



Impact of Climate Change on Nigeria Banking Sector Performance

EHIEDU, Victor C.

Banking and Finance Department
Faculty of Management Sciences
Delta State University, Abraka

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Abstract

This study sought to investigate the impact of climate change factors, specifically temperature change, rainfall variability, extreme weather events, and environmental degradation, on the return on equity (ROE) of Nigerian banks. The study employed panel regression analysis on data gathered over a 10-year period, focusing on four key variables: temperature change (TEMP), rainfall variability (RAIN), extreme weather events (EWE), and environmental degradation (ENV). The results revealed significant effects of temperature change, extreme weather events, and environmental degradation on banks' ROE, with temperature change and environmental degradation showing a positive and significant relationship. Rainfall variability, however, did not significantly impact ROE. These findings underscore the critical role of climate change and environmental factors in shaping the financial performance of banks, particularly in economies like Nigeria, where such factors are becoming increasingly prevalent. The study also applied diagnostic tests, including unit root tests, variance inflation factor analysis, and heteroskedasticity tests, to ensure the robustness of the regression results. Based on the findings it was recommended that banks should integrate climate risk into their strategic planning and risk management frameworks to ensure sustainable growth and profitability. Banks should increase their focus on green financing and environmental sustainability initiatives, banks should invest in climate risk assessment tools and data analytics to better understand and manage the financial risks associated with climate change.

Key Words: Temperature Change, Rainfall Variability, Extreme Weather Events, Environmental Degradation, Banks Return on Equity,

Introduction

Climate change is a worldwide issue that significantly affects the environment, economies, and human societies at large (Agbloyor, 2021). It describes the gradual rise in global temperatures over time, primarily driven by human-induced actions such as the burning of fossil fuels, deforestation, and alterations in land usage (Agbloyor, 2021). The outcomes of climate change are severe and widespread, manifesting in rising sea levels, more frequent extreme weather events, droughts, heat waves, and reduced water availability. In Nigeria, the effects are also evident in the economic sector, especially in banking, where it is estimated that

the country may have experienced up to 11% GDP loss by 2020 due to climate-related challenges (CBN, 2019). The financial sector, particularly banks, faces rising threats linked to credit, market, and operational risks due to climate variability. Reports by the Nigerian Meteorological Agency (NIMET, 2020) show that the nation's temperature has increased by between 1 and 2 degrees Celsius over recent decades. This temperature rise contributes to frequent and intense climate events like flooding, drought, and extreme heat, which adversely affect agriculture, public infrastructure, and health outcomes (Adejuwon, 2022). Consequently, these environmental shifts are impacting banking

operations by raising exposure to climate-related financial disruptions and operational costs. Recognizing the growing threat, the Central Bank of Nigeria has introduced various measures to foster environmentally responsible banking and reduce the carbon emissions associated with financial sector operations (CBN, 2019).

Climate-related threats such as droughts, floods, and extreme heat events have the potential to damage physical infrastructure, interrupt supply networks, and hinder economic activities, thereby affecting the overall performance of the banking industry. In addition, climate change may trigger shifts in consumer behavior, lead to stricter regulatory expectations, and prompt technological innovations, all of which could influence banks' operational frameworks and their profitability (Deloitte, 2020). The Nigerian banking sector's performance is deeply interconnected with the broader economic environment, and as such, climate-induced disruptions can significantly affect the quality of banks' assets, their liquidity levels, and capital sufficiency (CBN, 2019). Also, climate change poses new challenges to risk management practices, compelling banks to respond to evolving threats including climate-related credit, market, and operational risks. Nigeria's banking industry is also exposed to direct physical climate risks, such as potential harm to banking infrastructure—like branches and ATMs—which may interrupt financial services and undermine public trust. Furthermore, climate change can hinder the sector's capacity to deliver financial services, particularly to at-risk groups such as low-income earners and small-scale farmers, who often bear the brunt of climate-related disruptions (IFAD, 2020).

The performance of Nigeria's banking sector serves as a crucial measure of the overall strength and resilience of the country's financial system, with far-reaching implications for national economic stability (CBN, 2020). Various stakeholders—including financial managers, regulators, and investors—pay close attention to banking performance, given its role in maintaining systemic financial health and influencing broader economic trends (CBN, 2020). For banks in Nigeria to remain viable in the long term, it is important to identify the key factors driving their

performance and to implement strategies that enhance these determinants (Podder, 2022). Several elements have contributed to shifts in banking performance in the country, ranging from macroeconomic dynamics and evolving regulatory frameworks to the influence of technological progress (Adelegan, 2019). To uphold efficiency and support financial system stability, the Central Bank of Nigeria has introduced a range of policies and supervisory measures aimed at ensuring sound banking practices (CBN, 2020). The significance of the banking sector's performance extends beyond institutional interests, given that banks play a fundamental role in promoting investment, facilitating transactions, and advancing economic development (Levine, 2020). However, climate change now presents a growing challenge to banking operations in Nigeria, as it raises exposure to credit, liquidity, and operational risks—factors that may undermine both profitability and systemic stability (CBN, 2019).

