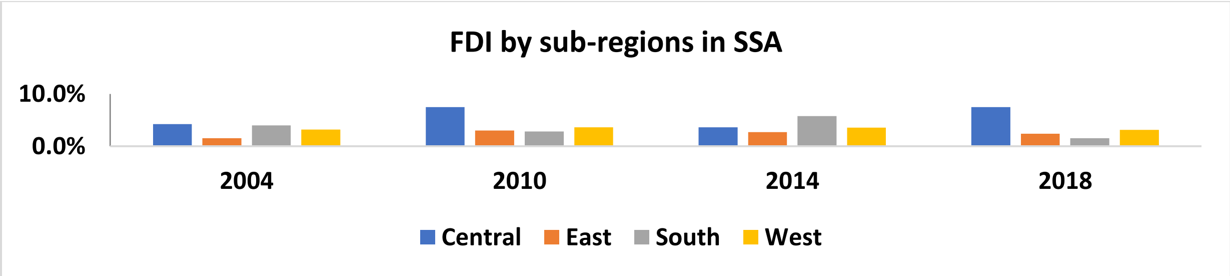

Figure 4: The trend of FDI by Sub-Regions in SSA (source: own chart)

Across the region of SSA, Central Africa has the highest foreign direct investment as a percentage of their GDP hovering around 3 per cent and 7 per cent for the period under study. This is followed by Southern Africa which has FDI as a percentage of GDP between 1.5 per cent and 6 per cent. Also, West Africa has FDI as a percentage of GDP to be approximately 3 per cent and for East Africa, FDI as a percentage of their GDP is between 1.5 per cent and 3 per cent in approximation.

Investigating the institutional role in the FDI-Ecological nexus is a worthy research endeavour. Institutions are generally weak in SSA with West Africa having the weakest in the region (Olaniyi and Oladeji (2021). Institutions used included: the rule of law, political stability, quality of regulation, voice and accountability, effectiveness of government and corruption control which are computed on a scale of -2.5 (indicating weak institutions) to 2.5 (indicating strong institutions).

Literature Review

Researchers (Klasra, 2009; Tsai, 1994; Mottaleb, 2007; Gunawardhana and Damayanthi, 2020; Tang and Tan, 2015) studied FDI closely because of its perceived importance to economic growth. However, little work has been done on establishing a threshold for and examining the role of institutional quality in determining the effect of FDI on ecological footprint particularly in SSA, as most of the previous studies focused on the effect of FDI on the growth of the economy and/or the environment, without recourse to the role of institutions.

Foreign direct investment (FDI) and Ecological footprint (EF)

Doytch (2020) examined the role of FDI in the exhaustion of bioproduction in physical land using a dynamic panel methodology which incorporates the Environmental Kuznets curve (EKC). The study disaggregated countries into developed and emerging nations and tested the differences in the ecological performance of FDI along the following footprints: Production EF, Consumption EF, Export EF and Import EF. Findings from the study showed that while foreign direct investments affect the ecological footprint of high-income countries negatively through consumption EF, low-income and middle-income nations experienced it through production EF. The study also shows that while middle-income countries suffer from Export EF, FDI in financial services reduced the production EF in high-income countries. Also, non-financial and extractive FDI were ecologically damaging. It was suggested that policies encouraging consumption in an ecologically responsible manner should be adopted in rich countries, while other countries should adopt policies which will promote environmentally clean technologies and production practices.

Arogundade, Mduduzi, and Hassan (2022) investigated the effect of FDI on the ecological footprint of 31 African countries, for the period between 1990 and 2017, employing the robust standard-error technique and the spatial Durbin model. The study's findings showed that FDI significantly reduces ecological footprint when it is within $404.75 – $669.96 million. Once it crosses this threshold, it increases ecological degradation. The study also showed that the environmental quality of a country in the African region affects the environmental quality of its neighbours. The paper recommends that policies aimed at attaining efficient environmental management should be adopted. Also, the surrounding countries' features should be put into consideration by African countries when formulating their environmental policies. In a similar study, Tang and Tan (2015) investigated the impact of foreign direct investment, consumption, and income on CO_2 in Vietnam from 1976 to 2009, using a Vector error correction model (VECM) and the Multivariate Johansen cointegration technique. Their findings indicated that while FDI does not influence CO_2 emission in the short run, an increase in FDI influx into Vietnam reduces environmental pollution and carbon emission over the long run. The result further shows a bi-directional causality between CO_2 emissions and FDI. The study suggested that clean technologies should be adopted by foreign investors.

Also, Chisti (2023) adopted the Wavelet Transform Coherence (WTC) technique to study the connections between Pakistan's ecological footprint (EF), the influx of foreign remittances, and foreign direct investment (FDI) between 1976 and 2020. The study concluded that Ecological footprint is sensitive to FDI, as environmental degradation worsens with an increase in FDI. Udemba and Yalcintas (2021) studied the impact of FDI and natural resources on Algeria's environmental performance from 1970 – 2018. The methodology used was nonlinear ARDL and long-run asymmetric cointegration. They concluded that negative and positive shocks to natural resources and FDI reduce carbon emissions.

Demena and Afesorgbor (2020) evaluated the effect of foreign direct investment on the pollution of the environment by employing a Meta-Analysis involving 65 studies. Findings from the research showed that foreign direct investment decreases environmental pollution and emissions. The study also shows that FDI tends to reduce emissions more in developed countries than in developing countries and suggests that developing countries adopt stricter environmental policies. Using panel data from 99 countries from 1975 to 2012, Shahbaz et al. (2015) used the fully modified ordinary least square (FMOLS) estimation technique to evaluate the relationship between FDI and environmental degradation. Results showed a bi-directional causality between FDI and CO_2 emissions. It further showed that while FDI lowers CO_2 emissions in countries with high incomes, it worsens the pollution level in low-income countries. Ojewumi and Akinlo (2017) explored the growth of the economy, the quality of the environment, and FDI relationship, in 33 countries across SSA. The time covered was from 1980 to 2013. Panel Vector Autoregressive (PVAR) and Panel Vector Error Correction (PVEC) estimation methods were employed. The result of the estimation showed that while FDI improves economic growth (real GDP) and promotes environmental quality, improvement in environmental quality does not increase FDI flow. The study advocates that governments of the SSA countries strike a balance between policies protecting the environment and those promoting investments.

