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Impact of Technology, Green Economy, Green Financing and Climate Change: Evidence from Nigeria

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Abstract

Climate change has become a major environmental and developmental challenge, particularly in developing economies such as Nigeria, where technological advancement, economic activities, environmental sustainability, and access to green finance interact in complex ways. This study examines the effects of technology adoption, green economy development, green financing, economic growth, and institutional quality on climate change in Nigeria. Climate change is proxied by greenhouse gas emissions, green economy development by waste recycling, and green financing by investment in renewable energy. The study employs the Autoregressive Distributed Lag (ARDL) model to investigate both the short-run and long-run relationships among the variables. The empirical results reveal that technology adoption and institutional quality have positive and statistically significant effects on greenhouse gas emissions in both the short run and long run, suggesting that technological advancement and institutional performance have not yet translated into effective emission reduction. Conversely, green economy development, green financing, and

economic growth exhibit negative and statistically significant relationships with greenhouse gas emissions in both periods. These findings suggest that waste recycling initiatives, investment in renewable energy, and economic growth, as captured by the model, are associated with reductions in greenhouse gas emissions in Nigeria. The study concludes that strengthening the circular economy, expanding renewable energy investment, and promoting environmentally sustainable economic activities are essential for mitigating climate change. It recommends that policymakers align technology adoption with low-carbon development objectives, improve the environmental effectiveness of institutions, scale up green financing mechanisms, and strengthen waste recycling infrastructure. These measures could support Nigeria's transition towards a low-carbon and environmentally sustainable economy.

Keywords: climate change, technology adoption, green economy, green financing, economic growth, greenhouse gas emissions

1.1 Introduction

Climate change has emerged as a major threat to sustainable economic development, environmental quality, and human welfare, particularly in developing economies such as Nigeria. The increasing frequency of climate-related hazards, including flooding, drought, extreme temperatures, and coastal erosion, poses substantial risks to agriculture, energy supply, infrastructure, public health, and economic productivity. Nigeria's vulnerability is further compounded by its dependence on climate-sensitive economic activities, persistent energy-access challenges, rapid urbanization, and reliance on fossil fuels. Consequently, the transition towards a green economy has become increasingly important for achieving economic diversification, environmental sustainability, and climate resilience. The World Bank Group (2022) emphasizes that integrating climate considerations into national development planning is essential for reducing climate risks while sustaining economic growth. In this context, technology, green financing, and the development of a green economy constitute interconnected mechanisms through which Nigeria can respond to climate change while pursuing its development objectives.

Technology plays a critical role in facilitating the transition towards a green economy through renewable energy generation, energy efficiency, sustainable agricultural practices, waste management, electric mobility, and climate information systems. In Nigeria, technologies such as solar photovoltaic systems, mini-grids, smart electricity meters,

precision agriculture, and digital climate-monitoring platforms offer opportunities to reduce greenhouse gas emissions and improve resource efficiency. These technologies can also expand electricity access, support small and medium-sized enterprises, create green employment opportunities, and strengthen the resilience of vulnerable communities. However, the adoption and diffusion of green technologies remain constrained by high initial investment costs, inadequate infrastructure, limited research and development, technological import dependence, and shortages of relevant technical skills. Atedhor (2025) identifies technological deficiencies, weak grid infrastructure, inadequate financing, and competing fossil-fuel investment priorities as important obstacles to Nigeria's low-carbon energy transition. Therefore, the contribution of technology to climate mitigation and adaptation depends not only on the availability of innovations but also on the institutional, financial, and infrastructural conditions that support their adoption.

The concept of a green economy provides a broader framework for understanding how technological innovation can be aligned with economic development and environmental protection. A green economy promotes low-carbon production, efficient resource utilization, environmental conservation, and inclusive economic growth. For Nigeria, this transition involves diversifying the economy beyond petroleum, improving the sustainability of industrial production, expanding renewable energy, promoting climate-smart agriculture, and developing environmentally responsible transport and waste-management systems. The transition also presents opportunities for developing domestic green industries, attracting sustainable investment, creating employment, and reducing the environmental costs associated with conventional economic activities. Nevertheless, achieving these benefits requires a shift in investment priorities and economic incentives towards activities that support environmental sustainability. The Climate Policy Initiative (CPI, 2025) notes that Nigeria faces considerable investment requirements for infrastructure and energy transition, while climate-related risks threaten the country's long-term development prospects. This suggests that the green economy should be understood not merely as an environmental agenda but as a potential pathway towards economic transformation and resilience.

Green financing is central to this transformation because the implementation of green technologies and the expansion of environmentally sustainable economic activities require substantial and sustained financial resources. Green financing refers broadly to financial instruments and investment mechanisms that support environmental sustainability, climate mitigation, and adaptation. Such mechanisms include green bonds, sustainability bonds, concessional loans, climate funds, carbon finance, green credit facilities, blended finance, and private-sector investment in renewable energy and climate-resilient infrastructure. In

Nigeria, the development of green financing has gained institutional recognition through government green bond initiatives and the introduction of a sovereign sustainable bond framework. The Federal Government of Nigeria's Sustainable Bond Framework provides a basis for mobilizing capital for eligible environmental and sustainable development projects, including renewable energy, sustainable agriculture, and resilient infrastructure (Debt Management Office [DMO], 2025). These initiatives demonstrate the potential of financial markets to channel resources towards climate-related priorities.

Despite these developments, the availability of green financing remains inadequate relative to Nigeria's climate and development needs. According to CPI (2025), Nigeria received approximately US$2.5 billion in tracked climate finance in 2021/2022, compared with estimated annual financing needs that exceeded available flows by US$27.2 billion. Although climate finance increased from approximately US$1.9 billion in 2019/2020, the reported flows remained substantially below the estimated requirements. The report also indicates that public institutions provided about 70% of tracked climate finance in 2021/2022, while private actors accounted for approximately 30%. Furthermore, adaptation finance remained particularly limited relative to estimated needs. These figures illustrate the persistent financing gap confronting Nigeria and the importance of mobilizing domestic resources, international climate finance, and private-sector capital. The high cost of capital, perceived investment risks, inadequate project preparation, data limitations, and insufficient access to affordable green technologies further complicate the mobilization of sustainable finance (CPI, 2025).

The relationship between technology, green financing, the green economy, and climate change is therefore mutually reinforcing. Green financing can facilitate the acquisition, development, and deployment of environmentally sustainable technologies, while technological innovation can improve the efficiency and commercial viability of green investments. The diffusion of these technologies can support the expansion of green industries, reduce dependence on carbon-intensive production, and strengthen climate adaptation. In turn, the development of a green economy can generate new investment opportunities and improve the long-term viability of green financial markets. Evidence from Nigeria's renewable energy sector demonstrates the importance of examining these relationships empirically. Research on financial development and renewable energy consumption in Nigeria has investigated the relationship between financial-sector development and renewable energy use over the period 1981–2019, highlighting the relevance of financial conditions to the country's renewable energy transition (Financial Development and Renewable Energy Consumption in Nigeria, 2022). Similarly, research comparing renewable energy financing in Nigeria and Brazil identifies policy uncertainty

and weaknesses in financing arrangements as constraints on renewable energy investment in Nigeria, while highlighting the potential of blended finance, public development finance, and improved public-private partnerships (Financing Renewable Energy: Policy Insights from Brazil and Nigeria, 2023).