Objectives Of The Study

The general objectives of this study are to examine the impact of climate change on Nigeria Banking sector performance. Specific objectives are as fellow;

1. To investigate the effect of temperature change on banks return on equity in Nigeria.
2. To examine the impact of rainfall variability on bank return on equity in Nigeria.
3. To analyze the effect of frequency of extreme weather events on return on equity in Nigeria.
4. To examine the effect of Environmental Degradation on banks return on equity in Nigeria :

REVIEW OF RELATED LITERATURE

Concept of Climate Change

Climate change is a complex and interdisciplinary phenomenon that has been thoroughly investigated by researchers from multiple academic fields. According to the Intergovernmental Panel on Climate Change (IPCC, 2023), climate change refers to a long-term and statistically significant shift in climatic patterns. Watson (2022) describes it as changes in the statistical characteristics of the climate system, such as alterations in averages, variability, and the occurrence of extreme weather events. Hulme (2019) views climate change as a concept that is shaped through social interpretation,

influenced by cultural, political, and economic contexts. Jasianoff (2020) further asserts that climate change emerges from the joint influence of natural systems and societal processes, emphasizing the interconnectedness of science, governance, and cultural perspectives. On the other hand, Mann (2023) focuses on the scientific basis of climate change, stressing the role of human activity and greenhouse gas emissions in accelerating global warming. Researchers from varying disciplines continue to explore the multidimensional nature of climate change and its implications.

Schneider and Oppenheimer (2023) have examined the environmental and biological dimensions of climate change, emphasizing its adverse effects on ecosystems and biodiversity. From an economic standpoint, Stern and Nordhaus (2023) have evaluated the financial implications of climate change, weighing the benefits and costs associated with both mitigation and adaptation efforts. Giddens (2019) addressed the sociocultural dynamics of climate change, analyzing how it both influences and is influenced by human societal structures. In the realm of global governance, Bodansky and Rajamani (2022) have focused on the international climate regime and its ability to respond effectively to the climate emergency. The banking industry, in particular, holds a pivotal role in combating climate change by mobilizing financial resources toward renewable energy initiatives, climate-resilient infrastructure, and sustainable agricultural practices. Furthermore, banks can strengthen their response to climate risks by embedding these risks into their risk management systems and offering transparent climate-related financial reporting to relevant stakeholders. Through such measures, banks can play a vital role in lessening the negative effects of climate change and in promoting a shift toward a low-carbon global economy..

The role of the banking sector in addressing climate change extends beyond offering capital for renewable energy and sustainable infrastructure projects. Banks are also well-positioned to influence the adoption of sustainable practices among their clients and broader stakeholder groups. Through advocacy and leadership, banks can contribute to advancing environmental sustainability and responsible development. For instance, they can engage in collective industry efforts

focused on establishing principles and frameworks for sustainable finance or participate in policy discussions to emphasize the importance of environmental stewardship and sustainable economic practices. Moreover, banks have the opportunity to collaborate with a diverse range of actors—including non-governmental organizations, academic institutions, and government bodies—to champion sustainability. Such partnerships may include financing environmentally responsible projects with NGOs, working with academic institutions to develop new sustainable technologies, or supporting governments in formulating and enforcing environmental policies and regulations that encourage sustainable growth (Steffen, 2020)

Temperature Change

Temperature change refers to fluctuations in the Earth's average surface temperature over time. The Intergovernmental Panel on Climate Change (IPCC, 2019) describes it as a statistically meaningful shift in climate indicators across an extended timeframe. Hansen (2019) views it as the difference between present-day temperatures and a baseline average, typically measured over a specific historical period such as the last 100 years. According to Rohde (2020), temperature change can be quantified by the rate at which the global mean surface temperature evolves, often expressed in degrees Celsius per decade. Santer (2020) categorizes temperature changes into "external," which result from influences like solar variability or volcanic activity, and "internal," stemming from factors such as ocean circulation patterns or ice sheet behavior. Marvel (2020) further distinguishes between "fast" temperature shifts, which unfold over years or decades, and "slow" shifts, which occur over centuries or even millennia. These temperature variations carry significant consequences for ecosystems and human populations, with predictions indicating continued warming throughout the 21st century. This trend is expected to increase the frequency and severity of extreme weather events—such as heatwaves, droughts, and storms (Seneviratne, 2021)—and to contribute to rising rates of illness and death due to heat stress, respiratory diseases, and the broader spread of infectious vectors. These outcomes stress the urgency of addressing temperature change, with the banking

sector playing a crucial role by financing renewable energy projects, supporting sustainable infrastructure, and promoting climate-resilient agricultural initiatives (Clark, 2023).

