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Financial Development, Environmental Policy Stringency, and Renewable Energy Innovation in Nigeria

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Abstract: Harnessing renewable energy resources in order to achieve environmental sustainability is vital. The innovation of renewable energy provides solutions for energy transition and environmental degradation. Therefore, this paper aims at investigating how financial development and environmental policy stringency influence renewable energy innovation in Nigeria. This study covers the period of 2000–2025 based on annual time series data. Autoregressive Distributed Lag model (ARDL) approach was used to analyse the short-run and long-run relationship between renewable energy innovation with financial development and environmental policy stringency. Findings show that financial development has a negative and significant impact on renewable energy innovation in the long-run. This means that financial resources have not been fully allocated to activities that support green innovation in Nigeria. Environmental policy stringency significantly affects renewable energy innovation but its effect is weak which means that environmental regulation may not be properly enforced in Nigeria. Also, the interaction term is negative which means that environmental regulation does not complement financial development in Nigeria. However, in the short-run none of the variables were found statistically significant. Therefore, the study concludes that financial development and environmental policy does not jointly influence renewable energy innovation because of poor complementarity and weak institutional mechanisms. Hence, the study recommends government enforcements on green finance policy implementation and effective compliance with environmental regulation policies; also financial

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experts should endeavour to provide more funds for renewable energy innovation research and should improve on the coordination between financial and environmental bodies.

Keywords: Financial Development; Environmental Policy Stringency; Renewable Energy Innovation; ARDL; Nigeria

JEL Codes: Q28; Q42; Q55; O13; C22

1. Introduction

The global transition to low-carbon development has created huge demands for renewable energy innovation worldwide. As such, renewable energy innovation has become one of the key features that most economies embed in their growth strategies. In that regard, financial systems and environmental regulatory systems play an important role as enablers of renewable energy innovation. Increasingly, scholars are examining the link between financial development and environmental policy stringency given the technology-push role financial development plays as well as the innovation-stimulating role of environmental policy stringency predicted under the Porter Hypothesis (Porter & Van der Linde, 1995). Li and Shao (2023) find that financial development and environmental policy stringency promote renewable energy innovation because financial development eases access to funds and reduces uncertainties associated with innovation activities. On the contrary, Nur et al. (2025) argue that financial development stimulates renewable energy innovation, albeit restricted by environmental policy stringency. Nur et al. (2025) posit that financial development can be pollution-enhancing by stimulating capital investments into carbon-intensive sectors when weak environmental regulations exist. Other studies show that renewable energy innovation is boosted by financial aids and policy instruments across the globe (Hille & Oelker, 2023).

Likewise, stringent environmental policies may induce firms to innovate; however, this could only hold if countries have good quality institutions that can implement these policies, firms can comply with such policies, and the financial system can support firms in their innovation pursuits. For example, Degirmenci et al. (2025) find environmental policy stringency does not lead to a positive environmental outcome when human capital and innovation is weak. The role of finance innovation environment nexus is however highly underdeveloped in Africa. For instance, most extant studies focus on OECD and advanced economies. This could be because these countries have relatively stable financial markets that aid investments into renewables and have relatively binding environmental policies that can stimulate

innovation (Li & Shao, 2023; Nur et al., 2025). On the other hand, Africa (Nigeria in particular) has relatively weak financial markets characterised by market failures, distortions, and regulations that are not strict enough to stimulate climate action. Nigeria especially, depends heavily on fossil fuels as the key drivers of growth due to structural challenges which presents a different scenario for the finance innovation environment nexus. Nigeria has one of the largest potentials of renewable energy in Africa but records low levels of renewable innovation. The question then is: what is the role of finance and environmental policies in stimulating renewable energy innovation in Nigeria?

