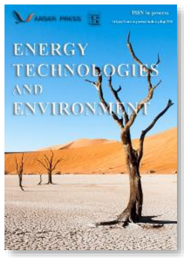
Energy Technologies and Environment 2024 2(3) 46-56

ANSER PRESS

Energy Technologies and Environment

Homepage: https://www.anserpress.org/journal/ete



Impact of Financial Market and Institution Development on Renewable Energy Consumption in Selected Sub-Saharan African Countries: Implications for Sustainable Development

Sani Abubakar [a, b, *], Abayomi Awujola [a], Marvelous Aigbedion [a]

[a] *Department of Economics, Bingham University, Karu, Nigeria*

[b] *Research Department, Central Bank of Nigeria, Abuja, Nigeria*

ABSTRACT

This research is informed by the reality that Sub-Saharan Africa requires new sources of energy for development and sustainability, but with minimum negative effects on the environment. This paper looks at the role played by financial market and financial institutions in the consumption of renewable energy in four Sub-Saharan African countries between 1995 and 2022. According to the IPAT model, we estimate our model through Panel Corrected Standard Errors and Feasible Generalized Least Squares to maintain the robustness of our test. The results reveal a clear divergence: while the financial markets and the financial institutions are both adding to the renewable energy consumption, the later has a greater influence. This implies that financial markets in the current region are relatively inefficient in facilitating the uptake of renewable energy. The findings of this study bear some significant policy implications as follows; policymakers should ensure the soundness of the financial institutions so as to finance the renewable energy investment for sustainable growth in SSA.

KEYWORDS

Financial Development; Renewable Energy; IPAT Equation; Financial Institution

* Corresponding author: Sani Abubakar
E-mail address: sabubakar8@cbn.gov.ng

ISSN
doi: 10.58567/ete02030004

Received 5 July 2024; Accepted 6 November 2024; Available online 7 March 2025; Version of Record 15 September 2024

1. Introduction

The burning of fossil fuels is one of the major causes of emissions of green house gases. As a result, it is now expected that countries shift towards the use of sustainable energy sources and focus on the renewable energy sources to mitigate the global pollution and for economic development (Akadiri et al., 2022; Akadiri et al., 2020; Fukuda, 2024; Shahbaz et al., 2022). Climate change has adverse impacts in SSA region; for instance, the region is prone to droughts and extreme weather conditions (IMF, 2022, 2023). Although SSA countries produce a negligible amount of carbon dioxide (CO_2) emissions, they are highly vulnerable to climate change effects. The latest trends in the CO_2 emissions have been on the rise in the region and this has attracted the attention of policymakers and researchers who are now demanding for sound policy interventions to address this issue (Acheampong et al., 2019). Several countries in the region have been targeting high rates of renewable energy in their total energy consumption (Baye et al., 2021).

Renewable energy has the possibility to enhance energy accessibility and decrease energy poverty. However, according to Alagidede et al. (2016), there are several challenges to renewable energy development in SSA. These are high initial costs of infrastructure, policy and regulatory support, lack of technical skills and geopolitical rivalry. Developing renewable energy infrastructure may lead to the use of renewable energy sources including solar, wind and hydro power which emit far much lesser carbon than fossil fuel (Alshehry & Belloumi, 2017; Mezghani & Haddad, 2017; Alsagr & Hemmen, 2021).

The present study adds to the literature on the link between financial development and RE consumption. Unlike previous studies, we focus on how various dimensions of financial development of financial markets and financial institutions influence renewable energy adoption in SSA, which is vulnerable to the negative impacts of non-renewable energy use on the environment. This focus on SSA sets our work apart from other research, for instance, Habiba and Xinbang (2023) that examined emerging economies in general. The study's purpose is to determine which sector is more significant in encouraging the consumption of renewable energy in SSA – the financial markets or the financial institutions. We also use a broad measure of financial development, unlike the previous studies which have used credit ratios or stock market capitalization ratios to measure financial development, thus giving a narrow perspective of the scope of financial development (Habiba & Xinbang, 2023).

Key findings from our analysis indicate that while both financial markets and financial institutions contribute to renewable energy development, financial institutions exert a more substantial positive impact. This result underscores the importance of strengthening financial institutions to foster renewable energy investments in SSA, where financial markets may currently lack the necessary depth for effectively supporting sustainable energy transitions.

