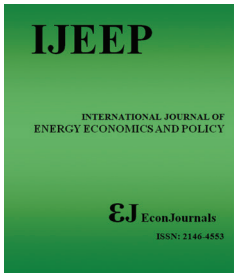

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Financing Green Transitions: The Institutional Link in Sub-Saharan Africa's Renewable Energy Drive

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ABSTRACT

The transition to renewable energy in Sub-Saharan Africa is shaped by both financial and institutional determinants, yet empirical evidence on their joint effect remains limited. This study examines the relationship between financial resources and renewable energy adoption across 20 Sub-Saharan African nations from 2004 to 2023, using Fully Modified Ordinary Least Squares to capture long-run relationships and System Generalised Methods of Moments (GMM) to address endogeneity, it tests whether finance alone can drive RE growth and whether institutional quality moderates this effect. Results show that FDI is not sufficiently a driver for renewable energy transition, with effects varying across estimators. Also, political stability emerges as a driver for renewable energy adoption, while institutional quality has a mixed-moderating effect. These findings support recent evidence that governance quality and green finance mechanisms enhance the FDI flows for clean energy transition. This study contributes to the renewable energy finance literature by offering one of the first SSA-wide empirical analyses integrating finance-institution interaction in a green economy. Policy implications highlight the need for coordinated strategies that combine FDI inflows, institutional reforms and innovative green finance tailored to country-specific contexts.

Keywords: Renewable Energy, Financial Resources, Institutional Quality, Sub-Saharan Africa, Green Finance
JEL Classifications: Q4, Q5, Q43, Q420

1. INTRODUCTION

Energy is universally acknowledged as a pillar of sustainability, ensuring social well-being, environmental protection, and economic development (Sohail et al., 2025). It also offers opportunities for progress in education, employment, industrialisation, and information technology, thereby encouraging sustainable economic growth. However, access to energy remains one of the most significant disparities between developed and developing nations (Oyewole et al., 2024). In sub-Saharan Africa (SSA), more than 600 million people live without electricity, with many communities relying on traditional biomass fuels such as firewood and charcoal for their daily energy needs. This chronic energy poverty hinders social progress and restricts economic transformation.

Furthermore, renewable energy (RE) has been recognised as a transformative solution to SSA's energy crisis (Okoye et al., 2025; Mperejekumana et al., 2024). SSA possesses vast untapped potential in solar, wind, hydro, and biomass resources, positioning it to adopt clean energy for both energy security and economic prosperity. Furthermore, transitioning to renewable energy aligns with global climate commitments such as the Paris Agreement, creating pathways to reduce carbon dioxide emissions and foster environmental resilience (Yang et al., 2024). The development of renewable energy infrastructure in SSA offers the opportunity to improve living standards, enhance competitiveness, and advance sustainable development.

Despite these opportunities, RE deployment in SSA has been slow (Ukoba et al., 2024). One of the persistent structural issues

is inadequate financial resources. Large-scale RE projects, including solar farms, wind parks and hydroelectric plants, require substantial upfront capital with long payback periods. Consequently, RE development in SSA is heavily dependent on external financing from global institutions such as the African Development Bank, the Green Climate Fund and the World Bank. Many SSA governments face competing budgetary priorities such as healthcare and education, while weak domestic capital markets, exchange rate volatility and high finance costs deter private investment (Voto et al., 2025).

Accordingly, financial instruments such as green bonds and climate funds offer promising solutions, their application remains stunted due to fragmented policies, governance issues, and investors' weak perceptions (Raman et al., 2025). Also, even where successful financing models such as South Africa's Renewable Energy Independent Power Producer Procurement Program (REIPPPP) exist, smaller nations like Chad, Niger and the Republic of Congo struggle to adapt such models due to weak financial markets and poor institutional quality (Enebe et al., 2024).

Furthermore, innovative financing mechanisms, including public-private partnerships (PPP), pay-as-you-go solar bundles, and sustainable investing, are emerging as promising pathways to foster RE adoption (Adelakun et al., 2024; Chukwuma-Eke et al., 2025); however, their advancement is hindered by the absence of robust regional frameworks, limited case-based evidence and contrasting institutional contexts. Furthermore, while technological advancements and declining renewable technology costs are creating new opportunities (Ikemba et al., 2024), the speed of adoption remains constrained by structural financial bottlenecks.

