An Examination of FDI's Moderating Effect on Finance, Growth and Energy Nexus in Brics.

Paidamoyo Mutepfa

Ministry of Local Government and Public Works, Zimbabwe

DOI: https://dx.doi.org/10.47772/IJRISS.2025.906000242

Received: 29 May 2025; Accepted: 04 June 2025; Published: 09 July 2025

ABSTRACT

The objective of the study was to analyse the connection among renewable energy consumption, financial development and economic growth with particular attention paid to the moderating role of foreign direct investment. The study employed panel data from the BRICS[1] countries over the period 1995-2022. The panel regression approach took into account the interaction term which captured the moderating impact of FDI on the growth-finance-energy nexus. The outcome of the study revealed that economic growth had a positive impact on REC which implied that as economies grow, consumption of clean energy also increases. In addition, FDI on its own exerted a positive impact on REC, emphasising its significant role in permitting capital inflows, innovation as well as technological transfer. However, the interaction between FDI and GDP revealed a negative moderation role which can be explained by the fact that when FDI is the dominant component of GDP, its effects are likely to divert resources away from sustainable energy investments to non-renewable based industries. Furthermore, the results of the study highlighted that urbanization and inflation also promoted REC, whilst trade and natural resource rents suppress it, implying that the resource curse hypothesis holds water within BRICS economies. As part of the recommendations, BRICS nations are encouraged to adopt policies which ensure that FDI flows to sustainable energy initiatives, cut their dependence on resource rents and strengthen financial systems to better support clean energy initiatives. The introduction of FDI as a moderating factor in the growth-finance-energy link and the policy guidance provided are the key contributions of this paper to the literature.

Keywords: Renewable Energy Consumption, Moderating Role, Foreign Direct Investment, Financial Development, Economic Growth and BRICS

INTRODUCTION AND BACKGROUND OF THE STUDY.

One of the most topical issues which has captured the attention of global leaders in our life time is climate change. This is as a result of its impact on economic growth, especially on emerging countries (Yadav , Ozturk , Ferreira, Karalinc, & Bekun, 2024). Economic growth has always been and it is still considered a key priority by most policy makers and researchers alike (Fernando & McKibbin, 2021). As a result of the detrimental effects of climate change, renewable energy sources have been advocated as a key solution to mitigate its impact (Intergovernmental Panel on Climate Change , 2012). It has also been observed that one of the key drivers of economic growth and development is a consistent supply of energy (Mukhtarov, Humbatova, Seyfullayev, & Kalbiyev, 2020). This is based on the notion that power is a key input in the value chain of nearly all the goods and services. As a result, sustained economic growth increasingly depends on high power consumption to support the manufacturing and provision of goods and services.

It has however been noted that the continued demand for power to drive economic growth has been considered as one of the key factors accelerating climate change (Akpan & Akpan, 2012). The International Energy Agency in its 2024 report noted that global energy demand rose by approximately 2.2% which was below the GDP growth of 3.2%. However, the growth in demand for energy was considerably moving at higher pace as compared

[1] BRICS countries include Brazil, Russia, India, China and South Africa. The group expanded in 2024 to include Egypt, Ethiopia, Indonesia, Iran and United Arab Emirates which were not included in this study.

to the yearly average demand increase of 1.3% observed between 2013 and 2023 (International Energy Agency [IEA], 2025). The increase in the global demand for energy has been primarily driven by emerging and developing countries, which accounted for over 80% of the global energy demand growth (International Energy Agency [IEA], 2025). In China, energy demand growth slowed down to below 3% in 2024, which was half the rate of the previous year and lower than the country's average yearly growth rate of approximately 4.3% in the previous years. Despite the reduction in the demand for energy, China still recorded the biggest demand growth in absolute terms as compared to any country in 2024 (International Energy Agency [IEA], 2025). In addition, India recorded the second- highest increase in energy demand in absolute terms. The increase recorded in India was more than the increase in all the advanced economies combined (International Energy Agency [IEA], 2025). As the global demand for energy continue to increase, countries are likely to continue to produce more electricity to meet that demand. However, the increase in energy production is likely to increase emissions of various air pollutants as well as greenhouse gases which contributes to climate change. Policymakers and researchers alike have recognised the need for financing packages specifically aimed at supporting renewable energy initiatives.

In order to achieve sustainable development, recent studies have been focusing on the contribution of the financial sector in promoting renewable energy consumption (Koffi, 2020; Asongu & Odhiambo, 2020; Dimnwobi, et al., 2022 & Prempeh, 2023). The growth of the financial sector has been credited with enhencing renewable energy consumption by diversifying or expanding the power mix as well as improving energy security of countries (Dossou, Pascal, Kambaye, Asongu, & Alinsato, 2024). Furthermore, financial development has also been credited for reducing rampant energy poverty. As nations pursue economic growth, financial systems play a critical role of shaping energy use through the enhancement of accessing capital, promoting technological improvements as well as promoting energy efficiency (Gashiten & Mutepfa, 2021). In the case of BRICS countries which are considered as substaintial contributors of global carbon emissions, a comprehension of the link amongst financial development, economic growth and renewable energy consumption is of paramount importance. By diving deep into this area of study, the study intends to bridge the current knowledge gaps by providing the latest perspectives on the efficacy of financial systems and economic development on the transition towards green energy systems amongst the BRICS countries. The study therefore seeks to explore this relationship by highlighting the efficacy of financial development in accelerating the shift towards carbon neutrality in an area that has received limited attention in past studies (Yadav , Ozturk , Ferreira, Karalinc, & Bekun, 2024).