The remainder of the paper is organized as follows: Section 2 provides an overview of the existing literature, Section 3 details the methodology and data, Section 4 presents the empirical analysis and discussion, sections 5 and 6 offer conclusions and recommendations, respectively.

2. Literature Review

As the world seeks to attain sustainable and efficient energy system, the relationship between financial development (FD) and energy consumption has received considerable attention among scholars. This section discusses previous literature, with a focus on the interaction between FD and REC, as well as conventional energy sources.

A lot of papers have investigated the relationship between FD and conventional electricity use and the results have been mostly positive. On the same note, Liu et al. (2018) used the Autoregressive Distributed Lag (ARDL) approach in the case of China and found that FD has a direct relation with energy consumption. In the same way, Kahouli (2017) established a positive connection between FD and energy consumption in the South Mediterranean countries, but with the application of conventional energy only. Paramati et al. (2016) extended this study to emerging economy and found a strong positive impact of foreign capital inflows, stock markets and energy consumption. These results are also in harmony with the study of Rafindadi and Ozturk (2017) which was Japan based and confirmed the positive relationship between FD and energy demand.

On the other hand, some other works find a negative relationship between FD and energy consumption implying that sound financial structure promotes energy conservation. Chiu and Lee (2020) noted that FD was negatively related with energy consumption in countries with low risk fluctuation. Similarly, Destek (2018) found the similar result in the case of developing economy where expansion of banking and bond markets are detrimental for energy consumption. These studies provide another view, indicating that financial developments can have the potential to help improve the utilisation of energy.

As the field of FD and REC is still in the development stage, there are not many empirical studies carried out on this subject but some research works have been done. Habiba and Xinbang (2023) decomposed the relationship between FD and REC in E7 countries during 1991–2018 and revealed that both financial markets and total FD have a positive impact on REC in these nations. Dimnwobi et al. (2022) concentrated on Nigeria while emphasizing the importance of FD in enhancing REC. Along the same line, Khan et al. (2021) found a significant relationship between FD and REC and pointed out that financial development drives renewable energy investments in different environments.

Some other works, for instance, Shahbaz et al. (2022) and Lahiani et al. (2021) argue that more research is required since the findings are not conclusive or are mixed across the globe. The increasing body of research on FD and REC also suggests that more research needs to be devoted to this relationship, especially in areas where the use of renewable energy is not well developed.

A notable limitation in many empirical studies is the reliance on isolated measures of FD, such as private credit, stock market capitalization, or broad money supply (M2), all expressed as ratios of GDP. However, FD is a multifaceted process that involves various dimensions beyond single indicators (Svirydzenka, 2016). Using these isolated measures may only partially capture the complexity of FD, thereby limiting the scope of analysis. This study addresses this gap by employing a more comprehensive measure of FD to provide a clearer understanding of its impact on REC.

While studies increasingly explore the link between FD and REC, the literature remains fragmented, with inconsistent findings across regions and methodologies. Furthermore, few studies focus specifically on Sub-Saharan Africa (SSA), a region facing unique challenges in achieving sustainable energy transitions. By examining the differentiated impact of financial markets and financial institutions on REC in SSA, this study aims to address these gaps and contribute a nuanced perspective to the literature on FD and sustainable energy.

3. Methodology

Theoretically, we use Dietz and Rosa (1997) proposition of the regression model for the IPAT model, which is expressed as:

$$I = aP^{b1}A^{b2}T^{b3}e \quad (1)$$

Where α is a constant an erm, $\beta_1, \beta_2, \beta_3$ are the exponential terms for P (population), A (Afluence) and, T (technology), and e is the error term. When you log-transform equation (1), you have equation (2):

$$ln\, I = \alpha + b_1\, ln\, P + b_2\, ln\, A + b_3\, ln\, T + e \quad (2)$$

The IPAT model has undergone modifications and is currently a commonly employed tool for analyzing the determinants of environmental change. Due to its association with pollution as a byproduct of energy consumption, this model has been used to investigate energy consumption issues, particularly those related to non-renewable energy consumption.

Equation 2 delineates the subsequent three equations, which are formulated according to the research's stated objective.