Although previous studies have examined the role of finance in RE development (Ackah et al., 2024; Nawaz and Rahman, 2023), several gaps remain. First, there is limited empirical evidence on the link between financial resources and RE adoption in SSA. Additionally, recent literature highlights several methodological and scope-related gaps that this study needs to address. Many studies are country-specific or technology-specific (Obada et al., 2024; Amadi et al., 2024; Mukhtar et al., 2023), or focus on cross-sectional snapshots, which constrain insights into the dynamics of financing flows, causality, and how policy effectiveness evolves (Appiah et al., 2023). Furthermore, concerns regarding endogeneity and causality direction (Vatamanu and Zugravu, 2023) are frequently raised.

Given these gaps, this study investigates the relationship between financial resources and RE adoption in SSA, focusing on trends, policy frameworks, and investment patterns over 20 years across countries. By incorporating macroeconomic variables into the model, the research aims to contribute to Sustainable Development Goal 7 (clean and affordable energy) and Goal 13 (climate action) by providing actionable insights to policymakers, investors, RE developers, and international development partners, thereby supporting SSA's transition to a sustainable and inclusive energy future.

2. LITERATURE REVIEW

2.1. Financial Resources

Financial resources include monetary assets such as cash, loans, credit facilities, investment capital, and grants mobilised to fund economic activities, including renewable projects (Mukhtarov et al., 2021). These resources collectively enable investments, operational expenses, and growth initiatives. Large-scale projects depend on these resources, which can be significantly limited by budgetary constraints and competing interests, such as infrastructure or social services (Asongu and Odhiambo, 2021). Consequently, the use of public funding is highly influenced by the economic conditions and the strategic policies chosen. Robust financial systems comprising commercial banks, capital markets, and microfinance institutions are essential for the mobilisation and distribution of financial resources (Mbodj and Laye, 2025).

Furthermore, these systems facilitate loans, access to equity capital via initial public offerings, and financing for individuals or small businesses, although access can be hindered by high-interest rates or inadequate infrastructure (Anton and Nucu, 2020; Prempeh, 2023). Therefore, financial efficiency- reflected in the lowest transaction and credit arrangement costs- is crucial for optimising resource utilisation. Experts support the development of innovative financing models, which are vital for sustaining economic growth (Shabbir and Cheong, 2024).

2.2. Renewable Energy

Renewable energy is produced from naturally replenishable sources such as sunlight, wind, water, and biomass (Ajibola et al., 2025; Singh et al., 2024), and it plays a vital role in meeting the world's energy demands as well as counteracting the effects of climate change. These sources are essential in reducing environmental degradation and lowering greenhouse gas emissions compared to those from fossil fuels, helping achieve international climate goals (including the Paris Agreement) against climate change (Dincer and Aydin, 2023). As recently as 2024, renewables accounted for nearly 30% of global electricity, predominantly generated by solar, wind, hydro, biomass, and geothermal energy, with further growth expected as costs decline and technological advances continue (IEA, 2024).

Solar energy, harnessed through the sun, exceeded 1,000 gigawatts of capacity worldwide by 2023, despite intermittency issues requiring high-capacity storage solutions like lithium-ion batteries for rapid response (IRENA, 2023). In 2024, turbines in onshore and offshore farms supplied 8% of global electricity, with offshore wind gaining popularity due to its efficiency despite challenges such as visual impact and site limitations (IEA, 2024). Hydropower remains the largest source of renewable electricity, producing 16% of global electricity in 2023, offering dependable baseload power but raising environmental and social issues such as ecosystem disruption and community displacement (IRENA, 2023). The advantages of renewables are considerable, including lower emissions, improved energy security, and job creation.

Nevertheless, challenges remain, including intermittency in solar and wind, high initial costs in developing countries, and land

use impacts from projects like hydropower dams or bioenergy crops (Rahman et al., 2022). Supply chain issues for materials like lithium and cobalt also raise concerns over resource scarcity and mining impacts (Da Silva Lima et al., 2023). Global policies, like the EU's Green Deal, aiming for 55% renewable energy by 2030 and China's focus on expanding wind and solar power, along with initiatives such as the UN's Sustainable Development Goal 7, are fostering investment and deployment. This potential depends on strong grid integration, storage solutions, and fair access, particularly in developing nations, underpinned by ongoing research and international cooperation (IEA, 2024).