Moreover, extant literature uses broad environmental indicators such as emissions, environment absorption activities, and environment-friendly consumption instead of proximate measures of innovation. For example, Nur et al. (2025) use green growth as the outcome variable under environmental policy stringency while Degirmenci et al. (2025) focus on sustainable development. In that case, most findings would capture the long-run impact of environmental regulations on emissions and energy absorption activities but fail to capture the fundamental pathway which is innovation.

Therefore, three gaps could be derived from this study: first, there is scanty evidence on how finance affects renewable energy innovation especially in developing economies. Second, while some studies focus on environmental policy, they focus on its existence rather than its intensity. Third, there is no study known to the authors that has looked at the interaction between financial development and environmental policy stringency in Nigeria.

To fill these gaps, this study aims to explore the nexus between financial development and environmental policy stringency on renewable energy innovation in Nigeria. This study seeks to answer three main questions: does financial development promote renewable innovation? Do stringent environmental policies drive renewable energy innovation? Does environmental policy stringency matter in the finance innovation linkage?

The study contributes to the literature in three major ways. Firstly, while other studies focus on emissions and environment-friendly consumption, this study measures the direct impact on renewable energy innovation. Secondly, while other studies test this nexus in either OECD countries or advanced economies, this study provides Africa-specific evidence. Thirdly, while no studies considered the interaction effects, this study introduces the interaction between financial

development and environmental policy stringency to capture possible policy complementarities.

2. Literature Review

Extant studies examined the roles financial development play in renewable energy innovation. Financial development contributes to innovation by allowing a more efficient capital allocation mechanism, improving transaction cost efficiencies, and enabling higher risk-sharing. Developed financial markets have been found to promote renewable energy innovation. This relationship was particularly strong in developed economies (Li & Shao, 2023). The consequences of financial development can also be negative for the environment depending on where credit flows are directed (Nur et al., 2025). The above findings provide suggestive evidence that financial development on its own cannot ensure sustainability innovation without complementary regulations. Additional evidence on country specific case studies can be found. Ngcobo & De Wet (2024) concluded that financial development does aid renewable energy supply globally and within South Africa. Although this was through private participation and the economy being conducive to renewables rather than financial development only Aberu and Taiwo, (2025) argues that environmental depletion as well as the quality of governance significantly impact sustainable development in Nigeria. Kinda & Ben Youssef (2024) researched if renewable energy innovation was driven by renewable energy policies. Unlike other studies they did not focus on if the policy existed or not, but how it performed at aiding renewable energy innovation. Renewable innovation is spurred when there are market-based incentives, risk mitigation policies, and clear regulatory policies. Existence of fiscal incentives that are poorly designed may have no effect on renewable energy innovation. Martínez-Zarzoso et al., (2019) reported that environmental policy stringency positively affects patent applications, meaning tighter environmental restrictions cause greater innovation. Hassan & Rousseliere, (2022) discovered that nations with greater environmental policy stringency saw quicker technological innovation.

Environmental policy stringency has been found to spur innovation, firms are willing to innovate to avoid costly pollution fines and comply with regulations making them more competitive. This concept is famously captured in the Porter Hypothesis (Porter & Van der Linde, 1995). There is also empirical evidence that supports this hypothesis especially in developed economies. Li and Shao (2023) concluded that

renewable energy innovation increases with stricter environmental regulations. Although research conducted by Degirmenci et al. (2025) concluded that environmental regulations had no significant effect on renewable energy innovation in European countries. The study concludes that environmental institutions had a mediating effect, without innovation capacity countries will struggle to back environmental regulation. Attributable to environmental technology policies and renewable energy growth sustainability was concluded in South Africa by Smaoui (2025).