Foreign direct investment, ecological footprint and institutional quality

Yang et al. (2023) analysed the effect of FDI and the quality of institutions on environmental quality and growth of the economy for 8 emerging Asian economies (divided into economies producing oil and those that are not) between 1975 and 2020. The AMS estimation methodology was used. The study showed that while FDI added to CO_2 emissions, its impact was, however, higher in economies producing oil. Similarly, all 8 nations saw a considerable decrease in carbon emissions due to the quality of institutions. The study further suggested that a two-way causality runs between FDI and CO_2, and between CO_2 and institutional quality. It was recommended that institutions should be strengthened, particularly those promoting regulatory efficiency and the rule of law. Dada et al. (2022) employed a fully modified ordinary least square (FMOLS), together with Autoregressive Distributed Lag (ARDL) techniques to examine how the quality of institutions determined the environmental quality and financial development link for Malaysia from 1984 to 2017. They discovered that while FDI, financial development and institutional quality improve environmental quality in the short run, they worsen it over the long run. Furthermore, the interaction between financial development and the quality of institutions improves the quality of the environment in the long run. It was suggested that institutions responsible for enforcing environmental laws be strengthened to prosecute violators.

Ahmad et al. (2022) studied the contribution of the quality of institutions in the financial development and quality of the environment nexus for 18 emerging economies within a timeframe of 1984 - 2017. The study adopted a cross-sectional autoregressive distributed lag (CS-ARDL) methodology and discovered financial development deteriorates the quality of the environment in the short run and long run. On the contrary, institutional quality improves the quality of the environment. A uni-directional casualty was established, from financial development and institution to ecological footprint. To determine the impact of FDI, employment and quality of institutions on the quality of the environment, Xaisongkham and Liu (2022) adopted a two-step SYS-Generalised Methods of Moments (GMM) estimation method. The study utilised panel data for 115 developing countries for periods between 2002 and 2016 and found out that the quality of institutions (i.e., government effectiveness (GE) and rule of law (RL)) improves environmental quality and reduces carbon dioxide emissions. It was discovered that a rise in FDI increases CO_2 emissions. The study recommended that institutional quality should be strengthened by improving RL and GE, strict enforcement of environmental laws and restricting protection mechanisms. Zakaria and Bibi (2019) adopted the Generalised least squares (GLS) method and analysed how institutional quality determined the impact of financial development on environmental performance for South Asian nations between 1984 and 2015. The study findings showed that environmental quality is diminished by financial development. Institutions enhance the quality of the environment, and FDI reduces carbon emissions.

Institutional quality and ecological footprint

Karim et al. (2022) studied the effect of institutional quality on CO_2 emission for 30 countries in Sub-Saharan Africa from 2000 to 2021. They adopted the cross-sectional Auto-Distributed Lag technique and discovered carbon emissions are greatly reduced by institutional qualities like regulatory control, corruption control and the rule of law. Adopting a systematic generalised method of moments (SGMM), Azam et al. (2021) assessed the effect of institutional quality on the consumption of energy and environmental quality for sixty-six emerging nations between the periods of 1991-2017. The result indicated that institutional quality expands the consumption of energy. It likewise contributes to the deterioration of the environment. They recommended that the institutional framework of the legal and political systems be strengthened. Hassan et al. (2020) assessed the part played by institutions on CO_2 emissions in Pakistan for periods between 1984 and 2016. With the help of an Autoregressive Distributed Lag (ARDL) model, they discovered that Institutional quality promotes CO_2 emissions in Pakistan. Their findings indicated a one-way causality extending from Institutional quality to CO_2 emissions in the short run, which turns bi-directional in the long run.

Using the dynamic ordinary least squares (DOLS) and Driscoll and Kraay regression (DK) estimation techniques, Danish and Ulucak (2020) examined the interrelations between institutional quality, consumption of energy, CO_2 emissions and economic performance during the period of 1992 – 2025, for eighteen Asian nations. Findings from the study showed that the quality of institutions enhances the quality of the environment and reduces CO_2 emissions, and causality only runs in one direction from institutional quality to carbon emissions. Also, renewable energy cuts down carbon emissions while non-renewable damages the environment. The study advocated for a stronger institutional arrangement among the APEC countries. Findings from previous studies have failed to reach a compromise on the exact function of Institutions in determining the FDI - ecological footprint (environment) relationship, with results ranging from a negative, zero and positive correlation between the variables. As noted by Abid (2016), the conclusion from past studies varied across individual countries and based on the indicators used to measure environmental impact (which include carbon monoxide (CO), national risk indicators (for threats to biodiversity), heavy metal, faecal waste, nitrogen oxide (NOx), dissolved oxygen, CO_2 (for atmospheric changes), sulfur dioxide (SO2), biodiversity and annual deforestation, smoke (for air quality), suspended particulate materials (SPM), and other metrics).

Therefore, this study aims to tackle the challenge of scanty research and conflicting findings in previous studies.