2.3. Theoretical Framework

The relationship between financial resources and renewable energy in SSA can be best interpreted through an integration of financial development theory (FDT), the resource-based view theory (RBT), institutional theory and public-private partnership theory (PPP). Together, these theories offer a broad lens for evaluating how financial resources interact to shape energy transition in SSA. From the perspective of FDT (Kapaya, 2024), a well-functioning financial system attracts domestic and foreign investments, savings, allocates capital efficiently and facilitates sustainable investments. In RE investments (where projects such as solar farms, wind parks and hydroelectric plants require huge funding), deep and efficient capital markets are key to attracting both domestic and foreign direct investments. In contrast, shallow markets, volatile exchange rates and high interest rates limit the achievement of RE projects and slow down the adoption (Ullah and Nobanee, 2025).

The RBV theory complements this by capturing financial resources as key strategic assets that, when combined with other critical resources such as technical skills and institutional support, enable countries to fully exploit their RE potentials (Larabi, 2025). In SSA, natural resources are widely available, yet without sufficient funding and transformation capacity, these resources remain underutilised. Also, RBV outlines why nations with similar renewable resources may have achieved different energy outcomes; those able to mobilise and deploy financial resources effectively can transform potential into tangible capacity, while others remain constrained (Rizavi et al., 2025).

Furthermore, institutional theory adds a key perspective by highlighting that the efficiency of financial resource models is contingent on the quality of governance and institutions (Khan et al., 2024). Even when financial resources are abundant, weak institutions and regulatory inefficiencies can affect investments, increase operational costs and limit project sustainability. In SSA, institutional quality is a key driver in the finance-RE nexus (Dilanchiev et al., 2024). Consequently, the PPP theory emphasises the importance of collaborative investments between public and private investors in overcoming the finance gap and minimising risks (Akomea-Frimpong et al., 2024). In capital-intensive sectors like RE, PPP can channel the strength of both sectors (Danfulani and Gülseven, 2024). This is particularly relevant in SSA, where financial constraints limit the government's ability to finance RE projects.

By integrating these theories and perspectives, this study creates a multi-dimensional framework, where financial markets provide the capital base (Financial Development Theory); strategic development of these resources enables the exploitation of natural energy potentials (RBV); institutional quality creates the enabling environment for these investments (institutional theory); and blending financial models promotes collaborative pathways to overcome structural constraints (PPP Theory). This integrated framework recognises that financial resources alone are not enough for sustaining RE adoption in SSA but are hinged on financing capacity, institutional quality and collaborative financing solutions.

2.4. Empirical Review

Recent empirical work converges on the centrality of finance as an enabler of RE adoption, but also how that finance, alone, is not sufficient without institutional factors and tailored financial instruments. Panel and GMM studies (Appiah et al., 2023; Vatamanu and Zugravu, 2023; Prempeh, 2023) consistently report that financial development promoted RE usage and capacity growth, while case and country-specific analyses (Ugwu et al., 2024) outline how developed markets, typified by the United States and to a lesser extent, South Africa, mobilise significantly more clean-energy investments than emerging markets. Several contributions also promote that green finance mechanisms (Chen et al., 2024; Bai and Lin, 2023) and innovative investment channels (Raikar and Adamson, 2024) provide promising pathways to channel capital into RE, though empirical evaluation of these across SSA contexts remains limited.

Furthermore, institutional quality emerges as a key moderator for finance-RE outcomes. Panel methodology and country analyses (Diallo and Ouoba, 2024; Nawaz and Rahman, 2023; Asongu and Odhiambo, 2021) show that governance, regulatory quality, and control for corruption intensify the impact of financial inflows on RE adoption. When institutions are weak, available finance is underutilised and projects are poorly managed. In addition, institutional quality is greatly professed in regional studies (Ackah et al., 2024; Adanma et al., 2024), which documents strong heterogeneity across SSA and calls for region and country-specific policy designs rather than a one-size-fits-all policy model.

3. METHODOLOGY

The research design adopted for this study is the ex post facto research approach. This study will be well-suited with an ex-post facto design that will help to analyse the available data to find out the possibilities of cause and effect relationships between financial resources and the adoption of renewable energy in Sub-Saharan Africa. The use of both historical and current data will allow undertaking an orderly evaluation of the effect of financial investments and funding mechanisms in renewable energy growth in the region. The research population is the 49 Sub-Saharan African countries. A sample of twenty (20) SSA nations was selected using the purposive sampling technique. This sample size is considered to be suitable to give a detailed and adequate analysis of the correlation between financial resources and renewable energy results in the region, and emphasis was placed on countries

that have demonstrated considerable renewable energy potential and diverse degrees of financial resource availability.