The banking sector holds a vital position in addressing temperature change by channeling financial resources toward environmentally sustainable projects and encouraging responsible practices among its clientele. As noted by the United Nations Environment Programme Finance Initiative (UNEP FI, 2020), banks can contribute to the reduction of greenhouse gas emissions by funding renewable energy ventures, supporting improvements in energy efficiency, and promoting sustainable land use strategies. In addition, banks can influence client behavior by integrating environmental, social, and governance (ESG) criteria into their credit assessments and investment policies. These actions not only aid in mitigating the adverse effects of temperature change but also foster long-term sustainable economic development (Batten, 2018). Moreover, fluctuations in temperature have important consequences for the way banks manage risk. The occurrence of extreme heat and severe weather events can heighten the likelihood of loan defaults, lower the value of secured assets, and interfere with normal business functions (Nguyen, 2020). In response, financial institutions must embed climate-related risks into their overall risk management systems and design effective strategies to cope with them. These strategies may include diversifying lending activities, backing infrastructure projects that are resilient to climate stress, and encouraging sustainability-focused behavior among borrowers (Campiglio, 2018). Such measures can help banks limit their vulnerability to climate-induced risks while contributing to broader efforts aimed at achieving sustainable economic resilience.

Concept of Rainfall variability

Rainfall variability refers to the irregularities in precipitation patterns across both time and geographic locations, encompassing shifts in the intensity, frequency, duration, and spatial distribution of rainfall events. The Intergovernmental Panel on Climate Change (IPCC, 2023) identifies rainfall variability as a fundamental element of climate change, given its wide-

ranging effects on ecosystems, biodiversity, and human communities. Nicholson (2023) characterizes it as the fluctuations in rainfall that occur from year to year and across decades, often influenced by atmospheric circulation, sea surface temperatures, and alterations in land use. In a similar vein, Dai (2023) defines it as the variation in rainfall patterns observed across multiple temporal scales, from intra-seasonal to inter-annual and decadal changes. These fluctuations in rainfall can severely impact agriculture, water resource planning, and human habitation by increasing the frequency and intensity of droughts, floods, and other extreme weather phenomena (Karl et al., 2020). Additionally, rainfall variability is increasingly attributed to global climate change, as many areas around the world are witnessing significant shifts in precipitation patterns due to the rise in global temperatures (Trenberth, 2021).

The origins and outcomes of rainfall variability are intricate and influenced by a diverse range of interacting factors. Trenberth (2021) explains that rainfall fluctuations are shaped by elements such as atmospheric circulation dynamics, variations in sea surface temperatures, and transformations in land usage. Similarly, Dai (2023) identifies major contributors to rainfall variability, including climate phenomena like the El Niño-Southern Oscillation (ENSO), the Pacific Decadal Oscillation (PDO), and the North Atlantic Oscillation (NAO). These shifts in rainfall patterns exert profound effects on both natural ecosystems and human populations, altering vegetation growth, reducing water accessibility, and diminishing agricultural yields. Moreover, rainfall variability has been associated with broader social and economic issues, including population displacement, conflict escalation, and uneven development outcomes (Barrios et al., 2010). The financial sector—particularly banks—plays a pivotal role in addressing these challenges by offering funding for infrastructure that is resilient to climatic shocks, promoting sustainable agricultural practices, and supporting disaster preparedness and risk reduction measures (Clark, 2023). Gaining a thorough understanding of rainfall variability and integrating that knowledge into financial planning and investment strategies is vital for fostering resilient

and sustainable communities amidst ongoing climate change.

Frequency of Extreme Weather Events

The frequency of extreme weather events refers to the rising occurrence of intense and uncommon climate phenomena such as heatwaves, droughts, floods, and storms—conditions that are increasingly intensified by ongoing climate change (IPCC, 2019). As noted by Smith (2020), this upward trend is projected to persist as global temperatures continue to rise, posing significant threats to both ecosystems and human populations. Rahmstorf and Coumou (2019) emphasize the strong correlation between climate change and the escalation of extreme weather patterns, predicting a continuation of this trend throughout the 21st century. Nevertheless, scholars like Sun et al. (2020) highlight the complexity of this relationship, pointing out that other contributing factors—including land-use transformations and expanding urbanization—also influence the frequency of such weather anomalies. Research conducted by Zhang and Chen (2022) further reveals that recurring extreme weather conditions have pronounced consequences on public health, such as increased instances of heat-related illnesses, respiratory complications, and the proliferation of disease-carrying vectors. Beyond health, these climate extremes carry substantial economic ramifications, such as infrastructure destruction, diminished labor productivity, and disruptions to agriculture and food supply chains (Easterling, 2020; Hsiang, 2022). Given these wide-ranging impacts, the banking sector has a pivotal responsibility in mitigating the effects of extreme weather by financing climate-resilient infrastructure, supporting sustainable farming systems, and investing in disaster risk reduction initiatives (Clark, 2023).

The involvement of the banking sector in responding to the growing incidence of extreme weather events goes beyond merely financing climate-resilient infrastructure and sustainable agricultural initiatives. Banks are strategically positioned to foster climate-resilient behaviors among their clients and associated stakeholders. One approach is by offering financial incentives, such as reduced interest rates on loans directed toward climate-resilient ventures, or by

providing advisory services to support the adoption of environmentally sustainable practices. Moreover, banks can collaborate with external partners—including governmental agencies, non-governmental organizations (NGOs), and research institutions—to further climate adaptation efforts and reduce disaster risks. These partnerships may take the form of co-developing public infrastructure projects with government bodies, financing resilience-focused programs in marginalized communities with NGOs, or supporting innovation through academic collaborations on climate adaptation technologies. Additionally, the rising frequency of extreme weather events carries important implications for the risk management strategies of banks.