Equation (2) is at this moment rewritten into equations (3), (4), and (5):

$$REC_{it} = b_{0i} + b_1 OFDI_{it} + b_2 GDP_{it} + b_3 ICT_{it} + b_4 POP_{it} + \mu_{it} + \gamma_{it} + \varepsilon_{it} \quad (3)$$

$$REC_{it} = b_{0i} + b_1 OFII_{it} + b_2 GDP_{it} + b_3 ICT_{it} + b_4 POP_{it} + \mu_{it} + \gamma_{it} + \varepsilon_{it} \quad (4)$$

$$REC_{it} = b_{0i} + b_1 OFMI_{it} + b_2 GDP_{it} + b_3 ICT_{it} + b_4 POP_{it} + \mu_{it} + \gamma_{it} + \varepsilon_{it} \quad (5)$$

Where REC means renewable energy consumption, b_0 through b_4 represent parameters to be estimated. OFDI, OFII, and OFMI are indexes on overall financial development, overall financial institution development, and overall financial market, respectively. GDP depicts economic growth, ICT means information and communication technology, and POP represents the population. μ_{it} represents an unknown country specific while γ_{it} is an unknown year specific. Finally, ε_{it} is the error term. Each model is built for every segment of financial development to avoid multicollinearity.

3.1. Nature and Sources of Data

The research covers 1995 to 2022 and uses panel data from four countries in SSA (Ghana, Kenya, Nigeria and South Africa). This study empirically examines the relationship between different components of FD and REC in selected SSA. The data on REC (% of total final energy consumption), Information and communication technology (number of mobile subscribers by 100), Economic Growth (GDP, constant 2015 US$), and population (population, total) are sourced from WDI (2024). The data on the multidimensional segments of FD are obtained from the IMF (2024) data world[1].

The accessibility of data justifies the utilization of periods. The utilization of SSA data in this study is justified due to its distinctive characteristics, which offer an exceptional opportunity for investigation. The Sub-Saharan Africa (SSA) region needs more renewable energy infrastructure. The continent exhibits the lowest level of electrification among all regions and is inhabited by around 600 million individuals lacking access to electricity. Furthermore, it possesses one of the most underdeveloped policy frameworks to facilitate energy accessibility. The 4 Sub-Saharan African countries selected are the nations with the most developed financial markets: South Africa, Nigeria, Kenya, and Ghana (see African Securities Exchange Association[2]). The four countries also account for 95 percent of the SSA market capitalization as a percentage of GDP in 2022 (see WDI, 2022). Hence, the selected SSA countries provide an interesting case to be studied.

3.2. Method of Data Analysis

The initial step in the empirical study involves conducting a cross-sectional dependence (CD) test across the countries to ascertain the appropriate methodologies. The potential for CD in panel data is significantly elevated due to the near spatial proximity of the units and the potential for shared common characteristics. The Pesaran (2004) CD test is conducted according to the following procedure:

---

[1] https://data.imf.org/?sk=f8032e80-b36c-43b1-ac26-493c5b1cd33b

[2] https://african-exchanges.org/

$$CD = \sqrt{\frac{2T}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \acute{P}_{ij} \quad (6)$$

T stands for time, N denotes the sample size, and p_{ij} explains the link among pairs of residual series.

Bias estimations and conclusions may arise CD exist in the data, as noted by Pesaran (2006). When CD is present, second-generation (SG) unit root tests are employed so as to mitigate the risk of obtaining incorrect inferences from the data. Hence, the cross-sectional augmented Im, Pesaran, and Shin (CIPS) methodology of (2007) is utilized in this study. The process can be described as follows:

$$CIPS(N,T) = \check{T} = N^{-1} \sum_{i=j}^{N} t_i\,(N,T) \quad (7)$$

N means number of cross-sections and T stands for time. The left-hand side of the equation expresess the unit root test for heterogeneous panels.

Subsequently, we evaluate the long-run relationship between the variables by employing the second-generation panel cointegration test. The second-generation cointegration technique is appropriate when confronted with conditional heteroscedasticity in the data. When CD is observed, and cointegration among the variables exist, the panel-corrected standard errors (PCSE) is employed to account for serial correlation as well as heteroscedasticity. To confirm consistency of our results and assess the stability of the outcomes, we employ the feasible generalized least squares (FGLS) methods.

