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Does Financialization Enhance Renewable Energy Development in Sub-Saharan African Countries?

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Abstract

Utilizing more renewable energy in a market that combines advancements in technology, finance, and customer engagement is one of the African Union's top priorities. On the other side, there is a dearth of information on how the financial sector upsets the development of renewable energy. We thereby assess panel data from 21 Sub-Saharan African (SSA) nations from 2000 to 2022 to analyze the influence of financial development, fiscal policy, and foreign capital on renewable energy development while adjusting for industrialization and institution quality. To jointly observe the short- and long-term influences of these factors on renewable energy development, the Panel Quantile Autoregressive Distributed Lag (PQARDL) technique was used. Subsequently, we observed significant developmental impediments on renewables from financial development and fiscal policy across all quantile distributions in the long-run, while foreign capitals boosted renewable energy development throughout all quantiles except the 70th quantile. Furthermore, a declining trend is observed in SSA's share of renewable development due to industrialization and institutional quality in the long term. Finally, the interactive roles of fiscal policy and institutional quality also impede renewable advancement in the SSA countries in the long term. Therefore, these empirical outcomes provide useful perceptions on how to galvanize foreign capital and allocate investments in renewable development to broaden cost-competitive choices for consumers with the ultimate goal of extending high-value-added facilities within a sustainable environment.

Keywords; *Renewable energy, financial development, fiscal policy, foreign capital, ARDL Quantile Autoregressive Distributed Lad, Sub-Saharan Africa countries.*

1. Introduction

In the aftermath of the industrial revolution, the environment has been getting worse at a rate that has never been seen before. As a result, extreme weather and natural disasters occur regularly today (Doytch & Narayan, 2016; IPCC, 2021). Moreover, environmental deterioration influences economic actors' consumption and production patterns and contributes to several diseases that impact humans. As a result, stopping environmental degradation is a global issue. It is frequently stated that greenhouse gases are to blame for the appalling state of the environment. Carbon dioxide (CO_2) emissions are the most important component of greenhouse gases, accounting for the highest proportion of the overall volume. High CO_2 pollution is mostly caused by human-based production and consumption activities (IPCC, 2021). Most industrial production primarily uses non-renewable energy sources, which produce significant amounts of CO_2 emissions. Like this, many consumer activities—including logistics and transportation services—use energy sources, particularly non-renewable ones. Hence, one of the causes of excessive carbon is the usage of non-renewable energy (Khan et al., 2021). In contrast, non-renewable energy is also triggered by several issues, including energy instability and price volatility, which make it difficult to make decisions about consumption- and production-based activities. As a result, everyone in the world is looking for alternatives to non-renewable forms of energy. Besides, renewable energy is seen as a clean energy source that reduces CO_2 emissions without having a negative effect on the rate of economic growth (Assi et al., 2021). In view of this, a diversion from the non-renewable consumption paths to renewable energy is underway globally. The development of renewable energy is, however, being hampered by certian problems. For instance, among the main issues that deter the generation of renewable energy are the high installation costs, the absence of storage facilities, the lack of investment in the field, and unpredictable economic policies. To create policies for the furtherance of greater renewable energy production, it is key to detect the drivers of renewable energy production.

The development of renewable energy has been influenced by certain identified factors or forces, including how an economy grows over time (Ren. et al., 2021; Hamid et al., 2022; Bozkaya et al. 2022), price level (Buchholz & Brandenburg, 2018; Lisin, 2021), CO_2 emissions (Akpanke et al., 2023; Xin-gang et al., 2020), and financial instruments (Ayana, 2022; Zhao et al., 2020), among others. Other explorations on the elements that affect the production of renewable energy are also provided by Papaie et al. (2018) and Tu et al. (2002). The author divides the factors that affect the production of renewable energy into several key categories, including institutional, financial, technological, environmental, and social factors. However, the voluminous literature still lacks the needed exploration of how financial instruments influence the growth of renewable energy. Through several avenues, financial instruments have the power to influence the development of renewable energy. These channels include financial development, fiscal policy, and foreign capital; nevertheless, there are questions about the importance that each of these plays in the growth of renewable energy. Unexpected occurrences like COVID-19 (Hosseini, 2020), trade issues (Wang & Zhang, 2021), environmental concerns (Hamid et al., 2022), political unrest (Wang et al., 2022), economic instability (Hamid et al., 2022), inflation (Deka et al., 2022), customer ebbs and flows (Hast et al., 2015), and cash flow issues (Bhattacharya et al., 2020) are a few examples of these financial instruments. These doubts have caused the growth of renewable energy to decline steadily over time. It is important to keep in mind that financial instruments can have both a positive and a negative impact on the growth of renewable energy. For this reason, it is essential to scrutinize further how financial tools affect renewables in terms of their developmental pace.

The current exhibition plans to examine the effect of financial policies on the growth of renewable energy in selected African countries based on the aforementioned discussion. The nations considered for the research include those in the south of the Sahara Desert and were picked for the following reasons: a) Fiscal policy is quite difficult in Sub-Saharan African nations. The 2008 financial crisis hindered the worldwide economic growth path, and despite the recovery, financial decisions are likely to be below pre-crisis levels; b) inflation has increased in a number of the region's countries as well, which is a problem that is occasionally made worse by fiscal dominance brought on by high public debt levels; and c) as the major central banks in advanced economies remove policy stimulus and raise interest rates in the coming years, several of SSA countries are likely to experience lower economic growth. The economic implications of the current conflict in Ukraine, particularly the resulting significant increase in energy and food costs, are expected to make the difficulties even more challenging. Even though the continent's economic future depends on its energy industry, its people and businesses still lack the stable domestic energy supply that they need. The highest among all continents, Africa's energy consumption has been rising at a pace of about 3% per year, but the continent's energy supply has lagged far behind. According to Figure 1, the energy mix of SSA nations shows that even with fruitful renewable energy projects, the total scale of renewables in Africa has remained fairly small over the past 30 years. Hydropower is the only significant source of renewable energy in Africa today, as fossil fuel generation predominates. The mix of renewable energy has changed more recently to speed up solar and wind technologies, but they are still only 1.6% of the total.

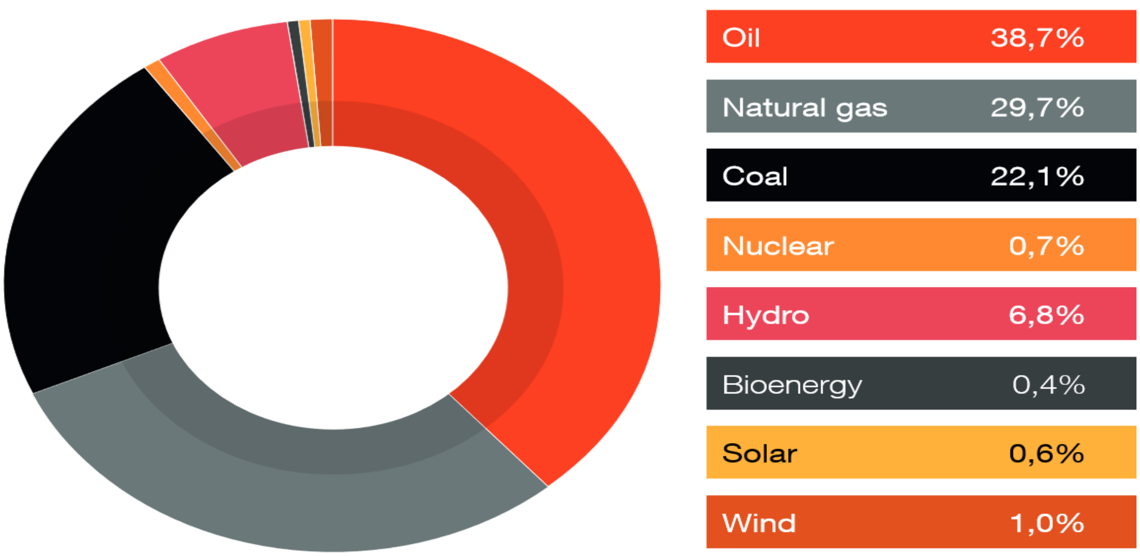

Figure 1: Africa Energy Mix, Source: BP Energy Outlook 2020

Concerning the use of clean energy in Africa, some of the smaller countries have set big goals for renewable energy. Africa’s big economies are spearheading the upsurge in renewable energy stock on the continent. With an annual growth rate of 21% between 2010 and 2020 and a total volume of more than 58 GW (of which hydropower supports 63%), renewable energy is gradually increasing across the continent. Solar energy generation climbed by 13%, wind energy by 14%, and all other renewable energy sources combined by 11% in 2020 over the previous year. In 2020, compared to 2019, the volume of solar panels increased by 13%, that of wind turbines by 11%, and that of hydropower by more than 25%. Since 2013, Africa's installed renewable energy volume has increased by nearly 24 GW. Although hydropower makes up a high proportion of this total, investments in non-hydro renewable energy sources, including solar, wind, and biofuels, have seen a considerable uptick and are expected to overtake hydro in the coming decade. By the end of 2021, capacity on the continent is anticipated to climb once again, with solar and wind projects leading the way. With more than 37 GW of installed capacity, hydropower is Africa's primary source of renewable electricity. With an estimated 11% of its hydropower potential being used, the continent has the most untapped hydropower potential in the entire globe. The technical potential of geothermal, wind, solar, and biofuel is also enormous. Most African nations are increasing their investments in solar and hydropower technologies, and current construction projects are anticipated to add 33 GW of renewable energy capacity. The statistics above are sourced from the Africa Energy Review Report, (2021).

Eliminating fossil fuel subsidies, enforcing carbon taxes, and instituting feed-in tariffs are just a few of the policy measures that can help reduce environmental deterioration (Zhang & Zheng, 2022). Institutional quality plays a critical part in this effort (Uzar, 2020). According to Appiah, Li et al. (2022), a robust institutional framework could enhance environmental quality through more effective resource allocation. Similarly, Rahman and Sultana (2022) emphasized the importance of institutional setup for environmental quality and economic growth by requiring the use of green energy, effective resource allocation, bolstering the judicial system, and luring foreign investment. A poor institutional framework, on the other hand, is unable to address the problem of environmental deterioration. Because of this, the impact of governmental institutions on the growth of renewable energy sources must still be considered. It is clear that there is a study vacuum not only in determining the function of financial instruments in the growth of clean energy but also in showing the impact of institutional quality. By examining the effects of key monetary instrument indicators such as fiscal policy, financial development (Haouas et al., 2022), and foreign capital on the advancement of renewable energy, this study henceforth bridges these gaps.