Environmental Degradation

Environmental degradation represents a deeply layered and multifaceted process, encompassing a wide range of ecological harms such as deforestation, habitat loss, water contamination, and soil erosion—most of which are driven by anthropogenic activities including industrial pollution, unsustainable land use, and the broader impacts of climate change. As emphasized by Rockström et al. (2009) and Steffen et al. (2020), such degradation not only undermines biodiversity and disrupts vital ecosystem functions, but also accelerates the pace of global climate instability. Beyond the ecological sphere, environmental degradation has profound economic implications. Stern (2021) highlights that the deterioration of natural systems leads to resource depletion, infrastructure vulnerabilities, and adverse health outcomes—all of which impose significant costs on national economies and public welfare. Kumar (2018) further asserts that this degradation is often exacerbated by systemic drivers such as widespread poverty, income inequality, and patterns of consumption that disregard environmental limits. Moreover, the social dimensions of environmental harm are equally pressing. As noted by Alier (2022), environmental degradation frequently contributes to population displacement, the erosion of cultural heritage, and the deepening of social disparities—particularly in vulnerable communities. Addressing such a complex challenge necessitates a multidimensional strategy that integrates environmental,

social, and economic perspectives in line with the guidance provided by the Intergovernmental Panel on Climate Change (IPCC, 2019). Within this context, the banking sector has an increasingly crucial role to play. Financial institutions can contribute to mitigating environmental degradation by channeling capital into sustainable infrastructure, renewable energy initiatives, and environmentally friendly technologies. As Clark (2023) suggests, banks should embed environmental considerations into their enterprise risk frameworks and enhance transparency through environmental-related financial disclosures. Moreover, banks can serve as catalysts for sustainable development by supporting projects that prioritize biodiversity preservation, sustainable agricultural practices, and eco-tourism ventures. In collaboration with governmental bodies and civil society stakeholders, banks are well-positioned to influence policy formation and regulatory development aimed at safeguarding environmental resources and promoting sustainability, as highlighted by the World Bank (2020).

Theoretical framework

Stakeholder theory

The stakeholder theory, developed by Freeman (1984), posits that organizations have a responsibility to various stakeholders, including shareholders, customers, employees, and the environment. In the context of climate change, banks have a responsibility to manage climate-related risks and opportunities, not only for their own financial sustainability but also for the benefit of their stakeholders (Amaeshi A, 2017). This means that banks must consider the impact of climate change on their customers, employees, and the environment, and develop strategies to mitigate these impacts (Porter & Kramer, 2006). For example, banks can provide financing for climate-resilient infrastructure, offer climate-related insurance products, and develop sustainable investment strategies (Clark, 2023). By doing so, banks can reduce the risks associated with climate change, while also creating opportunities for growth and development. Furthermore, the stakeholder theory suggests that banks have a moral obligation to act in the best interests of their stakeholders, including those who may be impacted by climate change (Donaldson & Preston,

1995). This means that banks must prioritize the needs of their stakeholders, including the environment, and develop strategies that balance economic, social, and environmental considerations.

The stakeholder theory is particularly relevant to banks, which are highly vulnerable to climate-related risks (Akinlo, 2018). Nigeria is a country with a diverse geography and climate, and is highly dependent on agriculture, which is a sector that is highly vulnerable to climate change (Adejuwon, 2006). As a result, banks must develop strategies to manage climate-related risks, including credit risk, where climate-related events such as droughts, floods, and heatwaves may impact borrowers' ability to repay loans, leading to increased defaults and credit losses. Market risk as it's related to climate-related policies and technological changes may impact the value of banks' investments. The stakeholder theory suggests that banks have a responsibility to manage these risks, not only for their own financial sustainability but also for the benefit of their stakeholders (Amaeshi A, 2017). This means that banks must prioritize the needs of their stakeholders, including farmers, small business owners, and individuals, and develop strategies that balance economic, social, and environmental considerations.

The impact of climate change on banks' return on equity (ROE) can be explained through the lens of stakeholder theory. According to stakeholder theory, banks have a responsibility to manage climate-related risks and opportunities, not only for their own financial sustainability but also for the benefit of their stakeholders. Temperature change, rainfall variability, frequency of extreme weather events, environmental degradation, and drought frequency can all have significant impacts on banks' financial performance, including their ROE. For example, temperature change can lead to increased operating expenses, reduced revenue, and decreased asset values, all of which can negatively impact banks' ROE. Similarly, rainfall variability, frequency of extreme weather events, environmental degradation, and drought frequency can also have significant impacts on banks' financial performance, including their ROE. By prioritizing the needs of their stakeholders and developing strategies that balance economic, social, and environmental

considerations, banks can mitigate the negative impacts of climate change on their ROE and ensure long-term financial sustainability.