However, the use of PCSE has a limitation of assuming the nature of serial correlation within each panel to estimate the variance of the errors which may not be well suited when there is a complex error structure in the data as observed in datasets from SSA. To address this as noted earlier, we apply FGLS that offers an alternative method by permitting different variances across the panels and is capable of estimating both cross sectional and serial correlation more effectively.

Although FGLS aids in confirming the stability and reliability of the results, it has some drawbacks: FGLS is sensitive to model specification, and the presence of a bias in estimates when the sample size is small. Being aware of this, we used FGLS in addition to PCSE to conduct the analysis, which made our results more credible. Furthermore, diagnostic checks were used to ensure that each method was appropriate and the assumptions were not over constraining hence yielding accurate and consistent results.

4. Empirical Results and Discussions

The paper examines the descriptive statistics of the series presented in Table 1.

Table 1. Descriptive Statistics.

	REC	OFDI	OFII	OFMI	GDP	ICT	POP
Mean	57.268	0.243	0.285	0.196	2611.319	59.697	68553412
Median	72.230	0.178	0.224	0.170	1721.961	58.827	47445610
Max.	88.680	0.592	0.638	0.549	6263.104	168.924	0.000
Min.	7.7200	0.098	0.138	0.531	931.185	0.008	17438874
Std. D.	29.430	0.147	0.151	0.860	1801.907	52.967	55509462
Skew.	-0.694	1.208	1.181	0.907	1.082	0.395	1.329
Kurt.	1.838	2.973	2.984	2.522	2.567	1.906	3.410
JB	15.287	27.27	26.06	16.30	22.92	8.493	33.767
Prob.	0.000	0.000	0.000	0.000	0.000	0.014	0.000

Source: Author's Compilation

The dataset exhibits a range of distinct properties across the variables. Nevertheless, the Jarque-Bera test holds significant importance as it evaluates the normality of a given dataset. The evaluation assesses the adherence of the data to a normal distribution, which carries various implications contingent upon the test outcomes. According to the data presented in Table 1, it can be observed that all series have a normal distribution, as indicated by the probability values.

The research further examines variables with significant correlations to identify variables incompatible with inclusion within the same model.

Table 2. Correlation Analysis.

	REC	OFDI	OFII	OFMI	GDP	ICT	POP
REC	1.0000						
OFDI	-0.8318	1.000000					
	0.0000	-----					
OFII	-0.8528	0.9637	1.0000				
	0.0000	0.0000	-----				
OFMI	-0.7488	0.9626	0.8555	1.000000			
	0.0000	0.0000	0.0000	-----			
GDP	-0.8650	0.9836	0.9535	0.9411	1.0000		
	0.0000	0.0000	0.0000	0.0000	-----		
ICT	-0.5012	0.5222	0.5621	0.4396	0.5122	1.0000	
	0.0000	0.0000	0.0000	0.0000	0.0000	-----	
POP	0.3899	0.0297	-0.1299	0.1897	0.0284	0.0412	1.0000
	0.0000	0.7555	0.1722	0.0451	0.7660	0.6656	-----

Source: Author's Compilation

Table 2 exhibits a strong positive association among the FD indicators. Hence, our study incorporates variables of interest into a set of three equations to mitigate the issue of multicollinearity.

Panel data frequently uncover the presence of CD because of interconnections among countries. To ensure reliable and unbiased outcomes, the estimates must be devoid of cross-sectional dependence (Phillips & Sul, 2003). Consequently, this investigation begins by verifying the presence of CD to confirm the findings' reliability and consistency.

Table 3. CD.

Variable	**Breusch-P LM**
REC	-1.06***
OFDI	8.77***
GDP	10.82***
ICT	12.44***
POP	12.71***
OFII	9.97***
OFMI	5.51***

*Note: ***, **, and * signifies 1%, 5%, and 10% significance levels, respectively. Source: Author's Compilation*

In Table 3, The statistical significance of the p-values associated with the test statistics indicates sufficient evidence to reject the null hypothesis. This suggests that variations in the economic conditions of a particular country can have an impact on others. Hence, the SG panel unit root test is employed.

The variables as shown in Table 4 are non-stationary at level. However, all are stationary at first difference. Therefore, using the second-generation cointegration, the paper examined cointegration.

