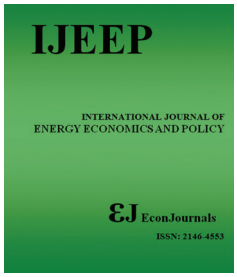

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Energizing Sub-Saharan Africa Economies through the Nexus of Foreign Direct Investment, Regulatory Quality, and Renewable Energy Consumption

Godwin Appiah-Kubi[1], Neeti Mathur[1], Steve Yaw Sarpong[2,3], Bright Akwasi Gyamfi[4,5]*, Stephen Prah[6]

[1]Faculty of Management, Sir Padampat Singhania University, N.H 76 Bhatewar, Udaipur, India, [2]Head of Internal Audit Unit, Kumasi South Hospital, Kumasi - Ghana, [3]Anglican University College of Technology, Nkoranza, Ghana, [4]Center of Accounting, Finance and Economics, Multimedia University, 63100 Cyberjaya Selangor, Malaysia, [5]DSI/NRF SARChI Industrial Development (SARChI-ID), University of Johannesburg, JBS Park, 69 Kingsway Avenue, Auckland Park, Johannesburg, 2092, South Africa, [6]Department of Agribusiness, Applied Economics and Agriscience Extension, North Carolina A&T State University, Greensboro, North Carolina, USA. *Email: brightgyamfi@mmu.edu.my

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ABSTRACT

The issue of foreign direct investment (FDI) and institutional quality in promoting renewable energy consumption has gained prominence among scholars and technocrats worldwide. This paper provides some interesting contributions to this subject matter by investigating the relationship between FDI and regulatory quality and renewable energy consumption in the Sub-Saharan African (SSA) context. We utilized FDI measured as the net investment inflows in a country and regulatory quality as parameters that could influence renewable energy usage in SSA from the period 2000-2020. The study adopted the generalized method of moments (GMM) approach to examine the relationship between FDI, regulatory quality, and renewable energy consumption. The empirical outcome reveals that both FDI and regulatory quality have a negative relationship with renewable energy consumption. However, FDI shows a significant positive effect on renewable energy consumption. This result is a wake-up call for governments within the SSA territory, proving that they have not been able to come up with policies that have an impact in promoting the private sector to improve the economy in the area of clean energy use investment. There is a need to give full attention to some important policy directions of the African Union, such as the Maputo declaration of 2003 and the 2015 African Charter on Democracy, Elections and Governance.

Keywords: Foreign Direct Investment, Regulatory Quality, Renewable Energy Consumption, Generalized Method of Moments
JEL Classifications: F21, Q28, Q42

1. INTRODUCTION

In recent years, the worldwide economy has been influenced by the rapid destruction of universal production and the internationalization of businesses. This tendency has expedited the process of global markets becoming interdependent, hence advancing global economic integration. This reliance is a result of economic globalization. One significant aspect of this process has been the influx of new capital as countries compete for foreign direct investment (Qamruzzaman, 2023). Capital is required to ensure the existence of enterprises and economies worldwide. Foreign direct investment (FDI) is critical for capital development because of its direct and indirect effects on the economy. FDI is crucial for economic growth and development, particularly when domestic savings are insufficient to meet local investment needs (Gyamfi, 2022; Ahmad et al., 2020). The importance of the connection between FDI and clean energy in sub-Saharan Africa (SSA) is paramount, as it is instrumental in determining a region's future energy accessibility and sustainability. The delivery of clean and renewable energy is not merely an objective; it forms

the foundation of the 2030 Agenda for sustainable development (Edziah et al., 2022). This agenda emphasizes the importance of enhancing public health and education, alleviating poverty and disparities, and protecting the environment. As nations worldwide aim to achieve net-zero targets, addressing the global climate crisis has become increasingly urgent.

Over half of the 789.6 million individuals without reliable electricity access reside in sub-Saharan Africa (Olugbire et al., 2021). This fact highlights the significant lag in regional experiences in conforming to the UNFCCC's comprehensive framework designed to promote widespread renewable energy service adoption in developing countries (Lefstad and Paavola, 2024). Despite these challenges, there are uneven yet notably positive correlations between FDI and renewable energy consumption in SSA. These interactions are associated with the technical efficiency of energy use, emphasizing the need for strategic investments to drive development and enhance energy access across the continent (Gyamfi et al., 2021; Pata et al., 2023). Existing studies emphasize the essential and prominent role that the institutional quality of the host country plays in influencing the positive or negative effects of FDI on sustainable projects. For instance, a host country's governmental approach to FDI can either significantly facilitate or, conversely, effectively obstruct investment inflows, greatly depending on the prevailing conditions and regulations that are enforced (Bekun et al., 2021; Gupta et al., 2024).

The transition to clean energy consumption in Africa is fraught with significant challenges that must be addressed to ensure a sustainable future. The foremost among these challenges is the lack of adequate infrastructure and investment in clean energy initiatives (Ali et al., 2023; Nalule, 2020). Many African countries are not equipped with the necessary infrastructure to harness renewable energy sources such as solar and wind power (Gyamfi et al., 2023; Abudu et al., 2023). This shortfall not only hampers development but also perpetuates reliance on fossil fuels, undermining efforts to combat climate change. Moreover, the success of clean energy initiatives hinges on robust institutions, effective policies, and sound economic indicators. Regulatory quality and the availability of funding for clean energy projects are critical factors that influence the feasibility of renewable energy adoption (Azam et al., 2023; Jie et al., 2023). Without these foundational elements, efforts to transition to renewable energy will falter. Despite the challenges, various regions in Africa are implementing efforts and initiatives to increase clean energy consumption. Most strategies employed in African countries to achieve this goal have focused on institutional quality and economic indicators, which have been the primary focus of existing studies. However, current research has narrowly examined the role of institutional quality and economic factors in shaping clean energy consumption. Most studies have concentrated on Asian countries, with little to no research conducted in the African context. This study aims to expand the scope of research by investigating the influence of regulatory quality and foreign direct investment on the use of renewable energy across 28 African countries.