Financial development provides the necessary capital needed for firms to comply with stringent environmental laws. While environmental policy stringency; Demand more innovation to meet regulatory standards. Nur et al. (2025) found that the relationship between financial development and environmental policy stringency had a positive impact on green growth in European countries. Supporting evidence on the nexus is still lacking especially in developing economies. Matenda et al. (2024) found that technological innovation and renewable energy had helped in reducing emissions. Furthermore, Umar et al. (2024) examined how green innovation mediates the finance environmental nexus in Sub-Saharan Africa. Their results showed that finance has a positive relationship with environmental degradation in SSA. However, the interaction between both variables significantly reduces environmental degradation. Alsakarneh et al., (2025) found that financial development could either harm or help the environment depending on the policies and regulations. Africa's finance environment relationship is highlighted by structural deficiencies. African countries have underdeveloped financial markets, limiting access to credit. Environmental regulations are not tailored to specific industries nor properly enforced, including the problem of over reliance on heavily fossil fuels for energy consumption. Therefore, this paper aims to fill the gap by explicitly examining renewable energy innovation in Nigeria.

3. Methodology

There exist several theories that can aid in answering our research question; however, alone they can provide a shallow understanding of why these variables affect renewable energy innovation. To obtain a holistic understanding, we will be merging the ideas of the Porter Hypothesis, the theory of financial development, and ecological modernisation theory. Porter and Van der Linde (1995) provide perhaps the strongest argument for why stringent environmental policies should encourage

innovation. The Porter hypothesis argues that well-executed and stringent environmental regulations encourage innovation that would otherwise not take place. In comparison to the popular opinion that environmental regulations hurt productivity by making firms incur extra costs to meet emission restrictions, the Porter Hypothesis shows that regulating pollutants can encourage firms to become more innovative to compensate for policy compliance costs. By embracing green innovations, firms can improve their productivity which exceeds the cost of compliance with these regulations. Supporting this claim Li and Shao (2023) show that environmental policy stringency positively affects renewable energy innovation and firms are likely to innovate more if environmental policies are stable over time. Although this study supports the Porter hypothesis; the effect of environmental policy stringency may not hold in developing countries. Environmental regulations are impractical if a country lacks the institution or ability to enforce these policies.

Financial development on the other hand provides a conduit through which economic growth can occur. Improvements in innovation are one of the channels through which a healthy financial system can spur economic development. A better financial system can spur innovation through improving access to information as well as reducing the cost of funding for entrepreneurs. In the context of renewable energy innovation, access to funding is critical in improving research and development as well as implementing renewable energy projects. In their study, Li and Shao (2023) show that financial markets development helps encourage innovation in renewable energy. Similar to environmental policy stringency, their results show that at high levels of financial development the relationship between finance and renewable energy innovation fades. Nur et al. (2025) provides reasoning for this relationship only being significant at low levels of finance development. The authors show that if environmental policies are not in place then financial development can actually encourage businesses to focus on pollution-intensive sectors.

Furthermore, ecological modernisation theory claims that economic development and pollution do not have a fixed relationship. Through better innovation as well as institutional change and integration of environmental concerns into policy-making, an economy can grow while reducing pollution. Degirmenci et al. (2025) provide evidence that environmental policy, green innovation, and improvement in human capital are all needed for sustainable development. However, their findings show that environmental policy stringency does not have a significant relationship with reduced pollution. One could argue that this is because environmental policy stringency is only one component of a country's environmental regulations.

Nigeria's issue with sustainable development and growth is rooted in its economic structure. The structure is framed by weak institutions, low innovation and technology capacity, and a focus on fossil fuel which all contribute to why the country struggles to develop sustainably.

Hence, environmental policy stringency and financial development should affect renewable energy innovation. However, one could make the argument that if a firm does not have sufficient funds to invest in renewable energy projects regardless of how motivated they are by policies, they will not be able to improve their green technology. At the same time, if a country has great financial development but imposes lax environmental policies, firms will not be motivated to become more innovative. This implies that there might be a possibility of interaction between financial development and environmental policy stringency in Nigeria. Thus;

$$\max_{REI_t} \pi_t = R(REI_t) - C(REI_t, FD_t) - \Phi(EPS_t, REI_t) \quad 1$$

Where:

$R(REI_t)$: returns to renewable energy innovation

$C(REI_t, FD_t)$: cost of innovation, decreasing in financial development

$\Phi(EPS_t, REI_t)$: regulatory cost (or penalty), decreasing with innovation

$$\frac{\partial C}{\partial FD} < 0 \quad 2$$

Hence, higher financial development lowers financing constraints and increases innovation

$$\frac{\partial \Phi}{\partial EPS} > 0, \frac{\partial \Phi}{\partial EPS} < 0 \quad 3$$

This reflects the Porter Hypothesis, where stricter regulation induces innovation.

$$\frac{\partial^2 REI}{\partial FD \partial EPS} > 0 \quad 4$$

Financial development enhances the ability of firms to respond to environmental policy, and this captures policy–finance complementarity, a central contribution of the model.

$$REI_t = f(FD_t, EPS_t, FD_t * EPS_t, Z_t) \quad 5$$

Where Z_t is a control variable. Thus;

$$REI_t = \alpha_0 + \alpha_1 \ln FD_t + \alpha_2 \ln EPS_t + \alpha_3 (\ln FD_t * EPS_t) + \alpha_4 \ln GDP_t \quad 6$$

Where;

REI: Renewable energy innovation (For instance; patents, renewable R&D)

FD: Financial development (credit to private sector or financial index)

EPS: Environmental policy stringency

FD * EPS: Interaction term

GDP : Economic development

The model is estimated using the Autoregressive Distributed Lag (ARDL) approach from 2000 to 2025, while the long and short-run dynamics are derived through the associated error correction term.

$$\Delta \ln REI_t = \beta_0 + \sum_{i=1}^p \beta_1 \Delta \ln REI_{t-i} + \sum_{i=0}^q \beta_2 \Delta \ln FD_{t-i} + \sum_{i=0}^q \beta_3 \Delta \ln EPS_{t-i} + \sum_{i=1}^q \beta_4 \Delta (\ln FD * \ln EPS)_{t-i} + \sum_{i=1}^p \beta_k \Delta \ln Z_{t-i} + \lambda ECM_{t-1} + \varepsilon_t \quad 7$$

Where:

$$ECM_{t-1} = \ln REI_{t-1} - \theta_1 \ln FD_{t-1} - \theta_2 \ln EPS_{t-1} - \theta_3 (\ln EPS * \ln FD)_{t-1} - \theta_4 Z_{t-1} \quad 8$$

$\lambda < 0$: Speed of adjustment toward long-run equilibrium

θ_1 : Long-run elasticities

Short-run coefficients capture dynamic adjustments

Table 1. Definition and measurements of variables

Abbreviation	Variable	Definition	Source(s)
FD	Financial development	Financial Development Index	IMF
REI	Renewable energy	Renewable energy consumption(% of total energy consumption)	World Bank (WDI)
EPS	Environmental policy	Environmental Policy Stringency Index	OECD, EPS, WDI Databas https://www.footprintnetwork.org
GDP	Economic growth	Economic development measured as GDP per capita	World Bank (WDI)