Table 4. SG Unit Root Test (Im–Pesaran–Shin).

Variable	Level	Variable	First Difference
REC	-0.2154	D.REC	-3.4145***
OFDI	-0.6008	D.OFDI	-3.4365***
OFII	1.4323	D.OFII	-3.6157***
OFMI	-2.1891	D.OFMI	-3.5023***
GDP	-0.0778	D.GDP	-2.9543***
ICT	0.3043	D.ICT	-2.9364***
POP	3.4186	D.POP	-2.6620***

*Note: ***, **, and * represent 1%, 5%, and 10% statistically significant levels, respectively. Source: Author's Compilation.*

Table 5 presents the outcomes of the Kao Tet test. The study concludes that the null hypothesis, which posits no cointegration among the models, is rejected in favor of the alternative hypothesis. The findings generally support the existence of cointegration between rec and the other variables under examination.

Table 5. Kao test for cointegration.

AR parameter	Statistics (OFDI)	Statistics (OFII)	Statistics (OFMI)
MDF	-10.7264***	-9.0402***	-10.7939***
DF	-9.2584***	-7.4260***	-9.4244***
ADF	-4.5303***	-3.3779***	-4.5033***
UMDF	-15.1922***	-12.8951***	-15.3502***
UDF	-9.7064 ***	-7.8900***	-9.8805***

***Note**: MDF stands for modified Dickey-Fuller, DF means Dickey-Fuller, ADF denotes augmented Dickey-Fuller, UMDF connotes unadjusted modified Dickey-Fuller, and UDF is an acronym for unadjusted Dickey-Fuller. *** means significant at 1 percent. Source: Author's Compilation*

Given the outcome of the CD and cointegration tests, we utilize the PCSE to estimate all three models of financial development. This approach effectively addresses issues of heteroscedasticity and serial correlation. In order to conduct robustness tests and assess the sensitivity of the results to various methodologies, this study employs the also the FGLS methodology. The findings are displayed in Table 6 and focus only on the components of FD, which are the objectives of the study.

OFDI has a positive coefficient of 0.65[3] Moreover, 0.63 for PCSE and FGLS, respectively, and the statistical significance suggests that a percentage change in the overall FD index is associated with a significant positive increase on REC. This suggests that a more advanced finance system will likely facilitate investment and foster growth within the renewable energy sector. The findings are consistent with the research conducted by Kim and Park (2016) and Habiba and Xinbang (2023).

The OFII has a coefficient of 0.36, which is statistically significant. This suggests that a substantial positive relationship between the OFII and REC exist. This observation suggests that robust FI play a vital role in promoting both the investment and use of RC.

The OFMI observed coefficient of 0.30 indicates a statistically significant and positive relationship between the financial market development and REC. A robust financial market has the potential to facilitate the expansion and advancement of renewable energy initiatives.

The above findings could be due to structural differences where the influence of financial institutions is stronger than that of financial markets in SSA. In SSA, banking systems are relatively more advanced than capital markets which are still in their infancy, and suffer from problems such as low turnover and limited demand. These factors may dampen the ability of financial markets to finance renewable energy investments compared to financial

[3] The confidences are divided by 100 because the growth rate of the dependent variable is taken before the estimation.

institutions, a trend that is different from more developed countries where capital markets are instrumental in financing.

Table 6. Contemporaneous Correlation Models.

Model 1	**(PCSE)**		**(FGLS)**	
Variable	**Coefficient**	**Standard Error**	**Coefficient**	**Standard Error**
OFDI	65.8738***	14.8313	63.48***	12.60
GDP	-0.0056***	0.0012	-0.00547***	0.0010
ICT	0.0182***	0.0069	0.0148**	0.0071
POP	0.0008***	0.0009	0.0000**	0.0000
CONS	-5.0213***	0.6970	-1.673**	0.776
WALD TEST	39***		35.91***	
Model 2	**(PCSE)**		**(FGLS)**	
Variable	**Coefficient**	**Standard Error**	**Coefficient**	**Standard Error**
OFII	35.9817***	10.5875	31.62***	11.58
GDP	-0.0032***	0.0010	-0.00174***	0.0005
ICT	0.0095	0.0070	-0.00451	0.0110
POP	0.008***	0.009	0.0000**	0.0000
CONS	-5.5726***	0.9632	-2.082***	0.751
WALD TEST	20***		16.58***	
Model 3	**(PCSE)**		**(FGLS)**	
Variable	**Coefficient**	**Standard Error**	**Coefficient**	**Standard Error**
OFMI	29.9880***	9.7025	-2.000	3.658
GDP	-0.0025***	0.0008	-0.0003	0.0003
ICT	0.0204**	0.0094	0.0162**	0.0080
POP	0.0009	0.0009	0.0000	0.0000
CONS	-2.9643***	0.5983	0.596	0.919
WALD TEST	22***		8.856***	