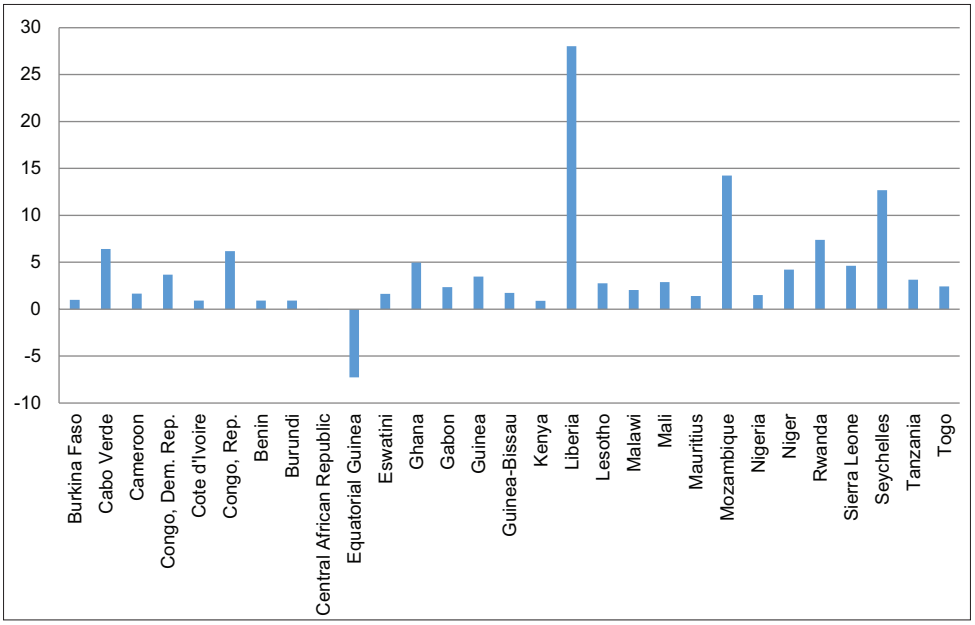
This study seeks to contribute significantly to recent studies concerning FDI and its considerable impact on fostering sustainable development by focusing on three key and interrelated objectives that are vital for understanding the broader implications of financial inflows in the region. Firstly, it will comprehensively and thoroughly analyze the intricate and complex relationship that exists between FDI in various sub-Saharan African countries and the successful execution and implementation of greenfield renewable energy projects, which have the potential to transform the energy landscape of these nations. In addition to this thorough examination, the paper will also explore in depth how FDI contributes to improving energy access for various demographic groups present within these diverse regions, which is essential for promoting equity and overall social well-being. Secondly, the research intends to identify and highlight significant institutional quality issues that serve as substantial intermediaries in the intricate relationship between FDI and the practical efforts of countries to enhance energy access effectively, thereby addressing a fundamental aspect of investment success. Understanding these critical challenges is crucial, as it may reveal significant obstacles to the effective implementation of investment strategies and pinpoint specific areas that require essential reform to overcome barriers that hinder progress. Thirdly, the findings emerging from this analysis will aim to inform relevant and actionable policy recommendations that are designed specifically to enhance the efficacy of FDI in promoting sustainable energy developments across the region, ultimately aiding in the alignment of investment flows with national development goals.

The organization of the study is as follows. Next section presents the literature review. Section 3 outlines the materials and methods used. Section 4 shows the empirical results, while Section 5 provides the conclusions and policy recommendations.

2. LITERATURE REVIEW

In sub-Saharan Africa, governments across different tiers are actively incorporating a broader range of renewable energy sources into their economies to alleviate the negative impacts of energy use and address the escalating challenges posed by climate change (Asongu and Odhiambo, 2022). This growth in the renewable energy sector is promoting the development of collaborations, as states seek effective strategies that not only advantage their citizens but also aim to diminish the environmental repercussions tied to traditional energy sources. The institutionalization hypothesis offers a robust theoretical foundation for this study (Adanma and Ogunbiyi, 2024). The current literature is systematically categorized into two main areas: foreign direct investment (FDI) and renewable energy development within the sub-Saharan African framework, providing important perspectives on the connections between these essential sectors (Wei et al., 2022). This extensive research also explores different theoretical frameworks that seek to clarify the intricate link between FDIs and clean energy projects in both developing and underdeveloped countries (Saqib and Dincă, 2024). Within this framework, FDI connected to clean energy initiatives is directly linked to policies aimed at enhancing energy access and dependability. In contrast, in developed nations, environmental elements usually have a greater impact on FDI movements (Aluko et al., 2023; Sarpong et al., 2020).

Figure 1: FDI inflows into SSA from 2000 to 2021



Source: Author's construct

This suggests that FDI could stem from expected government regulations or local energy needs, leading to either efficient energy policies that encourage sustainability or opportunistic actions that undermine environmental standards (Mahbub et al., 2022). Many empirical investigations have shown that the total amount of FDI attracted by a nation can inadvertently hinder adherence to established international environmental standards, creating a complex relationship that requires thorough examination (Tan and Uprasen, 2022). Studies indicate that FDI may prompt countries to loosen their environmental obligations to conform to global standards, which could lead them to pursue pollution havens—scenarios where richer countries entice poorer ones to adopt lenient regulations, thereby establishing a harmful decline in environmental safeguards (Ofori et al., 2023).

This engagement may additionally undermine the environmental regulations of hosting countries, highlighting the necessity of grasping the consequences of these investments. Additionally, case studies from Ghana and South Africa demonstrate that institutions in these host nations can significantly contribute to attracting FDI into their developing clean energy sectors, emphasizing the opportunity for fruitful collaboration and beneficial impact within the renewable energy field (Ren et al., 2022).

2.1. Foreign Direct Investment (FDI) Trends in Sub-Saharan Africa

Foreign Direct Investment (FDI) typically denotes a foreign investor's ownership stake in a business within a country, through which the investor aims to operate and manage the business over the long term. International investment may occur via foreign direct investments, foreign portfolio investments, or official development assistance (Zreik, 2023; Sarpong et al., 2020). FDI is believed to possess distinct features that set it apart from other types of international investment. In sub-Saharan Africa, the trends in FDI have differed both between and within countries, and over time, due to numerous factors (Dingru et al., 2023). Reports at both the global and continental levels concerning exports and foreign direct investment (FDI) emphasize the crucial role of FDI in sub-Saharan Africa. The information reveals a cumulative value of FDI inflows from 2000 to 2013, highlighting a shift in the view of sub-Saharan Africa, which had previously focused on its dependence on aid, susceptibility to conflicts, and issues in governance.

In sub-Saharan Africa, specific regions draw in more international investment; for instance, West Africa receives a significant share of FDI, succeeded by North Africa and Southern Africa. From the year 2000 onwards, FDI inflows stayed fairly stable, although there were some significant variations. The information provided in Figure 1 show that from the year 2000 to 2021, Liberia Mozambique and Rwanda received the highest FDI. Researchers recognize separate "expansion" and "downturn" stages in FDI engagement. A significant surge in inflows took place in 2007, mainly because of increasing commodity prices. In comparison, throughout the global financial crisis of 2007 and 2008, there was a significant rise in FDI outflows from sub-Saharan Africa. Nonetheless, the circumstance experienced a restoration of stability in 2009, succeeded by a continuation of the overall upward trajectory in 2010.

2.2. Clean Energy growth in Sub-Saharan Africa

Sub-Saharan Africa has some of the lowest rates of electrification in the world (Figure 2), with only a few countries having improved access to electricity. The area mainly depends on fossil fuels to meet its energy demands, resulting in carbon dioxide emissions that surpass those seen in numerous other regions (Egli et al., 2023). This reliance on hydrocarbons places both governmental bodies and local populations at risk from changes in oil and natural gas prices. In reaction to ongoing energy deficits, multiple governments have developed strategies to attain universal

electricity access (Akpahou et al., 2024). Nevertheless, because of constraints in financial resources and technology infrastructure, these efforts often emphasize clean energy solutions. Renewable energy alternatives, such as large-scale hydroelectric power, solar PV systems, solar thermal energy, and wind energy, are being prioritized (Babayomi et al., 2023). Clean electricity is regarded as crucial not only for fulfilling energy needs but also as a possible driver for job creation and economic development (Chou et al., 2023).