2. Literature Review and Theoretical Background

The theoretical underpinning that encapsulates the link between the variables in the current study is connected to the pollution Haven hypothesis and the pollution Halo hypothesis. There appears to be a consensus on the need for energy transition to renewables following the rise in environmental pollution given the increase in energy demand over the past decades (Chapman et al, 2018; Onifade & Alola, 2022). As such, the calls for environmental pollution control are increasing by the day and some of the necessary actions in line with pollution control often center on the demand for more climate action and responsibility vis-à-vis responsible production and consumption. On the part of many investors (manufacturers), executing related tasks in this direction such as payment of carbon tax and adherence to strict environmental regulations among others, often comes as an extra cost that investors may try to avoid. In this regard, according to the pollution haven hypothesis, polluting factories can be shifted elsewhere especially through the transfer of investments abroad. Hence, it is argued that the foreign capitals movement amidst other global financial development indicators would create more pollution rather than benefiting the environment (Walter & Ugelow, 1979; Balsalobre-Lorente et al. 2019; Onifade et al. 2021). While this may be true, it is also pertinent to examine the other side of the coin. There are arguments that this capital movement would create better environmental quality as postulated in the pollution halo hypothesis (Birdsall & Wheeler, 1993; Ahmad et al. 2021). Nevertheless, the overall opinions regarding the validity of these two divergent theoretical views are still subject to empirical testing. Therefore, in the current study, based on the nature of the link between the variables, we have split the literature into three competing nexuses. These nexuses include the connections between (I) financial development and the development of renewable energy, (II) fiscal policy and the development of renewable energy, and (III) foreign direct investment & advancement in renewable energy.

2.1 Financial developments and renewable energy advancement

According to Inglesi-Lotz (2016), renewable energy is an essential socially optimal public policy goal that ensures intergenerational energy security and efficiency, and greenhouse gas reduction to maintain environmental sustainability and social desirability. Nonetheless, the global expansion of greener energy is currently notably insufficient. The lack of public sentiment and the affordability of fossil fuels, in addition to some governments' inertia, contribute to this inadequacy (Sequeira and Santos, 2018). The main barrier to evolving technological innovations and achieving low-carbon economies, however, is a financial constraint (EIA, 2015). In addition to being a barrier to the generation of renewable energy, financing is essential for R&D to boost economic viability, investments in raising consumer awareness, advocacy for policymaking, and investments in the wholesale and retail markets for renewable energy. Although financing sustainable energy remains a significant obstacle, things are changing. Increasing consumer knowledge and demand for renewable energy have culminated in a global drive for ecological responsibility by a wide range of stakeholders (including academic projects, NOG activism, civil society organizations, and activist organizations, among others). Demand and awareness have led to the enormous commercial potential for renewable energy that exists today, encouraging potential investors to exploit never-before-seen future market opportunities (Grabara et al., 2021; Yoshino and Taghizadeh-Hesary, 2018).

Particularly among SSA nations, the study on the connection between financial developments has gotten less attention. Clearly, there is much research on this relationship in industrialized countries, and most of the studies put financial changes into different groups. For instance, Liming (2009) compares the financing options for rural renewable energy development in China and India and contends that the stock market has grown to be a significant source of funding for projects, particularly those involving renewable energy. In their study of 20 developing market economies from 1991 to 2012, Paramati et al. (2016) discovered a significant favorable impact of stock market developments on the adoption of renewable energy sources. The authors contend that the growth of a stock market and FDI can influence developing nations to employ cutting-edge technologies to produce clean energy, which subsequently increases the share of clean energy consumption. The main premise is that the growth of the stock market enables investors to earn higher risk-adjusted returns while assisting renewable energy initiatives in obtaining funding. Using a panel of data for 20 developing nations from 1991 to 2012, the model demonstrates a significant positive impact from the output, FDI inflows, and stock market development on the use of clean energy. These results are at odds with those of Lee (2013), who found no association between FDI flows and the use of clean energy by G20 nations. He et al. (2019) look into how green financing has helped propel China's renewable energy sector. They show that the relationship between green finance and green development is not linear by using data from publicly traded companies. The significance of financial growth for emission reduction is further supported by Kim and Park (2016). This is due to its crucial role in spreading the use of alternative energy sources. Using a panel of 30 nations, their empirical model follows the evolution of the equity and credit markets. The effects of economic growth on various forms of renewable energy vary widely. Solar photovoltaics, for instance, stand to gain more than biomass or geothermal power. Financial development, growth, capital, commerce, and energy use in China have been studied using a range of indicators (Shahbaz et al., 2013; Ofori et al. 2023). These indicators include FDI influx, stock market advancements, and banking activities. Their data shows that economic growth raises energy needs, which can lead to more pollution and a greater reliance on fossil fuels. China has to increase energy efficiency and invest in renewable energy for the long haul.

The available literature generally demonstrates an increasing interest in advancing renewable energy growth, and the usefulness of financial development has been clearly demonstrated, albeit mainly in a small number of nations. Thus, these studies, to start with, are not particular to SSA nations. As was already indicated, SSA nations are in a transitional phase and are looking for funding in this regard. What types of financial development are more important, and how much can they contribute to the development of renewable energy? These are the challenges facing policymakers. There are no clear answers to these queries in the existing literature. SSA nations' unique circumstances are not covered by these cross-country studies, even though they offer important information on the factors that influence the growth of renewable energy. We believe that the growth of financial development will enable investors to take advantage of the commercial and socially desired potential of renewable energy technologies by synthesizing the stated facts. Therefore, we hypothesized that H_1: Financial development significantly enhances renewable energy development.

2.2 Fiscal policy and renewable energy development nexus

The idea of the fiscal policy refers to a method of managing income and expenses. The income component of fiscal policy also addresses the issue of taxation-based revenue collection. Tax increases and cuts can both be used to achieve this (Ayana, 2022). On the other hand, the expenditure component of fiscal policy addresses how much money the government spends on various things. Hence, fiscal policy is a planned tool used by the government to raise money and control spending in an economy (Ayana, 2022). Keynes was the first to theorize fiscal policy, and Keynesian economists are now popularizing it. A three-part fiscal policy is described. A neutral budgetary policy comes first. A strong economy uses this kind of fiscal policy. The recession and the expansion have not negatively impacted the economy (Jahan et al., 2014). The fiscal policy that is in contraction is the second. It is relevant when decreasing deficit spending is hurting the economy. In other words, when there is a problem with excessive inflation, contractionary fiscal policy is preferred. You can implement a tight (contractionary) fiscal policy by increasing tax rates and decreasing government spending. Fiscal expansion is the third factor. It is applicable when unemployment is a problem for an economy. This time, countries lower taxes and increase expenditure on the government in an effort to boost economic growth. To counteract unemployment, an economy's investment rises (Hansen, 2003).

Sub-Saharan Africa's fiscal policy has important goals, just like anywhere else's. These are: 1. Economic growth: All governments in sub-Saharan Africa have economic growth as their top priority. In order to do this, they implement the budgetary policy. They invest more money in building schools, roads, hospitals, and other infrastructure in order to accomplish this goal (Mazorodze, 2018). 2. Price Stability: Inflation, in general, and sub-Saharan African nations, in particular, face severe challenges. This is evident. Fiscal policy is a way to treat the issue because inflationary occurrences are constant in this area (Ayana, 2022). 3. Optimal resource distribution: Since it can be difficult for emerging nations to utilize their resources effectively, fiscal strategy is advised. The developing world can adopt better procedures for funding deficits, broaden the base and rate of their taxes, and enhance the management of their physical resources to encourage better resource allocation (Igwe et al., 2019). 4. Promote investment: Developing countries utilize fiscal policy to encourage investment because it is the answer to macroeconomic problems like unemployment. Spending on unnecessary purchases and investments should be reduced in developing countries. Moreover, emerging nations should expand their marketplaces and boost social and marginal productivity in their societies (Benos, 2009).

There is a rising discussion about the usefulness of fiscal policy in fostering equitable and environmentally friendly economies. On the bond between fiscal tools and the growth of renewable energy, little empirical research has been done. For instance, Azhgaliyeva et al. (2019) observed that the fiscal policy had a substantial impact on the investment in the generation of renewable energy over the period of 2004–2016. In the FMOLS paradigm, a recent study by Florea et al. (2021) found that budget & public debt policies jointly produced an unintended effect on the use of renewable energy in the European Union. Moreover, Yoshino and Taghizadeh-Hesary (2018) believe that financing for renewable energy projects is scarce or comes with high-interest rates, making them riskier investments. The conclusion of this study was that tax money collected from polluting entities should go into programs that produce renewable energy. According to Şen (2017), the industrialized European nations' extraordinary reliance on renewable energy can be attributed to the stream of fiscal incentives in those nations. Yet, Turkey, which is creative in renewable energy, has lagged since its fiscal incentives through fiscal policy have not acquired a good advantage in terms of fiscal policy incentives. Similarly, Meng et al. (2022) found that fiscal tax incentives reduce underinvestment in renewable energy and fiscal tax subsidies worsen overinvestment, utilizing data from 158 renewable energy firms over the period of 2010–2018 in the Richardson model framework. Evaluation of data from 2010–2017 also suggests that tax discounts help overall investment (Chang et al., 2020). The possibility of using fuels and energy to achieve energy security, combat climate change, and advance other sustainable development goals is discussed (Brown & Chandler, 2008). We argue that sustainable societies require sound fiscal and monetary policies. As such, we hypothesized that ***H_2***: *Fiscal policy* (taxation) significantly enhances renewable energy development.

2.3 Foreign capital and renewable energy development linkage

Foreign capital (FC) is generally acknowledged as a significant origin of funding for the international transfer of technology and know-how. The linkage between FDI inflows and energy-related concerns like energy consumption (Akpanke et al., 2023; Boohene & Darkwah, 2023; Paramati et al., 2016; Sarkodie et al., 2020), energy production (Khan et al., 2021; Rashed et al., 2022; Shang et al., 2023), and energy security (Koyama & Krane, 2021; Le & Park, 2021; Rajavuori & Huhta, 2020; Zhao et al., 2020) have been seen in the literature (Le & Park, 2021; Rajavuori & Huhta, 2020; Rajavuori & Huhta, 2020). Unfortunately, there hasn't been much focus on considering the connection between FDI inflows and the growth of clean energy. For the UAE economy, Sbia et al. (2014) discovered bidirectional causality between FDI and clean energy. List and Co (2000) contend, however, that by lowering CO2 emissions, FDI would raise energy efficiency in the countries where it flows into. According to Lee (2013), FDI inflows can help with environmental issues, which results in the development of eco-friendly goods and technology that benefits both businesses and the wider community. In contrast, Doytch and Narayan (2016) found that, across a panel of 74 nations, FDI generally inhibits the use of dirty energy, promotes energy efficiency, and shifts toward renewable energy sources. FDI and stock markets are crucial for boosting renewable energy consumption, according to research by Kutan et al. (2018) on the "determinants of renewable energy consumption" for BRICS states. Parallel to this, Paramati et al. (2016) reported that enlarged FDI inflows encourage the production of renewable energy and are advantageous for reducing CO2 emissions. It was refuted by Lin et al. (2016) and Kilicarslan (2019) that FDI and renewable energy have a beneficial association.

It has also been observed in the literature that the inflow of foreign investments could facilitate modern and clean energy technology acceptance by all as well as help to reach efficiency targets with low emission rates (List & Co., 2000; Tamazian et al., 2009). According to Elliott et al. (2013), the inflows of foreign investments worsen the intensity of energy in the Chinese case. (Amri, 2016) examined the relationship between FDI, GDP, and energy use across 75 nations. There was proof of a connection between FDI output per person, conventional energy consumption per person, and green energy consumption per person. According to the author, a 1% increase in renewable energy increased FDI by 0.1850%, but the opposite is also true: a 1% increase in FDI increased the amount of renewable energy used by 0.2920%. These findings were attained using a dynamic panel model and the Cobb-Douglas production function. Moreover, Khandker et al. (2018) calculated the causality between FDI and renewable energy in Bangladesh from 1980 to 2015. They discovered that FDI serves as a source of capital that draws investors to the energy and renewable energy industries. They concluded that there are reciprocal relationships between FDI and Bangladesh's use of renewable energy. The cointegration link between FDI, clean energy, trade openness, energy consumption, and GDP in the UAE from 1975 to 2011 was further validated by Sbia et al. (2014). Also, they discovered more connections between these variables. The effect of FDI on renewables is equally examined by Lee (2013) across the G20 states. The author shows that there is no connection between FDI inflows and clean energy. Hence, we hypothesized H_3: Foreign capital significantly enhances renewable energy development.