The historical trajectory of Nigeria's response to climate change also demonstrates increasing recognition of the need to integrate environmental considerations into economic and financial policymaking. Earlier development strategies largely emphasized economic growth, petroleum production, and conventional infrastructure expansion, with comparatively limited integration of climate objectives into investment decisions. Over time, however, international climate commitments, growing awareness of environmental risks, and the need to diversify energy sources have encouraged the development of renewable energy policies, green bond initiatives, and national climate strategies. The Federal Government's green bond program represents an important attempt to mobilize capital specifically for environmentally beneficial projects, while the Sustainable Bond Framework broadens the range of eligible sustainable investments (DMO, 2025). These developments indicate a gradual movement towards climate-conscious public finance and investment. Nevertheless, the coexistence of climate commitments with continuing fossil-fuel dependence, infrastructure deficiencies, and financing constraints reveals a gap between policy ambition and implementation.

A major concern is that technological progress and the availability of green financial instruments do not automatically translate into measurable improvements in environmental sustainability. The effectiveness of these interventions depends on the scale of investment, the quality of institutions, regulatory consistency, technology affordability, and the extent to which finance reaches viable projects. For example, investment in renewable energy may contribute to emissions reduction and energy access, but its impact can be limited by inadequate transmission infrastructure, foreign-exchange exposure, high borrowing costs, and the absence of reliable long-term financing. Similarly, climate adaptation projects may generate substantial social and economic benefits without producing immediate commercial returns, making them less attractive to conventional private investors. CPI (2025) identifies limited access to affordable technology, insufficient investment-ready projects, and high financing costs among the barriers to scaling up climate action in Nigeria. Consequently, understanding the interaction between technology and green financing is necessary for assessing the extent to which green economic transformation can contribute to climate mitigation and adaptation.

Against this background, the central concern is whether technological development and green financing can jointly promote the transition towards a green economy and

significantly improve climate change outcomes in Nigeria. Although the country has introduced sustainable finance initiatives and continues to explore renewable energy and other low-carbon technologies, the scale of implementation remains constrained by financing deficits, technological barriers, institutional weaknesses, and competing development priorities. Moreover, the relationships among technology adoption, green financing, green economic development, and climate change may be complex and multidirectional. Green finance can encourage technological innovation, but technological development may also attract additional green investment. Likewise, a growing green economy may reduce emissions intensity and improve resilience, although the actual environmental outcome depends on the composition of economic growth and the technologies employed. These interdependencies provide a basis for investigating the individual and combined effects of technology and green financing on green economic development and climate change in Nigeria.

1.2 Objective of the Study

The main objective of this study is to examine the impacts of technology, green economy, green financing and climate change in Nigeria, the specific objective is to:

i. Investigate the joint effect of technological development and green financing on the green economy and climate change outcomes in Nigeria.

1.3 Research Question

To analyze the above objective, the study will attempt to answer the question:

i. What is the joint effect of technological development and green financing on the green economy and climate change outcomes in Nigeria?

1.4 Research Hypothesis

To answer the question stated above, the study will test the hypothesis state in null form below:

i. Technological development and green financing have no significant joint effect on the green economy and climate change outcomes in Nigeria.

2. Literature Review

2.1 Theoretical Literature

The theoretical framework provides the foundation for understanding the relationships among technology, green financing, the green economy, and climate change in Nigeria. It explains the mechanisms through which technological development and financial resources

may promote green economic transformation and influence environmental sustainability. This study therefore is anchored on three complementary theories: Endogenous Growth Theory, Financial Intermediation Theory, and Environmental Kuznets Curve Theory.

2.1.1 Endogenous Growth Theory

The Endogenous Growth Theory was developed through the contributions of Romer (1986, 1990) and Lucas (1988). The theory emerged as a response to the limitations of traditional growth models, which largely treated technological progress as an external factor. In contrast, Endogenous Growth Theory argues that long-run economic growth can be generated internally through investments in technological innovation, research and development, human capital, knowledge accumulation, and productive activities. Romer (1986) emphasized the importance of knowledge accumulation and technological spillovers in promoting economic growth. According to the theory, knowledge differs from conventional productive inputs because its benefits may extend beyond the individuals or firms responsible for generating it. Romer (1990) further explained that technological progress can result from purposeful investment in research and development, while Lucas (1988) highlighted the importance of human capital accumulation in improving productivity and sustaining economic growth. These contributions suggest that investment in technology, skills, and innovation can increase productive capacity and support structural transformation.

The major assumptions of Endogenous Growth Theory include the proposition that technological progress can be generated through deliberate investment, knowledge accumulation contributes to productivity, human capital enhances innovation, and institutional arrangements influence the development and adoption of new technologies. The theory also assumes that investment in research, education, and technological capacity can generate long-term economic benefits. However, technological progress does not automatically guarantee environmental sustainability because some innovations may increase energy consumption or encourage carbon-intensive production. Consequently, the environmental implications of technological advancement depend on the direction and nature of technological change.

The relevance of Endogenous Growth Theory to this study lies in its explanation of how technological development can contribute to the transition towards a green economy in Nigeria. The adoption of renewable energy technologies, energy-efficient production systems, smart electricity infrastructure, sustainable agricultural technologies, and improved waste-management systems can enhance productivity while reducing the environmental intensity of economic activities. These innovations may also create employment

opportunities, encourage industrial diversification, and reduce dependence on environmentally damaging production processes. Furthermore, green financing can complement technological development by providing the financial resources required for research, equipment acquisition, technology transfer, and the deployment of environmentally sustainable innovations. In Nigeria, where access to affordable technology and investment capital remains a challenge, the interaction between technological advancement and financing is particularly important. Adequate financing may enable firms to adopt cleaner production technologies, while technological improvements may enhance the efficiency and commercial viability of green investments.

The implication of Endogenous Growth Theory for this study is that technological development may have a positive effect on green economic development and may improve climate change outcomes when innovation is directed towards environmentally sustainable activities. The theory therefore provides a foundation for examining the effect of technology on the green economy and climate change in Nigeria. It also supports investigating whether technological advancement, in combination with green financing, can facilitate a transition towards a low-carbon and resource-efficient economy.

2.1.2 Financial Intermediation Theory

The Financial Intermediation Theory is associated with the work of Gurley and Shaw (1960), with an important subsequent contribution by Diamond (1984). The theory explains the role of financial institutions and financial markets in mobilizing savings and allocating financial resources to productive investments. It proposes that financial intermediaries connect economic agents with surplus funds to individuals, businesses, and governments that require financing for investment and development. Gurley and Shaw (1960) explained the importance of financial institutions in facilitating the flow of funds within an economy, while Diamond (1984) demonstrated how financial intermediaries can reduce the costs associated with monitoring borrowers and evaluating investment opportunities. The theory emphasizes that financial institutions can address information asymmetry, transaction costs, and other barriers that prevent funds from reaching productive sectors. Through these functions, financial intermediaries can influence the volume, direction, and efficiency of investment within an economy.