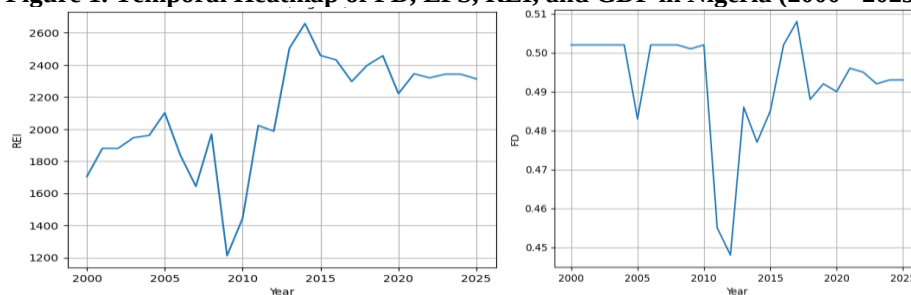
Source: Authors compilation 2026

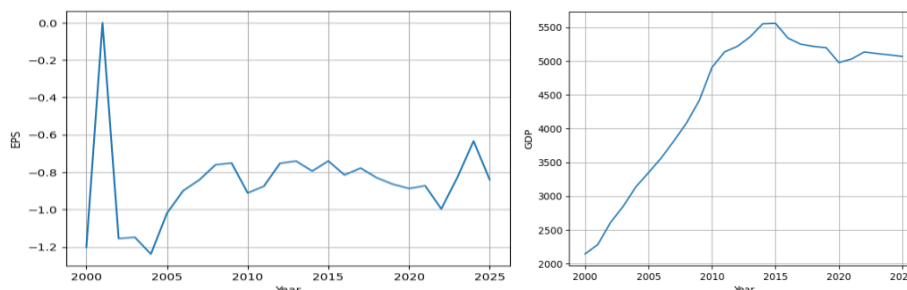
Financial development and renewable energy variables are sourced from IMF Financial Development Index database and World Development Indicators database respectively. The study employed environmental policy stringency index as a proxy for environmental policy because the study relied on the Porter Hypothesis. Data on Environmental policy stringency was obtained from World Bank database. Following recent studies (Tian et al., 2025; Ibrahim et al., 2024), Financial development was adopted because it captures the avenues of renewable energy innovation well. Renewable energy adoption is considered a proxy of renewable energy innovation and diffusion inspired by Ecological Modernisation theory in this study. Thus, Renewable energy consumption (% of total energy) was adopted as proxy to measure renewable energy adoption inspired by recent studies that considered clean energy transition for developing countries (Umar et al., 2024; Ngcobo & De Wet, 2024).

Environmental policy stringency captures constraints posed by the government on businesses which have become more stringent over time inspired by Porter hypothesis, for measuring environmental policy (Kinda & Ben Youssef, 2024; Smaoui, 2025). In line with Ecological Modernisation theory, GDP per capita, a proxy for economic development serves as control variable which captures size effects and absorptive capacity of technological advancements such as renewable energy innovation. The variable as representative of renewable energy innovation diffusion will ensure economy size is held constant as supported by recent studies (Acheampong et al., 2025; Matenda et al., 2024). Consequently, the variables are consistent with the adopted theories and thus were employed.

4. Results and Discussion

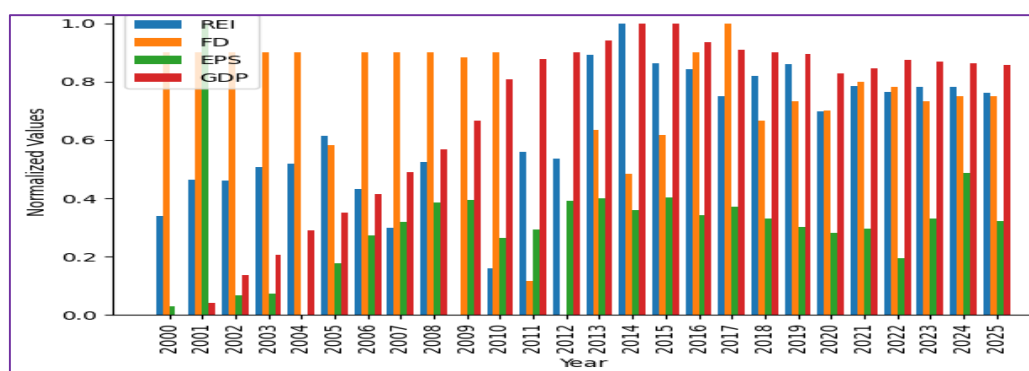
Figure 1. Temporal Heatmap of FD, EPS, REI, and GDP in Nigeria (2000– 2025)





Source: Authors computation 2026

Figure 2. Comparative Dynamics of REI, FD, EPS, and GDP in Nigeria (2000-2025)