Literature Gaps and Contributions

A thorough examination of the empirical literature revealed that the relationship between FDI and renewable energy is well examined. However, research on their involvement in the buildout of renewable energy is lacking, particularly in developing nations, and the findings are conflicting. Hence, further research is needed to supplement the scant conversation on FDI and the growth of renewable energy. Most importantly, we have observed that no research has been done to reveal and contrast the results of SSA countries. Considering the aforementioned goals, this study, therefore, sought to make important policy recommendations in this study. Overall, the contributions of this work are summarized in three dimensions. In SSA nations, this is the first attempt to combine financial instruments with the development of renewable energy. Importantly, when examining individual variables' roles in the renewable energy development assessment, we addressed financial instruments in three separate broad categories: financial development, fiscal policy, and foreign capital. The study also examines how institutional quality affects the relationship between fiscal policy and the growth of renewable energy sources. The findings can serve as significant guidance for creating policies for renewable energy. These nations may have the chance to benefit politically and environmentally if institutional quality is found to have a beneficial impact on renewable energy. The study is distinct from Tu et al. (2022) and Papaie et al. (2018), which employ many measures to assess the development of renewable energy. With the aid of the innovative panel quantile ARDL (Cho et al., 2015), the projected dynamics among financial development, fiscal policy, foreign investment, and the development of renewable energy sources were later examined. Also, in a bid to confirm the consistency of integrating coefficients throughout the quantiles, both the long- and short-term effects are evaluated.

3. Data, Model, and methodology

To conduct an empirical analysis, the current study constructs a balanced panel of 21 developing economies (SSA countries) from 2000 to 2022 utilizing annual time series data. The aims of UN-SDG 7 and how they might be accomplished through financial factors, including financial development, fiscal policy, and foreign capital, were the basis for choosing the sample. In the multivariate framework of the current study, dollar amounts are used to measure investments in renewable energy. It mostly refers to internal investment, which is the money used by businesses to buy different types of operational assets, such as fixed assets, intangible assets, and other long-term assets. In this study, renewable energy investment is defined as the money spent by renewable energy firms on fixed assets, intangible assets, and other items that utilize renewable energy development (Li and Yang, 2015). Information, enforcement, and transaction costs are lessened by financial development related to financial instruments, markets, and intermediaries; fiscal policy explains the total amount of government spending to affect the economy; and foreign capital is a cross-border investment made by businesses and nations. One may define foreign capital as a net inflow of investment into a nation. Industrialization, which denotes that the value added is the net output of a sector after adding up all outputs and removing intermediate inputs, and institutional quality, which is defined by the CPIA's measurement, are taken into consideration as control variables in the study. The World Bank serves as the primary data source for the entire study series. The IMF is responsible for financial development.

3.1 Model

Based on empirical evidence and our main hypotheses, this work gives two different models for classifying the dynamic effects of financial development, fiscal policy, and foreign capital on the development of renewable energy. According to the report, foreign capital, fiscal policy, and financial development all favor the development of renewable energy in SSA nations. Many studies in various parts of the world have also looked into similar claims. A couple of studies have shown that countries with abundant financial resources can utilize their financial clout to support RE development and thereby slow down environmental damage. (Usman et al., 2022) provided evidence that rich financial resource states can use their funds to accelerate renewable energy development, in contrast to developing countries that lack the financial infrastructure to do so. The usage of fossil fuel energy, which is generally inexpensive and simple to harness, is common in countries with limited financial resources, which indicates an adverse bearing on the ecology (Doran et al., 2023; Onifade, 2023). The literature provides reams of data indicating that financial development is crucial for creating sustainable renewable energy projects that aim to attain carbon neutrality objectives (Tong et al., 2022). Consequently, by funding renewable energy projects, financial development indirectly lowers greenhouse gas emissions and, subsequently, global warming (Zhongming et al., 2018).

Only a few researchers have looked at the linkage involving foreign capital and renewable energy development in the FDI-RED nexus, but those that have (Kutan et al., 2018) found a considerable positive effect. He further observed that FDI is crucial to advancing the development of renewable energy. These results demonstrate that countries with limited financial resources may use funding from foreign investors to promote RE. In addition to fostering the growth of RE, FDI has a detrimental impact on CO_2 outflows, as shown by Bhujabal et al. (2021). Hence, encouraging FDI inflows among emerging countries is vital. The conclusion that fiscal policy has a positive impact on the development of renewable energy is supported by some studies, including Chien et al. (2022; Xin-gang et al., 2020). According to Chien et al. (2022), many international nations could greatly alleviate their energy scarcity by increasing their efficiency as well as environmental fiscal policies linked to public contribution and tax reduction. A single-way connection between fiscal policy and energy use was also discovered by Ike (2020). They validated the significance of fiscal policy on energy usage and ecological quality in their study, which used data from Thailand. Whether environmental taxes can spur the production of renewable energy was the subject of a study that built an even model of the energy trade under the control of environmental taxes. They concluded that the regulation of environmental taxes might raise the proportion of renewable energy output in China's energy trade. The first equation (1) is a description of the initial experimental model created to test the aforementioned presumptions:

$$RED_{it} = a + \beta_1 FD_{it} + \beta_2 FIS_{it} + \beta_3 FC_{it} + \beta_4 IQ_{it} + \beta_5 IND_{it} + \varepsilon_{it} \ldots\ldots\ldots (1)$$

In the model above, RED represents renewable energy development, FD, FIS, FC, IQ and IND signify financial development, fiscal policy, foreign capital, institutional quality and industrialization, respectively. a denotes the intercept with $_{i,t}$ defines cross-sectional countries and time, including ε as the error term.

The second model includes fiscal policy as an independent variable and takes institutional quality into account as a moderator. There is not much scientific data supporting the institution-renewable energy development link (Rahman & Sultana, 2022; Uzar, 2020). This omission in the literature on renewable energy development is shocking, given the relevance of institutional quality in the rise of renewable energy usage. To estimate imbalanced data of institutional effectiveness built on panel data from 1997 to 2019, (Rahman & Sultana, 2022) used the panel ARDL approach. The study aims to provide light on the area's policies and research. The findings show a positive correlation between enforced restrictions, high-quality regulations, and the switch to renewable energy. According to (Rahman & Sultana, 2022), institutional quality and renewable energy are positively associated. (Wang et al., 2022)'s study indicated that weak institutional governance has an adverse influence on the environment and stressed the significance of institutional governance for OECD economies. The following model is created based on the presumptions:

$$RED_{it} = a + \beta_1 FD_{it} + \beta_2 FIS_{it} + \beta_3 FC_{it} + \beta_4 IQ_{it} + \beta_5 IND_{it} + (\beta_6 FIS_{it} * IQ_{it}) + \varepsilon_{it} \ldots\ldots\ldots (2)$$

From the model, the new addition is the interactive effects. It is hypothesized that β_6 has a positive linkage with renewable energy development.

3.2 Methodology

Here, the study presents the following econometric approaches to investigate the influences of financial development, fiscal policy, and foreign capital on renewable energy development. The study again explored the moderation role played by institutional quality, which is revealed to be an influencing variable in the growth of renewable energy among SSA countries. The section begins with the preliminary tests, which consist of the CSD, SCH, unit root tests, and cointegration estimations. The next stage deals with the assessment of both the long- and short-term coefficients. The article went through five different stages of estimation to realize the objectives.

3.2.1 Panel CSD, SCH and Unit root

When working with datasets, preliminary tests are necessary, especially for heterogeneous panel analysis, which relies more on panel series structures than homogeneous panel computation, which is modeled by a linear model of random and fixed effects with an individual slope. By analyzing the variable for each cross-section, the heterogeneous panel evaluation, as opposed to the homogeneous panel analysis, focuses on the series movements. The fixed and weighted panel estimator, developed by Pasaran and Yamagata (2008) and employed in this inquiry, is compared to a pooled estimate's reliability using the slope homogeneity test. Additionally, a unit root testing approach is performed to find the series' non-stationarity characteristics in order to resolve the disruptions from them. It ought to be carried out following the slope homogeneity test. We carry out unit root testing to prevent the false regression issue (Fan & Hao, 2020; Wang et al., 2022).

There have been many unit root testing methodologies put out, and each trial has a null and alternative proposition. Using two-unit root testing methodologies, non-stationarity in individual panel series is determined. The CIPS and CADF tests, which were created by Pasaran (2007), are these two-unit root tests. These tests, as opposed to the first-generation unit root analysis, can remove serial correlation and allow constant cross-section dependency (Appiah, Onifade, et al., 2022; Karim et al., 2022). After these unit root tests rule out the null hypothesis, the evaluation should be conducted using methods that can handle non-stationary datasets. Another circumstance that influences panel findings is the CSD test, which is conducted on each variable in a manner similar to the unit root test. (Pesaran, 2004; Pesaran, 2015; Pesaran et al., 2008) recommend two CSD tests that were used in the study.

3.2.2 Panel cointegration

After checking the order of integration of the variables being looked at, it is very important to look at the long-term dynamics of the model. Because of this, Westerlund and Edgerton (2007) created the error correction-based (ECM) cointegration test, which does not rely heavily on prior knowledge regarding the integration orders of series that allow for the existence of different solidity ranks in the regressors and considers the CSD and slope heterogeneity issues. As a result, this test can be used in a variety of situations (Wolde-Rufael and Weldemeskel, 2020). Finally, this method favors a flexible bootstrapping process that enables numerous long-run co-integration tests. This approach is based on four tests of valuation, including two mean-group analyses (Gt and Ga) and two panel exams. (Pt. and Pa.). The mean group test results show the alternative, while the panel test results assume that the panel is long-run cointegrated. The hypothesis (H1) with the smallest possible long-term link between the variables (Kilicarslan, 2019; Sequeira and Santos, 2018; Westerlund and Edgerton, 2007).