Members of the BRICS forum for cooperative trade are considered the largest emerging economies, exhibiting considerable economic growth alongside varying patterns of renewable energy consumption (Yadav , Ozturk , Ferreira, Karalinc, & Bekun, 2024). The researcher sets the study apart by focusing specifically on renewable energy consumption among the BRICS economies, recognised as the largest emerging economies, while also examining the mediating role of Foregin Direct Investment [FDI] dynamics within the renewable energy mix. To the best of the researchers knowledge, previous studies analysing the impact of financial development and economic growth on renewable energy consumption have overlooked the significant role played by FDI in shaping the growth, finance and renewable energy nexus.

Inasmuch as this paper offers valuable insights into how financial development, economic growth, FDI, and the use of renewable energy interact in the BRICS economies, it should be noted that there are some weaknesses that should be taken into account in order to put the results in perspective. These limitations are mostly due to methodological issues, such as the potential for endogeneity from simultaneity bias, reverse causation, and missing data. Furthermore, the accuracy of the research may be weakened by measurement limitations associated with the use of aggregated macroeconomic variables, such as composite financial development indexes and undifferentiated FDI inflows. These elements are likely to affect the study's conclusions' generalizability, causation, and robustness.

The rest of the paper is structured as follows: Section two reviews the literature on the nexus amongst financial development, economic growth and renewable energy consumption. Section three outlines the methodology, focusing on three main areas: the specification and the estimation technique of the model, a discussion of the key variables used and the data sources. Section Four presents the results of the study while Section Five provides the recommendations and suggestions for future studies.

LITERATURE REVIEW

Theoretical Literature Review

The theoretical connection between renewable energy consumption and financial development can be analysed in a multifaceted context. The most common perspective includes analysing the link through economic growth and foreign direct investment channels. Several theories have supported the vital role played by foreign direct investment when it comes to strengthening the link between financial development and renewable energy consumption (Alfaro, Kalemli-Ozcan, Chanda, & Sayek, 2004). Economies with well-developed financial markets are capable of attracting more foreign direct investment in the field of renewable energy. This is attributed to their efficient capital markets which provide a platform for investors to invest their excess funds. In addition, economies with well organised banking system are better positioned to facilitate project financing and typically have stock markets that provide viable exit strategies for international investors (Alfaro, Kalemli-Ozcan, Chanda, & Sayek, 2004).

Theories of FDI also suggest that foreign direct investment facilitates the transfer of technological transfer from developed countries to emerging countries such as those in the BRICS group (Omri , Nguyen, & Rault, 2014). This therefore allows emerging economies to transit to clean sustainable energy technologies. Moreover, efficient financial markets accelerate this transfer of technology by ensuring the effective allocation of financial resources to environmentally friendly and innovative projects. As such, foreign direct investment serves as a key enabler of sustainable technological diffusion for emerging countries.

Theories of financial development have also suggested that greenfield foreign direct investment is largely capital intensive. Greenfield foreign direct investment can be described as a situation in which foreign firms establish new renewable energy projects from the ground up. In such cases, well developed financial systems are more likely to provide long-term financing instruments like green bonds, support these investments (Xueqing , et al., 2021). A well organised financial system, therefore, facilitates foreign direct investment inflows as well as investments in renewable energy. Furthermore, financial institutions such as commercial banks, green investment banks and development banks offers guarantees that can help reduce investment risks. Moreso, insurance and other tools of hedging such as currency and political risk enables foreign direct investment in renewable energy more attractive.

In addition, emerging economies with efficient financial systems are able to implement policies such as feed-in tariffs and carbon pricing which are capable of attracting sustainable foreign direct investment. Financial markets which are regulated transparently, facilitates efficient capital repatriation as well as lowering the risk of expropriation are more preferred by investors (Lorente , Shahbaz, Roubaud, & Farhani , 2018). Financial systems are therefore key enabler of the efficacy of foreign direct investment in renewable energy venture.

In conclusion, theoretical literature emphasizes the critical role of financial development in accelerating renewable energy consumption, especially through its interaction with FDI. Efficient financial markets not only attract FDI but rather goes a long way in providing the financial instruments, risk mitigation mechanisms as well as policy frameworks necessary to support large-scale clean energy projects. These systems improve the efficacy of FDI by facilitating technology transfer, reduction of investment risk and allowing long-term capital commitments. As a result, financial development emerges a key pillar in the transition towards sustainable energy systems, especially in emerging economies such as those within the BRICS bloc. This theoretical foundation sets the stage for the empirical investigation into how financial development influences renewable energy consumption through the moderation role of foreign direct investment.