*Source: Author's Compilation, *** p<0.01, ** p<0.05, * p<0.1.*

Since the SSA policymakers rely on financial institutions in supporting REC, the latter should enhance the capacity of these institutions. This could mean adopting green lending standards, encouraging sustainability-secured financing, and providing incentives for banks to finance renewable energy. Moreover, the work is needed to create and develop financial markets that would increase the variety of funding sources and the availability of funds for the development of renewable energy projects in the long term. Measures to encourage the inflows of FDI and improve the conditions of the market could over time increase the contribution of financial markets to sustainability.

5. Conclusions

This paper examines the role of the components of FD on REC in the selected SSA countries over the period 1995-2022. Research outcomes show that the most significant impact on REC is experienced by the financial institution index, especially the Overall Financial Institution Development Index (OFII). This result further reinforces the need for an efficient financial sector with strong and available financial institutions that support investments and the promotion of renewable energy in SSA. he financial institution index, particularly the Overall Financial Institution Development Index (OFII), exerts the highest influence on REC. This result underscores the importance of a well-developed financial system characterized by robust, accessible financial institutions in facilitating investments and expanding renewable energy use across SSA.

6. Recommendations

Based on the findings, the following recommendations are proposed:

i. Since there is a positive relationship between OFII and REC, more emphasis has to be placed on the establishment of financial institutions. This can involve: Enhancing the institutional structures in order to increase the solidity, effectiveness and transparency of the financials. Promoting the institutional frameworks that foster appropriate financing of renewable energy projects in order to advance energy transformations.

ii. Incentivize Financial Institution Support for Renewable Energy: In order to raise REC, governments must encourage financial institutions to invest in renewable power projects. Measures could include: Setting up of dedicated funds or financial instruments for clean energy activities. Providing grants, tax credits and loan guarantees to lenders and other financial institutions that can sponsor renewable energy projects.

iii. Develop Financial Markets to Support Green Investments: Although OFMI had comparatively lesser contribution, development of financial markets is crucial for the sustainable support of renewable energy in the long run. This could be achieved by: Lowering the barriers of entry and improving the market transparency that can boost the attractiveness of financial markets for renewable energy investments. Enhancing investor protections, lowering transaction costs and increasing transparency in order to promote a safer environment for green investments. Targeted Interventions in Financial Markets: The overall results show that financial market development has a less significant role in increasing FDI in SSA, thus pointing at the importance of continued development of these markets. This can also involve actions that enhance market liquidity and extend the range of green financing schemes to enhance the position of financial markets in the support of REC.

7. Limitations and Suggestions for Future Research

These findings of this study are restricted to the selected SSA countries and the period between 1995 and 2022, which may not capture current advancements in renewable energy and financial market. More research could be done to include other SSA countries in this analysis and to advance the time period as more data is released. Additionally, future studies could explore:

Comparative Analysis of Financial Development Measures: Perhaps, the analysis of other forms of financial development, such as green bonds or microfinances, could add more variables to the discussion of FD and REC connections.

Sector-Specific Financial Impacts on REC: If the roles of financial institutions and markets are evaluated more in specific renewable energy segments such as solar or wind, it would facilitate better policy prescriptions for SSA's energy environment.

Funding Statement

This research received no external funding.

Acknowledgments

We appreciate Bingham University.

Conflict of interest

All the authors claim that the manuscript is completely original. The authors also declare no conflict of interest.

Author contributions

Conceptualization: Marvelous, Aigbedion; Investigation: Sani Abubakar; Methodology: Sani Abubakar; Formal analysis: Sani Abubakar; Writing – original draft: Sani Abubakar; Writing – review & editing: Abayomi Awujola, Marvelous Aigbedion.