3.3.3 Panel Quantile Autoregressive distributed lag ((P)QARDL) Estimation.

The panel quantile ARDL approach is used in this study to investigate the relationships among financial development, fiscal policy, foreign capital, and the development of renewable energy across various quantiles of the dependent variable. This model's key benefit is that it is more resistant to non-normal errors. It also considers the dependent variable's skewness, heterogeneity, and outliers (Hashmi et al., 2022; Sahin & Sahin, 2023). To study the interactions between financial development, fiscal policy, foreign capital, and the development of renewable energy sources, we apply the following standard OLS specification as a benchmark. To prevent omitted variable bias, the following equations additionally include IQ and IND as control variables.

$$RED_{it} = a + \beta_1 FD_{it} + \beta_2 FIS_{it} + \beta_3 FC_{it} + \beta_4 IQ_{it} + \beta_5 IND_{it} + \varepsilon_{it} \quad (3)$$

RED here is the explained variable that depends on other explanatory factors like FD, FIS, and FC, with IQ and IND acting as the appropriate controls. We specifically use (Cho et al., 2015) quantile's ARDL (QARDL) in this investigation. By evaluating the short-run and long-run effects across several quantiles of the dependent variable, this model expands on the conventional ARDL model. The benefit of this model is that it makes it easier to analyze how independent variables affect the dependent variable over the short- and long-term at various quantiles of the dependent variable (Peng et al., 2022). Moreover, it offers superior outcomes with a smaller sample size. Finally, it is helpful when the variables are integrated of order zero (I(0)) or one (I(1)), just like the ARDL model (Hashmi et al., 2022; Peng et al., 2022). Unfortunately, when either of the variables is integrated of order two, this model is unable to produce solid findings. Consequently, we employ CIPS and CADF unit root tests with CSD and SCH preventive routines to examine the order of integration of the variables. After verifying the variables' integration order, we move on and employ the QARDL model suggested by (Cho et al., 2015). The following QARDL models, which are based on the common OLS model in equations (1) and (2), are produced by extending the ARDL model in the quantile framework. We offer the QARDL model in the following structure, as suggested by [44], following [42] and [33].

$$QRED_{it} = \alpha_i(\psi) + \sum_{i=1}^{p1} b_{it}(\psi)\, \Delta RED_{it-i} + \sum_{i=1}^{p2} c_{it}(\psi)\, \Delta FD_{it-i} + \sum_{i=1}^{p3} d_{it}(\psi)\, \Delta FIS_{it-i} + \sum_{i=1}^{p4} e_{it}(\psi)\, \Delta Fc_{it-i} + \sum_{i=1}^{p5} f_{it}(\psi) \Delta IND_{it-i} + \sum_{j=0}^{p6} g_{it}(\psi) IQ_{it-i} + \varepsilon_{it} \quad (4)$$

$$QRED_{it} = \alpha_i(\psi) + \sum_{i=1}^{p1} b_{it}(\psi)\, \Delta RED_{it-i} + \sum_{i=1}^{p2} c_{it}(\psi)\, \Delta FD_{it-i} + \sum_{i=1}^{p3} d_{it}(\psi)\, \Delta FIS_{it-i} + \sum_{i=1}^{p4} e_{it}(\psi)\, \Delta Fc_{it-i} + \sum_{i=1}^{p5} f_{it}(\psi) \Delta IND_{it-i} + \sum_{j=0}^{p6} g_{it}(\psi) IQ_{it-i} + \sum_{j=0}^{p6} h_{it}(\psi)\, FIS * IQ_{it-i} + \varepsilon_{it} \quad (5)$$

which has residuals that are independent, normally distributed, have a zero mean, and have a constant variance. The coefficients to be calculated are represented by the elements (c,d,e,f,g,h). The ECM is included in the model mentioned above. The speed of adjustment to the equilibrium level is designated by the parameter μ_{it}. The dependent variable in the ECM model is RED, and it is specified as follows:

$$QRED_{it}=\alpha_i(\psi)+\sum_{i=1}^{p1} b_{\mathrm{it}}(\psi)\,\Delta RED_{it-i}+\sum_{i=1}^{p2} c_{\mathrm{it}}(\psi)\,\Delta FD_{it-1}+\sum_{i=1}^{p3} d_{\mathrm{it}}(\psi)\,\Delta FIS_{it-1}+\sum_{i=1}^{p4} e_{\mathrm{it}}(\psi)\,\Delta Fc_{it-1}+\sum_{i=1}^{p5} f_{\mathrm{it}}(\psi)\Delta IND_{it-1}+\sum_{j=0}^{p6} g_{\mathrm{it}}(\psi)IQ_{it-1}+\mu_i ECT_{it-1}+\varepsilon_{it}\ldots\ldots(6)$$

$$QRED_{it}=\alpha_i(\psi)+\sum_{i=1}^{p1} b_{\mathrm{it}}(\psi)\Delta RED_{it-i}+\sum_{i=1}^{p2} c_{\mathrm{it}}(\psi)\,\Delta FD_{it-1}+\sum_{i=1}^{p3} d_{\mathrm{it}}(\psi)\,\Delta FIS_{it-1}+\sum_{i=1}^{p4} e_{\mathrm{it}}(\psi)\,\Delta Fc_{it-1}+\sum_{i=1}^{p5} f_{\mathrm{it}}(\psi)\Delta IND_{it-1}+\sum_{j=0}^{p6} g_{\mathrm{it}}(\psi)IQ_{it-1}+\sum_{j=0}^{p6} h_{\mathrm{it}}(\psi)FIS*IQ_{it-i}\,\varepsilon_{it}+\mu_i ECT_{it-1}+\varepsilon_{it}\ldots\ldots(7)$$

Subsequently, the following quantiles were applied in the empirical investigations: (ψ)=(0.10, 0.30, 0.50, 0.70, 0.90).

4. Results and Discussion

The results and discussion section begin with the preliminary analysis. The summary statistics and assessment of the correlation coefficient are the empirical findings of the study that are covered in this part and depicted in table 1. All the variables indicated a negatively skewed analysis span, with the omission of financial development, institutional quality, and foreign capital, which have positive skewness, according to Table 1's fundamental assessment of the coefficients under consideration. Kurtosis demonstrates that only institutional quality obtained a light tail in comparison to the dataset's peaks, whereas the other variables (renewable energy, financial development, fiscal policy, industrialization, and foreign capital) all have hefty tails. According to the median values of fiscal policies (FIS), the average government financial subsidy for the development of renewable energy in SSA is 3.5%. Nonetheless, industrialization and foreign capital accumulated a mean of 6.0 and 3.7, respectively. Nonetheless, the fiscal policy's standard deviation is lower than that of any other development-related factors for renewable energy, which shows that its supports are more stable. The institutional quality and industrialization standard deviations among the control variables are 0.698 and 13.07, respectively, showing that the laws and regulations governing the construction of industries for the development of renewable energy differ greatly. According to the results of the correlation study, all of the variables (RED, FD, FIS, IQ, and IND) are positively and significantly connected with the dependent variable; however, foreign capital has a negative and significant affiliation with the development of clean energy sources. However, there is criticism of the Pearson correlation evaluation, necessitating additional econometric analysis, which is covered in the next step of the current investigation.

Table 1: Descriptive Statistics

	RED	FD	FIS	IQ	IND	FC
Mean	77.39517	1.030255	3.477778	3.094857	5.993273	3.704228
Median	80.64	.754673	3.5	3	5.23244	1.91836
Std Dev.	13.03055	.6842197	.6673563	.6979923	13.07159	6.356729
Minimum	36.15	0	1	1.5	-75.0456	-5.20812
Maximum	94.73	3.53046	4.5	4.5	127.446	40.1672
Skewness	-1.312555	1.705111	-.7960433	-.2248712	3.391475	2.977298
Kurtosis	4.286117	5.790544	4.232044	2.770747	40.52468	12.76574
Correlation Statistics						
RED	1.0000					
FD	0.0226	1.0000				
FIS	0.0456	-0.3006***	1.0000			
IQ	0.0685	0.2531***	-0.0302	1.0000		
IND	0.0889	-0.0031	0.0488	0.0504	1.0000	
FC	-0.3235***	-0.0074	0.0052	-0.0820	-0.0271	1.0000

Note: ***, ** and * denote the significance at 1%, 5% and 10% level, respectively

Table 2: CSD and SCH Test

Test	Delta	P-value
Pesaran's test of CSD	15.311	0.000***
Slope Homogeneity	6.661	0.000***
Slope Homogeneity (Adjusted)	9.121	0.000***

Note: ***, ** and * denote the significance at 1%, 5% and 10% level, respectively

Table 3: Panel Unit Root Tests

	RED	FD	FIS	IQ	IND	FC
	Level Estimation					
CIPS Test	-1.559	-1.853	-2.067	-1.726	-2.837***	-2.281***
CADF Test	-1.561*	0.441	-0.524	0.635	-1.599*	-1.756*
	First Difference Estimation					
CIPS Test	-2.531***	-3.600***	-3.691***	-3.802***	-4.333***	-4.250***
CADF Test	1.756*	-3.327***	-3.987***	-2.243**	-5.564***	-5.540***

Note: ***, ** and * denote the significance at 1%, 5% and 10% level, respectively

As was already mentioned, there are a number of economic and non-economic factors at play when one country relies on another to accomplish its goals, which leads to some parallels and variances. The Pesaran and Yamagata, there are a number of economic and non-economic factors at play when one country relies on another to accomplish its goals, which leads to some parallels and variances. The Pesaran and Yamagata (2008) SCH test is used in this case, and the outcomes are shown in Table 2. Because disregarding the slope heterogeneity/homogeneity issue could result in inaccurate estimation (Korankye et al., 2021). It is crucial to determine whether the slopes are diverse as a result. The empirical estimates of both SCH and adjusted SCH (adjusted) are highly statistically significant, supporting the null hypothesis that slopes are homogeneous. In light of this, it might be deduced that the slopes' coefficients are heterogeneous and that the null hypothesis may need to be rejected. On the other hand, Gyamfi et al. (2021) asserted that as cross-sectional dependency causes estimate bias, a problem with the panel data may be discovered. According to empirical estimations see table 2, all variables are shown to be highly statistically significant, rejecting the null hypothesis of cross-sectional independence. Yet, because these variables are cross-sectional dependent, it is further demonstrated that industrialization, financial development, fiscal policy, institutional quality, and the influx of foreign capital in one country have an impact on the aforementioned factors in other economies. Given that the variables exhibited cross-sectional reliance and slope heterogeneity, using the empirical results revealed in Table 3, this study used the second-generation unit root testing approach, which included the CIPS and CADF tests (Pesaran, 2007). According to the empirical findings, only two variables—IND and FC—provide statistically significant estimates at I(0) with the CIPS test, and (RED, IND, and FC) with the CADF estimates, so the null hypothesis that there is a unit root in the time variables is rejected. The final three variables, however, are non-stationary at I (0). In order to test for stationarity at I(1), when these variables yield significant estimates that rule out the existence of a unit root, this study tested for stationarity at that point. As a result, all the variables are discovered to be stationary while integrating in a mixed order.

Table 4: Panel Cointegration Test

	G_t	G_a	P_t	P_a
FD	-6.966***	-4.702***	-1.989**	-6.376***
FIS	-6.411***	-3.583***	-8.222***	-7.796***
IQ	-1.701**	-5.838***	-4.123***	-10.788***
IND	-3.665***	-7.947***	-3.971***	-7.231***
FC	-3.065***	-3.874***	1.937	-1.511*

Note: ***, ** and * denote the significance at 1%, 5% and 10% level, respectively

The application of the cointegration test, which must be of the second generation, is sanctioned once the order of the variables' integration is determined. The outcomes of the panel cointegration test used in this investigation by Westerlund (2008) are shown in Table 4. The empirical findings show that, despite cross-sectional dependence, there is strong cointegration between the variables. Four tests are included in the cointegration analysis (G_T, G_A, P_T, and P_A). The findings indicated above suggest that there is cointegration between the dependent and independent variables. It is comprehensible why FD, FIS, IQ, IND, and FC have a long-term connection to the growth of renewable energy in SSA countries. The calculation of long-run coefficients is necessary to determine whether cointegration exists or not. The analysis went on to access the panel QARDL's long-term impact.

4.1 Main Regression Results

From the discussion section below, the main regression results are depicted through the employment of the panel quantile auto regressive distributed lag approach.