Governments are presently partnering with multilateral and bilateral organizations to gather resources while they establish Energy Cooperation Agreements (ECAs), especially those aimed at renewable energy projects (Othman and Khallaf, 2022). This partnership primarily seeks to tackle substantial initial expenses, which may ultimately result in reduced electricity costs derived from renewable sources. The advancement in securing ECAs differs among various countries, with certain nations implementing swift and proactive strategies to establish partnerships with these entities (Osman et al., 2023). An essential element in successfully carrying out renewable energy initiatives in Sub-Saharan Africa (SSA) is the readiness of significant support organizations to fund efforts that tackle social risks in at-risk areas where projects will occur, highlighting the crucial role of community involvement in project activities (Mulopo, 2022).

2.3. Institutional Quality, FDI and Clean Energy Use in sub-Sahara Africa

The impact of institutional quality in influencing the connection between FDI and clean energy has garnered significant empirical focus. Institutional quality includes elements like the effectiveness of governance, legal structures, transparency, and consistency in policies, all of which impact foreign investment choices (Gupta et al., 2024). Research conducted by Wei et al. (2022) indicates that nations with superior institutional quality receive larger FDI inflows in renewable energy initiatives. Their research indicated that robust institutions lower investment risks, leading to greater confidence among foreign investors in funding sustainable initiatives. Likewise, Olaniyi and Odhiambo (2023) contend that fragile institutions marked by corruption and inconsistent regulations discourage foreign investors from participating in clean energy initiatives. A study by Ofori et al. (2023) compared the effects of governance on FDI in SSA, showing that nations with effective legal enforcement and consistent regulatory systems draw long-term investments in renewable energy. Their research additionally emphasizes that the impact of FDI on advancing clean energy is enhanced when institutional frameworks effectively implement sustainability policies and environmental regulations.

Empirical research has thoroughly explored the connection between Foreign Direct Investment (FDI) and clean energy in Sub-Saharan Africa (SSA), emphasizing the opportunities and challenges in utilizing FDI for sustainable energy advancement. Asongu and Odhiambo (2022) contend that foreign direct investment (FDI) plays a vital role in economic growth, especially in areas lacking energy, by enabling capital influxes, technology exchange, and skill advancement in the renewable energy field. This is consistent with the results of Wei et al. (2022), who highlight that FDI can facilitate energy security and decarbonization initiatives by improving access to cleaner energy resources. Nonetheless, empirical studies indicate that the effect of FDI on clean energy differs markedly depending on the economic, political, and institutional contexts of host nations.

Research conducted by Ren et al. (2022) revealed that nations possessing stable institutions and clear policies draw more FDI in renewable energy, whereas politically unstable areas with poor governance often face reduced investment flows. In a similar vein, Aluko et al. (2023) claims that although FDI can promote clean energy initiatives, its effectiveness is frequently compromised by poor governance, corruption, and insufficient regulatory structures. In their panel data analysis of SSA economies, Pata et al. (2023) discovered a positive relationship between FDI inflows and the consumption of renewable energy. Their research showed that FDI enhances energy efficiency and supports the growth of green energy infrastructure in nations with investor-friendly regulations. Nonetheless, they also observed that nations without transparent regulatory processes often draw investment towards carbon-heavy industries instead of clean energy.

2.4. Pollution Haven Hypothesis and Sustainable Energy Development

A major body of empirical research investigates the pollution haven hypothesis (PHH) within the framework of SSA. This hypothesis suggests that multinational companies move their activities to areas with less stringent environmental laws, resulting in heightened pollution and environmental harm (Ofori et al., 2023). This phenomenon has been extensively researched in developing economies, showing varied results regarding its relevance to SSA. Tan and Uprasen (2022) performed an empirical study on BRICS and SSA economies, discovering that nations with relaxed environmental regulations frequently draw FDI in sectors linked to elevated carbon emissions. Their findings indicate that in certain SSA countries, the quest for FDI has resulted in the weakening of environmental laws, rendering them appealing locations for companies aiming to avoid strict emission regulations. In contrast, empirical research by Saqib and Dincă (2024) challenges the pollution haven hypothesis in specific SSA nations. Their study emphasizes that certain governments have effectively enforced stringent environmental regulations that draw in foreign investors seeking clean energy opportunities. Nations like South Africa and Kenya have utilized regulatory incentives to direct FDI towards renewable energy initiatives, illustrating that a robust environmental policy structure can aid in attracting sustainable investment.

2.5. Theoretical Frameworks Linking FDI and Clean Energy

Empirical research has investigated the connection between clean energy and foreign direct investment (FDI). This part seeks to examine various conceptual frameworks that may aid in the possible alignment of these two international trends (Saqib and Dincă, 2024). The primary emphasis is on the theoretical bases linking FDI to environmental management strategies, especially within clean energy industries. Important economic theories that help clarify why investors may seek clean energy investments encompass transaction cost economics, opportunity cost factors,

assumption-driven expectations, and a particular investment framework (Zahoor et al., 2022). This model emphasizes that a company's financial outcomes, shaped by decision-making timelines and management's capacity for long-term thinking, can pose a major challenge to executing broad environmental changes (Chen et al., 2023).

The effectiveness of institutions in a host economy is acknowledged in theoretical models as a key factor in whether institutional flaws or shortcomings can encourage or hinder foreign direct investment (FDI). This gives rise to hypotheses concerning the attraction of institutional weaknesses for FDI in the renewable energy sector, especially in a present landscape where factors such as dual bottom lines, environmental efficiency, and corporate social responsibility are crucial in influencing global economic strategies (Boburmirzo and Boburjon, 2022). The existence of these theories suggests that answers in this domain are improbable to be straightforward. A comparison can be made from FDI research: poorly functioning institutions can concurrently draw in FDI while permitting a nation to build the economic strength required to remain competitive with other resource-abundant countries (Shittu et al., 2022).

The resource curse theory posits that investment choices influenced by resource clusters may transform a country into a global resource center, potentially indicating inertia and collective action dynamics. These theoretical ideas are likewise pertinent to the policy research agenda explored later in this document (Challoumis, 2024). Countries participating in FDI can gain advantages by implementing an "eco-modernization strategy," reliant on their capacity to merge new technologies with revised standards, knowledge, and regulations. The success of this integration depends on the host nation's political system successfully applying the required technological and legal structures for clean energy projects (Liu et al., 2023). The political and governance factors in the host nation are crucial for enhancing foreign direct investment (FDI), particularly in developing nations. Grasping the impact of governance quality on FDI in the clean energy sector necessitates taking this broader context into account (Wei et al., 2022). The examination of FDI incentives can be linked to governance structures, such as the model of dispersed vested interests. Additionally, the growing significance of local and regional governance bodies in China is remarkable, as they are acquiring influence over new types of FDI within a capitalist market environment (Mahbub et al., 2022). The distinction between effective and ineffective governance is not always straightforward and requires thorough analysis. Moreover, studies on FDI, similar to those in trade and finance, could uncover advantageous synergies from various investment methods, especially in traditional sectors. Current transition theories indicate that emerging economies are leveraging conventional FDI and their resources to spearhead a shift in the clean energy sector (Nhuong et al., 2024).