This study relied on secondary data sourced from the World Bank Development Database. The dataset spans a 20-year period (2004-2023) to enable a robust longitudinal analysis of financial resource availability and renewable energy adoption patterns. To achieve the research objectives, the study made use of descriptive statistics, a correlation analysis, a Variance Inflation Factor (VIF) analysis, trend analysis, a Panel Ordinary Least Squares (OLS) regression, a Panel Fully Modified Least Squares (FMOLS) and the Generalised Method of Moments (GMM). The GMM methodology was used to analyse in order to address endogeneity and serial correlation issues, thereby providing outcomes with reliable and unbiased measures

3.1. Model Specification

This study adapts the model from Fotio et al. (2022).

The baseline model is specified as:

$$RE_{it} = \beta_0 + \beta_1 AC_{it} + \beta_2 FDI_{it} + \beta_3 GDP_{it} + \beta_4 PS_{it} + \beta_5 ED_{it} + \varepsilon_{it} \quad (1)$$

The mediating model from the interaction between FDI × INST

$$RE_{it} = \beta_0 + \beta_1 AC_{it} + \beta_2 FDI_{it} + \beta_3 GDP_{it} + \beta_4 PS_{it} + \beta_5 ED_{it} + \beta_6 (FDI \times INST)_{it} + \varepsilon_{it} \quad (2)$$

Where:
RE: Renewable energy
AC: Access to credit
FDI: Foreign direct investment
GDP: GDP per capita
INST: Institutional quality
PS: Political stability.
ED: Energy demand
η: Country-specific fixed effects to control for unobserved heterogeneity
ε: Error term
i: Country, t: Time period (2003-2024).

3.2. Variable Definition and Sources

Measurement and sources of variables are presented in the Table 1.

4. ANALYSIS AND DISCUSSION

4.1. Descriptive Statistics

The descriptive analysis shows valuable insight into the patterns and variability of the study variables over a 20-year period across SSA nations (Table 2). RE adoption recorded an average value of 60.13, with a median of 68.60, indicating a moderate penetration but with significant variability (standard deviation of 27.72). The range depicts significant disparities in RE utilisation across SSA. Also, political stability (PS) averaged -0.55, reflecting persistent governance and security issues in SSA. In addition, FDI showed a more stable mean of 8.58, but with moderate moderation, suggesting that while some nations attract substantial FDI inflows, others remain marginal in the global investment network. Institutional quality (INST) averaged 34.28, underscoring institutional capacity heterogeneity. GDP per capita averaged 4.27, but the distribution was highly skewed, with a kurtosis of 14.97, indicating extreme outliers likely caused by resource-rich economies.

Also, energy demand (ED) and energy access (EA) displayed average mean values of 37.90 and 40.42, respectively, suggesting a persistent supply-demand gap. Access to credit (AC) averaged 20.89 but showed substantial variability, suggesting limited or unbalanced financial inclusion for RE financing. The Jarque-bera statistics reveal that most variables deviate from normality, which is consistent with cross-country panel data features, necessitating a robust estimation technique.

4.2. Correlation Analysis

The correlation matrix above reveals significant relationships between variables. Re adoption is negatively associated with political stability (−0.38), institutional quality (−0.48), energy demand (−0.52), energy access (−0.60), and access to credit (−0.53), emphasising that a unit increase in these variables does not automatically lead to enhanced RE adoption (Table 3). Interestingly, GDP per capita shows only a weak positive correlation with RE adoption (0.15), suggesting that higher income levels do not directly drive renewable transitions in SSA. Furthermore, it is clear that multicollinearity is absent, as most associations fall within the acceptable benchmark of 80%.

4.3. Variance Inflation Factors Test

The VIF analysis above demonstrates that multicollinearity is not a concern, as all values fall well below the commonly accepted threshold of 5, with the highest being 2.61 of energy access (Table 4). This validates the stability of the coefficient estimates for the multivariate regressions. Additionally, stationarity issues are addressed using robust estimation techniques (panel GMM, FMOLS and GMM), ensuring unbiased inferences.