The major assumptions of Financial Intermediation Theory are that financial resources are unevenly distributed among economic agents, financial intermediaries facilitate the allocation of these resources, information asymmetry affects lending and investment decisions, and the availability and cost of finance influence investment behavior. The theory also assumes that institutional arrangements, risk assessment, and monitoring

mechanisms affect the efficiency of financial resource allocation. In the context of green financing, these assumptions imply that the availability of financial resources and the conditions attached to them can influence the adoption of environmentally sustainable technologies and the development of green industries.

Green financing involves the mobilization and allocation of financial resources to projects that contribute to environmental sustainability, climate change mitigation, and climate change adaptation. Such financing may take the form of green bonds, sustainability bonds, green loans, concessional financing, climate funds, blended finance, and private investment in renewable energy and other sustainable economic activities. These instruments can help finance projects that might otherwise struggle to attract conventional investment because of high initial costs, long payback periods, uncertain returns, or perceived risks.

The relevance of Financial Intermediation Theory to this study is that it provides an explanation of how green financing can influence the development of a green economy and climate change outcomes in Nigeria. The transition towards a green economy requires substantial investment in renewable energy, energy efficiency, sustainable agriculture, waste management, clean transportation, and climate-resilient infrastructure. Financial institutions and capital markets can support these activities by mobilizing domestic savings, attracting international investment, and providing financing for environmentally beneficial projects. In Nigeria, the development of green financial instruments provides opportunities to channel resources towards sustainable development priorities. However, the effectiveness of green financing depends on the availability of investment-ready projects, affordable borrowing costs, credible environmental standards, and adequate institutional capacity. Where these conditions are weak, the existence of green financial instruments may not translate into sufficient investment or measurable environmental improvements.

The implication of Financial Intermediation Theory for this study is that green financing may positively influence green economic development by increasing investment in environmentally sustainable activities. It may also improve climate change outcomes by facilitating the deployment of renewable energy and other low-carbon technologies. Nevertheless, the magnitude and direction of these effects depend on how financial resources are allocated and the extent to which financed projects achieve their intended environmental objectives. The theory therefore provides a basis for examining the effect of green financing on the green economy and climate change in Nigeria.

2.1.3 Environmental Kuznets Curve Theory

The Environmental Kuznets Curve (EKC) Theory was popularized by Grossman and Krueger (1991) and further developed in their influential study on economic growth and the environment (Grossman & Krueger, 1995). The theory examines the relationship between economic development and environmental degradation. It proposes that environmental degradation may initially increase as economic activity expands but may decline after an economy reaches a particular level of development. This relationship is commonly represented by an inverted U-shaped curve. According to Grossman and Krueger (1995), the relationship between economic growth and environmental quality can be understood through three mechanisms: the scale effect, the composition effect, and the technique effect. The scale effect occurs when increased production and consumption lead to higher resource use and pollution. The composition effect arises when an economy changes its production structure, potentially moving from pollution-intensive activities towards less environmentally damaging sectors. The technique effect occurs when technological improvements and cleaner production methods reduce the pollution generated per unit of output.

The major assumptions of the Environmental Kuznets Curve Theory include the proposition that economic development influences environmental quality, the possibility of structural transformation as an economy develops, and the capacity of technological progress and environmental regulation to reduce pollution intensity. The theory also assumes that changes in income, production methods, public preferences, and environmental policies can influence environmental outcomes. However, the theory does not imply that economic growth automatically improves environmental quality. The relationship varies across countries, pollutants, institutional settings, and stages of development (Dinda, 2004).

The relevance of the Environmental Kuznets Curve Theory to this study lies in its explanation of the potential relationship between green economic development and climate change outcomes in Nigeria. Nigeria's economic development has been associated with industrial expansion, urbanization, increased energy demand, transportation growth, and the exploitation of natural resources. These activities can increase greenhouse gas emissions when they rely heavily on fossil fuels and environmentally unsustainable production methods.

Nevertheless, technological development, green financing, and structural transformation may provide opportunities to reduce the environmental costs of economic growth. Investments in renewable energy, energy-efficient infrastructure, cleaner industrial processes, and sustainable transportation can reduce emissions intensity and support the transition towards a green economy. Green financing can facilitate these investments, while

technological innovation can improve the efficiency and affordability of cleaner alternatives. In Nigeria, however, the achievement of environmental sustainability depends on whether economic growth is accompanied by cleaner technologies, effective environmental policies, and a gradual reduction in dependence on carbon-intensive activities. The country cannot assume that environmental quality will improve automatically as income rises. Instead, deliberate investment and appropriate policy interventions may be required to align economic development with climate objectives.

The implication of the Environmental Kuznets Curve Theory for this study is that the relationship between economic development and climate change outcomes may be nonlinear. Technological progress and green financing may contribute to improved environmental quality by facilitating changes in production methods and energy consumption. The theory therefore provides a basis for examining how green economic development relates to climate change outcomes in Nigeria. Where economic growth is included in the empirical model, it may also justify testing whether the relationship between income and environmental degradation follows an inverted U-shaped pattern.

2.2 Empirical Literature

Adebanjo et al. (2026) examined technological innovation and carbon dioxide emissions in Nigeria using annual data covering 1989–2023. The study applied an integrated Environmental Kuznets Curve, STIRPAT, and Vector Error Correction Model framework and used artificial neural networks to assess robustness. The findings established a long-run relationship among economic growth, technological innovation, and carbon dioxide emissions. Technological innovation was found to moderate the emissions-increasing effect of economic growth. This suggests that technological advancement can help Nigeria pursue economic growth while reducing environmental pressure. However, the study did not directly examine green financing as a determinant of technology adoption or emissions reduction.

Similarly, Iormom (2026) investigated the effects of green innovation and renewable energy transition on climate pressure in Nigeria. The study used annual data from 1990 to 2023 and applied a quantile autoregressive distributed lag model. Climate pressure was measured using ecological footprint per capita, while green innovation was proxied by internet use and renewable energy transition by the share of renewable electricity generation. The findings indicated that green innovation and renewable energy were associated with reductions in climate pressure, particularly at higher levels of environmental pressure. The study supports the relevance of clean technology and renewable energy in climate change mitigation. Nevertheless, its use of internet penetration as a proxy for green innovation

means that the results should not be interpreted as measuring every dimension of technological innovation.

Akinsowon et al. (2026) examined the impact of green finance on sustainable development in Nigeria using annual data covering 2010–2024. The study employed fully modified ordinary least squares and dynamic ordinary least squares methods, with sustainable development measured using a sustainable development index. Green investment and green credit had positive and statistically significant relationships with sustainable development, whereas green bonds had a positive but statistically insignificant relationship in the preferred model. The study concluded that green finance supports sustainable development, although its contribution differs across financing instruments. This study is particularly relevant because it provides country-specific evidence on green credit, green investment, and green bonds. However, it focuses on sustainable development rather than directly estimating the separate effects of green financing on climate change mitigation.