3. MATERIALS AND METHODS

3.1. Data Source

This paper studied the relationship between renewable energy consumption and FDI and RQ in SSA using a panel dataset of 28 countries spanning from 2000 to 2020. The study employed factors such as regulatory quality, foreign direct investment, and direct credit, as well as some controlling variables to discover their association with renewable energy consumption. We selected countries to be part of this research only when the country had available data for the entire period of this study concerning the variables in the World Bank Development Indicators repository (WDI; World Bank, 2020). Renewable energy consumption is measured as the amount of renewable energy consumed out of the total final energy consumption. This variable is measured as a percentage of final energy consumption. The primary rationale behind the choice of renewable energy consumption for this study is necessitated by the fact that several researchers, such as Sarpong et al. (2022; 2020), Bekun and Gyamfi (2020), and Adedoyin et al. (2021), who opined that increased renewable energy consumption discourages growth in emerging economies like the SSA region. The researchers suggest that there should be increased investment in renewable energy sources to have the desired impact on the consumption of renewable energy in the African region. Regulatory quality is defined as the capability of governments to initiate and implement policies and procedures that promote private sector growth and advancement. It is estimated as a score that ranges from −2.5 to 2.5. Foreign direct investment is defined as the net inflows of resources as a proportion of the receiving country's GDP. This variable is appropriate to show the amount of investment that foreign investors could make towards green energy usage in the SSA region.

3.2. Empirical strategy

Following Arellano and Bond (1991) rule of thumb, we implemented ordinary least squares (OLS), fixed effect (FE) and random effect (RE) models to ascertain the strength and power of the anticipated correlation between renewable energy consumption and FDI and regulatory quality (Table 1 for variables definition). The renewable energy consumption variable was lagged as the response variable in all our estimations. The problem of endogeneity of the regressors was tackled by adopting the GMM

Table 1: Variable definitions

Variables	Measurement	Indices
Renewable energy consumption	Total renewable energy consumption (% of total final energy consumption)	RE
Foreign direct investment	Net inflows of resources as a proportion of the receiving country's GDP	FDI
Regulatory quality	People's opinions of government's ability to formulate regulations to promote private sector advancement. Scores range from−2.5 to 2.5	RQ
Domestic credit	Local credit granted to the private sector as a percentage of GDP	DC
Renewable electricity output	Proportion of electricity generated by clean electricity plants in overall electricity output by total plants	REO
Gross domestic product growth	Yearly proportion growth rate of GDP at market figures using constant domestic currency.	GDPG
Gross domestic product per capita	GDP as a proportion of the population in half a year measured in current US dollars	GDPPC

Author's estimations

estimation technique. This method is consistent with a recent study in the subject matter of renewable energy consumption-FDI nexus in particular and a cross-sectional study in broad. There was the need to remove the problems associated with the lagged dependent variables and country fixed effect, so the researchers introduced an advanced economic method. We introduced difference-GMM to make sure that the entire independent variables are converted through the technique of differencing (Sarpong and Bein, 2021). By so doing the fixed effects were removed and no data was lost, given that the research utilized a panel data that was balanced in all the estimates performed. Again, the issue of weak instrumentation was solved since the results obtained from the difference-GMM were greater than the estimations generated by the fixed effects, indicating that the two-step GMM gives reasonable contributions to the results from the one-step approach, notwithstanding the presence of heteroscedasticity (Mileva, 2007; Rodman, 2009). According to Mileva (2007), introducing these approaches challenges the heterogeneity associated with panel data, and estimation errors are resolved, especially with the help of the GMM approach, since variable biases that are removed are taken care of in all estimations performed.

3.2.1. Model specification

To achieve the aim of the study, we estimated a baseline model as:

$$REC_{it} = \propto_0 + \propto_1 FDI_{it} + \propto_2 RQ_{it} + \propto_3 DC_{it} + \propto_4 REO_{it} + \propto_5 GDPG_{it} + \propto_6 GDPP_{it} + P_{it} + \in_{it} \quad (1)$$

To address the endogeneity problem and enhance the efficiency of our estimates, we computed the GMM panel dynamic model as:

$$REC_{it} = \propto_0 + \beta_1 REC_{it-1} + \propto_1 FDI_{it} + \propto_2 RQ_{it} + \propto_3 DC_{it} + \propto_4 REO_{it} + \propto_5 GDPG_{it} + \propto_6 GDPPC_{it} + P_{it} + \in_{it} \quad (2)$$

Where REC_{it} denotes renewable energy consumption in a country i at a period t; FDI_{it} represents foreign direct investment; RQ_{it} is regulatory quality; DC_{it} denotes domestic credit; $GDPG_{it}$ denotes gross domestic product growth; $GDPPC_{it}$ denotes gross domestic product per capita; P_{it} denotes the country-specific fixed effects; $\in_{it}$ denotes the factors that were not observed in the model; $\propto_0$–$\propto_7$ are the parameters to be estimated. The variables were transformed into logs to allow for reduced skewness in the data distribution. It was also necessary to allow for greater interpretations and meaningful analytical conclusions.

To estimate Equation (1), the study first conducted the Hausman test to determine whether to use fixed or random effects models. The results revealed a P = 0.000, which is <0.05, indicating that the fixed effects model is the appropriate choice in this study. Additionally, as shown in Table 1, the multicollinearity assessed through the variance inflation factor (VIF) does not exceed levels that would render the variable coefficients insignificant. This suggests that the conclusions drawn from the regression analysis based on these coefficients will remain valid. The VIF values are well below the threshold of 5, supporting the notion that multicollinearity is not a concern in this model. Furthermore, the initial estimations indicate that there is no second-order autocorrelation present in the GMM estimates, confirming the validity of the instruments used, as evidenced by the P-values obtained from the Hansen J test (Table 2 for details). This means that the outcomes of these estimations can be utilized for policy guidance in various economic contexts.

4. EMPIRICAL RESULTS

4.1. Descriptive Statistics

Table 3 shows the descriptive statistics of all variables used in the model. Findings indicate that the average FDI is 37.03% of GDP. Whereas RE averages 4.02% of final energy consumption in the sub-Sahara African region for the period. The mean of DC is 2.22% with the highest credit extended to the private sector during the study period representing 4.56% of GDP and in situations where there is little credit given to private institutions domestically, it was in the negative of 6.88. On average, the RQ ranking was 2.31, indicating a positive perception of governments in this African region regarding their ability to implement policies that support private sector advancement. This encouraging ranking reflects a generally favorable view. The average REO is 1.47%, and the average GDP growth recorded was 4.21%. Additionally, GDP per capita (GDPPC) has a mean of 694.77 USD. Furthermore, the correlation analysis shown in Table 4 reveals that all independent variables, except for REO and GDPG, are significantly negatively