4.4. Trend Analysis

Figure 1 captures the trend analysis of the variables. It can be seen that renewable energy consumption (RE) declined steadily, indicating a gradual shift away from renewables in Sub-Saharan Africa, while logged foreign direct investment (LFDI) exhibits high volatility, peaking in 2008 and 2021, with a notable dip in 2020, reflecting global economic sensitivities and fluctuating financial resources in the region. Access to credit (AC) grows steadily from 2004 to 2015, stabilising thereafter, suggesting improved financial resource availability to support economic activities. GDP growth fluctuates between 2020 and 2010, showing resilience during recovery phases (2010, 2021) but no consistent upward trend, highlighting the region's uneven economic progress linked to financial resource dynamics. Institutional quality (INST) and political stability (PS) remain stable but low, indicating governance challenges that may impact the allocation of financial resources. At the same time, energy demand (ED) rises from 33.604% to 41.431%, and energy access (EA) increases from 27.345% to 51.525%, reflecting infrastructure-driven electrification efforts. However, the lack of correlation with RE suggests reliance on diverse energy sources amid fluctuating financial support.

Table 1: Measurement and sources of variables

S. No.	Variable	Role	Measurement	Source
1.	Renewable energy adoption	Dependent	Installed renewable energy capacity (megawatts)	World Bank Development Indicators.
2.	Access to credit	Independent	Domestic credit to private sector (% of GDP)	World Bank Development Indicators.
	Foreign direct investment	Independent	Net FDI inflows to the renewable energy sector (USD)	World Bank Development Indicators
3.	GDP per capita	Control variable	GDP growth (constant 2015 USD).	World Bank Development Indicators.
	Energy demand	Control variable	Urban rate (% of total population).	World Bank Development Indicators.
	Energy access	Control variable	% Of population with electricity	World Bank Development Indicators
4.	Institutional quality.	Mediating variable	Corruption perceptions rank	World Bank Development Indicators
	Political stability	Mediating variable	Political stability and absence of violence/terrorism index (−2.5 to+2.5, higher indicates greater stability).	World Bank Governance Indicators.

Source: Author's Compilation (2025)

Table 2: Descriptive analysis

Variables	RE	PS	FDI	INST	GDP	ED	EA	AC
Mean	60.13	−0.55	8.58	34.28	4.27	37.90	40.42	20.89
Median	68.60	−0.36	8.67	33.17	4.43	35.66	36.95	14.61
Maximum	97.90	1.10	10.61	82.93	33.63	72.88	90.00	142.42
Minimum	0.000	−2.39	5.75	0.98	−14.14	14.96	3.50	0.00
Std. Dev.	27.72	0.79	0.82	20.16	3.73	15.40	24.88	24.76
Skewness	−0.93	−0.35	−0.73	0.27	0.39	0.42	0.35	3.45
Kurtosis	2.80	2.67	3.50	2.25	14.97	2.12	1.86	14.71
Jarque-Bera	54.86	9.53	37.48	13.27	2278.79	23.57	28.09	2923.86
Probability	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Observations	380	380	380	380	380	380	380	380

Source: Author's Computation (2025)

Table 3: Correlation matrix

INFO	RE	PS	LGFDI	INST	GDP	ED	EA	AC
RE	1.00	−0.38	−0.10	−0.48	0.15	−0.52	−0.60	−0.53
PS	−0.38	1.00	−0.28	0.73	−0.08	0.19	0.19	0.21
LGFDI	−0.09	−0.28	1.00	−0.08	0.14	0.44	0.0	0.29
INST	−0.48	0.7	−0.08	1.00	−0.05	0.25	0.30	0.41
GDP	0.15	−0.08	0.14	−0.05	1.00	−0.13	−0.19	−0.16
ED	−0.52	0.19	0.44	0.25	−0.13	1.00	0.61	0.44
EA	−0.60	0.19	0.09	0.30	−0.17	0.61	1.00	0.52
AC	−0.53	0.21	0.29	0.41	−0.16	0.44	0.52	1.00

Source: Author's Computation (2025)

Table 4: Variance inflation factors

Variable	Coefficient variance	Uncentered VIF
PS	12.91803	1.201725
LGFDI	9.278078	1.203733
INST	0.023429	1.172624
GDP	0.121265	1.135809
ED	0.341204	2.501856
EA	0.032376	2.606585
AC	0.051777	1.252348

Source: Author's Computation (2025)

4.5. Summary of Key Regression Results

The Table 5 captures the summary of the regression outputs. To ensure robustness, the study employed multiple estimation techniques, including Panel ordinary least squares (OLS), fully modified ordinary least squares (FMOLS), and Generalised Methods of Moments (GMM), with and without mediation through institutional quality.