Oye and Azuh (2026) examined climate-responsive fiscal and monetary policies in Nigeria using an environmental dynamic stochastic general equilibrium model. The study analyzed the effects of carbon taxes, green subsidies, green relending policies, and alternative monetary policy arrangements. The results suggested that green subsidies and green relending could support economic activity while contributing to emissions reduction. The study also found that policy sequencing and coordination were important for achieving desired outcomes. These findings are relevant because they demonstrate how government policy and financial-sector interventions may complement technological investment in the transition towards a low-carbon economy. However, the results are based on a model-based policy analysis and should not be interpreted as direct evidence that an existing nationwide green relending program has achieved these effects.

Obiora and Udeagbala (2026) examined financial technology and environmental sustainability in Nigeria: An empirical analysis, investigated the relationship between financial technology and environmental sustainability using Nigerian data covering 1986–2024. The study employed a Vector Error Correction Model and reported a positive and statistically significant relationship between financial technology, financial inclusion, and environmental sustainability. The findings suggest that digital financial infrastructure could support the mobilization and distribution of resources for environmentally sustainable activities. Nevertheless, the study's results should be interpreted within the limits of its variable definitions and econometric specification.

Bello et al. (2025) examined technological innovation and the green economy in Nigeria. Their study drew on literature published between 2019 and 2025 and considered innovation across renewable energy, agriculture, manufacturing, financial technology, and

education. The findings indicated that technological innovation and green investment were associated with improvements in economic growth, human development, and environmental quality. However, institutional weaknesses, inconsistent policies, and limited innovation capacity constrained the transition towards a green economy. The study recommended the integration of green investment, policy reform, and skills development. The study is relevant because it directly connects technology with green economic development, although its literature-based approach does not establish the causal effect of each technological intervention.

Atedhor (2025) examined Nigeria's Climate Responsiveness: Navigating Energy-Climate and Techno-Financial Conundrums in the Low-Carbon Energy Transition, reviewed Nigeria's energy transition and identified technological and financial barriers to decarbonization. The study highlighted inadequate electricity transmission infrastructure, poor grid maintenance, limited domestic technological capacity, insufficient skilled manpower, high investment costs, and difficulties accessing finance as important constraints. It recommended grid modernization, decentralized energy systems, local technological development, public-private partnerships, and improved access to international climate finance.

Ekpenyong, et al. (2025), examined blue economy and sustainable development in Sub-Sahara Africa: Evidence from Nigeria, the study specifically examined the relationship between selected blue economy indicators and sustainable development in Nigeria. Using annual time-series data covering 1981–2024, the authors investigated the relationships between the human development index and variables including fishing revenue, investment in marine energy resources, life expectancy, governance quality, inflation, interest rates, trade openness, and per capita gross domestic product. Their study employed unit root tests and the autoregressive distributed lag (ARDL) technique to investigate the short-run and long-run relationships among the variables. They found out that fishing revenue, per capita GDP, trade openness, and interest rates were positively associated with human development. However, negative relationships involving investment in marine energy resources and discussed the implications of institutional quality and inflation for sustainable development and recommended integrate policies perspective to improving investment in marine diversity.

2.3 Summary of the Literature Review

The literature reviewed demonstrates that technology, green financing, the green economy, and climate change are interconnected components of sustainable development in Nigeria. Technology provides opportunities to reduce emissions, improve resource efficiency, expand

renewable energy access, and strengthen climate adaptation. Green financing provides the capital required to develop and deploy environmentally sustainable technologies. The green economy provides a framework for combining economic growth with environmental protection, while climate change creates an urgent need to adopt low-carbon and climate-resilient development strategies.

Recent empirical studies indicate that technological innovation and renewable energy can contribute to reducing environmental pressure in Nigeria. Other studies suggest that green credit and green investment can support sustainable development, while climate-responsive fiscal and monetary policies can encourage the transition towards low-carbon economic activities. However, the benefits of these interventions depend on effective institutions, affordable finance, adequate infrastructure, appropriate technology, and transparent project monitoring. The literature also reveals that different financing instruments may produce different outcomes and that sustainable development indicators cannot automatically be treated as direct measures of climate change mitigation.

The central gap is the limited integration of technology, green financing, green economic development, and climate change within a single Nigeria-specific empirical framework. Addressing this gap would improve understanding of how technological innovation and green financial instruments jointly influence environmental sustainability and economic development. Consequently, further research on the four variables is justified because it could provide evidence to guide policymakers, financial institutions, investors, and businesses in designing effective strategies for Nigeria's transition towards a green and climate-resilient economy.

3. Research Method

3.1 Research Design

The design adopted in this study is an ex post facto (after the fact) design. Hence, this study used secondary sources information and therefore time series data sourced from various publications of Central Bank of Nigeria Statistical Bulletin and world development indicators (WDI). The models for this study were estimated using data on technology, green economy, green financing and climate change indicators, which include: Technology Adoption (TECHAD), Green financing proxied by Investment in Renewable Energy (REINV), Green economy development measured by Waste Recycling (WASTRE), Institutional Quality (INSTQ), economic growth measured by GDP growth rate (GDPg) and Greenhouse Gas Emissions (GHG) as a measure of climate change serves as dependent variable for the period 1995-2025.A multiple regression analysis was used, predicated on various data diagnostics including Augmented Dickey-Fuller (ADF) and Philip-Peron (PP)

unit root tests, bound testing method for co integration and the autoregressive distributed lag technique (ARDL.) was employed in this study to investigate the joint effect of technological development and green financing on the green economy and climate change outcomes in Nigeria.

3.2 Model Specification

The model for this study is anchored on The Endogenous Growth Theory was developed through the contributions of Romer (1986, 1990) and Lucas (1988) and the Environmental Kuznets Curve (EKC) Theory popularized by Grossman and Krueger (1991) and further developed in their influential study on economic growth and the environment. These theories provide a foundation for examining how the effect of technology, green economic development relates to climate change outcomes in Nigeria. Hence, the model is as specified below:

3.2.1 The joint effect of technological development and green financing on the green economy and climate change outcomes equation:

CC= F (TECH, GEC, GFIN) Equation 3.1

Equation 3.1 states that climate change is dependent upon technology development, green economy, and green financing variables. In demystifying the above model, the climate change, technology development, green economy and green financing will be capture by the following variables listed below. It follows that Equation 3.1 will be the formula presented by Equation 3.2 as follows:

GHG = F (TECHAD, WASTRE, REINV, GDPg, INSTQ) Equation 3.2

The functional form of technological development and green financing on the green economy and climate change outcomes equation of the study is given as:

The econometric form of the model is given as:

$GHG_t = a_0 + a_1TECHAD_t + a_2WASTRE_t + a_3REINV_t + a_4GDPg_t + a_5INSTQ_t + U_t$

Equation 3.3

Where:

GHG_t = Greenhouse gas emission in time t

$TECHAD_t$=Technology adoption in time t
$WASTRE_t$ = Green economy development measured by Waste Recycling in time t
$REINV_t$ = Green financing proxied by Investment in Renewable Energy in time t
$GDPg_t$ = Economic growth measured by GDP growth rate in time t (used as control variable).
$INSTQ_t$ – Institutional Quality in time t (used as control variable).
U_t– Error term
A priori Expectation shows that a_1(+), a_2 (-), a_3 (+), a_4 (+) and a_5 (-).