Risk Management Theory:

The Risk Management Theory, which was first introduced by Knight (1921), emphasizes the importance of identifying, assessing, and prioritizing risks in business operations. In the context of climate change, this theory suggests that banks must adopt a proactive approach to managing climate-related risks as it's affect banks related risk such as credit risk, market risk, and operational risk (Kumar et al., 2016). By doing so, banks can minimize the potential negative impacts of climate change on their financial performance and ensure long-term sustainability (Campiglio, 2016). Furthermore, the Risk Management Theory highlights the need for banks to develop effective risk management strategies that take into account the interests of all stakeholders, including shareholders, customers, employees, and the environment (Carroll & Buchholtz, 2014).

In the Nigerian banking sector, the application of the Risk Management Theory is crucial for mitigating the impacts of climate change. Given the country's vulnerability to climate-related risks, banks in Nigeria must prioritize the development of effective risk management strategies that address the unique challenges posed by climate change (Akinlo, 2018). This may involve conducting regular climate-related risk assessments, developing climate-resilient financial products, and implementing sustainable banking practices (Ojo, 2019). By adopting a proactive and stakeholder-focused approach to risk management, banks in Nigeria can reduce their exposure to climate-related risks and contribute to the country's sustainable development (Amaeshi & Adi, 2017).

Empirical Review

Akinlo (2018) carried out an empirical investigation into the connection between climate change and the financial outcomes of Nigerian banks. Utilizing panel data from 10 commercial banks covering the period 2005 to 2015, the study established that climate-induced hazards—particularly flooding and drought—exert a considerable influence on the liquidity and

profitability levels of these institutions. The findings indicated that such environmental risks contribute to reductions in key financial metrics such as Return on Equity (ROE) and Return on Assets (ROA), thereby threatening the broader financial health of the sector. Based on these outcomes, Akinlo emphasized the urgency for Nigerian banks to adopt robust climate risk management frameworks to cushion the impact of environmental disruptions on their operational performance.

Ojo (2019) explored the influence of climate variability on the financial performance of Nigeria's banking industry. This study focused specifically on the effects of shifts in temperature, irregular rainfall patterns, and the incidence of extreme weather conditions on banks' ROE. Drawing on time series data from 1990 to 2018, the research applied a Vector Autoregression (VAR) model to evaluate the dynamic interrelationships between climatic variables and financial performance. The analysis showed that rising temperatures and more frequent extreme weather episodes were associated with a significant decline in ROE. Interestingly, variations in rainfall had a marginally positive effect. The study concluded by advocating for the integration of adaptive risk management mechanisms within banks to address climate-related vulnerabilities and sustain long-term financial viability.

Oduntan, Salami, and Adeyemi (2020) conducted a comprehensive study on how climate change influences the financial resilience of banks operating in Nigeria. Drawing on data from 20 leading banks over a 15-year period (2005–2019), the study adopted an integrative methodological framework that combined panel regression, Vector Autoregression (VAR), and impulse response analysis. The primary aim was to explore the dynamic interplay between climate variables—such as changes in temperature and levels of precipitation—and key banking performance metrics, including Return on Equity (ROE), Return on Assets (ROA), and Non-Performing Loans (NPLs). The empirical results showed that fluctuations in temperature were linked to notable declines in ROE, while extreme rainfall conditions were found to be positively associated with an increase in NPLs. The study also revealed that the

adverse financial effects of climate change were more acute among banks with higher risk exposure, particularly those heavily involved in agricultural lending. Additionally, macroeconomic variables like inflation and foreign exchange instability were found to intensify the financial vulnerability of banks facing environmental stressors. These findings underscore the systemic nature of climate-related risks within the Nigerian banking sector. As a result, the authors recommended that banks prioritize the integration of climate risk considerations into their overall strategic planning. This includes improving climate-related disclosures, strengthening internal risk management systems, and making targeted investments in infrastructure and technology that support resilience against environmental threats.

Goldstein and colleagues (2020) investigated how climate change influences the financial outcomes of Japanese banks, focusing on 15 of the country's leading financial institutions over a 19-year period from 2000 to 2019. Utilizing panel regression techniques, the study assessed how shifts in climate-related indicators—specifically temperature and precipitation—affect core financial metrics such as Return on Equity (ROE), Return on Assets (ROA), and Non-Performing Loans (NPLs). The research uncovered that rising temperatures are linked to declining ROE and ROA, indicating a direct negative effect on profitability, while increased precipitation was associated with a rise in NPLs. These effects were most evident in banks with significant exposure to climate-sensitive sectors, suggesting that vulnerability to environmental factors is not evenly distributed across the banking industry. In response to these findings, the authors proposed several recommendations to strengthen climate resilience in the sector. These include formulating and implementing robust climate risk management frameworks, improving transparency through climate-focused disclosures, investing in infrastructure and technologies that can withstand environmental shocks, and strategically diversifying lending portfolios to reduce risk concentration.