Data and methodology

Theoretical framework

Environmental Kuznets Curve (EKC) has been the major framework on which studies revolving around environmental sustainability and quality were grounded. However, recent literature on environmental quality deviated from most of the previous studies through the inclusion of other important variables such as Institutions, FDI, Openness to Trade, and variables relating to the structure of the economy. The inclusion of these variables has been justified in the literature to overcome the bias that arises from the omission of variables (Swain et al., 2020; Dada et al, 2021). Weak environmental regulations in emerging economies are attributable to the low quality of political institutions. This is due to bias in the selection and implementation of laws on the environment and as such, it adversely affects the environment (Ahmed et al, 2020). Furthermore, it has been suggested that FDI benefits developing nations since it brings capital, advanced technology, and additional methods of production (Danakol et al., 2014). On the other hand, foreign direct investment (FDI) could worsen environmental degradation in developing countries (Jorgenson et al, 2007). This argument against developing countries follows the claim advanced by the Pollution Haven Hypothesis, which posits that because of rigid environmental regulations in developed countries, multinational corporations seek out economies that have lax environmental regulations to maximise profits, and as a result lead to higher pollution in developing nations. Accordingly, the Pollution Haven Hypothesis contends that FDI from overseas corporations adversely affects environmental standards (Duodu et al, 2021).

This study thereby built on the EKC and Pollution Haven hypothesis to investigate the nexus between FDI and Ecological Footprint in SSA while specifically capturing the mediating role played by institutions in the region and its sub-regions.

Model specification

The panel data methodology of the system generalised method of moment (SGMM) is used for this study. This technique is appropriate for this research for the following reasons: First, the inclusion of the lagged dependent variable as part of the explanatory variable makes the model dynamic and as such renders the traditional techniques of the static panel such as pooled OLS, fixed effect, and Random effect inappropriate due to their inconsistency and biases (Duodu et al, 2021; Dada et al, 2021). Also, SGMM is the best estimator to use when a good fit is uncertain because of the persistent feature of the dependent variables (Ibrahim et al, 2022). Second, the system GMM is also an appropriate technique when N (how many countries) exceeds T (years) which is the situation in this study as N(40) > T(15) (Arellano and Bover, 1995). Third, a common trend in environmental literature is the bottleneck of endogeneity, thus making the system GMM more appropriate to address this issue. Fourth, SGMM checks for serial correlation and heteroscedasticity by exploiting the weighting matrix. It transforms instruments to avoid them being correlated (Blundell & Bond,1998).

In addition, the Sargan test of over-identifying constraints was carried out to verify the instruments' combined validity by measuring the SGMM's reliability and consistency (Roodman, 2009). The probability values for the Sargan test are expected to be higher than 10 per cent, indicating that the test is not expected to be statistically significant (Ibrahim et al, 2022). Meanwhile, the AR (2) test looks for evidence of autocorrelation at the second level. Then, we know that the moment conditions are accurately given if our null hypothesis is not rejected (Keane and Runkle, 1992). We expect the AR (2) test to be insignificant.

Following the theoretical proposition of EKC and its extension to capture Structural, Economic, and institutional variables as suggested by recent literature, the model is specified:

$$EF_{it} = f\left(FDI_{i,t}\,, X_{i,t}\right) \tag{1}$$

Equation 1 illustrates the relation between foreign direct investment (FDI) and ecological footprint (EF). In its specific form, we have;

$$EF_{i,t} = \theta + \lambda EF_{i,t-1} + \Upsilon FDI_{i,t} + \Phi INST_{i,t} + \Psi(FDI * INST)_{i,t} + \delta X_{i,t} + \mathrm{p}_i + \upsilon_t + \mathcal{E}_{i,t} \tag{2}$$

In equation 2, the dependent variable is ecological footprint (EF) and it captures the degradation of the environment. Foreign direct investment (FDI) is the main independent variable while INST stands for institutions. FDI interacted with institutions $(FDI * INST)$ to detect the moderating role of institutions. $X_{i,t}$

stands for control variables in the model which include economic growth and openness to trade. Their inclusion is justified in line with the literature (Duodu et al, 2021). η_i, $\upsilon_{t,}$ and $\mathcal{E}_{it}$ represent the country-fixed effect, time-fixed effect and the random error term respectively. λ, Υ, Φ, Ψ and δ are the estimated parameters.

Furthermore, from equation 2, we can obtain the direct and marginal effect of institutions in the association between FDI and EF. This allows us to see the direct impact INST has on the ecological footprint as well as clearly understand the moderating role institutions play in the FDI-EF nexus. Generating the marginal effect has been argued to be important especially because of the inclusion of the interactive term in the model (Brambor et al, 2006). By differentiation, we obtained the direct effect of INST as Φ. To obtain the marginal effect of INS in the FDI-EF nexus, the study follows the previous literature of Duodu et al., (2021), Huynh, (2020), and Chen et al., (2018). This marginal effect is computed by partially differentiating the dependent variable (EF) from the independent variable (FDI) in Equation 2.

Therefore, from equation 2, we have the marginal effect as.

$$\frac{\partial EF_{i,t}}{\partial FDI_{i,t}} = \Upsilon + \Psi INST_{i,t} \quad (3)$$

From equation 3, it can be inferred that Υ and Ψ are the two vital parameters in determining the mediating role INST is playing in the FDI-EF nexus. The economic implication of the equation is that FDI and INST are increasing EF through weak institutions whenever both Υ and Ψ are greater than 0. It can also mean that Strong institutions are mitigating the Positive effect of FDI on EF provided Ψ is less than 0 whenever Υ greater than 0. This can also be interpreted as FDI improving environmental quality but weak institutions mitigating FDI's impact if Ψ is greater than 0 when Υ is less than 0. Another interpretation of equation 2 is INST reinforcing FDI to improve environmental quality when both Υ and Ψ are less than 0.

Now, a threshold is established for institutions such that above that level, institutions will impact FDI to later translate to either a positive or negative impact on ecological footprint. To obtain this threshold, equation 3 is set equal to 0 to ensure that Υ and Ψ alternate their signs as we have below:

$$INST > \frac{-\Upsilon}{\Psi} \quad (4)$$

The threshold established in equation 4 is in tandem with the extant literature of Ivanova (2010) and Duodu et al., (2021).