Source: Authors computation 2026

Figure 2 provides a combined bar chart showing the movement of the four normalised variables involved. It is not hard to see from Figure 2 that in Nigeria, GDP experiences stable growth with mild fluctuations from 2000 to around 2014 but remains roughly steady after 2014. REI presents fluctuated pattern in general. After experiencing a dramatic drop around 2009, REI rapidly returned to its peak level within 2013–2014 before stabilising at a high level with some fluctuations as well. FD values are always around 0.08 with only minor fluctuations and it experiences a little downturn around 2011–2012. EPS maintains the lowest values among the four variables and only shows insignificant improvement overtime, while such improvements are marginal at best and hardly steady.

Based on the figure, it could be argued that GDP seems to have the driving effect over REI while FD and EPS serve as intermediate forces. While the former maintains a steady increase over time, though with some fluctuations, the latter two variables show weak and minor changes over time, especially for EPS.

Table 2. Descriptive statistics

	REI	FD	EPS	GDP
Mean	2103.247	0.492385	-0.852895	4437.637
Median	2161.864	0.495500	-0.840694	5048.361
Maximum	2658.422	0.508000	0.000000	5558.026
Minimum	1211.625	0.448000	-1.238120	2144.825
Std. Dev.	351.1282	0.014249	0.232127	1088.469
Skewness	-0.707082	-1.854180	1.552912	-0.900094
Kurtosis	2.978691	6.108330	8.400204	2.341898
Jarque-Bera	2.167007	25.36478	42.04237	3.979924
Probability	0.338408	0.000003	0.000000	0.136701
Sum	54684.42	12.80200	-22.17526	115378.6
Sum Sq. Dev.	3082275.	0.005076	1.347072	29619140
Observations	26	26	26	26

Source: Authors computation 2026

REI and GDP have relatively high variance and near-normal distributions. FD has very low variance, while EPS shows our index of stringency remained at relatively low levels for the duration. FD and EPS significantly deviate from normality. REI and GDP approximate normal distributions. All variables except EPS contain enough variation in REI, FD, and GDP.

Table 3. Optimal Lag Length Selection Criteria

Lag Length	LogL	LR	FPE	AIC	SC	HQ
0	-143.363	NA	0.052	7.126	7.2721	5.612
1	55.4753	4.611*	5.45e-07*	-1.254 *	0.640*	-0.839*

Source: Authors computation 2026

As seen from Table 3, all of the criteria including LR, FPE, AIC, SC and HQ select lag length 1 as it favours lag 1 over lag 0. Therefore, lag 1 is used since it caters for both the short-run and long-run.

Table 4. Correlation Test

Variables	REI	FD	EPS	GDP
REI	1			
FD	-0.26166	1		
EPS	0.10774	-0.08501	1	
GDP	0.57655	-0.41902	0.18024	1

Source: Authors computation (2026)

Table 4 reports the correlation coefficients among the variables. REI is moderately positively correlated with GDP (0.5766), whereas FD is moderately negatively

correlated. EPS is weakly correlated with REI (0.1077) and GDP (0.1802), implying weak direct connection. Therefore, because all regressors are only weakly to moderately correlated, we do not have severe multicollinearity issues.

Table 5. Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.824024	41.69783	27.58434	0.0004
At most 1 *	0.794896	38.02175	21.13162	0.0001
At most 2 *	0.531311	18.18757	14.26460	0.0114
At most 3 *	0.158249	4.134504	3.841466	0.0420

Source: Authors computation (2026)

Table 5 presents the Johansen maximum eigenvalue results for testing the presence of long-run relationship between REI, FD, EPS and GDP. The null hypotheses of no-cointegration (None) and at most 1, 2 and 3-cointegrating equations are rejected at the 5% level since all the Max-Eigen statistics are greater than the critical values and the associated probabilities are less than 0.05. Hence, we can infer that there exists at most four cointegrating equations and that implies a stable long-run equilibrium relationship between the variables under consideration. This further validates our choice of employing long-run estimation technique like ARDL and ECM.