Empirical Literature Review

In one of the closely related studies by Yadav , et al., (2024) attempted to investigate the link between financial development and renewable energy consumption amongst BRICS countries. Their study observed a positive and statistically significant connection between economic growth and renewable energy utilization. The result of this study was an indication that higher economic growth is positively correlated with increased renewable energy consumption. In addition, their study also observed a significant positive relationship between inflation and

domestic credit with renewable energy consumption. Lastly, they also observed a counterintuitive connection between foreign direct investment and renewable. However, their study is different from this current study in that they treated foreign direct investment as a control variable whilst in this study it is moderating variable. In addition, their study also employed a weak measure of financial development in the form of domestic credit which ignores other components of financial development such as stock markets. There is need however to employ a comprehensive measure of financial development as done by the researcher in this study.

Another closely related study investigated the connection between financial development, renewable energy utilization, energy prices and economic growth for Azerbaijan (Mukhtarov, Humbatova, Seyfullayev, & Kalbiyev, 2020). Their study employed the autoregressive distributed lagged (ARDL) econometric model for empirical estimations as a result of performing better as compared to other models in small samples. The outcome of the study revealed that there is positive and statistically significant effect of financial development and economic growth on renewable energy utilization. The study however, assumed that inflation measured by the consumer price index was a good proxy for energy prices which is disputed by the current researcher and also the use domestic credit as a measure of financial development was not good enough. Another significant difference is the econometric methodology employed by the researcher for time series data which is different from the one employed for this study which focus on panel data which is combination of both time-series and cross-sectional data.

Attempts have also been made to analyse the relationship between financial development, renewable energy consumption and other macroeconomic variables like unemployment in other emerging markets like North-African countries (Tsaurai, 2022). In his study, Tsaurai, (2022) also used panel data analysis which include fixed effects, fully modified ordinary lest squares (FMOLS) as well as ordinary least squares (OLS). The study revealed that financial sector development played a role in reducing the influence of unemployment. Furthermore, other control variables had a significant effect on reducing unemployment. In as much as the methodology employed was similar to the one which is to be applied in this study, the selection of the variables was however different. Tsaurai, (2022) used unemployment as a dependent variable whilst renewable energy consumption, economic growth and foreign direct investment were all treated as independent variables. In addition, there was no any moderating variable which is another main distinction.

The review of literature revealed a recurring thematic insight around the multi-dimensional interplay amongst renewable energy consumption, financial development economic growth. Studies reviewed have revealed that financial development consistently exert a positive and statistically significant impact on renewable energy consumption. However, these studies relied predominantly on domestic credit as a proxy for financial development, such an approach may underrepresent the broader financial architecture which this paper intends to capture by using a more comprehensive index. Moreover, the treatment of foreign direct investment within these studies varied. Foreign direct investment was treated as control variable and in some cases observed with unexpected negative influence. This may imply that the contextual dynamics as well as the moderating mechanisms warrant further exploration. The researcher however addressed this gap by treating FDI as a moderating variable which provides a more nuanced comprehension of its conditional impact on the growth-finance- energy nexus.

DATA AND METHODOLOGY

Data and data sources

This study utilizes annual time-series data from the five BRICS nations which are Brazil, Russia, India, China, and South Africa covering the period from 1995 to 2022. This time frame was chosen based on data availability and reliability to ensure a comprehensive analysis. In the study the dependent variable was Renewable Energy Consumption (REC) which served as an indicator of sustainable energy usage by measuring the share of renewable energy in total final energy consumption. In order to approximate the effect of economic growth on Renewable Energy Consumption, Gross Domestic Product (GDP) was used as a measure of income, are based on constant 2015 prices. Additionally, Foreign Direct Investment (FDI), expressed as a percentage of GDP, is included to reflect the level of foreign investment in the economy and how it moderates the effect of GDP on renewable energy consumption. Financial Development Index (FD) is an index which is applied by the IMF to

rank countries in terms of depth, access as well as financial institutions and financial markets. It is also regarded as an index which aggregates the financial institutions index as well as the financial markets index. The data for financial development index was obtained from the International Monetary Fund dataset. Data for these variables are sourced from reputable institutions such as the World Bank's World Development Indicators, the International Monetary Fund (IMF), and other globally recognized organizations. These country-specific datasets facilitate a thorough analysis of the relationship between REC and key economic indicators within the BRICS nations.