Measurement and description of data

Table 1 describes the variables used and the source of data. This study used 40 Sub-Saharan African (SSA) nations from 2004 – 2018. The nations were selected based on data availability. The countries used are presented in Appendix 1.

Table 1: Variables and Sources of Data

Variable	Symbol	Unit	Source
Ecological Footprint	EF	Per capita global hectares	Global Footprint Network,2023
Foreign direct investment	FDI	% of GDP	World Development Indicator,2020
Institutions	INST	Scale of -2.5 to2.5	World Governance Indicator,2020
Economic growth	GDP	Per capita (constant 2015 US$)	World Development Indicator,2020
Trade Openness	TR	% of GDP	World Development Indicator,2020

Source: Authors' Computation, (2024)

Results

Table 2 reveals the summary statistics of the variables in the study. As observed, ecological footprints have an average value of 1.55 global hectares per capita, a minimum value of 0.642 and a maximum value of

4.539. Meanwhile, FDI inflow has an average of 3.9324, a minimum value of -10.72, and a maximum value of 39.811. The considerable difference between the minimum and the maximum value of FDI denotes a substantial level of heterogeneity across the African countries under observation. This is also true for trade openness and GDP, where the minimum and maximum values are significantly different. The trade openness variable had a minimum value of 20.723 and a maximum value of 163.619, while GDP had a minimum value of $274.13 and a maximum value of $14,222.55.

Table 2: Summary of Decriptive Statistics of the Variables

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
Ecological Footprints	599	1.5518	0.7320	0.642	4.539
FDI	599	3.9324	5.2857	-10.725	39.811
Trade Openness	588	69.2703	28.7174	20.723	163.619
GDP	599	2010.603	2428.555	274.132	14222.55
Voice and Accountability	599	-0.6056	0.7357	-2.197	0.974
Political Stability	599	-0.5930	0.9762	-3.313	1.201
Government Effectiveness	599	-0.8207	0.6337	-2.445	1.161
Regulatory Quality	599	-0.7345	0.6174	-2.548	1.197
Rule of Law	599	-0.7479	0.6696	-2.591	1.024
Control of Corruption	599	-0.7029	0.6394	-1.849	1.182

Source: Authors computation, 2024

In Table 3, the correlation matrix is presented. It is revealed that while FDI, voice/accountability, political stability, government effectiveness, regulatory quality and rule of law have a negative correlation with the ecological footprint, trade openness, GDP and the control of corruption have a positive correlation with the ecological footprint in SSA. Additionally, it is revealed that the explanatory variables, apart from the institutional quality indicators are not strongly correlated with each other, signifying that there is no multicollinearity. For the institutional variables, we will place them in separate regression to avoid multicollinearity.

Table 3: Correlation Matrix of the Variables

	EF	FDI	TO	GDP	VA	PS	GE	RQ	RL	CC
EF	1.000									
FDI	-0.0214	1.000								
TO	0.3999	0.3382	1.000							
GDP	0.7357	-0.0185	0.4924	1.000						
VA	-0.1718	0.2347	-0.0081	-0.2145	1.000					
PS	-0.0742	0.2539	0.1197	-0.0044	0.6994	1.000				
GE	-0.0765	0.3282	0.1293	-0.0732	0.7625	0.7181	1.000			
RQ	-0.1258	0.2722	0.0712	-0.1800	0.7828	0.6830	0.9020	1.000		
RL	-0.0726	0.3193	0.0847	-0.0935	0.8326	0.7886	0.9218	0.9052	1.000	
CC	0.0126	0.2555	0.0654	-0.0390	0.8221	0.7335	0.8627	0.8067	0.8939	1.000

Source: Authors computation, 2024. *Note: EF is ecological footprint, FDI is foreign direct investment, TO is trade openness, GDP is a gross domestic product, VA is voice and accountability, PS is political stability, GE is government effectiveness, RQ is regulatory quality, RL is rule of law and CC is control of corruption.*

In Table 4, the principal component analysis (PCA) is computed to derive a composite index for institutional quality. This is aimed at estimating the total effect of institutions on the relationship between FDI and ecological footprint in SSA. Jollife (2002) revealed that only common factors which are greater than one or the mean should be left in the computation of the new index. Asongu et al. (2017) and Tchamyou (2017) note that PCA is about the reduction in a set of strongly correlated variables into an uncorrelated set of small variables known as principal component. The new variable accounts for most of the information in the original data. For this study, the first principal component is retained because its eigenvalue is greater than one.

Table 4: Principal Component Analysis used to compute an Institutional Quality Index

Component	Eigenvalue	Proportion	Cumulative
First PC	5.0190	0.8365	0.8365
Second PC	0.3725	0.0621	0.8986
Third PC	0.2830	0.0472	0.9458
Fourth PC	0.1827	0.0305	0.9762
Fifth PC	0.0820	0.0137	0.9899
Sixth PC	0.0606	0.0101	1.0000

Source: Authors computation, 2024

Table 5 presents the result of the systems GMM. The interpretation of the results follows Brabor et al. (2006), revealing that the variables constituting the interactions should not be interpreted as unconditional effects but should be interpreted given the absence of the other variable in the model. Our findings showed that in the absence of voice/accountability, FDI significantly reduces the ecological footprint in SSA. This result contradicts the pollution haven hypothesis but supports the halo hypothesis where FDI improves environmental quality. In the absence of FDI, the result showed that voice and accountability have a positive and significant impact on ecological footprint, which is in line with Azam et al. (2021). Furthermore, the interaction term showed that an increase in voice and accountability in the region results in a positive association between FDI and ecological footprint. This means that increasing voice and accountability counteracts the negative association between FDI and ecological footprints. Additionally, the net effect is revealed to be negative. A positive interactive effect and a negative net effect signify the existence of a threshold. The computation of thresholds following Asongu and Odhiambo (2021) and Iheonu and Ichoku (2022) using absolute values are derived for each regression model. The findings showed that voice and accountability counteract the negative association between FDI and ecological footprint when it surpasses the 2.13 threshold. Above this threshold, the net effect becomes positive. The study also finds that FDI significantly reduces the ecological footprint in SSA, in the absence of political stability, regulatory quality, rule of law and the control of corruption. In the absence of FDI, it is found that political stability, regulatory quality, rule of law and the control of corruption increase the ecological footprint in SSA, significantly. These findings contradict the study of Danish and Ulucak (2020) but support the conclusions of Hassan et al. (2020). Nonetheless, the interactive terms are observed to be positive for political stability, government effectiveness, regulatory quality and rule of law, while the interactive term for regulatory quality is negative. The results show considerable heterogeneity in the impact of institutional quality indicators on the relation between FDI and ecological footprints in SSA. The study further finds a threshold value of 0.0029 for political stability and 0.0181 for the control of corruption. Above these corresponding values, FDI will have a positive impact on ecological footprints in the region.