Table 2: Renewable energy consumption in SSA: GMM dynamic panel regression

Variable	Model 1		Model 2		Model 3	
	A	B	A	B	A	B
L.RE	0.788*** (0.035)	0.788*** (0.055)	0.786*** (0.034)	0.786*** (0.055)	0.780*** (0.033)	0.780*** (0.062)
FDI	−0.031** (0.015)	−0.031*** (0.010)	−0.032** (0.015)	−0.032*** (0.011)	−0.036** (0.015)	−0.036*** (0.013)
RQ	−0.697 (0.784)	−0.697 (0.630)	−0.637 (0.776)	−0.637 (0.609)		
DC	−0.234 (0.350)	−0.234 (0.497)	−0.208 (0.346)	−0.208 (0.454)	−0.044 (0.333)	−0.044 (0.435)
REO	0.004 (0.009)	0.004 (0.012)				
GDPG	−0.033** (0.021)	−0.033** (0.017)	−0.033** (0.021)	−0.033** (0.017)		
GDPPC	−1.201** (0.505)	−1.201** (0.572)	−1.268*** (0.487)	−1.268*** (0.478)	−1.532*** (0.460)	−1.532*** (0.430)
Constant	−27.061*** (5.023)	−27.06*** (6.347)	−27.773*** (4.810)	−27.773*** (5.935)	−26.973*** (4.573)	26.973** (6.099)
Wald X^2	712.29	1351.51	738.32	1353.72	599.90	1357.57
AR (1)	−4.1239 (0.034)		−3.012 (0.011)		−2.2061 (0.023)	
AR (2)	−4.120 (0.008)		1.120*** (0.093)		−3.002** (0.120)	
Sargan Test	242.0320		415.2314		130.2654	

Standard errors are placed in the brackets. ***, **, * denote statistical significance levels of 1%, 5% and 10% respectively. P□values for the Hansen test and serial correlation test are also place in parentheses

correlated with the dependent variable. It is important to note the limitations of the Pearson correlation evaluation; therefore, further econometric analysis is needed, which is discussed in the ensuing sections.

4.2. Baseline Estimations of OLS, Fixed Effect and Random Effect Regression Models

To explore the relationship between foreign direct investment, regulatory quality, and renewable energy in the Sub-Saharan African region, the study first estimated the baseline Equation (1) using FE, RE, and OLS methods. Table 5 presents the baseline estimates, revealing a relatively high explained variation in the dependent variable across all models, as indicated by the R^2 values. Also, the F-statistics confirm that the explanatory variables collectively influence the dependent variable in all models. The results indicate that, across all models—except for OLS in models 2 and 3—FDI is negatively and significantly associated with RE in SSA. Similarly, RQ negatively and significantly affects RE. While the REO and GDPG also show significant negative effects, REO was found to be insignificant. Furthermore, DC significantly and negatively influences RE in models 1 and 2, but its effect was insignificant in model 3.

4.3. Estimation of Generalized Method of Moments - Dynamic Panel Regression

The findings in Table 2 were obtained by estimating two different models that included two control variables. In both GMM (A) and GMM (B), the strong standard errors indicate that the lagged independent variable remains a robust predictor, even after controlling for additional factors. This suggests that renewable energy consumption in the previous period is a significant determinant of current renewable energy consumption in the average country within the Sub-Saharan African region. The GMM results in Table 2 reveal a significant negative relationship between FDI and RE, consistent

Table 3: Descriptive statistics

Variable	Mean	Standard deviation	Minimum	Maximum	VIF (mean=1.15)
RE	4.01782	0.9522993	0.3566749	4.588024	
FDI	37.02624	9.973259	0.7673223	136.3374	1.03
RQ	2.305253	0.5360701	0.1438755	2.419947	1.35
DC	2.219347	−6.876621	−6.876621	4.652952	1.22
REO	1.4685.5	2.260007	0.696205	5.57008	1.00
GDPG	4.21337	5.679079	2.80229	5.53799	1.04
GDPPC	694.7731	1.112762	471.3187	985.9614	1.22

VIF is variance inflation factor. Source: Author's estimations

Table 4: Correlation matrix

	RE	FDI	RQ	DC	REO	GDPG	GDPPC
RE	1.0000						
FDI	−0.0203	1.0000					
RQ	−0.3684***	0.0506	1.0000				
DC	−0.2195***	−0.0021	0.4033***	1.0000			
REO	0.0211	−0.0133	−0.0266	−0.0178	1.0000		
GDPG	0.0531	0.1594 ***	−0.0259	−0.0929**	−0.0222	1.0000	
GDPPC	−0.7166***	−0.0492	0.4034***	0.2644 ***	−0.0434	−0.0476	1.0000

Author's estimations. ***, **, * denotes significance levels of 1%, 5% and 10% respectively

Table 5: Renewable energy consumption and FDI in SSA: Fixed effects, random effects and OLS estimations

	Model 1			Model 2			Model 3		
Variable	OLS Coefficient	FE Coefficient	RE Coefficient	OLS Coefficient	FE Coefficient	RE Coefficient	OLS Coefficient	FE Coefficient	RE Coefficient
FDI	−0.005***	−0.064***	−0.045***	0.092	−0.064***	−0.066***	0.092	0.046**	−0.045**
	(0.002)	(0.023)	(0.025)	(0.064)	(0.023)	(0.024)	(0.064)	(0.9237)	(0.024)
RQ	−0.159*	−3.903***	−4.098***	−1.825	−3.890***	−4.009***			
	(0.058)	(0.907)	(0.918)	(1.657)	(0.906)	(0.943)			
DC	0.000	−0.205***	−0.216***	−0.495***	−0.205***	0.288***	−1.825	−5.039	−5.367
	(0.017)	(0.036)	(0.372)	(0.056)	(0.036)	(4.339)	(1.657)	(0.923)	(0.931)
REO	−4.641	5.340	5.350						
	(1.190)	(8.270)	(8.440)						
GDPG	0.004	0.131***	−0.001***	−0.195*	0.130***	0.150***			
	(0.004)	(0.034)	(0.0001)	(0.114)	(0.034)	(0.036)			
GPDPC	−0.583***	−0.001***	0.125***	−0.004***	−0.001***	−0.001***	−0.005***	−0.001***	−0.001***
	(0.026)	(0.0001)	(0.035)	(0.0002)	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)
Constant	8.448***	71.79***	72.04***	86.86***	71.82***	72.08***	72.165***	68.807***	68.776***
	(2.321)	(0.999)	(3.078)	(2.135)	(0.998)	(3.028)	(1.382)	(0.762)	(3.147)
R^2	0.52	0.54	0.55	0.64	0.54	0.550	0.60	0.56	0.56
F-stats	65	52.46			48.91			43.75	
Wald Test			213.37			213.55			148.05

Standard errors are placed in the brackets. ***, **, * denote statistical significance levels of 1%, 5% and 10% respectively

with the findings of earlier studies (Lee, 2013; Asante et al., 2022; Marton and Hagert, 2017; Sarkodie et al., 2020; Yousafzai et al., 2023; Jahanger & Usman, 2023). This contrasts with the conclusions of Yilanci (2019), Wei et al. (2022), and Asongu and Odhiambo (2022). The results imply that net inflows of investments in the SSA region tend to reduce renewable energy consumption, suggesting that these investments do not promote clean energy initiatives. Instead, they may hinder progress in this area, as investors are not focused on supporting clean energy projects in these countries.