Model Specification and Estimation Technique

Based on the general model specifications provided by Dossou, et al., (2024) and Awijen , et al., (2022) the primary or baseline model can be expressed as indicated in equation 1 below:

$$REC_{it} = \beta_0 + \beta_1 GDP_{it} + \beta_2 FD_{it} + \beta_3 TOT_{it} + \beta_4 URB_{it} + CPI_{it} + GCF_{it} + RENTS_{it} + \epsilon_{it} - - - - - - - - - - (1)$$

However, taking into account the moderating effects of Foreign Direct Investments on the finance- growth – energy nexus equation (1) above can be extended as follows:

$$REC_{it} = \beta_0 + \beta_1 GDP_{it} + \beta_2 FD_{it} + \beta_3 TOT_{it} + \beta_4 URB_{it} + \beta_5 CPI_{it} + \beta_6 GCF_{it} + \beta_7 RENTS_{it} + \beta_8 (GDP * FDI)_{it} + \epsilon_{it} - - - - - - - - (2)$$

In the above equation, the moderating variable which shows the interaction between Gross Domestic Product and Foreign Direct Investment captures the moderating effects of Foreign Direct Investment in the model. Equation (2) above will be estimated using panel regression which is a combination of both time series and cross-sectional data. In equation (2) above REC_{it} captures the Renewable energy consumption for each country (i) at time (t) and GDP, FD, TOT, URB, CPI, GCF, RENTS are part of the exogenous variables with coefficients $\beta_1 \ to \ \beta_7$, whilst β_8 is the coefficient of the moderating variable. ε_{it}captures the error term which accounts for the heteroskedasticity within the model. In order to capture the general specification for either the fixed or random effects model the following equation can be used as its representation:

$$Y_{it} = \alpha_i + X_{i,t} * \beta + \varepsilon_{i,t} - - - - - - - - - - - - - - - - (3)$$

In equation 3 above, $Y_{it}$is the dependant variable (REC), X_{it} is a vector of independent variables β is a coefficient vector and lastly $\varepsilon_{i,t}$ is the error term. In order to control for unobserved heterogeneity across countries the Fixed Effects model is ideal for that and it also ensure much more reliable estimates. Furthermore, to correct for heteroskedasticity as well as improving the reliability of the model inferences, robust standard errors were applied in the model. The interaction term (GDP*FDI) attempts to captures the moderating impact of FDI on the link between GDP and renewable energy consumption. It assists in making an assessment of whether higher levels of FDI either strengthen or weaken the relationship economic growth and renewable energy consumption.

EMPIRICAL RESULTS AND DISCUSSIONS.

In this section, the results of the study are analysed and interpreted

Descriptive Statistics

The descriptive statistics for the variables are provided in table 1 below in order to have a comprehensive evolution of the variables before their econometric interaction is applied.

Table 1: Descriptive Statistics

	REC	GDP	FD	FDI	TRADE	URB	CPI	GCF	RENTS
Count	145	145	145	145	145	145	145	145	145
Mean	13.40	4.38	0.49	2.19	42.68	59.56	8.89	5.64	5.66

Std	15.44	3.97	0.09	1.49	12.73	19.57	18.62	12.64	4.72
Min	0.14	-7.80	0.30	-1.76	15.64	26.61	-1.40	-45.20	0.86
Max	50.33	14.23	0.67	9.66	69.39	87.79	197.41	75.20	21.50