Furthermore, results showed the absence of a U-shaped relationship between economic growth and ecological footprint in the models where voice/accountability, regulatory quality, rule of law and the control of corruption were used as proxy for institutional quality. The result showed that the early stages of economic growth reduce ecological footprint. However, later stages of economic growth are associated with an increase in ecological footprint. This invalidates the EKC hypothesis. Also, the study found no robust connection between trade and ecological footprints in SSA. The Hansen probability values suggest that the instruments in the model are valid as it also revealed that the models do not suffer serial correlation. The models also validate the system GMM because of the absence of instrument proliferation where the number of instruments is less than the number of cross-sections in each model.

Table 5: Systems GMM Estimates

Variables	(1)	(2)	(3)	(4)	(5)	(6)
EF(-1)	0.5647*** (0.000)	0.7266*** (0.000)	0.7562*** (0.000)	0.6612*** (0.000)	0.6753*** (0.000)	0.6560*** (0.000)
FDI	-0.0041*** (0.000)	-0.0029*** (0.000)	-0.0006 (0.551)	-0.0064*** (0.000)	-0.0044*** (0.000)	-0.0019*** (0.003)
VA	0.2097*** (0.000)					
PS		0.0984*** (0.007)				
GE			-0.0045 (0.883)			
RQ				0.2298*** (0.000)		
RL					0.2000*** (0.000)	
CC						0.1051*** (0.002)
FDI * VA	0.0015** (0.013)					
FDI*PS		0.0984*** (0.007)				
FDI*GE			0.0063*** (0.000)			
FDI*RQ				-0.0029*** (0.001)		
FDI*RL					-0.0001 (0.887)	
FDI*CC						0.0031*** (0.000)
GDP	-1.4533*** (0.000)	-0.0964 (0.772)	-0.0850 (0.809)	-1.0667*** (0.000)	-1.1062*** (0.000)	-1.1357*** (0.000)
GDP^2	0.1219*** (0.000)	0.0202 (0.359)	0.0166 (0.493)	0.0925*** (0.000)	0.0944*** (0.000)	0.0955*** (0.000)
Trade	0.00004 (0.899)	0.0015* (0.052)	0.0009 (0.141)	-0.0001 (0.723)	0.0006 (0.212)	0.0005 (0.267)
Constant	19.8894*** (0.000)	12.4287*** (0.000)	13.7245*** (0.000)	18.0886*** (0.000)	19.2214*** (0.000)	14.6528*** (0.000)
Net Effect	-0.0050	-0.0612	Na	-0.0032	na	-0.0041
Threshold	2.1333	0.0029	-	-	-	0.0181
F-statistics	10021.59*** (0.000)	2367.31*** (0.000)	2548.30*** (0.000)	18774.15*** (0.000)	30902.41*** (0.000)	14082.87*** (0.000)
No. of Instruments	35	28	28	35	35	35
AR(1)	-2.31** (0.021)	-2.36** (0.018)	-2.35** (0.019)	-2.30** (0.021)	-2.31** (0.021)	-2.34*** (0.020)
AR(2)	1.25 (0.210)	1.16 (0.244)	1.20 (0.229)	1.24 (0.216)	1.19 (0.235)	1.25 (0.209)
Hansen P-value	25.54 (0.489)	19.12 (0.449)	19.19 (0.445)	27.82 (0.367)	29.53 (0.287)	31.29 (0.218)
Observations	551	551	551	551	551	551

Source: Authors computation, 2024. Note: Probability values are in parenthesis. ***, ** and * represent statistical significance at 1%, 5% and 10%, respectively. The P-value is the probability value. Year Fixed Effect is included in each modelling computation.

In Table 6, the institutional quality index derived from the PCA is utilised as a proxy for institutional quality. Results showed that in the absence of institutional quality, FDI significantly reduces ecological footprints. In the absence of FDI, we do not see a significant relationship between institutional quality index and ecological footprint. While the interaction between FDI and institutional quality index is revealed to be positive and significant, the net effect is revealed to be negative. As is in Table 5, a positive interactive effect and a negative net effect mean a threshold value for institutional quality exists. Computation following Asongu and Odhiambo (2021) shows a value of 1.4871. Above this value for the institutional quality index, FDI is revealed to positively influence ecological footprints in SSA.

Table 6: Systems GMM Estimate using the Institutional Quality Index as a proxy for Institutions

Variables	(1)
EF(-1)	0.7562***
	(0.000)
FDI	-0.0058***
	(0.000)
INST	-0.0028
	(0.883)
FDI*INST	0.0039***
	(0.000)
GDP	-0.0850
	(0.809)
GDP^2	0.0166
	(0.493)
Trade	0.0009
	(0.141)
Net Effect	-0.0057
Threshold	1.4871
Constant	13.7283
F-statistics	2548.31***
	(0.000)
No. of Instruments	28
AR(1)	-2.35**
	(0.019)
AR(2)	1.20
	(0.229)
Hansen P-value	19.19
	(0.445
Observations	551

Source: Authors computation, 2024. Note: Probability values are in parenthesis. ***, ** and * represent statistical significance at 1%, 5% and 10%, respectively. The P-value is the probability value. Year Fixed Effect is included in each modelling computation.