Table 5: Panel Quantile ARDL Tests

	Model 1					Model 2				
	Short Term					Short Term				
	0.10	0.30	0.50	0.70	0.90	0.10	0.30	0.50	0.70	0.90
FD	-0.0049 (2.756)***	-0.0022 (-2.307) **	-0.0005 (-0.534)	0.0019 (10.56)***	0.0011 (42.66) ***	-0.0057 (-15.98)***	-0.007(-8.874)***	-0.0029 (-3.041)***	-0.0045 (-8.053)***	-0.0046 (-41.23)***
FIS	0.0633 (10.30) ***	0.0312 (7.886) ***	0.0507 (12.50***	0.0219 (13.25) ***	0.0568 (491.1)***	11.4300 (33.83)***	12.1900 (14.87)***	8.9230 (7.894)***	12.2300 (38.10)***	11.2700 (315.6)***
IQ	-0.0076 (-1.662)*	-0.0126 (-3.956)***	-0.0102 (-4.907) ***	-0.0084 (-11.53) ***	-0.0138 (-238.9)***	11.38 (33.74)***	12.15 (14.79)***	8.848 (7.852)***	12.18 (37.79)***	11.22 (313.3)***
IND	-0.0037 (-8.994)***	-0.0022 (-5.080)***	-0.0040 (-18.06)***	-0.0042 (-10.92)***	-0.0038 (-416.0)***	-0.0053 (-34.48)***	-0.0045 (-17.81)***	-0.0048 (-9.147)***	-0.0048 (-24.83)***	-0.0049 (-103.0)***
FC	-0.0002 (-0.582)	0.0005 (2.613)***	-7.1505 (-0.260)	-0.0009 (-3.782)***	0.0014 (296.9)***	0.0013 (7.524)***	0.0023 (11.76)***	0.00086 (3.042)***	0.0017 (5.354)***	0.0018 (98.99)***
FIS* IQ	-	-	-	-	-	-11.3900 (-33.76)***	-12.1600 (-14.82)***	-8.8600 (-7.859)***	-12.1900 (-37.94)***	-11.2300 (-313.7)***
Long Term						Long Term				
llred	0.0264(16.69)***	0.0271(21.66)***	0.0273(19.94)***	0.0157(19.49)***	0.0235(479.7)***	0.0326(24.63)***	0.0258(15.08)***	0.0331(21.00)***	0.0313(36.79)***	0.0318 (412.4)***
FD	-0.0052 (-6.480)***	-0.0022 (-4.838)***	-0.0026 (-4.531)***	-0.0028 (-11.21)***	-0.0040 (-152.8)***	-0.0026 (-7.343)***	-0.0039 (-5.380)***	-0.0009 (-2.265)**	-0.0020 (-4.976)***	-0.0020 (-72.21)***
FIS	-0.0143 (-5.769)***	-0.0164 (-10.72)***	-0.0100 (-6.423)***	-0.0175 (-16.59)***	-0.0188 (-455.8)***	2.4430 (12.36)***	4.1930 (6.312)***	3.2140 (2.073)**	3.4390 (11.08)***	3.0860(70.07)***
IQ	-0.0060(-3.557)***	0.0024 (3.527)***	0.0013 (1.323)	-0.002 (-4.002)***	-0.0017 (-43.70)***	2.4590 (12.44)***	4.2060 (6.322)***	3.2230 (2.081)**	3.4530 (11.12)***	3.0990 (70.27)***
IND	-0.0026 (-6.967)***	0.0011 (1.871)*	-0.0029 (-6.483)***	-0.0045 (-25.25)***	-0.0024 (-262.4)***	-0.0035 (-23.19)***	-0.0030 (-6.801)***	-0.0047 (-18.76)***	-0.0025 (-15.38)***	-0.0029 (-34.36)***
FC	0.0007 (5.044)***	0.0007 (3.770)***	1.9805 (0.164)	-0.0003 (-3.000)***	0.0015 (336.9)***	0.0016 (23.20)***	0.0018 (15.48)***	0.0005 (2.817)***	0.0012 (10.88)***	0.0016 (122.4)***
FIS* IQ	-	-	-	-	-	-2.4570 (-12.43)***	-4.2060 (-6.329)***	-3.2250 (-2.082)**	-3.4540 (-11.14)***	-3.1010 (-70.35)***

Note: ***, ** and * denote the significance at 1%, 5% and 10% level, respectively

As was already established, the variables' dynamism and the presence of cointegration indicated that they were moving along a long-term trajectory. As a result, the innovative QARDL, which handles auto-correlation as well as locational asymmetries, was used in the current investigation. This is significant since the criteria could change depending on where renewable energy projects are developed. The QARDL method examines the long-term equilibrium effects of financial development, fiscal policies, institutional quality, industrialization, and foreign capital on the development of renewable energy across quantiles, as was previously demonstrated. The Wald test allows for the verification of the stability of the integrating coefficients across a wide variety of quantiles while simultaneously testing the time-varying relationship of integration. Table 5 provides the predicted outcomes of the aforementioned strategy.

The QARDL estimation findings are split into two models: model 1 deals with the dynamic relationship between independent factors and dependent variables, and model 2 deals with the interaction impact. The long-term and short-term effects of the panel are shown in Table 2. When the development of renewable energy sources is employed as the dependent variable and the explanatory factors include financial development, fiscal policy, institutional quality, industrialization, and foreign capital, quantile ARDL findings are obtained. Long-term financial development and fiscal policy have a negative and considerable impact on the specified quantiles. Results over the long run are more crucial since they are meaningful. The high capital-to-operation and maintenance cost ratio in renewable energy projects is just one of many barriers that make it difficult for these projects to attract financial sources in SSA nations. Moreover, renewable energy projects have a high development-to-investment cost ratio. Moreover, the costs of producing renewable energy are not accurately priced. Due to this, the risk profile for the majority of projects has increased, which needs to be fixed to please lenders and investors. Financial institutions have focused their assistance on projects and investments that support the oil trade and sectors reliant on this energy due to the SSA countries' need for quick growth. The government's investment in industrialization in Ghana as well as the most recent oil extraction facility built by the Nigerian government served as inspiration for this outcome. It was shown that as financial development increases as a percentage in SSA nations, renewable energy development decreases by -0.0052 (10), -0.0022 (30), -0.0026(50), -0.0028 (70), and -0.0040(90). These findings are growing as one moves from the lower to the upper quantile and are highly statistically significant at the 1%, 5%, and 10% levels. Assi et al. (2021) and Lei et al. (2021) outcomes support the findings above.

The outcome from Table 5 further indicates that fiscal policy has a considerable and unfavorable impact on the development of renewable energy in SSA countries. This suggests that a one percent increase in the FIS of SSA countries tends to slow down progress in the production of renewable energy by around

0.01430, 0.0164, 0.0100, 0.0175, and 0.0188% for each 10th-90th quantile. This finding shows that the governments of these nations are not interested in investing in the growth of renewable energy sources. Due to the IMF bailout and the conditions that came with it, it is hard for most SSA countries to put more money into researching and developing renewable energy. In the end, the biggest problems with developing renewable energy are related to money and getting things done. For SSA countries, storage infrastructure for renewable energy has grown to be a major problem. Renewable energy production is made less desirable by the lack of storage facilities. It should be mentioned that the popularity and use of renewable energy sources will soar if their infrastructure expands. However, the use of conventional energy sources like fossil fuels by the SSA countries will increase carbon emissions as there is little investment in the development of renewable energy. Furthermore, the studies by Zhongming et al. (2018) and Tong et al. (2022) support this outcome.

A necessary prerequisite for enforcing energy-related laws and regulations is an institutional framework. Mixed reactions to the findings are observed, with our findings showing that IQ restrains the development of renewable energy sources in the 10th, 70th, and 90th quantiles. Similarly, institutional quality and the growth of renewable energy are positively correlated for quantiles 30 and 50. The findings demonstrate that institutional norms and regulations in the SSA nations are so tight in the lower and upper quantiles that they are impeding the development of renewable energy. Thus, governments in SSA nations should loosen regulations to encourage the growth of renewable energy sources (i.e., hydropower, solar, and wind). The use of renewable energy in consumption and production can help these SSA economies become more environmentally friendly. This is supported by the fact that, as compared to non-renewable energy, renewable energy is produced naturally and emits less carbon into the atmosphere (i.e., coal, oil, and natural gas). If energy regulations are not reduced across the board in all SSA member nations, these nations' economies may develop in the long run, but at the expense of the environment because of a greater reliance on fossil fuels. We advise policymakers to take the rules for the development of renewable energy into account when creating policies for energy development and conservation, as well as the deployment of clean energy sources and the mitigation of climate change, given the degree of environmental risk that these SSA economies pose to the environment due to their IQ. Also, the results of the research (Cadoret & Padovano, 2016; Sequeira & Santos, 2018; Uzar, 2020) support the positive correlation. For instance, from 2004 to 2011, Canet & Padovano (2016) employed a sample of 26 European nations. The authors discovered that the distribution of renewable energy is boosted by greater governance. According to

Sequeira & Santos (2018), nations with higher levels of democracy spend more money on renewable energy. Equally, Uzar et al. (2020) discovered that institutional quality had a long-term beneficial effect on the consumption of renewable energy for a sample of 38 industrialized and developing states from 1990 to 2015.

Similarly, the regression outcomes show a substantial and negative agreement between industrialization and the development of renewable energy in SSA nations for the 10th, 50th, 70th, and 90th quantiles, but a positive relationship for the 30th quantile. The findings suggest that a percentage rise in industrialization results in a 0.0026(10), 0.0029(50), 0.0045(70), and 0.0024(90) drop in renewable energy. The findings indicate that the industrial sector in SSA nations is steadfast in its commitment to supporting the growth of renewable energy. It also illustrates the industry's inability to advance the development of renewable energy sources. This specific empirical study has shown that the industrial sector should adopt the potential to encourage the buildout of renewable energy, even though the usage of renewable energy in SSA nations differs substantially by sector. Via the value chain that results in the generation of renewable energy, the industrial sector may have contributed to the development of renewable energy. This is because, as previously mentioned, the industrial sector contributes to the value chain that results in the production of renewable energy, resulting in more than one third of the world's total primary energy consumption, according to the United Nations Industrial Development Organization (UNIDO, 2019).

Furthermore, the results show that FC, with the exception of the 70th quantile, is positively and significantly related to the growth of renewable energy development at a 1% significance level. According to the data above, a 1% upsurge in FC in the SSA nations is associated by improvements in the renewable energy development of 0.0007(10), 0.0007(30), 1.9805(50), and 0.0015(90). This research demonstrates how FC has had a considerable bearing on the growth of clean energy in SSA nations. These results concur with those of the authors of (Fan & Hao, 2020; Grabara et al., 2021; Kilicarslan, 2019), who all state that FC is positively and significantly related to the development of renewable energy in several picked countries and various economic models. For instance, (Sbia et al., 2014) claim that FC had a major impact on the demand for green energy in the UAE by using the ARDL test. For 20 emerging market countries, there is a substantial correlation between FC and renewable energy development, according to (Paramati et al., 2016). The ARDL model was used by the authors of [36] to analyse how FC affected renewable energy development in BRICST region. The results indicate that FC had a negative impact on renewable energy development. (Fan & Hao, 2020) recently looked into the relationship between FC and renewable energy development in China from 2000 to 2015. The results demonstrate the FC's strong and positive impact on China's clean energy development levels. The relationship between FC and renewable energy development was examined by the (Grabara et al., 2021) in two Arab nations from 1992 to 2018. The outcomes demonstrate that FC had a favorable impact on renewable energy development levels in these countries. This outcome can be a sign that FCs are flowing into the renewable energy industry. In this regard, the findings show that strategic policies to draw FC investments to this industry have been put in place. The results' positive claims run counter to those of (Hye & Riaz, 2008; Kang et al., 2021).