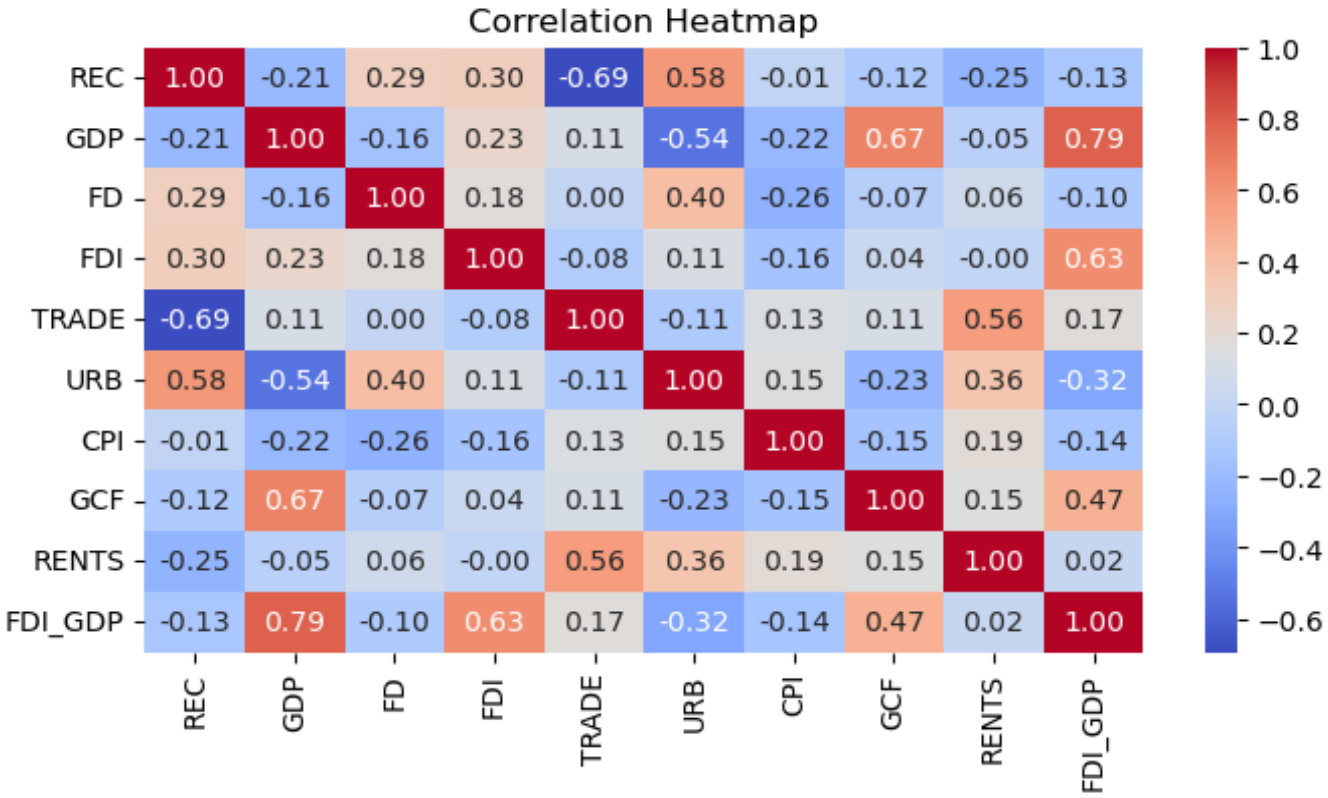
Source: Python Computations

The majority of the variables display substantial variability as indicated by high standard deviations, with specific reference to REC, CPI, GCF as well as URB. Fig 1 also indicated that GDP ranges from 0.14 to 50.33 and recorded a mean of 13.40. on the other hand, GDP ranges between -7.80 and 14.23 with an average of 4.38. FD and FDI had narrow ranges which illustrates lower dispersion. The most notable variables which displayed extreme minimum values of -1.40 and -45.20 respectively were CPI and GCF, which may point out to potential outliers or even high volatility. In a nutshell, the data illustrates diverse spread of economic indicators from several observations which are suitable for panel regression analysis.

Correlation Matrix Analysis

Table 2, shows the correlation matrix to illustrate the pairwise correlation between the variables. The results from table 2 revealed that a strong positive correlation existed between GDP and FDI_GDP of 0.79, which implies that as GDP increases, the share of FDI which is relative to GDP would also increase. Furthermore, GDP and GCF had a moderately strong positive correlation (0.67) and also between FDI and FDI_GDP (0.63). It can also be noted that strong negative correlations also existed between REC and Trade (-0.69), GDP and URB (-0.54). These strong correlations are an indication of potential multicollinearity problems which we further diagnosed by using the Variance Inflation Factor

Table 2: Correlation Matrix Heatmap



Source: Python Computations.

Further diagnosis using the Variance Inflation Factor illustrated in table 3 below revealed that multicollinearity was not a cause of concern amongst the exogenous variables within the model since all VIF values are below the commonly agreed threshold of 10 (Bayai & Nyangara, 2013). The results are illustrated in table 3 below.

Table 3: Variance Inflation Factor.

Feature	Variance Inflation Factor (VIF)
GDP	2.559279
FD	1.403840
TRADE	1.799960
URB	2.348765
CPI	1.242386
GCF	1.977684
RENTS	2.157529

Source: Python Computations

GDP recorded the highest VIF of 2.56, followed by URB (2.35) and RENTS (2.16), which is a clear indication of mild multicollinearity which is general acceptable and may not distort regression estimates substantially. On the other hand, variables such as FD, CPI as well as Trade displayed low VIF values implying minimal correlation with other exogenous variables. As a result, the set of exogenous variables were included in the model without any immediate need for corrective measures to address multicollinearity.

Hausman Test

The Hausman Test was also applied to determine which model between the random effects model and the fixed effects model to apply. The results are illustrated in table 4 below:

Table 4: Hausman Test Result

Chi- squared	**0.00**
Degrees of freedom (df)	9
P-value	1.00

Source: Python Computations

From table 4 above, it can be observed that the P-value of 1.00 is much bigger than the commonly applied significance level of 0.05 and hence failed to reject the null hypothesis that the Random Effects model is appropriate which imply that unobserved individual effects are uncorrelated with the explanatory variables.