This study found no significant relationship between GDP and ecological footprint in SSA. Furthermore, trade had no significant influence on the ecological footprint in the region.

Conclusion

Economies around the world have witnessed an influx in the rate of FDI flows, and this has increased the level of concern about how these FDI flows affect the environment of their host communities. This study investigated the role of institutions in the FDI-Ecological footprint relationship for 40 Sub-Saharan African (SSA) nations from 2004 - 2018, adopting the system of generalised method of moments (SGMM) method.

The results showed that FDI lowers the ecological footprint in SSA, validating the halo hypothesis. Surprisingly, institutions (voice and accountability) were found to be a significant contributor to the ecological footprint. However, when we interact with FDI and institutions, a positive relationship is observed, with the net effect of FDI remaining negative. Our result implies that institutions in SSA countries are weak links between FDI and ecological footprint relationship, influencing FDI to contribute to environmental degradation of the region. The result also showed that even though institutions influence the effect of FDI on ecological footprint negatively, the impact only starts to manifest after an institutional threshold of 2.73. Similarly, other measures of institutions (including political stability, government effectiveness, regulatory quality, and rule of law) all showed similar results with voice and accountability, except for government effectiveness which exerts a negative but not significant impact on ecological footprint.

The findings revealed a non-linear relationship between economic growth and ecological footprint. The initial stage of economic growth is linked to a reduction in ecological footprint. With the economy growing further, the increased economic activities are associated with a rise in ecological footprint. This invalidates the EKC hypothesis.

The empirical finding from this study showed that good institutions matter a great deal in the quest to achieve environmental sustainability and further asserts the conclusion from our literature review that institutions in Sub-Saharan African countries are generally weak. The weakness of public institutions inhibits these countries from having laws and regulations that will better protect their environment because institutional quality is a decisive factor in the quality of the environment. Therefore, policymakers must promote policies that will strengthen public institutions. Such policies should be targeted at promoting the rule of law, increasing accountability, improving government effectiveness, and providing clear regulatory framework. The political institution should also be coordinated and reformed to ensure that political instability is reduced to the minimum level possible. All efforts should be coordinated at the national (country) and regional (Africa) levels as this will ensure the attainment of a sustainable environment across the region.

References

Abid, M. (2016). Impact of economic, financial, and institutional factors on CO2 emissions: Evidence from Sub-Saharan Africa economies. *Utilities Policy, 41*, 85-94.

Adegboye, F. B., Osabohien, R., Matthew, O., Olokoyo, F. O., & Adediran, O. (2020). Institutional quality, foreign direct investment, and economic development in sub-Saharan Africa. *Palgrave Communications.*, *7*, 1-9. doi: 10.1057/s41599-020-0529-x.

Ahmad, M., Ahmed, Z., Yang, X., Hussain, N., & Sinha, A. (2022). Financial development and environmental degradation: Do human capital and institutional quality make a difference? *Gondwana Research, 105*, 299-310. Retrieved from https://doi.org/10.1016/j.gr.2021.09.012

Ahmad, M., Jiang, P., Majeed, A., & Raza, M. Y. (2020). Does financial development and foreign direct investment improve environmental quality? Evidence from Belt and Road countries. *Environ Sci Pollut Res Int., 27*(19), :23586-23601. doi:10.1007/s11356-020-08748-7.

Ahmed, F., Kousar, S., Pervaiz, A., & Ramos-Requena, J. P. (2020). Financial development, institutional quality, and environmental degradation nexus: New evidence from asymmetric ARDL co-integration approach. *Sustainability,* 12(18), 7812. https://doi.org/10.3390/su12187812

Alola, A. A., Yalçiner, K., Alola, U. V., & Saint Akadiri, S. (2019). The role of renewable energy, immigration and real income in environmental sustainability target. Evidence from Europe's largest states. *Science of The Total Environment*, 674, 307–315.

Arellano, M.; Bover, O. Another look at the instrumental variable estimation of error components models. *J. Econom*. 1995, 68, 29–52. [CrossRef]

Arogundade, S., Mduduzi, B., & Hassan, A. S. (2022). Spatial impact of foreign direct investment on ecological footprint in Africa. *Environ Sci Pollut Res Int., 29*(34), 51589-51608. doi:10.1007/s11356-022-18831-w.

Asongu, S., & Odhiambo, N. (2021). Finance, governance and inclusive education in Sub-Saharan Africa. *Social Responsibility Journal, 17*(8), 1044-1061.

Asongu, S., Tchamyou, V., Asongu, N., & Tchamyou, N. (2017). Fighting terrorism in Africa: Evidence from bundling and unbundling institutions. *Empirical Economics, 56*(3), 883-933.

Ayanlade, A., & Proske, U. (2015). Assessing wetland degradation and loss of ecosystem services in the Niger Delta, Nigeria. *Marine and Freshwater Research, 67*(6), 828-836. Retrieved from https://doi.org/10.1071/MF15066

Azam, M., Liu, L., & Ahmad, N. (2021). Impact of institutional quality on environment and energy consumption: evidence from developing world. *Environ Dev Sustain, 23*, 1646–1667. Retrieved from https://doi.org/10.1007/s10668-020-00644-x

Blundell, R.; Bond, S. (1998) Initial conditions, and moment restrictions in dynamic panel data models. *J. Econom.* 87, 115–143. [CrossRef]

Brambor T, Clark WR, Golder M (2006) Understanding interaction models: Improving empirical analyses. *Polit Anal* 14:63–82. Retrieved from https://www.jstor.org/stable/pdf/25791835.pdf