Also, RQ shows an insignificant negative relationship with clean energy, consistent with the findings of Tan and Uprasen (2022) and Aluko et al. (2023). These results suggest that the regulatory quality and domestic credit environment in the region are not strong enough to promote clean energy consumption. This indicates that governments struggle to implement effective policies that would enhance private sector operations, while financial institutions are also unable to extend credit to domestic private organizations for promoting clean energy production and consumption. Furthermore, DC demonstrates a weak negative relationship with RE. There is an insignificant positive relationship between REO and RE, suggesting that at least some levels of REO correspond to clean energy consumption. Moreover, Table 2 illustrates a strong negative relationship between RE and both GDPG and GDPPC, indicating that GDPG and GDPPC are not factors that promote clean energy consumption; rather, they appear to contribute to a reduction in clean energy consumption.

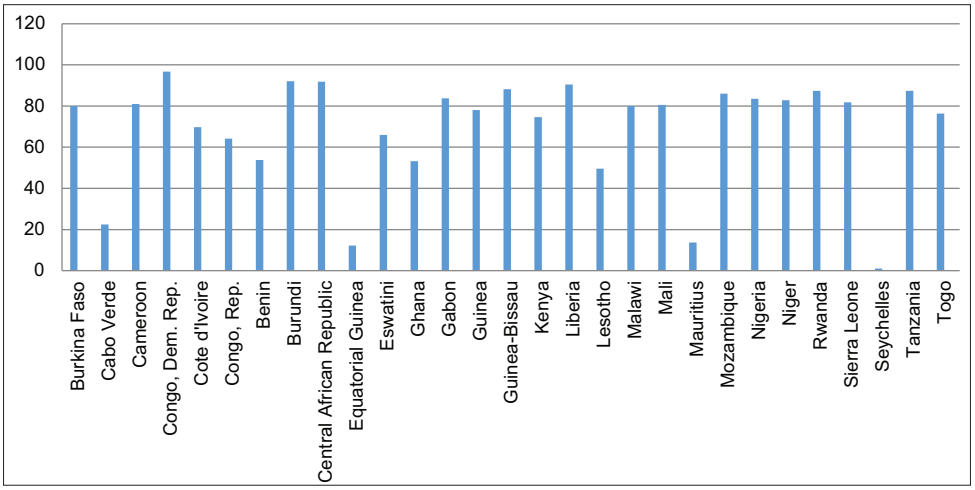
5. DISCUSSION

This paper empirically studies the relationship between clean energy, FDI and regulatory quality in SSA from the period 2000 to 2020, utilizing the most current dataset. Different estimation techniques were used for our study considering the heterogeneity characteristics of the selected variables. This study found that in the SSA region, FDI is negatively related to renewable energy consumption. This suggests that the net investment into the territory is not a parameter that has led to the use of clean energy creating concerns for regional authorities. It presupposes that foreign investors have not paid particular attention the area of investing in projects geared towards the production of clean energy sources for use by the African region. The amount of foreign direct investment is not increased or great enough to cause clean energy consumption. It is profound to refer to the study of Lee (2013) in G20 and Ozgur & Gorus (2019) in BRICS, who argue that increased foreign direct investment in the G20 countries led to spillover advantages in the area of clean energy consumption which increased economic growth. This is very important to consider in the SSA as it could be proven that the amount of FDI that a country receives is a precondition of its clean energy use significance.

When clean energy is consumed the scholars posit that it also becomes a check on pollution from carbon dioxide and other toxic emissions from energy use. Consistent with Asante et al. (2022) and Dilanchiev et al. (2024), investments that come in from foreign sources can give attention to improved technologies in production that lead to refined goods and services devoid of pollution which in the end benefits the people and governments at large. Certain environmental challenges could be curtailed when FDI is able to tackle issues of improved energy use for improved output through innovations for green environment that can improve quality of life of the African citizens (Sarpong and Bein, 2020).

In addition, the paper finds that regulatory quality in the region is poor and does not lead to increased renewable energy consumption as alluded to by some researchers (Hassan et al. 2020; Sarkodie and Strezov, 2019; Sarpong and Bein, 2020; Ali et al., 2021) for example who think that quality institutions is a great factor that can lead to clean energy use to prevent emissions of pollutants. On the contrary, what the results of this paper imply is that the countries in the region have not been able to prescribe efficient regulatory regimes that will lead to clean energy consumption. The negative relation that regulatory quality has with clean energy use means that there is a poor governance system implemented to promote investment in clean energy consumption in the region. This presupposes that there is corruption and poor government administrative procedures within the environmental protection institutions to handle issues of clean environmental concerns. It is therefore incumbent on the authorities in the sub-Sahara

Figure 2: Renewable energy consumption in SSA from 2000 to 2020



Source: Author's construct

African region to ensure that quality institutional systems are in place to serve as a check on institutions who operate to produce emissions that could be harmful to the environment. This paper has contributed to the argument that it is important to give great attention to a good governance regime to help promote a clean and sustainable environment in Africa. It is the strong environmental institution that can regulate the activities of industries or companies that use energy to produce goods in large quantities and therefore are likely to produce pollutants. When these institutions do not indulge in corrupt practices these industries will comply with clean environmental regulations that will promote a green environment.

6. CONCLUSION AND POLICY IMPLICATIONS

This study investigated the relationship between renewable energy use, foreign direct investment and regulatory quality in SSA using 20 years data spanning 2000-2020. The study employed the GMM estimation technique to prove the interactions between these variables. The main objective was to study the effects of foreign direct investment and regulatory quality on renewable energy use in the SSA region. The research concludes that there is a robust negative relationship between foreign direct investment and renewable energy consumption in the context of the SSA countries. With this outcome, the study therefore suggests that the net inflow of investment from foreign investors to acquire more than 10% of voting stocks in companies do not turn their attention to the issue of renewable energy use. Investments flowing from other countries into domestic economies are not enough to impact increased renewable energy consumption. Furthermore, the results prove that there is a negative relationship between regulatory quality and renewable energy consumption implying that institutional quality is not great enough to promote clean energy consumption in the SSA region. The findings suggest that governments have not come up with policies that will contribute to implementing regulations that will encourage the private sector to advance the issue of increased renewable energy consumption.

As a policy direction to this paper and concerning the above outcome, governments in the region are advised to fortify and provide regulatory agencies with the necessary supplies, and provisions outlined in regulatory instruments become operative rather than merely existing in books. Consequently, it is crucial that SSA nations put environmental oversight measures into place that are specifically designed to help reduce CO_2 emissions. For instance, all industries that carry out operations that have the potential to emit carbon dioxide should be subjected to strong national environmental control and management rules and regulations. If not, changes to the air purity laws should be made to account for pollution quantities. It is recommended that policymakers not minimize the significance of foreign direct investment in the context of the EKC's mandate to support the use of clean energy in the battle against excessive pollution.

Institutional quality has been proven by this study as a weak link in predicting energy use in the Region suggesting that there is weak institutional arrangement to deal appropriately and effectively with matters that promote clean environment. The implication is that government institutions are not strong and encourage good governance geared towards enforcing clean environmental policies to prevent harmful emissions. It is in the interest of the African region as a matter of policy direction to pay close attention to the 2015 resolutions in the African Charter on Democracy, Elections, and Governance as well as make implement the 2003 EX. EL/Dec.31 (III) which is the 2003 Maputo declaration. Furthermore, as member countries of the African Union, the Addis Ababa resolution number EX. CL/124(V) on good governance should be implemented to promote quality institutions and strong governance systems for countries in the region.