Panel Regression Result and interpretation

In this study, the random effects model was applied as indicated by the Hausman Test results. The results of the random effects model are illustrated in table below:

Table 5: Random effects model results

Variable	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
GDP	1.22	0.32	3.88	0.0002	0.6002	1.8464
FD	10.58	7.33	1.44	0.1510	-3.9087	25.067
TRADE	-0.62	0.06	-11.10	0.0000	-0.7347	-0.5125
URB	0.49	0.05	10.72	0.0000	0.3966	0.5761

CPI	0.08	0.03	3.0	0.0027	0.0299	0.1394
GCF	0.02	0.06	0.31	0.7574	-0.1068	0.1464
RENTS	-0.61	0.13	-4.61	0.0000	-0.8715	-0.3481
FDI	2.73	0.81	3.3	0.0010	1.1207	4.3340
FDI_GDP	-0.26	0.10	-2.68	0.0083	-0.4515	-0.0678

Source: Python Computations

In table 5 above, it can be revealed that GDP has a positive effect on REC, 1 % increase in GDP results in a 1.22% increase in REC. This relationship can be explained by the notion that as economies experience growth, investment in energy infrastructure such as renewable energy may also increase. In addition, increases in GDP can also means that there are stronger institutions within the BRICS countries in which environmental awareness is practised and prioritised as well as greater capabilities to afford clean energy transitions. Lastly, this can also be explained by an increased appetite energy, part of which is satisfied by clean energy sources.

However, the results revealed a negative relationship between TRADE and REC as a 1 % increase in trade openness decreases REC by approximately 0.62%. Many countries within the BRICS trading bloc rely on cheap fossil fuels for example China imports most of its fuel from Iran and South Africa also import from Middle East and some African countries.

In addition, a 1% increase in urban population (URB) resulted in approximately 0.49% in REC. In most urban areas the rate of adoption to modern infrastructure as well as smart technologies which promotes clean energy is becoming a trend in many emerging economies like the BRICS. This is in response to environmental policies as well as climate goals.

Moreso, inflation measured by the CPI had also a positive effect on REC. A 1% increase in the consumer price index resulted in a 0.08% increase in REC. despite being a small increase in REC, this reflects the soaring energy prices which then makes renewable energy more competitive as compared to fossil energy sources. If inflation makes fossil energy more expensive it therefore implies that renewables are likely to become a relatively more attractive form of investment.

On the other hand, REC had an inverse relationship with RENTS as a 1% increase in these natural resource rents resulted in a 0.61% decrease in REC. This result supports the resource curse hypothesis which states that economies which are endowed with natural resources are more likely to underinvest in renewables. Most BRICS countries are well resourced with natural resources and may be reluctant to invest in renewable energy. If resource rents are high there is likely going to be a reduction in the economic incentive of moving away from the extractive industries as well as fossil-based energy systems.

Moreso, foreign direct investment (FDI) is a key driver of REC as a 1% increase in FDI resulted in a 2.73% increase in REC. this result can be explained by the fact that FDI is likely to bring more technology transfer, capital as well as expertise in the clean energy sector mostly for emerging countries like those in the BRICS. It is most likely that BRICS nations have green investment frameworks as well as incentives which are highly likely to attract eco-friendly foreign investments. The huge impact that FDI has on REC suggests that it is a vital driver of renewable energy development within the BRICS.

Lastly, the moderating variable (FDI_GDP) had a negative impact on REC which may suggest that there may be inefficiencies or misallocation of FDI in the event that FDI is the dominant share of GDP. If for example most FDI is directly channelled towards fossil energy sectors which include mining, oil as well as real estate, this is likely to result in crowding out investment in clean energy. This may also be an illustration of reliance on foreign capital instead of a balanced domestic led transition.

In terms of the goodness of fit, the model demonstrated very strong overall as well between entity explanatory power as illustrated by higher scores of R-Squared values of 0.8961 and 0.9368 respectively. In addition, F-

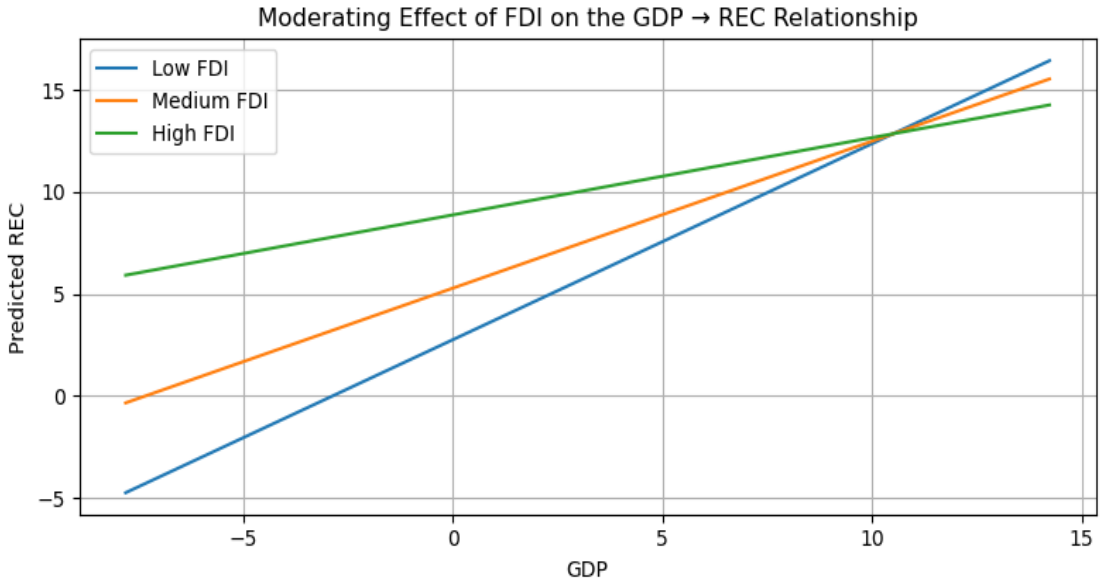
statistics of 130.34 and a p-value of 0.000 also confirmed that the regression was also statistically significant.