4.6. Discussion of Findings

The panel OLS results indicate that EA, ED and institutional quality exert significant negative effects on RE adoption, implying that a rise in the outcomes of these variables, without accompanying enabling frameworks, may hinder RE adoption. Studies such as Appiah et al (2023) and Prempeh (2023) also support that financial development and inflows tend to promote RE capacity and adoption. The inconsistency across the models suggests that RE outcomes depend on other factors, which is precisely stressed in the literature that finance needs to be cushioned by suitable instruments and intermediation systems (Chen et al., 2023; Bai and Lin, 2023; Raikar and Adamson, 2024)

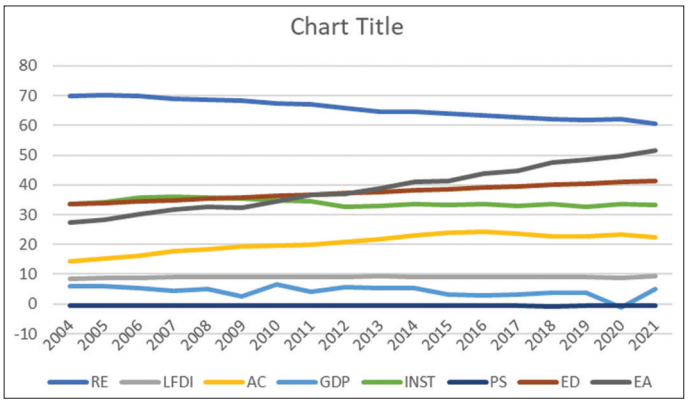
Furthermore, GDP per capita has a negative and significant effect, suggesting that growth outcomes in SSA may still be resource-intensive and carbon emission-heavy. Also, FMOLS outcomes corroborate these results, with EA, ED and INST remaining significant negative predictors. The GMM analysis,

Table 5: Regression output

Variables	Panel OLS	FMOLS	GMM (Baseline)	GMM (Mediation)
Political stability (PS)	−0.82 (0.82)	5.68 (0.12)	6.10*** (0.00)	4.74** (0.05)
FDI	−0.39 (0.87)	−1.37 (0.65)	1.11 (0.45)	0.75 (0.65)
Institutional Quality (INST)	−0.30*** (0.00)	−0.41*** (0.01)	−0.19 (0.65)	0.39 (0.32)
GDP Per Capita	−0.34* (0.09)	−0.62* (0.07)	−0.18 (0.60)	−0.13 (0.64)
Energy Demand (ED)	−1.68*** (0.00)	−1.58*** (0.00)	0.27 (0.67)	0.55 (0.58)
Energy Access (EA)	−0.47*** (0.00)	−0.81*** (0.00)	−0.58*** (0.01)	−0.54 (0.14)
Access to Credit (AC)	0.06 (0.66)	0.13 (0.57)	−0.03 (0.93)	−0.14 (0.60)
Mediation (FDI x INST)	-	-	-	3.87 (0.86)
RE(-1)	-	-	0.88***(0.00)	0.90*** (0.00)
Adj R2	0.79	0.65		

P-value in parentheses; ***,**, * denote significance at 1%, 5% and 10% respectively. Source: Authors' Computation (2025)

Figure 1: Graph analysis



Source: Author's Computation (2025) using Microsoft Excel

which addresses endogeneity, highlights political stability (PS) as a significant positive driver in the baseline model, implying that secure governance environments foster renewable investment uptake. This supports the findings of Ugwu et al. (2024) that a stable political and legal environment boosts investors' confidence, reduces perceived risks and facilitates long-term green investments.

However, mediation analysis (FDI × Institutional Quality) reveals no statistically significant moderating effect, suggesting that foreign investment channels do not inherently translate into RE adoption without direct policy directing. This outcome highlights that FDI do not automatically target or prioritise RE projects in SSA without specific incentives, credible regulatory frameworks or tailored green financing mechanisms. Methodologically, the use of FMOLS to capture long-term relationships and GMM to address endogeneity issues is in line with the best practice approach in contemporary empirical studies.