By raising the proportion of energy produced from renewable sources, intentional efforts ought to be established to provide readily available, clean, and dependable renewable energy per Sustainable Development Goal 7, which is the ambition for 2030 as well. This could be accomplished through increasing energy efficiency and taking the required actions to strengthen international cooperation through agreements like the Paris COP21 treaty and the Addis Ababa Agenda (AAAA) aimed to facilitate greater access to clean energy technological advances and boost investments in clean energy systems. To prevent corruption and inefficiency in environmental governance frameworks, deliberate measures should be taken to make sure that laws are properly upheld and followed.

African nations should strive for a restructured institutional view and governance to equip them to control and encourage reasonable economic activity that would guarantee an environmentally friendly future. The article offers a wealth of policy recommendations for sub-Saharan African authorities, urging them to dedicate themselves to advancing high-quality governance systems that guarantee funding for clean energy use that promotes green environment and to be technologically inventive in identifying refined renewable energy sources that can regenerate carbon dioxide produced with negligible environmental effects.

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REFERENCES

Abudu, H., Wesseh Jr, P. K., and Lin, B. (2023), Climate bonds toward achieving net zero emissions and carbon neutrality: evidence from machine learning technique. Journal of Management Science and Engineering, 9(1), 1-15.

Adanma, U.M., Ogunbiyi, E.O. (2024), Assessing the economic and environmental impacts of renewable energy adoption across different global regions. Engineering Science and Technology Journal, 5(5), 1767-1793.

Adedoyin, F. F., Bein, M. A., Gyamfi, B. A., and Bekun, F. V. (2021), Does agricultural development induce environmental pollution in E7? A myth or reality. Environmental Science and Pollution Research, 28, 41869-41880.

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. Environmental Science and Pollution Research, 27(19), 23586-23601.
Akpahou, R., Mensah, L.D., Quansah, D.A., Kemausuor, F. (2024), Energy planning and modeling tools for sustainable development: A systematic literature review. Energy Reports, 11, 830-845.
Ali, E.B., Shayanmehr, S., Radmehr, R., Amfo, B., Awuni, J.A., Gyamfi, B.A., Agbozo, E. (2023), Exploring the impact of economic growth on environmental pollution in South American countries: How does renewable energy and globalization matter? Environmental Science and Pollution Research, 30(6), 15505-15522.
Ali, S., Ying, L., Anjum, R., Nazir, A., Shalmani, A., Shah, T., Shah, F. (2021), Analysis on the nexus of CO_2 emissions, energy use, net domestic credit, and GDP in Pakistan: An ARDL bound testing analysis. Environmental Science and Pollution Research, 28, 4594-4614.
Aluko, O.A., Opoku, E.E.O., Ibrahim, M., Kufuor, N.K. (2023), Put on the light! Foreign direct investment, governance and access to electricity. Energy Economics, 119, 106563.
Arellano, M., and Bond, S. (1991), Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. The review of economic studies, 58(2), 277-297
Asante, D., Ampah, J.D., Afrane, S., Adjei-Darko, P., Asante, B., Fosu, E., Amoh, P.O. (2022), Prioritizing strategies to eliminate barriers to renewable energy adoption and development in Ghana: A CRITIC-fuzzy TOPSIS approach. Renewable Energy, 195, 47-65.
Asongu, S., Odhiambo, N.M. (2022), Governance and renewable energy consumption in Sub-Saharan Africa. International Journal of Energy Sector Management, 16(2), 209-223.
Azam, W., Khan, I., and Ali, S. A. (2023), Alternative energy and natural resources in determining environmental sustainability: a look at the role of government final consumption expenditures in France. Environmental Science and Pollution Research, 30(1), 1949-1965.
Babayomi, O.O., Olubayo, B., Denwigwe, I.H., Somefun, T.E., Adedoja, O.S., Somefun, C.T., Attah, A. (2023), A review of renewable off-grid mini-grids in Sub-Saharan Africa. Frontiers in Energy Research, 10, 1089025.
Bekun, F.V., Gyamfi, B.A., Onifade, S.T., Agboola, M.O. (2021), Beyond the environmental Kuznets Curve in E7 economies: Accounting for the combined impacts of institutional quality and renewables. Journal of Cleaner Production, 314, 127924.
Bekun, F. V., and Gyamfi, B. A. (2020), Rethinking the nexus between pollutant emission, financial development, renewable energy consumption and economic growth in G7 countries. Social, Human and Administrative Sciences-II, 73.
Boburmirzo, K., Boburjon, T. (2022), Exchange rate influence on foreign direct investment: Empirical evidence from Cis countries. International Journal of Management and Economics Fundamental, 2(4), 19-28.
Challoumis, C. (2024), Building A Sustainable Economy-how Ai Can Optimize Resource Allocation. In: XVI International Scientific Conference. p190-224.
Chen, S., Song, Y., Gao, P. (2023), Environmental, social, and governance (ESG) performance and financial outcomes: Analyzing the impact of ESG on financial performance. Journal of Environmental Management, 345, 118829.
Chou, C.H., Ngo, S.L., Tran, P.P. (2023), Renewable energy integration for sustainable economic growth: Insights and challenges via bibliometric analysis. Sustainability, 15(20), 15030.
Dilanchiev, A., Sharif, A., Ayad, H., Nuta, A.C. (2024), The interaction between remittance, FDI, renewable energy, and environmental quality: A panel data analysis for the top remittance-receiving countries. Environmental Science and Pollution Research, 31(10), 14912-14926.
Dingru, L., Onifade, S.T., Ramzan, M., Al-Faryan, M.A.S. (2023), Environmental perspectives on the impacts of trade and natural resources on renewable energy utilization in Sub-Sahara Africa: Accounting for FDI, income, and urbanization trends. Resources Policy, 80, 103204.
Edziah, B.K., Sun, H., Adom, P.K., Wang, F., Agyemang, A.O. (2022), The role of exogenous technological factors and renewable energy in carbon dioxide emission reduction in Sub-Saharan Africa. Renewable Energy, 196, 1418-1428.
Egli, F., Agutu, C., Steffen, B., Schmidt, T.S. (2023), The cost of electrifying all households in 40 Sub-Saharan African countries by 2030. Nature Communications, 14(1), 5066.
Gupta, S., Yadav, S.S., Jain, P.K. (2024), Does institutional quality matter for foreign direct investment flows? Empirical evidence from BRICS economies. International Journal of Emerging Markets, 19(12), 4431-4458.
Gyamfi, B.A. (2022), Consumption-based carbon emission and foreign direct investment in oil-producing Sub-Sahara African countries: The role of natural resources and urbanization. Environmental Science and Pollution Research, 29(9), 13154-13166.
Gyamfi, B.A., Bein, M.A., Udemba, E.N., Bekun, F.V. (2021), Investigating the pollution haven hypothesis in oil and non-oil sub-Saharan Africa countries: Evidence from quantile regression technique. Resources Policy, 73, 102119.
Gyamfi, B.A., Kwakwa, P.A., Adebayo, T.S. (2023), Energy intensity among European Union countries: The role of renewable energy, income and trade. International Journal of Energy Sector Management, 17(4), 801-819.
Hassan, S.T., Khan, S.U.D., Xia, E., Fatima, H. (2020), Role of institutions in correcting environmental pollution: An empirical investigation. Sustainable Cities and Society, 53, 101901.
Jahanger, A., Usman, M. (2023), Investigating the role of information and communication technologies, economic growth, and foreign direct investment in the mitigation of ecological damages for achieving sustainable development goals. Evaluation Review, 47(4), 653-679.
Jie, H., Khan, I., Alharthi, M., Zafar, M. W., and Saeed, A. (2023), Sustainable energy policy, socio-economic development, and ecological footprint: The economic significance of natural resources, population growth, and industrial development. Utilities Policy, 81, 101490.
Lee, J.W. (2013), The contribution of foreign direct investment to clean energy use, carbon emissions and economic growth. Energy Policy, 55, 483-489.
Lefstad, L., Paavola, J. (2024), The evolution of climate justice claims in global climate change negotiations under the UNFCCC. Critical Policy Studies, 18(3), 363-388.
Liu, W., Shen, Y., Razzaq, A. (2023), How renewable energy investment, environmental regulations, and financial development derive renewable energy transition: Evidence from G7 countries. Renewable Energy, 206, 1188-1197.
Mahbub, T., Ahammad, M.F., Tarba, S.Y., Mallick, S.Y. (2022), Factors encouraging foreign direct investment (FDI) in the wind and solar energy sector in an emerging country. Energy Strategy Reviews, 41, 100865.
Marton, C., Hagert, M. (2017), The Effects of FDI on Renewable Energy Consumption. Available from: https://lup.lub.lu.se/student-papers/search/publication/8912090
Mulopo, J. (2022), A mini-review of practical interventions of renewable energy for climate change in Sub-Saharan Africa in the last decade (2010-2020): Implications and perspectives. Heliyon, 8(11), e11296.
Mileva, E. (2007), Using arellano-bond dynamic panel GMM estimators in Stata. Economics Department, Fordham University, 64(1), 1-10.
Nhuong, B.H., Hang, L.T.T., Thuy, D.T.T., Quang, P.T., Anh, K.T.