References

Acheampong, A. O., Adams, S., and Boateng, E. (2019). Do globalization and renewable energy contribute to carbon emissions mitigation in Sub-Saharan Africa? *Science of the Total Environment, 677*, 436-446. https://doi.org/10.1016/j.scitotenv.2019.04.353

Akadiri, S. S., Alola, A. A., Bekun, F. V., and Etokakpan, M. U. (2020). Does electricity consumption and globalization increase pollutant emissions? Implications for environmental sustainability target for China. *Environmental Science and Pollution Research*, *27*, 25450-25460. https://doi.org/10.1007/s11356-020-08784-3

Akadiri, S. S., Adebayo, T. S., Nakorji, M., Mwakapwa, W., Inusa, E. M., and Izuchukwu, O. O. (2022). Impacts of globalization and energy consumption on environmental degradation: What is the way to achieve environmental sustainability targets in Nigeria? *Environmental Science and Pollution Research*, *29*(40), 60426-60439. https://doi.org/10.1007/s11356-022-20180-7

Alagidede, P., Adu, G., and Frimpong, P. B. (2016). The effect of climate change on economic growth: evidence from Sub-Saharan Africa. *Environmental Economics and Policy Studies, 18*, 417-436. https://doi.org/10.1007/s10018-015-0116-3

Alsagr, N., and van Hemmen, S. (2021). The impact of financial development and geopolitical risk on renewable energy consumption: evidence from emerging markets. *Environmental Science and Pollution Research, 28*, 25906-25919. https://doi.org/10.1007/s11356-021-12447-2

Alshehry, A. S., and Belloumi, M. (2017). Study the environmental Kuznets curve for transport carbon dioxide emissions in Saudi Arabia. *Renewable and Sustainable Energy Reviews, 75*, 1339-1347. https://doi.org/10.1016/j.rser.2016.11.122

Apergis, N. (2016). Environmental Kuznets curves: new evidence on both panel and country-level CO2 emissions. *Energy Economics*, *54*, 263–271. https://doi.org/10.1016/j.eneco.2015.12.007

Baye, R. S., Olper, A., Ahenkan, A., Musah-Surugu, I. J., Anuga, S. W., and Darkwah, S. (2021). Renewable energy consumption in Africa: Evidence from a bias-corrected dynamic panel. *Science of the Total Environment*, 766, 142583. https://doi.org/10.1016/j.scitotenv.2020.142583

Chiu, Y. B., and Lee, C. C. (2020). Effects of financial development on energy consumption: The role of country risks. *Energy Economics, 90*, 104833. https://doi.org/10.1016/j.eneco.2020.104833

Destek, M. A. (2018). Financial development and energy consumption nexus in emerging economies. Energy Sources, Part B: *Economics, Planning, and Policy, 13*(1), 76-81. https://doi.org/10.1080/15567249.2017.1405106

Dietz, T., and Rosa, E. A. (1997). Environmental impacts of population and consumption. *Environmentally significant consumption: Research directions*, 92-99.

Dimnwobi, S. K., Madichie, C. V., Ekesiobi, C., and Asongu, S. A. (2022). Financial development and renewable energy consumption in Nigeria. *Renewable energy, 192*, 668–677. https://doi.org/10.1016/j.renene.2022.04.150

Fukuda, T. (2024). ARDL and VECM Investigation of the Environmental Kuznets Curve Hypothesis in Egypt, India, Mexico, Pakistan, Thailand, and Turkey: Financial Development, Globalization, and Government Expenditure Implications for Sustainable Development. *Energy Technologies and Environment, 2*(2), 29-48. https://doi.org/10.58567/ete02020003

Habiba, U., and Xinbang, C. (2023). The contribution of different aspects of financial development to renewable energy consumption in E7 countries: The transition to a sustainable future. Renewable Energy, 203, 703-714. https://doi.org/10.1016/j.renene.2022.12.088

IMF (2022). *Climate Change and Chronic Food Insecurity in Sub-Saharan Africa. African and Research Departments*, Departmental Paper. https://www.imf.org/en/Publications/Departmental-Papers-Policy-Papers/Issues/2022/09/13/Climate-Change-and-Chronic-Food-Insecurity-in-Sub-Saharan-Africa-522211