Table 6. Unit Root Test

Variable	ADF @level)	KPSS @level	ADF @first dif	KPSS @first dif	Order of Integr
REI	-2.662	0.455**	-3.767*	0.232	I(1)
FD	-1.326*	0.384**	-3.336*	0.027	I(1)
EPS	-1.186	0.003	-4.164*	0.063	I(0)
GDP	-0.632	0.376**	-1.187*	-0.050	I(0)

Source: Authors computation (2026)

Table 6 reveals that our variables have mixed orders of integration. This is because REI and FD are integrated of order one I(1) from ADF and KPSS statistics whereas EPS and GDP are all stationary at level I(0). Again since our variables have mixed integration of orders I(0) and I(1) we can safely say that the ARDL testing approach can be used. Generally, all the results show that our variables are stable to be used in long-run and short-run dynamic analysis without giving rise to spurious regression.

Table 7. ARDL Long run

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-23105.82	9451.085	-2.444780	0.0264
REI(-1)*	-0.034541	0.207381	-0.166556	0.8698
LOG(FD(-1))	-33844.40	13679.39	-2.474116	0.0249
EPS(-1)**	34291.14	17051.50	2.011034	0.0615
FD(-1)*EPS(-1)**	-68352.14	34063.18	-2.006628	0.0620
GDP**	-0.058057	0.081000	-0.716758	0.4839

Source: Authors computation (2026)

The results presented in Table 7 indicate that financial development (FD) is negative and statistically significant in the long-run. This finding suggests that financial resources in Nigeria flow to fossil-based sectors instead of promoting renewable energy innovation activities. Therefore, this result supports Nur et al. (2025) and Alsakarneh et al. (2025) but not in tandem with the study of Li and Shao (2023). This could be attributed to weak institutions, shallow financial markets, and the lack of green finance initiatives. Furthermore, the coefficient of environmental policy stringency (EPS) is positive but marginally insignificant. This result partially supports the Porter Hypothesis and Li and Shao (2023) but confirms the findings of Degirmenci et al. (2025) that policy needs to be well enforced and depend on institutional quality. More importantly, the coefficient of the negative interaction result ($FD \times EPS$) is not consistent with Nur et al. (2025) interdependent argument. The finding shows the lack of policy direction between the financial system and the environmental regulations due to weak implementation and poor market-based incentives.

The insignificance of renewable energy innovation (REI) and GDP confirms that the country has weak innovation that cannot sustain itself. Based on the findings from our study, we can conclude that we add value to the literature frontier by finding that finance and environmental policy are not always complements in Nigeria. In addition, their effects on renewable energy innovation depend on policy design, and institutional quality as well as implementation. Furthermore, while previous studies assume that finance and environmental regulation are complements, we provide empirical evidence that this may not always be the case in developing countries like Nigeria with structural and governance issues. Hence, by focusing specifically on renewable energy innovation activity this study contributes to the Nigerian literature by providing more direct evidence on what drives sustainable technological change as opposed to emissions or energy use.

Table 8. ARDL Short run

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(FD)	-979841.3	5979637.	-0.163863	0.8719
EPS(-1)	992775.3	6026703.	0.164729	0.8712
FD(-1)*EPS(-1)	-1978888.	12011054	-0.164756	0.8712
GDP	-1.680839	11.83171	-0.142062	0.8888
CointEq(-1)*	-0.034541	0.007680	-4.497317	0.0004
C	-668945.0	4088223.	-0.163627	0.8721

Source: Authors computation (2026)

The ARDL Short-Run Results in Table 8 shows that financial development, environmental policy stringency, and the interacted variables, are all insignificant in the short run (p-values > 0.05). These findings imply that, short-run variations in finance, environmental policy, and economic growth do not have immediate impacts on renewable energy innovation activities in Nigeria. The absence of the short-run impact is not unconnected to the delays in policy implementation, weak responsiveness of financial systems, and structural rigidities in the innovation process.