(2024), Investigating the nexus between foreign direct investment and sustainable energy transition: The case of Vietnam. Journal of Environmental Assessment Policy and Management, 26(1), 2350023.
Nalule, V. R. (2021), How to respond to energy transitions in Africa: introducing the energy progression dialogue. Energy Transitions and the Future of the African Energy Sector: Law, Policy and Governance, 3-35.
Ofori, I.K., Figari, F., Ojong, N. (2023), Towards sustainability: The relationship between foreign direct investment, economic freedom and inclusive green growth. Journal of Cleaner Production, 406, 137020.
Ofori, I.K., Gbolonyo, E.Y., Ojong, N. (2023), Foreign direct investment and inclusive green growth in Africa: Energy efficiency contingencies and thresholds. Energy Economics, 117, 106414.
Olaniyi, C.O., Odhiambo, N.M. (2023), Does institutional quality matter in the financial development-economic complexity Nexus? Empirical insights from Africa. Research in Globalization, 7, 100173.
Olugbire, O.O., Olorunfemi, S., Oke, D.O. (2021), Global utilisation of cereals: Sustainability and environmental issues. Agro-Science, 20(1), 9-14.
Osman, A.I., Chen, L., Yang, M., Msigwa, G., Farghali, M., Fawzy, S., Yap, P.S. (2023), Cost, environmental impact, and resilience of renewable energy under a changing climate: A review. Environmental Chemistry Letters, 21(2), 741-764.
Othman, K., Khallaf, R. (2022), Identification of the barriers and key success factors for renewable energy public-private partnership projects: A continental analysis. Buildings, 12(10), 1511.
Pata, U.K., Dam, M.M., Kaya, F. (2023), How effective are renewable energy, tourism, trade openness, and foreign direct investment on CO_2 emissions? An EKC analysis for ASEAN countries. Environmental Science and Pollution Research, 30(6), 14821-14837.
Qamruzzaman, M. (2023), An asymmetric nexus between clean energy, good governance, education and inward FDI in China: Do environment and technology matter? Evidence for Chines provincial data. Heliyon, 9(5), e15612.
Ren, S., Hao, Y., Wu, H. (2022), The role of outward foreign direct investment (OFDI) on green total factor energy efficiency: Does institutional quality matters? Evidence from China. Resources Policy, 76, 102587.
Roodman, D. (2009), How to do xtabond2: An introduction to difference and system GMM in Stata, Stata Journal, 9, (1), 86-136.
Saqib, N., Dincă, G. (2024), Exploring the asymmetric impact of economic complexity, FDI, and green technology on carbon emissions: Policy stringency for clean-energy investing countries. Geoscience Frontiers, 15(4), 101671.
Sarkodie, S.A., Adams, S., Leirvik, T. (2020), Foreign direct investment and renewable energy in climate change mitigation: Does governance matter? Journal of Cleaner Production, 263, 121262.
Sarkodie, S.A., Strezov, V. (2019) Effect of foreign direct investments, economic development and energy consumption on greenhouse gas emissions in developing countries. Science of the Total Environment, 646, 862-871.
Sarpong, S.Y., Bein, M.A. (2021), The relationship between good governance and CO_2 emissions in oil-and non-oil-producing countries: A dynamic panel study of sub-Saharan Africa. Environmental Science and Pollution Research, 27, 21986-22003.
Sarpong, S.Y., Bein, M.A., Gyamfi, B.A., Sarkodie, S.A. (2020), The impact of tourism arrivals, tourism receipts and renewable energy consumption on quality of life: A panel study of Southern African region. Heliyon, 6(11), e05351.
Shittu, W.O., Musibau, H.O., Jimoh, S.O. (2022), The complementary roles of human capital and institutional quality on natural resource-FDI-economic growth Nexus in the MENA region. Environment, Development and Sustainability, 24(6), 7936-7957.
Tan, Y., Uprasen, U. (2022), The effect of foreign direct investment on renewable energy consumption subject to the moderating effect of environmental regulation: Evidence from the BRICS countries. Renewable Energy, 201, 135-149.
Wei, X., Mohsin, M., Zhang, Q. (2022), Role of foreign direct investment and economic growth in renewable energy development. Renewable Energy, 192, 828-837.
World Bank. (2020), World Bank Development Indicators. Available from: https://databank.worldbank.org/source/world-development-indicators# [Last accessed on 2024 Jun].
Yilanci, V., Ozgur, O., and Gorus, M.S. (2019), The asymmetric effects of foreign direct investment on clean energy consumption in BRICS countries: A recently introduced hidden cointegration test. Journal of Cleaner Production, 237, 117786.
Yousafzai, I., Sohail, M., Tahir, M. (2023), Impact of FDI and stock market expansion on clean energy: A case of selected countries. Journal of Asian Development Studies, 12(3), 556-572.
Zahoor, Z., Khan, I., Hou, F. (2022), Clean energy investment and financial development as determinants of environment and sustainable economic growth: Evidence from China. Environmental Science and Pollution Research, 29, 16006-16016.
Zreik, M. (2023), Analytical study on foreign direct investment divestment inflows and outflows in developing economies: Evidence of China. The Chinese Economy, 56(6), 415-430.