For the short run estimations, the results portray a negative and significant connection for all quantiles for the effects of institutional quality and industrialization on renewable energy development. It was found that a percentage increase in institutional quality index as well as industrialization leads to reduction in renewable energy development by (0.0076, 0.0126, 0.0102, 0.0084 & 0.0138) and (0.0037, 0.0022, 0.0040, 0.0042 & 0.0038) respectively. The results provided an interesting outcome with fiscal policy causing a positive and significant interconnection with the development of renewable energy in all the available quantiles. From the above table, it is evident that a percentage in government spending is leading to (0.0633, 0.0312, 0.0507, 0.0219, & 0.0568) in renewable energy development. In the same instinct, there are variations in the results of financial development and foreign capital with their influence on renewable energy development. The results exhibit both negative and positive influence at different quantiles and at different significant levels.

The next empirical results discussion is conducted on the interactional effects representing the model 2 of table 3. The findings in Table 3 indicate that the interaction effects of fiscal policy and institutional quality produced negative and effects in both the long and short run on renewable energy development. It can be seen that, an index increases in FIS*IQ results in a decrease of renewable energy buildout in the lengthy period by (2.4570, 4.2060, 3.2250, 3.4540 & 3.1010) percentage and a (11.3900, 12.1600, 8.8620, 12.1900 & 11.2300) % reduction in the short run. The coupling upshot of fiscal policy and institutional quality have a detrimental result on renewable energy development in SSA countries on their quest into the development of renewable energy. It is then recommended that SSA countries implement fiscal policy and institutional quality factors separately. The results simply record some few changes and similarities with the outcomes of model 1. Evidently the results displayed on financial development and industrialization are the same as that of model 1 but presents variations in the coefficient and significance at the listed quantiles. The results posit a negative and significant connection between FD and IQ with renewable energy development. On the other hand, the estimation produces different results for fiscal policy, institutional quality and foreign capital in this regard. The results reveal a direct significant association between fiscal policy, institutional quality and foreign capital and renewable energy development. It can be induced that a unit increase FIS, IQ and FC will increase the development of renewable energy by (0.0326, 0.0258, 0.0331, 0.0313 & 0.0318), (2.4590, 4.2060, 3.2230, 3.4530 & 3.0990) and (0.0016, 0.0018, 0.00054, 0.0012 & 0.0016) respectively for all quantiles. In its entity, the results show that when fiscal policy and institutional quality on energy related issues are enacted, it leads to the increment of renewable energy development with any small rise in fiscal policy, institutional quality and foreign capital.

4.2 Robustness Test Results

The table below reveals the robustness test results from the estimation of CSARDL application.

Table 6: Robustness Analysis

	Model 1		Model 2	
Short Run Results				
Variables	Coefficient	Z-Values	Coefficient	Z-Values
FD	.3181	0.77	-.6536	-6.40***
FIS	.9190	1.45	.8061	1.42
IQ	-.0218	-1.72*	-.1006	-1.76*
IND	.3270	0.80	-.0218	-1.87*
FC	-.1006	-1.71*	-.0640	-0.11
FIS*IQ	-	-	.2602	0.62
Long Run Results				
FD	.8079	2.76**	.0759	1.69*
FIS	-.0219	-1.72*	.1061	0.07
IQ	-.1036	-1.72*	-.9666	-0.70
IND	.8514	1.73*	.4007	2.67**
FC	.8218	2.83**	-.1036	-1.79*
FIS*IQ	-	-	-.6555	-6.39***
R-Squared	0.87		0.83	

Prob	0.000	0.060

Note: ***, ** and * denote the significance at 1%, 5% and 10% level, respectively

The study used the CS-ARDL estimate to test the baseline method's robustness. This approach is used in the context of data displaying CSD and heterogeneity. The long- and short-run estimations are both reliably produced by this procedure, in a similar manner. The long-run positive connection between the development of renewable energy and the predicted variables in model 1 is represented by the supporting factors of financial development, industrialization, and foreign capital, with coefficient values of.8079,.8514, and.8218. However, when it comes to other measures, such as fiscal policy and institutional quality, there is a clear negative correlation between the development of renewable energy. Accordingly, it is deduced that a 1% increase in fiscal policy and institutional quality negatively influences the development of renewable energy with the ratio of (0.219) and (0.1036). For instance, FIS and institutional quality reports a coefficient of (-0.219) and (-.1036), which is also significant at 10%. In the near run, institutional quality and foreign capital have a diminishing effect on the growth of renewable energy, with growth of renewable energy decreasing by.0218 and.1006 for every unit increase in institutional quality and foreign capital, respectively.

Similar results were found in model 2, which includes an interaction variable. The component of financial development and industrialization showed a positive association with the development of renewable energy, with coefficients of.0759 and.4007, meaning that a 1% increase in these two factors significantly increases the development of renewable energy content in SSA countries. However, a negative correlation between fiscal policy and institutional quality interaction with renewable energy development is found in the panel data of SSA nations that were chosen. In the same model, there is a short-term negative relationship between the development of renewable energy and financial development, institutional quality, and industrialisation.

5. Conclusion, Policy implications and Recommendations

A sizeable amount of energy is still produced using fossil fuels and this has been generally recognized as a very harmful situation for the global environment. Politicians and researchers have been interested in renewable energy resources as well as in the optimum use of those resources due to the negative externalities and other macroeconomic issues that emerge from environmental deterioration on a global scale. Besides, environmental catastrophes are becoming more widespread worldwide. Therefore, between 2000 and 2020, we looked at the effects of financial development, fiscal policy, foreign capital, industrialization, and institutional quality on the generation of renewable energy in 21 developing nations in sub-Saharan Africa. The Pesaran test is performed initially to ascertain whether or not there is a cross-sectional reliance between the variables in order for this study to achieve its objective. We performed the second-generation panel stationarity test to determine whether the variables included in the inquiry are stationary after validating the probable CSD. In order to find the long-run states of the series, we first checked that the integration order was accurate, and we did confirm that the variables are connected throughout the long term. For this research, the Panel Quantile Autoregressive Distributed Lad ((P)QARDL) method was used to examine the short- and long-term relationships between the independent variable and the advancement of renewable sources.

Following the simulations at all the quantiles of Model 1 and 2, credible negative relationships between financial development and renewable energy growth were supported in all periods (short and long-term). For fiscal policy, the long-short term result in model 1 exhibit a negative and positive significant bearing on renewable energy development respectively. For model 2 in both terms, there is a positive interconnection between fiscal policy and renewable energy development. Moreover, foreign capital shows mixed outcomes in model 1 with a positive connection given the long term perspective, and a negative link in the short-term. There is a change of results in model 2 indicating a positive and significant association in both long and short run. In the long-short run, both models 1 and 2 indicate a negative association between industrialization and renewable energy generation, whiles model 1 institutional quality has a negative significant relationship in both terms with renewable energy development, but renewable energy development is positively connected for all quantiles in model 2. The interaction term between fiscal policy and institution quality, which was employed in Model 2, obtained a negatively significant connection with renewable energy development in both the short and long run.

Based on the outcome of the study, the following recommendation are proposed:

- This finding calls for the reform of energy regulations that have been established as well as providing subsidies to the private sector for the generation of clean energy. The needed steps to alter consumption patterns of both industrial users and final consumers towards renewable energy also have to be taken. The only way to accomplish both the aim of sustainable development and the task of protecting the environment is to proceed in this manner. Domestic loans made available by the financial sector and bank loans made available to the private sector are generally used for investment in nonrenewable energy resources. At the moment, these investments are not being allocated effectively to renewable energy sources; the primary reason for this is that the prices of installing these sources of energy are so expensive. As a result, the implementation of measures by governments aimed at lowering the cost of energy is unavoidable. Due to the fact that emerging countries are increasingly reliant on power, their current account deficits have reached significant levels, which has a detrimental impact on their economies as well as the processes of growth and development. Investments in renewable energy will become less dependent on foreign energy sources as a result of regulatory decisions and financial incentives. However, when the practices of developing countries are analyzed, it is found that financial incentives for renewable energy resources are relatively minimal. In these countries, these resources do not qualify for any financial assistance, and there is no provision for tax breaks or deductions related to their use. Having said that, developing countries, which spend the most substantial portion of their annual current account deficit on energy imports, have the potential to dramatically lessen the severity of this issue by taking advantage of renewable energy sources. As a consequence of this, large-scale job opportunities can be created to assure the reliability of the supply of energy and to prevent the incurrence of additional expenses due to environmental concerns. In this context, developing nations should reconsider their incentives for renewable energy by learning from the experiences of leading countries in this field in order to take advantage of the opportunities presented by those experiences.

- Moreover, having quality institutions can help promote the needed societal progress that can promote the adoption of renewable sources over the long run. In this way, the establishment of strong institutions can produce a win-win situation that gives important opportunities for both individuals and policymakers. This can be a win for everyone involved. The formation of powerful institutions has the ability to mitigate economic, social, and political uncertainties, as well as boost the general well-being of communities. At the same time, the formation of these institutions can build confidence in the utilization of various forms of renewable energy, which can be a significant instrument in mitigating environmental catastrophes and guaranteeing energy security. The decision to encourage the growth of renewable energy sources is a political one. As a result, reputable institutions have the budding to play a pivotal part in the deployment of clean energy by means of strategic action plans that take environmental issues into consideration. In point of fact, advancements in environmental protection are not possible in isolation from the growth of democracy and the distribution of political power across society.

- In addition, particular suggestions for the implementation of policy might be provided with regard to the usage of clean energy. In order to be successful, funds in renewable energy sources need to be encouraged by subsidies like tax breaks and credit facilities. Within the confines of this structure, the allocation of greater funds to research and development activities will serve as a key accelerator for the lowering of investment costs associated with renewable energy. If there is a solid institutional structure in place, each of these incentives has a chance of being successful. Despite the fact that it makes only a minor contribution to the existing body of research, this study suffers from a number of methodological flaws. In this particular study, there were only two control variables used to reflect the various economic and environmental indices.
- Industrialization has an adverse influence on the growth of renewable energy, which highlights the fact that, despite the fact that industrialization has a deleterious impact on the intake of renewable energy, this adverse consequence becomes less pronounced as the level of industrialization increases. The findings of this analysis point to the advancement of technology as the driving force behind both the acceleration of industrialization and the transformation of non-renewable energy sources into renewable energy sources. As a result, we are advocating for the institution of a green industrial system, which includes modifying and optimizing the organization and arrangement of the industrial sector, as well as encouraging the industrial sector to strenuously advance and encourage novel methods and technologies that produce less waste, save water and energy, and recycle materials.

Having said all, there are a few problems with this study. In the first place, the purpose of this research was to investigate, using a limited number of samples and a limited amount of data, the relationship between renewable energy and the factors that influence it in 21 developing countries in SSA. Because of their central role in the advancement of renewable energy across the globe, the G-20 countries should be the focus of any future research in this area. It is possible that in the future, more in-depth research will be carried out on countries (regions) that have good development of renewable energy and the most recent statistics. Second, the Quantile ARDL panel was utilized in this investigation. In forthcoming studies, the time series threshold model as well as the dynamic threshold model may be applied to the problem of determining the potential threshold of particular nations and regions.