However, the error correction term (CointEq(-1)) is negative and statistically significant (-0.0345, $p < 0.01$), which validates the existence of the long-run relationship. The coefficient of the error correction term suggests that approximately 3.45% of the disequilibrium in the previous period is corrected in the current period, pointing to a slow speed of adjustment toward the long-run equilibrium. In generalising this result with the existing literature, the findings are not in tandem with the findings of Li and Shao (2023) in developed economies, however, it aligns with the perspectives of Degirmenci et al. (2025) and Matenda et al. (2024), who highlighted institutional weaknesses, policy inefficiencies, and technological absorptive capacity in developing countries as constraints. These factors may delay the effectiveness of both financial development and environmental policies. Furthermore, the non-significance of the interaction term corroborates our long-run finding by revealing that finance and environmental policy do not complement each other in promoting renewable energy innovation in Nigeria, even in the short run. Thus, this further highlights the importance of institutional quality in policy implementation speed while enriching our contribution by demonstrating that both short-run and long-run dynamics are affected by institutional quality.

Table 9. Breusch-Godfrey Serial Correlation LM Test

F-statistic	1.151661	Prob. F(5,17)	0.5113
Obs*R-squared	0.627224	Prob. Chi-Square(2)	0.3536

Source: Authors computation (2026)

Table 9 shows that the Breusch-Godfrey LM test is not statistically significant ($p > 0.05$), which means that there is no serial connection in the model residuals.

Table 10. Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.830591	Prob. F(7,16)	0.1498
Obs*R-squared	10.67321	Prob. Chi-Square(7)	0.1535
Scaled explained SS	6.111419	Prob. Chi-Square(7)	0.5268

Source: Authors computation 2026

Table 10 indicates that the Breusch-Pagan-Godfrey test is statistically insignificant ($p > 0.05$), implying that there is no evidence of heteroskedasticity in the model. This confirms that the error variance is constant, supporting the reliability and efficiency of the estimated ARDL results.

5. Conclusion and Recommendations

The study analysed the long-run and short-run relationships among financial development, environmental policy stringency and renewable energy innovation in Nigeria. Its goal was to examine whether finance and environmental regulation reinforce one another in fostering green technological innovation in a developing country context. The paper contributes to the strand of literature by estimating the ARDL framework to provide evidence specific to Nigeria on the nexus of three main drivers of renewable energy innovation within the context of weak institutions and structural challenges.

Results from the empirical analysis showed that financial development has a negative and significant long-run impact on renewable energy innovation in Nigeria. Also, environmental policy stringency has a positive albeit weak long-run impact on renewable energy innovation in Nigeria. Even more interesting is that the interaction term between finance and environmental regulation is negative, indicating that these two policy measures do not reinforced to strengthen renewable energy innovation in Nigeria in the long-run. In the short-run, none of the explanatory variables have a significant impact on renewable energy innovation. The error correction term is negative and statistically significant indicating that any disequilibrium is corrected

slowly towards the long-run equilibrium in the model. However, these results show institutional weaknesses, policies are weak and inconsistent and the green finance market is relatively undeveloped in Nigeria.

The implications of these results from a policy standpoint are that countries cannot just increase the size of their financial sector or enact environmental regulations and see improvements in renewable energy innovation. It has to do with how these frameworks interact with each other. As such, we recommend that policymakers develop a green finance framework for the country, improve on the enforcement of environmental regulations and better implement market-based policy instruments like carbon taxes and targeted green subsidies. There is also need to ensure better coordination between financial and environmental sector regulators. De-risking instruments like guarantees and blended finance can also help attract more private investments into renewable energy innovation.

Future studies can explore governance by directly including its various proxies in the analysis. Also, comparable African countries should be used for a cross-country study to capture some of these contextual differences.

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