IMF (2023). Financing for Resilience, Eleventh African Fiscal Forum, https://www.imf.org/en/News/Seminars/Conferences/2023/03/21/11th-african-fiscal-forum

IMF (2024). *Financial Development Index*. https://data.imf.org/?sk=f8032e80-b36c-43b1-ac26-493c5b1cd33b

International Energy Agency (2020). World Energy Outlook, Paris, 2020

Kahouli, B. (2017). The short and long run causality relationship among economic growth, energy consumption, and financial development: Evidence from South Mediterranean Countries (SMCs). *Energy Economics, 68*, 19–30. https://doi.org/10.1016/j.eneco.2017.09.013

Khan, A., Chenggang, Y., Hussain, J., and Kui, Z. (2021). Impact of technological innovation, financial development, and foreign direct investment on renewable, non-renewable energy and the environment in Belt & Road Initiative countries. *Renewable Energy, 171*, 479-491. https://doi.org/10.1016/j.renene.2021.02.075

Kim, J., and Park, K. (2016). Financial development and deployment of renewable energy technologies. *Energy Economics*, *59*, 238-250. https://doi.org/10.1016/j.renene.2021.02.075

Lahiani, A., Mefteh-Wali, S., Shahbaz, M., and Vo, X. V. (2021). Does financial development influence renewable energy consumption to achieve carbon neutrality in the USA? *Energy Policy*, *158*, 112524. https://doi.org/10.1016/j.enpol.2021.112524

Liu, H., Kim, H., Liang, S., and Kwon, O. S. (2018). Export diversification and ecological footprint: a comparative study on EKC theory among Korea, Japan, and China. *Sustainability, 10*(10), 3657. https://doi.org/10.3390/su10103657

Mezghani, I., and Haddad, H. B. (2017). Energy consumption and economic growth: An empirical study of the electricity consumption in Saudi Arabia. *Renewable and Sustainable Energy Reviews*, *75*, 145-156. https://doi.org/10.3390/su10103657

Pesaran, M. H. (2004). General diagnostic tests for cross-section dependence in panels. *Available at SSRN 572504*.

Pesaran, M. H. (2006). Estimation and inference in large heterogeneous panels with a multifactor error structure. *Econometrica*, *74*(4), 967-1012. https://doi.org/10.1111/j.1468-0262.2006.00692.x

Pesaran, M. H. (2007). A simple panel unit root test in the presence of cross-section dependence. *Journal of Applied Econometrics*, *22*(2), 265-312. https://doi.org/10.1002/jae.951

Phillips, P. C., and Sul, D. (2003). Dynamic panel estimation and homogeneity testing under cross-section dependence. *The econometrics journal*, *6*(1), 217–259. https://doi.org/10.1111/1368-423X.00108

Rafindadi, A. A., and Ozturk, I. (2017). Impacts of renewable energy consumption on the German economic growth: Evidence from combined cointegration test. *Renewable and Sustainable Energy Reviews, 75,* 1130-1141. https://doi.org/10.1016/j.rser.2016.11.093

Shahbaz, M., Sinha, A., Raghutla, C., and Vo, X. V. (2022). Decomposing scale and technique effects of financial development and foreign direct investment on renewable energy consumption. *Energy, 238,* 121758. https://doi.org/10.1016/j.energy.2021.121758

Shahbaz, M., Topcu, B. A., Sarıgül, S. S., and Vo, X. V. (2021). The effect of financial development on renewable energy demand: The case of developing countries. *Renewable Energy*, *178*, 1370-1380. https://doi.org/10.1016/j.renene.2021.06.121

Svirydzenka, K. (2016). *Introducing a new broad-based index of financial development*. International Monetary Fund.

World Bank (2024). World development indicators. Available on https://databank.worldbank.org/source/world-development-indicators

Yu, M., Jin, H., Zhang, H., and Chong, A. Y. L. (2022). ICT, Financial Development, and Renewable Energy Consumption. *Journal of Computer Information Systems*, 1–14. https://doi.org/10.1080/08874417.2022.2049017

Zhang, Y. J., and Da, Y. B. (2015). The decomposition of energy-related carbon emission and its decoupling with economic growth in China. *Renewable and Sustainable Energy Reviews, 41*, 1255–1266. https://doi.org/10.1016/j.rser.2014.09.021