Visualizing the Moderating Role of FDI: Interaction and marginal effects analysis

To deepen and improve the comprehension of the moderating effect of FDI on the growth-finance-energy nexus, figure 1 below illustrates an interaction plot indicating how predicted REC varies across different levels of GDP under three categories of FDI which are low, medium and high.

The interaction plot and marginal effects graph was employed to examine how Foreign Direct Investment (FDI) moderates the link between GDP and Renewable Energy Consumption (REC). Based on the 25th, 50th (median), and 75th percentiles of its distribution within the BRICS dataset, FDI was divided into three levels which are low, medium, and high to make the relationship easier to understand. The distortion that can result from utilizing extreme minimum or maximum values is avoided with this percentile-based method, which guarantees that the chosen values represent realistic and empirically supported thresholds shown in the data. With regard to the presence and direction of moderation, the marginal effects analysis provides a clear visual representation of how the effect of GDP on REC varies across FDI levels. By exposing threshold effects, it improves policy relevance, clarifies complicated interaction terms, and makes results easier to understand for both technical and non-technical audiences. As a result, the results are more reliable, understandable, and useful.

Fig 1: Moderating effect of FDI on the Growth- REC nexus Source: Python Computations



In fig 1 above, the interaction plot shows how the slope of the relationship between GDP and the predicted REC varies at different levels of FDI. For lower levels of FDI (blue line), the connection between GDP and REC is strongly positive. This implies that as GDP increases, REC also increases sharply. However, it can be noted that the predicted REC is lower at low GDP levels. Moreover, for medium FDI levels (orange line), there is a positive relationship between GDP and REC. however, the gradient of the orange line is slightly flatter as compared to low FDI (Blue line). Lastly, when there is high FDI (green line), REC starts at a higher base even at low GDP, but the gradient is significantly flatter. This implies that increasing GDP do not lead to a proportionately large increase in REC when FDI is high.

This illustrates that FDI moderates the GDP-REC nexus by flattening the marginal effect of GDP on REC specially at higher levels. In other words, as FDI increases, the incremental impact of GDP growth on REC becomes less pronounced. This may imply possible saturation or efficiency effects from foreign capital.

POLICY RECOMMENDATIONS AND AREAS OF FURTHER STUDY

Based on the outcome of this study, policy makers within the BRICS should invest in clean energy infrastructure since economic growth provides the much-needed fiscal space as well as investment capacity. Moreso,

policymakers need to take advantage on this through allocating a portion of GDP growth to clean energy development as well as fostering public-private partnerships. Likewise, there is need for policymakers to continue to attract more FDI and ensure that it is channelled towards clean energy projects by means of using targeted incentives as well as ensuring that regulatory support systems are in place. On the contrary, countries which are endowed with natural resources should minimise their reliance on natural resources rents and ensure that governments diversify their revenue sources and if possible, they should phase out non-renewable energy subsidies and consider sovereign green funds to finance clean energy. Furthermore, policymakers ought to support green urban planning as well as energy efficient shifts in energy consumption. Lastly, governments need to review their trading polices and ensure it supports sustainability, favour the green sector and that it discourages carbon intensive investments and that it is aligned with long-term climate objectives.

There are some potential policy risks and barriers which are likely going to hinder the redirection of FDI toward renewable energy. These policy risks include the dominance of fossil fuel interests within BRICS economies. Countries like China, South Africa and India have huge deposits of coal for thermal power production. In these countries state-owned enterprises dominate the fossil fuel industry which results in the resistant to shift to renewable energy. Lastly, the unavailability of targeted financial instruments within the BRICS economies such as green bonds, tax credits as well as low-interest loans makes sustainable energy initiatives less competitive and less attractive to FDI.

In the future, researchers should focus on disaggregating FDI flows, making assessments on institutional quality, evaluation of clean energy policy instruments as well as exploring regional or temporal differences within these relationships. A deep comprehension of these dynamics would improve and accelerate the design of effective, evidence-based energy transition policies. The outcome of this study combined with future studies would strengthen the importance and relevance of cohesive, combined, sustainability based economic planning in driving the adoption of renewable energy.

Ethical Approval

Since there was no involvement of human or animal it therefore implies that ethical approval was not necessary. The study heavily depended on secondary data which was obtained from various publicly available sources including World Bank, IMF and the International Energy Agency.