4. Results and Discussion of Findings

4.1 Descriptive statistics and matrix of correlations

Table 4.1: Descriptive Statistics

	GHG	TECHAD	WASTRE	REINV	GDPG	INSTQ
Mean	435.26	4.32	75.59	1.24	5.41	-1.32
Median	404.20	3.82	74.86	0.98	5.31	-1.32
Maximum	581.70	9.49	79.51	2.90	20.87	-0.10
Minimum	337.40	2.46	73.22	-0.04	-1.79	-2.79
Std. Dev.	76.24	1.83	1.77	0.78	4.65	0.37
Skewness	0.75	1.51	1.04	0.46	1.27	-0.88
Kurtosis	2.13	4.51	2.72	2.26	5.61	12.91
Jarque-Bera	3.87	14.67	5.72	1.80	17.12	130.97
Probability	0.14	0.00	0.06	0.41	0.00	0.00
Sum	134.93	134.02	234.32	38.56	167.84	-40.98
Sum Sq. Dev.	174.35	100.09	94.04	18.39	648.67	4.07
Observations	**31**	**31**	**31**	**31**	**31**	**31**

Source: Researcher's computation (2026), using E-Views 9.

Table 4.1 presents the descriptive statistics of the variables used in the study from 1995 to 2025. The results show that greenhouse gas emission (GHG) recorded an average value of 435.26 about 435.26%, maximum and standard deviation of 581.70%, 76.24%, indicating high greenhouse gas emission due to technology adoption despite poor institutional and regulatory framework, while technology adoption (TECHAD) had a low mean value of 4.32% and maximum of 9.49%, suggesting that although there is present of technology driven environmental degradation reduction in Nigeria, but the extent to which the government has committed resources to it take off does not lead to improvement greenhouse gas emission in Nigeria. Green economy development proxied by waste recycling

(WASTRE) records an average of 75.59% and a maximum and standard deviation of 79.51% and 1.77% respectively indicating a very high level of green economy development and therefore reflecting relatively high degree of waste recycling management generation within the studied period. Meanwhile, green financing proxied by investment in renewable energy (REINV) exhibited considerable low variation, as reflected by the mean value of 1.24% and maximum of 2.90% as well as low standard deviation of 0.78%, indicating inconsistent and low investment committed to climate change programs within the study period. Also, economic growth rate (GDPg) exhibited a low averaged of 5.41% and maximum of 20.87%, implying substantial low economic growth rate in the climate change framework. Further, institutional quality (INST) exhibited a very low averaged of -1.32% and maximum of -0.10% suggesting that institutional quality had a significant low effect on greenhouse gas emission, thereby having little or no effect on climate change. The skewness result shows that no variable is positively skewed showing no peak distribution. The result of the kurtosis shows that TECHAD, GDPg and INSTQ are leptokurtic (kurtosis > 3), indicating peaked distributions. The Jarque-Bera probabilities indicate that GHG and GDPg are normally distributed, whereas TECHAD, WASTRE, REINV and INSTQ deviate from normality due to variability and macroeconomic instability with the standard deviation of 1.83, 1.77, 0.78 and 0.37 respectively.

Table 4.2: Correlation Matrix

	GHG	TECHAD	WASTRE	REINV	GDPG	INSTQ
GHG	1					
TECHAD	0.35	1				
WASTRE	-0.55	-0.22	1			
REINV	0.02	0.19	0.16	1		
GDPG	-0.36	-0.24	0.51	0.23	1	
INSTQ	0.05	0.47	0.08	-0.34	-0.52	1

Source: Researcher's computation (2026), using E-Views 9.

The correlation matrix of the variables is as shown in Table 4.2 above. From the table, GHG has a positive correlation coefficient with TECHAD, REINV and INSTQ. This therefore indicates that the variables tend to move in the same direction. Meanwhile WASTRE and GDPg has a weak negative correlation (-0.55 and -0.36) indicating that as GHG increases WASTRE and GDPg tends to decrease. Also, from the table, there exist positive correlation coefficient between TECHAD and REINV, INSTQ; WASTRE and REINV, GDPg, INSTQ; as well as REINV and GDPg respectively. TECHAD exhibit negative relationship with

WASTRE and GDPg, while REINV exhibit negative relationships with INSTQ as well as GDPg and INSTQ respectively.

4.1.2 Unit Root Test

The Augmented Dickey Fuller and the Philip-Perron unit root tests were conducted to examine the stationarity condition of the variables. As indicated in Table 4.4 below, only WASTRE was stationary at level in ADF, and PP, while GHG, TECHAD, REINV and GDPg were stationary after first differencing in both ADF and PP. In other words, the variables are integrated of order zero and one (i.e., I (0) and I(I)). Where some of the variables are I (0) while others are I (1) one suggests the problem of unit root-= in the equations. It becomes imperative to perform co-integration tests to determine the presence of equilibrium relationship amongst the variables in each equation. The study adopts the ARDL bound testing technique for co-integration, as the variables are integrated of diverse orders (i.e., order zero and order one).

Table 4.3: ADF and Philip-Perron Unit Root Test Results

	ADF	1st Difference	Order of	Level	PP	
Variables	Level		integration		1st Difference	Order of integration
GHG	-2.444430	-8.285519	I(1)	-	-	I(1)
TECHAD	-1.425950	-5.072893	I(1)	-	-	I(1)
WASTRE	-3.631771	-	I(0)	-	-	I(0)
REINV	-1.704608	-8.292517	I(1)	-	-	I(1)
GDPg	-1.335777	-5.636672	I(1)	-	-	I(1)
INSTQ	-2.008058	-6.126417	I(1)	-	-	I(1)

Source: Researcher's computation (2026), using E-Views 9.

Note: Mackinnon critical values for ADF at 1, 5 and 10% levels are -3.60, -2.93 and -2.60 respectively, and for PP are 3.605, 2.936 and 2.606, respectively. ** means significant at 5% level.

4.1.3 Lag Length Selection

Table 4.4: lag length criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-358.3148	NA	8065.959	26.02249	26.30796	26.10976
1	-266.5832	137.5974	160.6697	22.04166	24.03997*	22.65256

2	-227.3728	42.01113	189.9548	21.81235	25.52349	22.94688
3	-146.9468	51.70243*	29.56168*	18.63906*	24.06304	20.29722*

Source: Researcher's computation (2026), using E-Views 9.

The efficiency and validity of an error correction model depends on the lag structure. The study used VAR lag order selection criteria to determine the lag lengths. The study employed the Akaike Information Criterion (AIC) and Schwarz Criterion (SC) and the result shows three optimal lag lengths for the model of technology, green economy, green financing and climate change: evidence from Nigeria as shown in Table 4.4 above. To reduce the possibilities of underestimation whilst maximizing the likelihood of recovering the true lag (Venus, 2004), the study used three as the maximum lag lengths, respectively.