Chishti, M. Z. (2023). Exploring the dynamic link between FDI, remittances, and ecological footprint in Pakistan: Evidence from partial and multiple wavelet based-analysis. *Research in Globalization, 6*(100109). Retrieved from https://doi.org/10.1016/j.resglo.2022.100109

Copeland, B. R., & Taylor, M. S. (1994). North-South trade and the environment. *The Quarterly Journal of Economics, 109*(3), 755–787. Retrieved from https://doi.org/10.2307/2118421

Dada, J. T., Adeiza, A., Ismail, N. A., & Arnaut, M. (2022). Financial development–ecological footprint nexus in Malaysia: the role of institutions. *Management of Environmental Quality: An International Journal*. doi:10.1108/MEQ-10-2021-0251

Danakol, S.H., Estrin, S., Reynolds, P., & Weitzel, U. (2014). Foreign direct investment and domestic entrepreneurship: blessing or curse? *CEP discussion paper*, no 1268. The London School of Economics and Political Science, May.

Danish, & Ulucak, R. (2020). The pathway toward pollution mitigation: Does institutional quality make a difference? *Business Strategy and the Environment* (2597). Retrieved from https://doi.org/10.1002/bse.2597

Demena, B. A., & Afesorgbor, S. K. (2020). The effect of FDI on environmental emissions: Evidence from a meta-analysis. *Energy Policy, 138*(111192). Retrieved from https://doi.org/10.1016/j.enpol.2019.111192

Dingru, L., Onifade, S. T., Ramzan, M., & Al-Faryan, M. (2023). Environmental perspectives on the impacts of trade and natural resources on renewable energy utilisation in Sub-Sahara Africa: Accounting for FDI, income, and urbanisation trends. *Resources Policy, 80*(103204). Retrieved from https://doi.org/10.1016/j.resourpol.2022.103204

Doytch, N. (2020). The impact of foreign direct investment on the ecological footprints of nations. *Environmental and Sustainability Indicators, 8*(100085, ISSN 2665-9727,), 100085, ISSN 2665-9727. Retrieved from https://doi.org/10.1016/j.indic.2020.100085.

Duodu, E., Kwarteng, E., Oteng-Abayie, E. F., & Frimpong, P. (2021). Foreign direct investments and environmental quality in sub-Saharan Africa: the merits of policy and institutions for environmental sustainability. *Environ Sci Pollut Res Int, 28*(46), 66101-66120. doi:10.1007/s11356-021-15288-1

Grimes, P., & Kentor, J. (2003.). Exporting the greenhouse: foreign capital penetration and CO_2 emissions 1980–1996. *J. World Syst. Res., 9*, 261–275.

Gunawardhana, C. S., & Damayanthi, N. M. M. (2020). Determinants of foreign direct investment and its impact on Economic Growth: Evidence from South Asian Association for Regional Corporation (SAARC) Countries. *Kelaniya Journal of Management*, *8*(2), 67–91. https://doi.org/10.4038/kjm.v8i2.7605

Hassan, S. T., Danish, Khan, S.U.D., Xia, E., & Fatima, H. (2020). Role of institutions in correcting environmental pollution: An empirical investigation. *Sustainable Cities and Societies*, *53*(101901). Retrieved from https://doi.org/10.1016/j.scs.2019.101901

Ibrahim, R.L., Al-Mulali, U., Ajide, K.B., Mohammed, A.& Bolarinwa, F.O. (2022). Investigating the mediating roles of income level and technological innovation in Africa's sustainability pathways amidst energy transition, resource abundance, and financial inclusion. *Sustainability*, 14, 12212. https://doi.org/10.3390/ su141912212

Iheonu, C., & Ichoku, H. (2022). Terrorism and investment in Africa: Exploring the role of military expenditure. *Economics and Business Review*, *8*(22), 92-112.

Ivanova, K. (2010). Corruption and air pollution in Europe. *Oxford Economic Papers*, *63*(1), 49–70. https://doi.org/10.1093/oep/gpq017

Muhammad, W. Z., Syed, A., Haider, Z., Naveed, R. K., Faisal M. M., Fujun, H., Syed. A.& Ashiq, K. (2019). The impact of natural resources, human capital, and foreign direct investment on the ecological footprint: The case of the United States. *Resources Policy*, 63(C). Retrieved from https://doi.org/10.1016/j.resourpol.2019.101428

Mottaleb, K. A. (2007). Determinants of foreign direct investment and its impact on economic growth in developing countries. *MPRA Paper*. https://mpra.ub.uni-muenchen.de/9457/1/MPRA_paper_9457.pdf

Jollife, I. (2002). *Principal Component Analysis* (2nd ed.). New York: Springer.

Jorgenson, A.K., Dick, C., Mahutga, M., 2007. Foreign investment dependence and the environment: an Eco structural approach. *Soc. Probl*. 54, 371–394

Jorgenson, A. K. (2007). Does foreign investment harm the air we breathe and the water we drink? A cross-national study of carbon dioxide emissions and organic water pollution in less-developed countries 1975–2000. *Orga. Environ.*, *20*, 137–156.

Karim, S., Appiah, M., Naeem, M. A., & Lucey, B. M. (2022). Modelling the role of institutional quality on carbon emissions in Sub-Saharan African countries. *Renewable Energy*, *198*, 213–221. doi:10.1016/j.renene.2022.08.074

Keane, M.P. & Runkle, D.E. (1992). On the estimation of panel-data models with serial correlation when instruments are not strictly exogenous. *J. Bus. Econ. Stat.*, 10, 8

Klasra, M. A. (2009). Foreign direct investment, trade openness and economic growth in Pakistan and Turkey: an investigation using bounds test. *Quality & Quantity*, *45*(1), 223–231. https://doi.org/10.1007/s11135-009-9272-5

Li, Q., & Resnick, A. (2003). Reversal of fortunes: democratic institutions and foreign direct investment inflows to developing countries. *International Organisation*, 57(1), 175–211. https://doi.org/10.1017/s0020818303571077

Ojewumi, S. J., & Akinlo, A. E. (2017). Foreign direct investment, economic growth and environmental quality in sub-Saharan Africa: a dynamic model analysis. *African Journal of Economic Review (AJER)*, *5*(1), 48–68.