Furthermore, the variations across models point out that policy conclusions as regards RE are sensitive to econometric specification and estimation strategy. This study reinforces that finance is an enabler for RE projects, but not in isolation, as other factors (institutional quality, political stability) play critical roles in determining whether financial inflows translate into tangible RE capacity. The results reveal a critical paradox in SSA's renewable energy pathway: variables typically associated with energy transition, such as energy access, institutional quality and GDP per capita, are negatively associated with RE adoption. This highlights that infrastructure expansion in SSA may still be fossil fuel-driven, the institutional framework may still be misaligned with RE objectives and economic growth patterns may remain tied to traditional energy models.

4.7. Economic and Practical Implications

From an economic perspective, the findings show that RE growth in SSA cannot depend solely on capital inflows or increasing GDP per capita; instead, it requires complementary governance reforms and deliberate infrastructural restructuring. It further explains that most SSA nations rely on non-renewable energy, which delays climate targets and worsens carbon dependency. Additionally, political stability is a key enabler, boosting investors' confidence and lowering perceived risks for RE projects. Furthermore, weak institutions not only restrict foreign investments but also raise project costs through inefficiencies and contractual uncertainties. Essentially, these outcomes highlight the need for energy sector reforms that are aligned with governance improvements. Consequently, project developers and financiers should incorporate institutional risk assessments into renewable energy project planning, especially in politically unstable or institutionally weak regions.

4.8. Theoretical implications

These study findings offer valuable contributions to several theoretical perspectives. From the FDT lens, the results highlight that while FDI inflows and access to credit are key drivers in the economy, their impact on RE in SSA is limited without supporting institutional factors and political reforms. This challenges the conventional assumptions of FDI's impact on investments.

Through the perspective of the Resource-based view theory, the study underscores that RE adoption depends not only on tangible resources such as financial capital but also on intangible resources such as institutional quality and political stability. Nations with weak governance are unable to transform resources into RE development despite having access to finance. Furthermore, applying institutional theory, the consistent negative outcomes between institutional quality and RE adoption in some contexts suggests that poorly designed or inconsistently enforced can act as a limitation to market entry and expansion. Weak institutions create regulatory uncertainty, undermine investors' confidence and promote short-term fossil-based energy sources over long-term

sustainable solutions. This verifies the theories assertion that institutional environment shape the strategic behaviours of foreign and home investors.

Finally, from the standpoint of PPP theory, the results point to the need for collaborative frameworks between government and private sector investors to bridge the financing and implementation gap in RE projects. Political stability is also a driver for successful PPP arrangements, as it ensures contractual reliability, lowers the cost of capital and facilitate technology transfer. The finding imply that without strong governance and stable political contexts, PPP in RE risks being underutilised or failing totally, despite available finance.

4.9. Policy Implications

These research outcomes advocate for a multi-pronged policy approach. First, improving institutional quality through anti-corruption measures; streamlining licensing and regulatory predictability should be prioritised to attract green investors. Importantly, institutional reforms must embed RE objectives into regulatory and fiscal systems to prevent misalignment. Second, energy policy should out rightly link electrification expansion to RE sources rather than embracing fossil-based energy generation. Third, political stability must be sustained to ensure that renewable energy investments are not derailed by unplanned policy shifts. Lastly, regional cooperation among SSA countries could facilitate knowledge sharing, harmonised regulations and pooled financing for large-scale RE projects.

5. CONCLUSION

The study finds that RE adoption in SSA is shaped more by governance, political and infrastructural factors than by financial resources alone. In addition, weak institutional governance and reliance on fossil-based energy appear to be critical barriers to RE adoption, while political stability plays a critical role in promoting RE adoption. It is recommended that SSA governments should:

i. Embed renewable energy targets with broader governance reforms
ii. Design electrification programs with explicit renewable integration mandates
iii. Strengthen political and regulatory stability to reduce uncertainty and inspire investors' confidence
iv. Encourage blending financing mechanisms that combine public funds, development aid and private capital investments for RE projects.

5.1. Limitations of the Study

While a 20-year panel dataset offers robust temporal coverage, the study's reliance on secondary data may not fully capture informal and decentralised renewable initiatives prevalent in rural SSA. Additionally, institutional quality, while comprehensive, may mask country-specific governance effects.

5.2. Contributions to Knowledge

This research contributes to the renewable energy and development literature by providing evidence on the nexus between financial resources, governance quality and political stability in shaping RE adoption in SSA. It enriches the institutional theory by empirically testing the mediating role of governance quality in a resource-constrained setting, while also offering actionable insights for policy formulation in emerging economies.

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