4.1.4 Co-integration Test Results

From the bound testing result reported in Table 4.5 below, long run relationship exists amongst the variables in all the estimated equations, given that the values of the F-statistic are greater than the critical values at five per cent level in both the upper and the lower bounds. Therefore, the null hypothesis of absence of co-integration is rejected, while the study proceeds to estimate the long run coefficient of each of the equations.

Table 4.5: Co-Integration Test Results

5% critical value					
Equation	K	F-Stat	I (0)	I (1)	Outcome
GHG (TECHAD, WASTRE, REINV, GDPg, INSTQ)	5	5.77	2.62	3.79	co integrated

Note: K =number of parameters
Source: Researcher's computation (2026), using E-Views 9.

4.2 Findings, Presentation and Analysis of Econometric Results of the Long run coefficients of the joint effect of technological development and green financing on the green economy and climate change outcomes in Nigeria Equation Results.

Table 4.6: Dependent variable: GHG

Variable	Coefficient	Std. Error	t-Statistic	Prob.

TECHAD	100.55284	85.378665	2.177728	0.0228
WASTRE	-7.355660	56.328200	-2.130586	0.0393
REINV	-191.18185	168.969245	-2.131457	0.0206
GDPG	-36.052773	23.720686	-2.519887	0.0170
INSTQ	-37.830928	439.133044	-0.086149	0.9335
C	869.37044	4804.15977	0.180962	0.8609

Source: Researcher's computation (2026), using E-Views 9.

The long-run relationship of the joint effect of technological development and green financing on the green economy and climate change outcomes in Nigeria equation variables is presented in Table 4.6 above. Based on the ARDL long-run estimates, the findings reveal the following insights:

The coefficient for technology adoption (TECHAD) is positive and statistically significant, indicating that a unit increase in TECHAD results in 100% increases in greenhouse gas emission (GHG). This finding is in line with a priori expectation, indicating that technological advancement may contribute to persistent environmental degradation when it is not adequately aligned with environmental sustainability objectives. This relationship may reflect continued dependence on fossil fuels, energy-intensive industrial production, and the adoption of technologies that increase economic activities without sufficiently reducing carbon emissions. The finding also implies that technological progress alone may be insufficient to achieve a green economy and desirable climate change outcomes. Although green financing can support the transition to cleaner technologies, its effectiveness depends on the allocation of financial resources to renewable energy, energy efficiency, and low-carbon innovations.

Conversely, the coefficient of green economy development proxied by waste recycling (WASTRE) is negative and statistically significant, indicating that a unit rise in WASTRE results in a -73.55% decreases in GHG. This result is in line with a priori expectation, suggesting that improved waste recycling practices contribute significantly to environmental sustainability by reducing emissions associated with waste disposal, landfill decomposition, and the production of new materials from virgin resources. This finding implies that green economy development, proxied by waste recycling, can mitigate climate change by promoting resource efficiency, reducing environmental pollution, and supporting a circular economy. Also, the result highlights the importance of investing in advanced recycling technologies, sustainable waste management infrastructure, and environmentally

friendly innovations. Green financing can provide the necessary financial resources to expand recycling facilities and encourage businesses to adopt cleaner production processes.

More so, green financing proxied by investment in renewable energy (REINV) exhibits a negative and statistically significant relationship with GHG. Therefore, a one-unit increase in REINV is associated with -19.11% decreases in GHG. This result is in line with a priori expectations, showing that increased investment in renewable energy contributes significantly to environmental sustainability by reducing dependence on fossil fuels and promoting cleaner energy sources. This finding implies that sustained financing for renewable energy projects, such as solar, wind, and hydropower, can facilitate the transition to a low-carbon economy and improve climate change outcomes. More so, the result also highlights the complementary role of technological innovation and green investment in accelerating renewable energy adoption, improving energy efficiency, and reducing carbon-intensive production.

The coefficient of economic growth rate (GDPg) is negative and significantly related to GHG, hence, a unit rise in GDPg will lead to -36.05% decreases in GHG. This result is not in line with a priori expectation, suggesting that sustained economic growth may contribute to environmental improvement through increased investment in cleaner technologies, improved energy efficiency, and the adoption of more sustainable production processes. This finding implies that economic expansion can be compatible with environmental sustainability when growth is supported by structural transformation and low-carbon development strategies, the result also highlights the importance of directing financial resources toward renewable energy, green infrastructure, and environmentally friendly technological innovations. These investments can enable Nigeria to decouple economic growth from greenhouse gas emissions, thereby promoting a green economy and improving long-term climate change outcomes.

Finally, the coefficient for institutional quality (INSTQ) is negative and statistically insignificant, indicating that a one-unit increase in INSTQ will lead to a -37.83% decreases in GHG. This finding is in line with a priori expectation, indicating that improvements in institutional effectiveness may contribute to reducing environmental pollution, but the effect is not sufficiently strong to establish a reliable long-run relationship. This finding may reflect persistent weaknesses in environmental regulation, inadequate enforcement of environmental policies, corruption, and limited institutional capacity to promote sustainable development. The result also implies that institutional quality alone may be insufficient to achieve substantial reductions in greenhouse gas emissions without effective policy implementation and accountability.

In summary, the long-run analysis highlights the complex interplay between the joint effect of technological development and green financing on the green economy and climate change outcomes in Nigeria. While only technology adoption (TECHAD) positively influenced greenhouse gas emission (GHG) in Nigeria, others such as green economy development proxied by waste recycling (WASTRE), green financing proxied by investment in renewable energy (REINV), economic growth rate (GDPg) and institutional quality (INSTQ) posed significant challenge. These findings underscore the need for Nigerian government to strengthen waste recycling systems, expand investment in renewable energy, and promote environmentally sustainable economic growth by encouraging waste recycling through improved waste collection infrastructure, public awareness campaigns, recycling incentives, and the adoption of advanced waste-management technologies, green financing should be strengthened by providing tax incentives, concessional loans, and public-private partnership opportunities for renewable energy projects, particularly solar, wind, and hydropower, to reduce dependence on fossil fuels and economic growth strategies should prioritize low-carbon industrialization, energy efficiency, sustainable transportation, and cleaner production processes to ensure that economic expansion does not compromise environmental quality.

4.2.1 Findings, Presentation and Analysis of Econometric Results of the Short run coefficients of the joint effect of technological development and green financing on the green economy and climate change outcomes in Nigeria Equation Results.