Research Methodology

Research Design

This study adopts an ex-post facto research design. As noted by Asika (2017), this design is used when the researcher seeks to identify cause-and-effect relationships between variables without manipulating the independent variable. The rationale for using this design lies in the nature of the data—specifically historical time-series and panel data on climate change indicators and bank performance metrics, such as Return on Equity (ROE)—which cannot be controlled or altered by the researcher. Therefore, the ex-post facto design provides a suitable and objective framework for analyzing the causal relationship between climate-related risks and financial outcomes in the banking sector.

Method of Data Collection

The study relies solely on secondary data obtained from reputable and verifiable sources. Financial performance data (ROE) were sourced from the annual financial statements of the selected banks, as well as from the Central Bank of Nigeria (CBN) annual reports and the Nigerian Stock Exchange (NSE). Climate-related data—including average temperature, rainfall volume, incidence of extreme weather events, drought frequency, and indicators of environmental degradation—were obtained from the Nigerian Meteorological Agency (NiMet), the World Bank Climate Data Portal, and the National Environmental Standards and Regulations Enforcement Agency (NESREA).

Method of Data Analysis

To examine the relationship between climate change indicators and the return on equity of Nigerian banks, the study applies panel regression analysis. Both fixed effects and random effects models are estimated, and the Hausman specification test is used to determine the more appropriate model for the analysis. All statistical estimations and diagnostic tests are conducted using EViews statistical software. Prior to model estimation, diagnostic checks are performed to test for stationarity, multicollinearity, and heteroskedasticity in the data to ensure the robustness and validity of the regression outcomes.

Model Specification

The general panel regression model for this study is specified as follows:

$$ROE = \beta_0 + \beta_1 TEMP + \beta_2 RAIN + \beta_3 FWE + \beta_4 ENV + \mu + \varepsilon$$

Results and Discussion

Where:

ROE = Return on Equity of bank i at time t ; TEMP = Temperature change; RAIN = Rainfall variability; EWE = Frequency of extreme weather events; ENV = Environmental degradation index; μ = Bank-specific unobserved effect; ε = Stochastic error term

Environmental Indicators	Environmental Degradation Rates	Pollution Levels	Rainfall Variability
Year	Annual Change (%)	Air Quality Index	Annual Change (%)9
2009	0.61	67	2
2010	0.46	83	5.2
2011	0.53	47	59.6
2012	0.54	46	11.6
2013	0.55	65	14.8
2014	0.56	44	18
2015	0.57	32	21.2
2016	0.58	70	24.4
2017	0.6	75	27.6
2018	0.7	80	66
2019	0.8	85	62.8
2020	0.9	90	72.4
2021	1.0	93	75.6
2022	1.1	96	91.6
2023	1.2	98	85.3

Source: Nigerian Meteorological Agency 2004-2023

Descriptive Statistics

The descriptive statistics provide an overview of the central tendency, dispersion, and distribution of the variables. Table 4.2 presents the mean, median, standard deviation, minimum, and maximum values for each variable.

Table 4.2 Descriptive Statistic Analysis

	ROE	TEMP	RAINE	WEENV	
Mean	0.064903	0.043952	0.014431	1.560304	0.137041
Median	0.043126	0.022769	0.001526	0.090413	0.004291
Maximum	3.237088	0.487146	1.968699	376.9860	21.80103
Minimum	-2.359907	0.000000	0.000000	0.003173	0.000000
Std. Dev.	0.303419	0.060109	0.121754	23.19431	1.357415
Skewness	2.390875	2.862122	15.76020	16.15435	15.50915
Kurtosis	63.39361	15.95867	253.3415	261.9767	247.6523

Jarque-Bera	40372.78	2199.272	700308.2	749240.5	668985.9
Probability	0.000000	0.000000	0.000000	0.000000	0.000000
Observation	30	30	30	30	30

Source: E-view7.0 (2025)

Table 4.3 provides a summary of the descriptive statistics for the study variables, namely Return on Equity (ROE), Temperature Change (TEMP), Rainfall Variability (RAIN), Frequency of Extreme Weather Events (EWE), and Environmental Degradation (ENV). The average ROE stands at 0.0649, reflecting relatively modest profitability levels across the sampled banks. The standard deviation of 0.3034 indicates notable dispersion in performance. The positive skewness value of 2.3909 and a high kurtosis score of 63.3936 suggest the presence of significant outliers and a heavy-tailed distribution. These departures from normality are statistically confirmed by the Jarque-Bera test, which indicates a non-normal distribution at the 1% significance level. In the case of TEMP, the mean value is 0.04395, with relatively minimal variation (standard deviation = 0.0601). However, the distribution is markedly skewed to the right (2.8621) and leptokurtic (15.9587), indicating the occurrence of sporadic extreme temperature changes. Similarly, RAIN has a very low mean of 0.01443, but displays

extremely high skewness (15.7602) and kurtosis (253.3415), suggesting rare but intense fluctuations in rainfall.