References

Akpanke, T. A., Deka, A., Ozdeser, H., & Seraj, M. (2023). Does foreign direct investment promote renewable energy use? An insight from West African countries. *Renewable Energy Focus*, *44*, 124-131. https://doi.org/https://doi.org/10.1016/j.ref.2022.11.007

Amri, F. (2016). The relationship amongst energy consumption, foreign direct investment and output in developed and developing countries. *Renewable and Sustainable Energy Reviews*, *64*, 694-702.

Appiah, M., Li, M., Onifade, S. T., & Gyamfi, B. A. (2022). Investigating institutional quality and carbon mitigation drive in Sub-Saharan Africa: Are growth levels, energy use, population, and industrialization consequential factors? *Energy & Environment*, *0*(0), 0958305X221147602. https://doi.org/10.1177/0958305x221147602

Appiah, M., Onifade, S. T., & Gyamfi, B. A. (2022). Building Critical Infrastructures: Evaluating the Roles of Governance and Institutions in Infrastructural Developments in Sub-Sahara African Countries. *Evaluation Review*, *0*(0), 1-25.

Assi, A. F., Isiksal, A. Z., & Tursoy, T. (2021). Renewable energy consumption, financial development, environmental pollution, and innovations in the ASEAN+ 3 group: Evidence from (P-ARDL) model. *Renewable Energy*, *165*, 689-700.

Ayana, I. D. (2022). Fiscal Policy and Economic Growth in Sub-Saharan African Countries: A Systematic Review. *Universal Journal of Finance and Economics*, 42-51.

Ahmad, M., Jabeen, G., & Wu, Y. (2021). Heterogeneity of pollution haven/halo hypothesis and environmental Kuznets curve hypothesis across development levels of Chinese provinces. Journal of Cleaner Production, 285, 124898.

Azhgaliyeva, D., Kapsalyamova, Z., & Low, L. (2019). Implications of fiscal and financial policies on unlocking green finance and green investment. In *Handbook of green finance* (pp. 427-457). Springer.

Balsalobre-Lorente, D., Gokmenoglu, K. K., Taspinar, N., & Cantos-Cantos, J. M. (2019). An approach to the pollution haven and pollution halo hypotheses in MINT countries. Environmental Science and Pollution Research, 26(22), 23010-23026.

Benos, N. (2009). Fiscal policy and economic growth: empirical evidence from EU countries. *MPRA Paper No. 19174,*, *2*(1), 1-29.

Bhattacharya, S., Gupta, A., Kar, K., & Owusu, A. (2020). Risk management of renewable power producers from co-dependencies in cash flows. *European Journal of Operational Research*, *283*(3), 1081-1093.

Bhujabal, P., Sethi, N., & Padhan, P. C. (2021). ICT, foreign direct investment and environmental pollution in major Asia Pacific countries. *Environmental Science and Pollution Research*, *28*(31), 42649-42669.

Bozkaya, Ş., Onifade, S. T., Duran, M. S., & Kaya, M. G. (2022). Does environmentally friendly energy consumption spur economic progress: empirical evidence from the Nordic countries?. Environmental Science and Pollution Research, 29 (46) 1-11. https://doi.org/10.1007/s11356-022-23452-4

Boohene, D., & Darkwah, J. A. (2023). The Interconnection of Economic Growth, Carbon Dioxide Emission, Foreign Direct Investment and Energy Consumption: Evidence from Sub-Saharan Africa. *Aswan University Journal of Environmental Studies*, *4*(1), 4-23.

Birdsall, N., & Wheeler, D. (1993). Trade policy and industrial pollution in Latin America: where are the pollution havens?. The Journal of Environment & Development, 2(1), 137-149.

Brown, M. A., & Chandler, S. (2008). Governing confusion: how statutes, fiscal policy, and regulations impede clean energy technologies. *Stan. L. & Pol'y Rev.*, *19*, 472-491.

Buchholz, P., & Brandenburg, T. (2018). Demand, supply, and price trends for mineral raw materials relevant to the renewable energy transition wind energy, solar photovoltaic energy, and energy storage. *Chemie Ingenieur Technik*, *90*(1-2), 141-153.

Cadoret, I., & Padovano, F. (2016). The political drivers of renewable energies policies. *Energy Economics*, *56*, 261-269.

Chang, K., Wan, Q., Lou, Q., Chen, Y., & Wang, W. (2020). Green fiscal policy and firms' investment efficiency: New insights into firm-level panel data from the renewable energy industry in China. *Renewable Energy*, *151*, 589-597. https://doi.org/https://doi.org/10.1016/j.renene.2019.11.064

Chapman, A. J., McLellan, B. C., & Tezuka, T. (2018). Prioritizing mitigation efforts considering co-benefits, equity and energy justice: Fossil fuel to renewable energy transition pathways. Applied Energy, 219, 187-198.

Chien, F., Hsu, C.-C., Zhang, Y., Tran, T. D., & Li, L. (2022). Assessing the impact of green fiscal policies and energy poverty on energy efficiency. *Environmental Science and Pollution Research*, *29*(3), 4363-4374.

Cho, J. S., Kim, T.-h., & Shin, Y. (2015). Quantile cointegration in the autoregressive distributed-lag modeling framework. *Journal of Econometrics*, *188*(1), 281-300.

Deka, A., Cavusoglu, B., & Dube, S. (2022). Does renewable energy use enhance exchange rate appreciation and stable rate of inflation? *Environmental Science and Pollution Research*, 1-10.

Doran, M. D., Poenaru, M. M., Zaharia, A. L., Vătavu, S., & Lobonț, O. R. (2023). Fiscal Policy, Growth, Financial Development and Renewable Energy in Romania: An Autoregressive Distributed Lag Model with Evidence for Growth Hypothesis. *Energies*, *16*(1), 70-90. https://www.mdpi.com/1996-1073/16/1/70

Doytch, N., & Narayan, S. (2016). Does FDI influence renewable energy consumption? An analysis of sectoral FDI impact on renewable and non-renewable industrial energy consumption. *Energy Economics*, *54*, 291-301. https://doi.org/https://doi.org/10.1016/j.eneco.2015.12.010

Fan, W., & Hao, Y. (2020). An empirical research on the relationship amongst renewable energy consumption, economic growth and foreign direct investment in China. *Renewable Energy*, *146*, 598-609. https://doi.org/https://doi.org/10.1016/j.renene.2019.06.170

Florea, N. M., Bădîrcea, R. M., Meghisan-Toma, G.-M., Puiu, S., Manta, A. G., & Berceanu, D. (2021). Linking public finances' performance to renewable-energy consumption in emerging economies of the European Union. *Sustainability*, *13*(11), 63-84.

Grabara, J., Tleppayev, A., Dabylova, M., Mihardjo, L. W. W., & Dacko-Pikiewicz, Z. (2021). Empirical Research on the Relationship amongst Renewable Energy Consumption, Economic Growth and Foreign Direct Investment in Kazakhstan and Uzbekistan. *Energies*, *14*(2), 3-22. https://www.mdpi.com/1996-1073/14/2/332

Gyamfi, B. A., Ozturk, I., Bein, M. A., & Bekun, F. V. (2021). An investigation into the anthropogenic effect of biomass energy utilization and economic sustainability on environmental degradation in E7 economies. *Biofuels, Bioproducts and Biorefining*, *15*(3), 840-851.

Hamid, I., Alam, M. S., Kanwal, A., Jena, P. K., Murshed, M., & Alam, R. (2022). Decarbonization pathways: the roles of foreign direct investments, governance, democracy, economic growth, and renewable energy transition. *Environmental Science and Pollution Research*, *29*(33), 49816-49831.

Hansen, B. (2003). *The economic theory of fiscal policy* (Vol. 3). Psychology Press.

Hashmi, S. M., Chang, B. H., Huang, L., & Uche, E. (2022). Revisiting the relationship between oil prices, exchange rate, and stock prices: An application of quantile ARDL model. *Resources Policy*, *75*, 102-113. https://doi.org/https://doi.org/10.1016/j.resourpol.2021.102543

Hast, A., Alimohammadisagvand, B., & Syri, S. (2015). Consumer attitudes towards renewable energy in China—The case of Shanghai. *Sustainable Cities and Society*, *17*, 69-79.

He, L., Zhang, L., Zhong, Z., Wang, D., & Wang, F. (2019). Green credit, renewable energy investment and green economy development: Empirical analysis based on 150 listed companies of China. *Journal of Cleaner Production*, *208*, 363-372. https://doi.org/https://doi.org/10.1016/j.jclepro.2018.10.119

Hosseini, S. E. (2020). An outlook on the global development of renewable and sustainable energy at the time of COVID-19. *Energy Research & Social Science*, *68*, 101-133.

Haouas, I., Khraief, N., Cooray, A., & Onifade, S. T. (2022). Exploring the time-varying causal nexuses between remittances and financial development in MENA region. Journal of Sustainable Finance & Investment, 1-27. https://doi.org/10.1080/20430795.2022.2112139

Hye, Q. M. A., & Riaz, S. (2008). Causality between energy consumption and economic growth: the case of Pakistan. *The Lahore Journal of Economics*, *13*(2), 45-58.

Igwe, A., Emmanuel, E. C., & Ukpere, W. I. (2019). Impact of fiscal policy variables on economic growth in Nigeria (1970-2012): a managerial economics persperctive. *Innovations*, *12*(2-1), 169-179.

Ike, G. N., Usman, O., & Sarkodie, S. A. (2020). Fiscal policy and CO2 emissions from heterogeneous fuel sources in Thailand: evidence from multiple structural breaks cointegration test. *Science of The Total Environment*, *702*, 134-154.

Inglesi-Lotz, R. (2016). The impact of renewable energy consumption to economic growth: A panel data application. *Energy Economics*, *53*, 58-63.

Jahan, S., Mahmud, A. S., & Papageorgiou, C. (2014). What is Keynesian economics. *International Monetary Fund*, *51*(3), 53-54.

Kang, X., 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*(12), 34-50.

Karim, S., Appiah, M., Naeem, M. A., Lucey, B. M., & Li, M. (2022). Modelling the role of institutional quality on carbon emissions in Sub-Saharan African countries. *Renewable Energy*, *198*, 213-221.

Khan, A., Chenggang, Y., Hussain, J., & Kui, Z. (2021). Impact of technological innovation, financial development and foreign direct investment on renewable energy, non-renewable energy and the environment in belt & Road Initiative countries. *Renewable Energy*, *171*, 479-491.

Khandker, L. L., Amin, S. B., & Khan, F. (2018). Renewable energy consumption and foreign direct investment: Reports from Bangladesh. *J. Account*, *8*, 72-87.

Kilicarslan, Z. (2019). The Relationship between Foreign Direct Investment and Renewable Energy Production: Evidence from Brazil, Russia, India, China, South Africa and Turkey. *International Journal of Energy Economics and Policy*, *9*(4), 291-297. https://www.econjournals.com/index.php/ijeep/article/view/7879

Kim, J., & Park, K. (2016). Financial development and deployment of renewable energy technologies. *Energy Economics*, *59*, 238-250. https://doi.org/https://doi.org/10.1016/j.eneco.2016.08.012

Korankye, B., Wen, Z., Appiah, M., & Antwi, L. (2021). The Nexus Between Financial Development, Economic Growth and Poverty Alleviation: PMG-ARDL Estimation. *ETIKONOMI*, *20*(1), 1-12.