Olaniyi, C. O., & Oladeji, S. I. (2021). Moderating the effect of institutional quality on the finance-growth nexus: Insights from West African countries. *Economic Change and Restructuring*, 54(1), 43–74.

Osuagwu, E. S., & Olaifa, E. (2018). Effects of oil spills on fish production in the Niger Delta. PloS ONE, *13*(10). Retrieved from https://doi.org/10.1371/journal.pone.0205114

Roodman, D. How to do xtabond2: An introduction to difference and system GMM in Stata. *Stata J.* 2009, 9, 86–136. [CrossRef]

Shahbaz, M., Nasreen, S., Abbas, F., & Anis, O. (2015). Does foreign direct investment impede environmental quality in high-, middle-, and low-income countries? *Energy Economics*, *51*, 275–287. Retrieved from https://doi.org/10.1016/j.eneco.2015.06.014

Sharif, A., Meo, M. S., Chowdhury, M. A. F., & Sohag, K. (2021). Role of solar energy in reducing ecological footprints: An empirical analysis. *Journal of Cleaner Production*, 292, Article 126028.

Sokhanvar, A. (2019). Does foreign direct investment accelerate tourism and economic growth within Europe? *Tour Manag Perspect*, *29*, 86–96. Retrieved from https://doi.org/10.1016/j.tmp.2018.10.005

Solarin, S.A., Bello, M.O., 2018. Persistence of policy shocks to an environmental degradation index: the case of ecological footprint in 128 developed and developing countries. *Ecol. Indicat.* 89, 35–44.

Ssali, M. W., Du, J., & Mensah, I. A. (2019). Investigating the nexus among environmental pollution, economic growth, energy use, and foreign direct investment in 6 selected sub-Saharan African countries. *Environ Sci Pollut Res, 26*, 11245–11260. Retrieved from https://doi.org/10.1007/s11356-019-04455-0

Swain, R. B., Kambhampati, U. S., & Karimu, A. (2020). Regulation, governance, and the role of the informal sector in influencing environmental quality? *Ecological Economics*, 173, Article 106649

Tang, C. F., & Tan, B. W. (2015). The impact of energy consumption, income and foreign direct investment on carbon-dioxide emission in Vietnam. *Energy*, *79*, 447–454. Retrieved from https://doi.org/10.1016/j.energy.2014.11.033

Tchamyou, S. (2017). The role of knowledge economy in African business. *Journal of the Knowledge Economy, 8*(4), 1189-1228. doi:10.1007/s13132-016-0417-1

Tsai, P. (1994). Determinants of foreign direct investments and its impact on economic growth. *Journal of Economic Development, 19,* 137-163. doi:10.1007/s13132-016-0417-1

Udemba, E. N., & Yalçıntaş, S. (2021). Interacting force of foreign direct invest (FDI), natural resource and economic growth in determining environmental performance: A nonlinear autoregressive distributed lag (NARDL) approach. *Resources Policy, 73*(102168). Retrieved from https://doi.org/10.1016/j.resourpol.2021.102168.

UNCTAD. (2022). Retrieved from https://unctad.org/news/investment-flows-africa-reached-record-83-billion-2021

World Bank. (2020). *World development indicators.* Washington DC: World Bank.

Xaisongkham, S., & Liu, X. (2022). Institutional quality, employment, FDI and environmental degradation in developing countries: evidence from the balanced panel GMM estimator. *International Journal of Emerging Markets*. Retrieved from https://doi.org/10.1108/IJOEM-10-2021-1583

Yang L, Bashiru Danwana S, Issahaku FY. Achieving Environmental Sustainability in Africa: The role of renewable energy consumption, natural resources, and government effectiveness: Evidence from symmetric and asymmetric ARDL models. *Int J Environ Res Public Health.* 2022 Jun 30;19(13):8038. doi: 10.3390/ijerph19138038. PMID: 35805708; PMCID: PMC9265570.

Yang, Y., Xu, X., Yin, J., & Zhang, T. (2023). An empirical analysis of FDI and institutional quality on environmental quality and economic growth, evidence from the panel of asian oil-producing and non-oil-producing economies. *Front. Environ. Sci, 10*(1066221). doi:10.3389/fenvs.2022.1066221

Zakaria, M., & Bibi, S. (2019). Financial development, and environment in South Asia: the role of institutional quality. *Environ Sci Pollut Res, 26*, 7926–7937. Retrieved from https://doi.org/10.1007/s11356-019-04284-1

Zoaka, J., Güngör, H. Effects of financial development and capital accumulation on labor productivity in sub-Saharan Africa: new insight from cross-sectional autoregressive lag approach. *Financ Innov* 9, 1 (2023). https://doi.org/10.1186/s40854-022-00397-8

Appendix 1- List of the 40 Sub-Saharan African Countries used for the Study

1	Angola	21	Madagascar
2	Benin	22	Malawi
3	Botswana	23	Mali
4	Burkina Faso	24	Mauritania
5	Burundi	25	Mauritius
6	Cameroon	26	Mozambique
7	Chad	27	Namibia
8	Comoros	28	Niger
9	Congo, Rep.	29	Nigeria
10	Cote d'Ivoire	30	Rwanda
11	Equatorial Guinea	31	Senegal
12	Eritrea	32	Sierra Leone
13	Ethiopia	33	Somalia
14	Gabon	34	South Africa
15	Ghana	35	Sudan
16	Guinea	36	Tanzania
17	Guinea-Bissau	37	Togo
18	Kenya	38	Uganda
19	Lesotho	39	Zambia
20	Liberia	40	Zimbabwe