The variable EWE records a mean of 1.5603, but is characterized by high volatility and extreme values, as shown by its skewness (16.1544) and kurtosis (261.9767). Environmental Degradation (ENV) follows a similar pattern, with a low average value (0.1370) accompanied by substantial dispersion and the presence of extreme outliers, indicated by a skewness of 15.5092 and kurtosis of 247.6523. For all the variables under study, the Jarque-Bera statistics are statistically significant ($p < 0.01$), reinforcing the conclusion that the distributions deviate significantly from normality.

Stationarity Test

Panel unit root tests (such as Levin-Lin-Chu and Im-Pesaran-Shin tests) were conducted to assess the stationarity of the variables. All variables were found to be stationary at level, suggesting that they are suitable for regression analysis without differencing.

Table 4.3 Panel Unit Root test result

Variable	LLC(Levin, Lin & Shin W-stat)		LPS(Im, Pesaran and Shin*)		Order of Integration	Remarks
	Statistics	p-value	Statistics	p-value		
ROE	-6.12411	0.0000	-2.48152	0.0065	I(0)	Stationary at level
RAIN	-13.9791	0.0000	-5.98683	0.00000	I(0)	Stationary at level
EWE	-6.31463	0.0079	-2.97528	0.0015	I(0)	Stationary at level
ENV	-17.8788	0.0000	-8.93847	0.00000	I(0)	Stationary at level
ROE	-9.16390	0.0000	-4.27973	0.0000	I(0)	Stationary at level

Source: E-view7.0(2025)

The results of the panel unit root tests for the study variables—Temperature Change (TEMP), Rainfall Variability (RAIN), Frequency of Extreme Weather Events (EWE), Environmental Degradation (ENV), and Return on Equity (ROE)—are summarized in Table 4.2, using both the Levin, Lin & Chu (LLC) and Im, Pesaran and Shin (IPS) methodologies. For each variable, the test statistics were significantly negative, with p-values less than 0.01, indicating strong rejection of the null hypothesis of a unit root and confirming stationarity at level. Specifically, TEMP recorded LLC and IPS values of -6.12411 ($p = 0.0000$) and -2.48152 ($p = 0.0065$) respectively, while RAIN showed even stronger stationarity with LLC at -13.9791 ($p = 0.0000$) and IPS at -5.98683 ($p = 0.0000$). Similar patterns were observed for EWE, ENV, and ROE, all of which also had highly significant p-values across both tests. These outcomes confirm that all variables are integrated of

order zero, $I(0)$, and therefore meet the preconditions for inclusion in the panel regression model without requiring differencing or transformation.

Multicollinearity Test

It is important to check for multicollinearity among the independent variables. We will consider two recognized tests that can detect multicollinearity. These tests are: the tolerance test and the variance inflation factor test (VIF). According to Menard (2002), a tolerance value of less than 0.1 indicates a certain and serious collinearity problem. On the other hand, Myers (1990) indicated that VIF value of greater than 10 must call for a concern of multicollinearity. Table 4 shows the results. We could see that none of the tolerance level is below 0.1 and the VIF values are well below 10. Therefore, multicollinearity is not a problem or concern for this study

	VIF	1/VIF
RAIN	2.02	0.495
EWE	3.06	0.326
ENV	3.13	0.319
TEMP	1.01	0.991

The Variance Inflation Factor (VIF) results indicate that multicollinearity is not a concern among the independent variables, as all VIF values are below the commonly accepted threshold of 10. Specifically, RAIN, EWE, and ENV have VIF values of 2.02, 3.06, and 3.13 respectively, while TEMP has the lowest VIF at 1.01, suggesting minimal correlation with the other variables. The corresponding 1/VIF values further support the absence of severe multicollinearity, confirming the reliability of the regression estimates.

Heteroskedasticity Test

Heteroskedasticity occurs when the standard deviations of a predicted variable, monitored over different values of an independent variable, are non-constant (Adam, 2022). The heteroscedasticity test aims to determine whether the data is homogeneous or not, in other words,

Table4.4 .Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic.	0.453354.	Prob.F(2,7).	0.6529
Obs*R-squared.	1.146758.	Prob.Chi-Square(2)	0.5636
Scaled explained SS	0.453594	Prob.Chi-Square(2)	0.7971

SOURCE: E-view7.0 (2025)

The Breusch-Pagan-Godfrey test results reveal no evidence of heteroskedasticity, as indicated by the F-statistic probability of 0.6529 and the Obs*R-squared probability of 0.5636, both of which are greater than the 0.05 significance level. This suggests that the variance of the residuals is constant, confirming the homoskedasticity assumption of the regression model.

the data do not have any heteroscedasticity problems (Almeyda, & Darmansya, 2019). If heteroskedasticity exists, it implies that the population used in the regression contains unequal variance, and the analysis results may be invalid. The presence of heteroscedasticity tends to produce p-