Koyama, K., & Krane, J. (2021). Energy security through FDI: The legacy of Early Japanese Investment in the Oil Sectors of the Persian Gulf. *Resources Policy*, *74*, 102165.

Ofori, E. K., Onifade, S. T., Ali, E. B., Alola, A. A., & Zhang, J. (2023). Achieving carbon neutrality in post COP26 in BRICS, MINT, and G7 economies: The role of financial development and governance indicators. Journal of Cleaner Production, 387, 135853. https://doi.org/10.1016/j.jclepro.2023.135853

Kutan, A. M., Paramati, S. R., Ummalla, M., & Zakari, A. (2018). Financing Renewable Energy Projects in Major Emerging Market Economies: Evidence in the Perspective of Sustainable Economic Development. *Emerging Markets Finance and Trade*, *54*(8), 1761-1777. https://doi.org/10.1080/1540496X.2017.1363036

Le, T.-H., & Park, D. (2021). What drives energy insecurity across the world? A panel data analysis. *Energy Research & Social Science*, *77*, 102093.

Lee, J. W. (2013). The contribution of foreign direct investment to clean energy use, carbon emissions and economic growth. *Energy Policy*, *55*, 483-489. https://doi.org/https://doi.org/10.1016/j.enpol.2012.12.039

Lei, W., Liu, L., Hafeez, M., & Sohail, S. (2021). Do economic policy uncertainty and financial development influence the renewable energy consumption levels in China? *Environmental Science and Pollution Research*, 1-10.

Liming, H. (2009). Financing rural renewable energy: A comparison between China and India. *Renewable and Sustainable Energy Reviews*, *13*(5), 1096-1103. https://doi.org/https://doi.org/10.1016/j.rser.2008.03.002

Lin, B., Omoju, O. E., & Okonkwo, J. U. (2016). Factors influencing renewable electricity consumption in China. *Renewable and Sustainable Energy Reviews*, *55*, 687-696. https://doi.org/https://doi.org/10.1016/j.rser.2015.11.003

Lisin, A. (2021). Renewable energy transition: Evidence from spillover effects in exchange-traded funds. *International Journal of Energy Economics and Policy*, *11*(3), 84-190.

List, J. A., & Co, C. Y. (2000). The effects of environmental regulations on foreign direct investment. *Journal of Environmental Economics and Management*, *40*(1), 1-20.

Mazorodze, B. T. (2018). Government expenditure and economic growth in Zimbabwe. *African Journal of Business and Economic Research*, *13*(2), 183-202. https://doi.org/doi:10.10520/EJC-10dd1a8e87

Meng, Z., Sun, H., & Liu, X. (2022). Impact of green fiscal policy on the investment efficiency of renewable energy enterprises in China. *Environmental Science and Pollution Research*, *29*(50), 76216-76234.
Onifade, S.T. (2023). Environmental impacts of energy indicators on ecological footprints of oil-exporting African countries: Perspectives on fossil resources abundance amidst sustainable development quests. Resources Policy, 82, 103481. https://doi.org/10.1016/j.resourpol.2023.103481
Onifade, S. T., & Alola, A. A. (2022). Energy transition and environmental quality prospects in leading emerging economies: The role of environmental-related technological innovation. Sustainable Development. 30(2), 1-13 https://doi.org/10.1002/sd.2346
Onifade, S. T., Gyamfi, B. A., Ilham, H. & Bekun, F. V. (2021). Re-examining the Roles of Economic Globalization on Environmental Degradation in the E7 Economies: Are Human Capital, Urbanization, and Total Natural Resources Essential Components? Resources Policy. 74, 102435 http://dx.doi.org/10.1016/j.resourpol.2021.102435
Papież, M., Śmiech, S., & Frodyma, K. (2018). Determinants of renewable energy development in the EU countries. A 20-year perspective. *Renewable and Sustainable Energy Reviews*, *91*, 918-934.
Paramati, S. R., Ummalla, M., & Apergis, N. (2016). The effect of foreign direct investment and stock market growth on clean energy use across a panel of emerging market economies. *Energy Economics*, *56*, 29-41. https://doi.org/https://doi.org/10.1016/j.eneco.2016.02.008
Peng, B., Chang, B. H., Yang, L., & Zhu, C. (2022). Exchange rate and energy demand in G7 countries: Fresh insights from Quantile ARDL model. *Energy Strategy Reviews*, *44*, 100-116. https://doi.org/https://doi.org/10.1016/j.esr.2022.100986
Pesaran, H. (2004). General diagnostic tests for cross-sectional dependence in panels. *University of Cambridge, Cambridge Working Papers in Economics No. 0435*.
Pesaran, H. M. (2007). A simple panel unit root test in the presence of cross-section dependence. *Journal of Applied Econometrics*, *22*, 265–312.
Pesaran, M. H. (2015). Testing weak cross-sectional dependence in large panels. *Econometric Reviews*, *34*(6-10), 1089-1117.
Pesaran, M. H., Ullah, A., & Yamagata, T. (2008). A bias-adjusted LM test of error cross-section independence. *Econometrics Journal*, *11*(1), 105-127.
Pesaran, M. H., & Yamagata, T. (2008). Testing slope homogeneity in large panels. *Journal of Econometrics*, *142*(1), 50-93.
Rahman, M. M., & Sultana, N. (2022). Impacts of institutional quality, economic growth, and exports on renewable energy: Emerging countries perspective. *Renewable Energy*, *189*, 938-951. https://doi.org/https://doi.org/10.1016/j.renene.2022.03.034
Rajavuori, M., & Huhta, K. (2020). Investment screening: Implications for the energy sector and energy security. *Energy Policy*, *144*, 111646.
Rashed, A., Yong, C.-C., & Soon, S.-V. (2022). The nexus among foreign direct investment in renewable electricity industry, renewable electricity production, and economic growth in Africa. *Cogent Economics & Finance*, *10*(1), 2001141.
Ren, X., Cheng, C., Wang, Z., & Yan, C. (2021). Spillover and dynamic effects of energy transition and economic growth on carbon dioxide emissions for the European Union: A dynamic spatial panel model. *Sustainable Development*, *29*(1), 228-242.
Sahin, G., & Sahin, A. (2023). An Empirical Examination of Asymmetry on Exchange Rate Spread Using the Quantile Autoregressive Distributed Lag (QARDL) Model. *Journal of Risk and Financial Management*, *16*(1), 2-25. https://www.mdpi.com/1911-8074/16/1/38
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.
Sbia, R., Shahbaz, M., & Hamdi, H. (2014). A contribution of foreign direct investment, clean energy, trade openness, carbon emissions and economic growth to energy demand in UAE. *Economic Modelling*, *36*, 191-197. https://doi.org/https://doi.org/10.1016/j.econmod.2013.09.047

ŞEn, S. (2017). Incentives As A Fiscal Policy Tool İn Renewable Energy Production: Experiences Of A Number Of Selected European Countries And Turkey. *Journal Of Life Economics*, *4*(1), 59-76. https://doi.org/10.15637/jlecon.185

Sequeira, T. N., & Santos, M. S. (2018). Renewable energy and politics: A systematic review and new evidence. *Journal of Cleaner Production*, *192*, 553-568.

Shahbaz, M., Khan, S., & Tahir, M. I. (2013). The dynamic links between energy consumption, economic growth, financial development and trade in China: Fresh evidence from multivariate framework analysis. *Energy Economics*, *40*, 8-21. https://doi.org/https://doi.org/10.1016/j.eneco.2013.06.006

Shang, Y., Zhu, L., Qian, F., & Xie, Y. (2023). Role of green finance in renewable energy development in the tourism sector. *Renewable Energy*, *206*, 890-896. https://doi.org/https://doi.org/10.1016/j.renene.2023.02.124

Tamazian, A., Chousa, J. P., & Vadlamannati, K. C. (2009). Does higher economic and financial development lead to environmental degradation: evidence from BRIC countries. *Energy Policy*, *37*(1), 246-253.

Tong, X., You, M., & Gu, L. (2022). The Impact of Fiscal Policy on the Sustainable Development of China's Photovoltaic Industry [Original Research]. *Frontiers in Environmental Science*, *10*, 1-17. https://doi.org/10.3389/fenvs.2022.883546

Tu, Y.-X., Kubatko, O., Piven, V., Sotnyk, I., & Kurbatova, T. (2022). Determinants of Renewable Energy Development: Evidence from the EU Countries. *Energies*, *15*(19), 70-93.

Usman, M., Balsalobre-Lorente, D., Jahanger, A., & Ahmad, P. (2022). Pollution concern during globalization mode in financially resource-rich countries: Do financial development, natural resources, and renewable energy consumption matter? *Renewable Energy*, *183*, 90-102. https://doi.org/https://doi.org/10.1016/j.renene.2021.10.067

Uzar, U. (2020). Political economy of renewable energy: does institutional quality make a difference in renewable energy consumption? *Renewable Energy*, *155*, 591-603.

Wang, E., Gozgor, G., Mahalik, M. K., Patel, G., & Hu, G. (2022). Effects of institutional quality and political risk on the renewable energy consumption in the OECD countries. *Resources Policy*, *79*, 103-111. https://doi.org/https://doi.org/10.1016/j.resourpol.2022.103041

Wang, Q., & Zhang, F. (2021). Free trade and renewable energy: A cross-income levels empirical investigation using two trade openness measures. *Renewable Energy*, *168*, 1027-1039.

Walter, I., & Ugelow, J. L. (1979). Environmental policies in developing countries. Ambio, 102-109.

Westerlund, J. (2008). Panel cointegration tests of the Fisher effect. *Journal of Applied Econometrics*, *23*(2), 193-233.

Westerlund, J., & Edgerton, D. L. (2007). A panel bootstrap cointegration test. *Economics Letters*, *97*(3), 185-190.

Wolde-Rufael, Y., & Weldemeskel, E. M. (2020). Environmental policy stringency, renewable energy consumption and CO2 emissions: Panel cointegration analysis for BRIICTS countries. *International Journal of Green Energy*, *17*(10), 568-582.

Xin-gang, Z., Ling, W., & Ying, Z. (2020). How to achieve incentive regulation under renewable portfolio standards and carbon tax policy? A China's power market perspective. *Energy Policy*, *143*, 111-136.

Yoshino, N., & Taghizadeh-Hesary, F. (2018). Alternatives to private finance: Role of fiscal policy reforms and energy taxation in development of renewable energy projects. *Financing for Low-carbon Energy Transition: Unlocking the Potential of Private Capital*, 335-357.

Zhang, Z., & Zheng, Q. (2022). Sustainable development via environmental taxes and efficiency in energy: Evaluating trade adjusted carbon emissions. *Sustainable Development*.

Zhao, Y., Shi, X., & Song, F. (2020). Has Chinese outward foreign direct investment in energy enhanced China's energy security? *Energy Policy*, *146*, 111803.

Zhongming, Z., Linong, L., Xiaona, Y., Wangqiang, Z., & Wei, L. (2018). *Implications of Fiscal and Financial Policies for Unlocking Green Finance and Green Investment*.