Table 4.7: Dependent variable: GHG

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GHG(-1))	-0.796536	0.243923	-3.265521	0.0114
D(GHG(-2))	-0.744393	0.224814	-3.311160	0.0107
D(TECHAD)	10.748231	4.350473	2.470589	0.0387
D(TECHAD(-1))	-7.382332	6.243565	-1.182391	0.2710
D(WASTREC)	-8.587245	8.760095	-0.980268	0.3557
D(WASTREC(-1))	3.408655	6.695020	0.509133	0.6244
D(WASTREC(-2))	-10.643525	6.612552	-1.609594	0.1462
D(REINV)	-0.194478	10.359983	-0.018772	0.9855
D(GDPG)	-1.809251	1.438259	-1.257945	0.2439
D(GDPG(-1))	3.103013	1.974435	1.571595	0.1547
D(INSTQ)	-49.866194	24.169536	-2.063184	0.0730
D(INSTQ(-1))	31.114777	30.287650	1.027309	0.3343
D(INSTQ(-2))	-51.414329	25.188709	-2.041166	0.0555

CointEq(-1)	-0.175649	0.082919	-2.118315	0.0670

R-squared	0.983488	Mean dependent var	420.5857
Adjusted R-squared	0.944272	S.D. dependent var	64.36789
S.E. of regression	15.19524	Akaike info criterion	8.455650
Sum squared resid	1847.163	Schwarz criterion	9.407225
Log likelihood	-98.37910	Hannan-Quinn criter.	8.746556
F-statistic	25.07856	Durbin-Watson stat	2.464799
Prob(F-statistic)	0.000040		

Source: Researcher's computation (2026), using E-Views 9.

The short-run dynamics of the joint effect of technological development and green financing on the green economy and climate change outcomes in Nigeria Equation Results is as presented in Table 4.7, reveal several significant findings.

The coefficient for technology adoption (TECHAD) is positive and significant in current period, negative but insignificant in first period, indicating that a unit increase in TECHAD will results in 10.74% increases in GHG in current period and -73.82% decreases in GHG in first period lag of the short run. The result of the current period is in line with a priori expectations, while the result of the first period lag does not conform to theoretical expectations. The positive and statistically significant effect of technology adoption on greenhouse gas emissions in the current period suggests that technological advancement initially increases environmental pollution in Nigeria, possibly due to greater energy consumption, increased industrial activities, and continued dependence on fossil fuels. However, the negative but statistically insignificant effect in the first period of the short run indicates a potential reduction in emissions, although the effect is insufficient to establish a reliable short-run environmental benefit. This changing relationship may reflect the gradual adjustment of production processes and the delayed benefits of adopting cleaner technologies.

The coefficient of green economy development proxied by waste recycling (WASTRE) is negative and insignificant in current and second period lags, positive but insignificant at first period lag of the short run. Specifically, a unit rise in WASTRE will result in -85.87% and -10.64% decreases in GHG in current and second period lags and 34.08% increases in WASTRE in first period lags. The result of the current and second period lags is in line with a priori expectation, while the result of the first period lag does not conform to theoretical expectations, suggesting that improvements in waste recycling may contribute to reducing emissions in Nigeria, although the effects are not sufficiently strong to establish significant short-run environmental benefits. Conversely, the positive but

statistically insignificant effect in the first-period lag may reflect temporary increases in energy consumption, transportation, and processing activities associated with recycling operations. These results suggest that the environmental benefits of waste recycling may take time to materialize because of infrastructural limitations, inadequate recycling technologies, and inefficient waste management practices. The findings also highlight the need for sustained investment in modern recycling facilities, energy-efficient waste-processing technologies, and effective waste management systems.

Also, the coefficient of green financing proxied by investment in renewable energy (REINV) exhibits a negative and insignificant relationship with GHG in short run, indicating that a unit rise in REINV will lead to a -19.44% decreases in GHG in the short run. This result does not conform to theoretical expectations, implying that renewable energy investments may contribute to reducing emissions, although their immediate impact is not sufficiently strong to establish a statistically reliable relationship. This outcome may reflect the time required to finance, develop, and operationalize renewable energy infrastructure, as well as Nigeria's continued dependence on fossil fuels and the limited penetration of clean energy technologies. The finding also suggests that the environmental benefits of green investments may take time to materialize.

The coefficient of economic growth rate (GDPg) is negative and insignificantly related to GHG, in current period, positive but insignificant after a period lag of the short run, showing that a unit rise in GDPg will lead to -18.09% decreases in GHG in current period and 31.03% increases in GHG in first period lags. The result of current period does not conform to a priori expectation, while the result of the first period lag aligns with a priori expectation, suggesting that economic expansion may initially contribute to reducing emissions, although the effect is not strong enough to establish a statistically reliable relationship in the short run. Conversely, the positive but statistically insignificant effect of economic growth at the first-period lag indicates a possible temporary increase in emissions as expanding economic activities stimulate industrial production, energy consumption, and transportation. However, the lack of statistical significance suggests that these effects are not conclusive. The findings also imply that the short-run relationship between economic growth and environmental quality remains uncertain and may depend on the extent to which growth is supported by clean technologies and renewable energy investments.

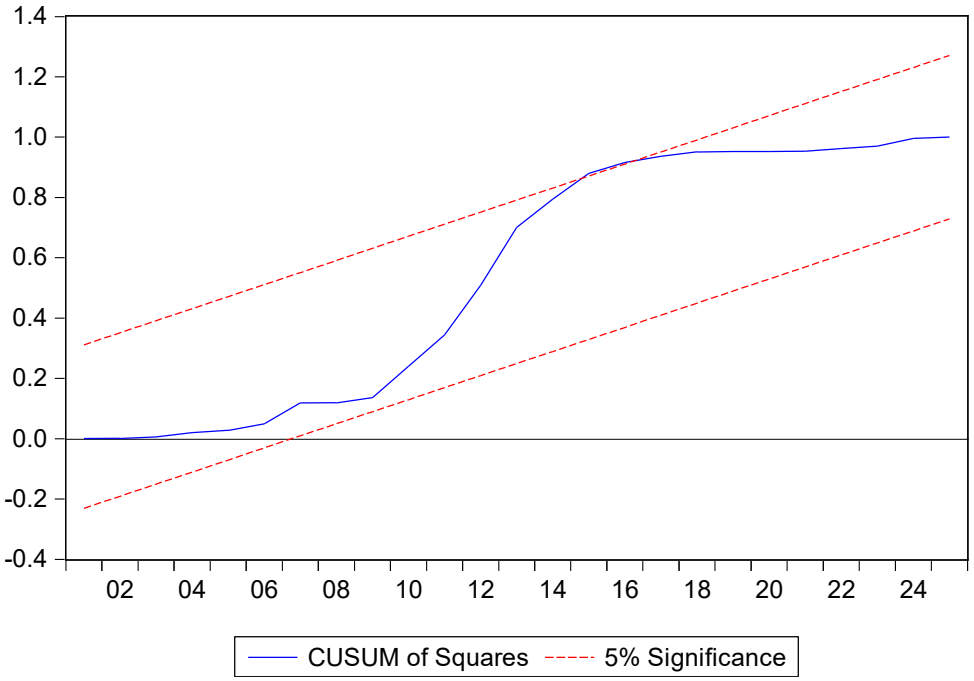
Finally, the coefficient for institutional quality (INSTQ) is negative and statistically significant in current period and second period lags, positive but insignificant in first period lag of the short run, specifically, a one-unit rise in INSTQ will lead to a -49.86% and -51.41% decreases in GHG in current and second period lags of the short run and 31.11% increases in GHG in first period lag. The findings of current and second period lags is in line

with a priori expectation, while the result of the first period lag do not conform to theoretical expectations, indicating that improvements in institutional effectiveness can contribute to reducing environmental pollution in Nigeria in the short run. This may reflect stronger environmental regulations, improved policy implementation, greater accountability, and better enforcement of climate-related policies. However, the positive but statistically insignificant effect in the first-period lag indicates a possible temporary increase in emissions, potentially arising from implementation delays or the continued influence of carbon-intensive economic activities. These findings also highlight the importance of effective institutions in ensuring that investments in clean technologies and renewable energy achieve their intended environmental benefits.