Conflict Of Interest

There were no any financial as well as personal relationships that could possibly inappropriately impact or bias the content of the manuscript. The author therefore declares no conflict of interest.

Data Availability Statement

The dataset employed and analysed during this study are publicly available from the sources listed below:

1. World Bank – World Development Indicators: https://data.worldbank.org
2. International Monetary Fund (IMF) – Financial Development Index: https://data.imf.org
3. International Energy Agency (IEA): https://www.iea.org

Fellow researchers who are interested in having access to the dataset which was employed in this study can freely retrieve it directly from the above sources or kindly request the cleaned version used in this analysis through contacting the corresponding author.

REFERENCES

1. Akpan, U. F., & Akpan, G. (2012). The Contribution of Energy Consumption to Climate Change: A Feasible Policy Direction. International Journal of Energy Economics and Policy , 2(1), 21-33.
2. Asongu, S., & Odhiambo, N. M. (2020). Inequality, finance and renewable energy consumption in Sub-Saharan Africa. Yaoundé: African Governance and Development Institute (AGDI), AGDI Working Paper, No. WP/20/084.

3. Dimnwobi, S. K., Madichie, C. V., Ekesiobi, C., & Asongu, S. A. (2022). Financial Development and Renewable Energy Consumption in Nigeria. Yaoundé: AGDI Working Paper, No. WP/22/024, African Governance and Development Institute (AGDI),.
4. Kelly, A. M., Ngo , D. R., & Radler, N. (2024). Does energy consumption matter for climate change in Africa? New insights from panel data analysis. Innovation and Green Development, 3.
5. Mukhtarov, S., Humbatova, S., Seyfullayev, I., & Kalbiyev, Y. (2020). The effect of financial developmen t on energy consumption in the case of Kazakhstan. Journal of Applied Economics , 23(1), 75–88.
6. Yadav , A., Ozturk , I., Ferreira, P. J., Karalinc, T., & Bekun, F. V. (2024). Unravelling the role of financial development in shaping renewable energy consumption patterns: Insights from BRICS countries. Energy Strategy Reviews, 54.
7. Alfaro, L., Kalemli-Ozcan, S., Chanda, A., & Sayek, S. (2004). FDI and Economic Growth: The Role of Local Financial Markets . Journal of International Economics, 64(1), 89-112.
8. Awijen , H., Fateh, B., Younes , B. Z., Nazim, H., & Lahouel, B. B. (2022). Renewable energy deployment in the MENA region: Does innovation matter? Technological Forecasting and Social Change, 179 (Article 121633).
9. Bayai, I., & Nyangara, D. (2013). An analysis of determinants of Private Investment in Zimbabwe for the period 2009 - 2011. International Journal of Economics and Management Sciences, 11-42.
10. Dossou, T. A., Pascal, D. K., Kambaye, E. N., Asongu, S. A., & Alinsato, A. S. (2024). The Financial development-renewable energy consumption nexus in Africa:Does governance quality matter? Johannesburg: EDWRG Working Paper Number 07-24. .
11. Fernando , R., & McKibbin, W. J. (2021). Macroeconomic Policy Adjustments Due to Covid-19 Scenarios to 2025 with a focus on Asia. Tokyo: Asian Development Bank Institute.
12. Gashiten, G., & Mutepfa, P. (2021). Financial Development, Foreign Direct Investment and Economic Growth: Evidence from Southern Africa Development Community (SADC) . International Journal of Management, Accounting and Economics, 647-667.
13. Intergovernmental Panel on Climate Change . (2012). Renewable Energy Sources and Climate Change Mitigation. Cambridge : Cambridge University Press.
14. International Energy Agency [IEA]. (2025). Growth in global energy demand surged in 2024 to almost twice its recent average. Paris: Global Energy Review.
15. Koffi, K. D. (2020). Dynamics between Financial development, Renewable energy consumption, and Economic growth:Some international evidence. Dongbei: Dongbei University of Finance and Economics.
16. Lorente , D. B., Shahbaz, M., Roubaud, D., & Farhani , S. (2018). How economic growth, renewable electricity and natural resources contribute to CO2 emissions? Energy Policy, 113, 356-367.
17. Omri , A., Nguyen, D. K., & Rault, C. (2014). Causal Interactions between CO_2 Emissions, FDI and Economic Growth: Evidence from Dynamic Simultaneous-Equation Models. Economic Modelling, 42, 382-389.
18. Prempeh, K. B. (2023). The impact of fnancial development on renewable energy consumption: new insights from Ghana. Future Business Journal , 9(6).
19. Tsaurai, K. (2022). Financial Development, Renewable Energy and Unemployment in North Africa. Journal of Accounting and Finance in Emerging Economies, 8(3), 413-424.
20. Xueqing , K., Khan, F. U., Ullah, R., Arif, M., Rehman, S. U., & Ullah, F. (2021). Does Foreign Direct Investment Influence Renewable Energy Consumption? Empirical Evidence from South Asian Countries. Energies , 14(3470).