The ECM coefficient (-0.175649) is correctly signed and statistically significant, indicating that approximately 17.56% of short-run disequilibria adjust to the long-run equilibrium within a year. The t-statistic (-2.118315) confirms the significance of the ECM at the 5% level.

The R-squared value (0.983488) and adjusted R-squared (0.944272) demonstrate that approximately 98% of the variation in EMP is explained by the included variables (both current and lagged), with 2% attributable to factors outside the model. The F-statistic (25.07) confirms the joint significance of the model's variables, ensuring a good overall fit. Additionally, the Durbin-Watson statistic (2.46) indicates no autocorrelation, affirming the reliability of the results for forecasting and policy formulation.

The stability test using the cumulative sum (CUSUM) test in figure 4.1 below further shows that the variables included in the GHG equation were stable within the period of the study. This is evidenced by the swing of the trends within the CUSUM bound at the ± five percent significance level. The study, therefore, infers that the equation is stable and consistent to be adopted for economic policies and forecast.



Source: Researcher's computation (2026), using E-Views 9.

Figure 4.1: Technology, green economy, green financing and climate change equation CUSUM.

4.3 Discussion of Findings

The short run and the long run ARDL dynamics shows an intriguing insight as the regression result shows that two variables of technology, green economy, green financing: technology adoption (TECHAD) and institutional quality (INSTQ) offers a positive and significant relationship with the dependent variable climatic change proxied by greenhouse gas emission (GHG). The result suggests that increases in technology adoption and institutional quality in essence will lead to corresponding increases in climate change in Nigeria. This finding therefore suggests that technological advancement and institutional changes may be associated with increased environmental pollution. The positive effect of technology adoption may reflect increased energy demand, industrial expansion, and continued dependence on fossil fuels, particularly when technological progress is not directed toward cleaner production. Similarly, the positive effect of institutional quality may indicate that existing institutional frameworks have not adequately translated into effective environmental regulation, policy enforcement, and sustainable resource management. Hence, the joint effect of technological development and green financing, therefore, implies that technological advancement and institutional improvements alone may not guarantee

better climate outcomes without appropriate environmental priorities and effective implementation mechanisms. The findings are in line with the assertion of Adebanjo et al. (2026), Iormom (2026) and Bello et al. (2025) who opined that long-run relationship among technological innovation, economic growth and carbon dioxide emissions. Technological innovation was found to moderate the emissions-increasing effect of economic growth. This suggests that technological advancement can help Nigeria pursue economic growth while reducing environmental pressure.

However, green economy development proxied by waste recycling (WASTRE), green financing proxied by investment in renewable energy (REINV) and economic growth rate (GDPg) exhibited negative relationship with climate change proxied by greenhouse gas emission (GHG) in both short and long run periods. The negative impact of green economy development proxied by waste recycling, green financing proxied by investment in renewable energy and economic growth rate suggest that these factors contribute to environmental sustainability in the short and long run. The findings imply that improved waste recycling reduces emissions associated with waste disposal and resource extraction, while increased investment in renewable energy reduces dependence on fossil fuels and promotes cleaner energy production. Similarly, the negative effect of economic growth suggests that economic expansion can support environmental improvement when driven by cleaner technologies, energy efficiency, and sustainable production practices. Hence, the joint effect of technological development and green financing highlights the importance of integrating technological innovation with green investment to accelerate the transition toward a low-carbon economy. This finding is in tandem with the propositions of Akinsowon et al. (2026), Oye & Azuh (2026), Obiora & Udeagbala (2026) and Atedhor (2025) who assert that green finance supports sustainable development, environmental degradation, although its contribution differs across financing instruments.

More overall, technology adoption, green economy development proxied by waste recycling, economic growth rate and institutional quality exhibited a dual impact on climate change as the empirical review shows a negative, positive, significant and insignificant influence in both current, first and second period lags of the short run and long run periods suggesting that variations in regulatory enforcement, governance effectiveness, and the implementation of environmental policies, therefore highlighting the importance of directing financial resources toward renewable energy, clean technologies, sustainable waste management, and low-carbon infrastructure.

The models were estimated using the error correction mechanism (ECM) and the outcome of the key urbanization and economic development equations revealed positive and significant relationship among the variables in both the short run and long run. The result of

the heteroscedasticity shows absence of heteroscedasticity. Therefore, the errors are homoscedastic. Hence, the long run results succeed all tests and thus useful for analyses and forecasting.

The Error Correction coefficients in all the estimated models met the three criteria for its acceptability given that it is negative, fractional and statistically significant. Consequently, the estimated result confirms the presence of long run relationship among the variables in the models. It also shows that the speed of adjustments is moderate in all the estimated models. The value of the adjusted R-squared implies that the models have good fit as the independent variables have high explanatory powers. The Durbin-Watson Statistic connotes absence of autocorrelation in the estimated equations. The study, therefore, accepts the null hypotheses of no serial correlation in the models. This further implies that the error terms of different periods are not serially correlated. The stability test using the cumulative sum tests showed that the variables included in all the models were stable within the period of the study.

5. Conclusion and Policy Recommendation

The study examined the impact of technology, green economy, green financing and climate change in Nigeria. Specifically, the study investigated the joint effect of technological development and green financing on the green economy and climate change outcomes in Nigeria using data from 1995-2025 and adopted the autoregressive distributive lag model (ARDL). The empirical findings reveal a positive and significant relationship between technology adoption (TECHAD), and institutional quality (INSTQ) and the dependent variable climate change proxied by greenhouse gas emission or carbon intensity (GHG) in Nigeria. This result therefore suggests that technological advancement and institutional improvements alone may not guarantee better climate outcomes without appropriate environmental priorities and effective implementation mechanisms.

In addition, the study revealed a negative relationship between green economy development proxied by waste recycling (WASTRE), green financing proxied by investment in renewable energy (REINV), economic growth rate (GDPg) and climate change in Nigeria. The finding suggests that; the joint effect of technological development and green financing should highlight the importance of integrating technological innovation with green investment to accelerate the transition toward a low-carbon economy.

5.1 Recommendations

Therefore, we recommend that Nigerian government should strengthen environmental regulations, invest in advanced renewable energy technologies, and integrate circular

economy principles into national development strategies. These coordinated policies would enhance the effectiveness of technological development and green financing, reduce greenhouse gas emissions, stimulate sustainable economic growth, and improve climate change outcomes.

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