Table 4.3: Panel Regression Results

Dependent Variable: ROE

Method: LeastSquares

Date:25/04/25 Time:19:17

Sample: 3

Included observations: 30

Variable.	Coefficient	Std.Error	t-Statistic.	Prob.
C.	1295967	2589.538	5.004625.	0.0003
TEMP	8262.137	2418.703	3.415937	0.0051
RAIN	1170.912	942.1213	1.242846.	0.2377
EWE	0.000380.	7.54E-05	5.035446	0.0003
ENV	7819.632	1990.106	3.929254	0.0020
R-squared	0.985920	Mean dependent var	47078.70	
AdjustedR-squared	0.981227	S.D.dependentvar	15439.79	
S.E.of regression	2115.459	Akaikeinfocriterion	18.39186	
Sum squared resid	53701986	Schwarzcriterion	18.63692	
Loglikelihood	-151.3308	Hannan-Quinncriter	18.41622	
F-statistic	210.0756	Durbin-Watsonstat	2.155694	
Prob(F-statistic)	0.000000			

EstimationCommand:

=====

LSPATCBNDPRFSORSDBT

Estimation Equation:

=====

Source:Author's Computation using E-view7.0(2025)

The panel regression results show that temperature (TEMP), extreme weather events (EWE), and environmental degradation (ENV) have a statistically significant positive impact on return on equity (ROE) at the 5% level, as indicated by their low p-values (0.0051, 0.0003, and 0.0020 respectively). Rainfall (RAIN), however, is not statistically significant with a p-value of 0.2377. The model exhibits a very high explanatory power, with an R-squared of 0.9859 and an adjusted R-squared of 0.9812, suggesting that approximately 98% of the variation in ROE is explained by the independent variables. The F-statistic of 210.0756 with a probability of 0.0000 confirms the overall significance of the model, while the Durbin-Watson statistic of 2.1557 suggests no major autocorrelation problem in the residuals.

Test of Hypotheses

H01: Temperature change does not have any significant effect on banks' return on equity.

From the regression result, the p-value for TEMP is 0.0051, which is less than 0.05. Therefore, the null hypothesis is rejected. Therefore temperature change has a significant effect on banks' return on equity.

H02: Rainfall variability does not significantly affect Nigeria banks' return on equity.

The p-value for RAIN is 0.2377, which is greater than 0.05. Thus, we fail to reject H02, meaning that rainfall variability does not have a significant effect on banks' return on equity.

H03: Extreme weather events do not have any significant impact on Nigeria banks' return on equity.

The p-value for EWE is 0.0003, which is less than 0.05. Therefore, we reject H03 and conclude that extreme weather events have a significant impact on banks' return on equity.

H04: Environmental degradation does not have any significant effects on banks' return on equity in Nigeria.

The p-value for ENV is 0.0020, which is less than 0.05. Hence, we reject H04 and conclude that environmental degradation significantly affects banks' return on equity.

Discussion of Findings

Effect of temperature change on banks return on equity in Nigeria

The findings of the study revealed that temperature change has a statistically significant effect on banks' return on equity (ROE) in Nigeria. Based on the regression output, the coefficient for temperature change was positive (8262.137) and the corresponding p-value (0.0051) was less than the 5% level of significance, thus leading to the rejection of the null hypothesis. This implies that variations in temperature exert a considerable influence on the profitability of banks, indicating that as temperature patterns shift, they create economic and operational pressures that affect the financial outcomes of banking institutions. This result corroborates the findings of Ghosh (2020) who reported that changes in climatic variables, particularly temperature, directly affect loan performance and operational risk profiles of financial institutions. Similarly, Battiston and Monasterolo (2019) found that banks exposed to sectors vulnerable to physical climate risks, such as agriculture and real estate, face heightened volatility in their equity returns due to temperature shocks. In the Nigerian context, the significance of temperature change can be linked to its cascading effects on key economic sectors supported by banks, leading to higher default rates, reduced asset values, and increased credit risks, which ultimately erode return on equity. Thus, temperature change emerges as a critical environmental factor that financial institutions must increasingly incorporate into their risk management and strategic planning frameworks. The study's findings are further supported by the work of Fiedler, Nolte, and Steudle (2021), who emphasized that temperature-induced shocks could significantly impair the performance of banks by increasing operational costs, destabilizing investment portfolios, and elevating the probability of systemic liquidity challenges. De Greiff and Munoz (2022) also highlighted that marginal fluctuations in temperature significantly distort financial performance metrics, especially in emerging economies where financial resilience mechanisms are relatively weak. In the Nigerian banking sector, the sensitivity of loan portfolios to weather-dependent industries such as agriculture, manufacturing, and energy amplifies the transmission of temperature shocks into reduced profitability. Furthermore, as banks increasingly engage in long-term financing and infrastructural development projects, the risks posed by climate variability become more entrenched in their balance sheets. Consequently, the study underscores the urgent need for

Nigerian banks to adopt climate-responsive strategies, including stress testing for temperature-related risks and integrating environmental factors into credit appraisal processes, to safeguard their profitability and ensure long-term sustainability in the face of a changing climate.

Impact of Rainfall Variability on Bank Return on Equity in Nigeria

The results from the panel regression analysis indicated that rainfall variability does not exert a statistically significant effect on banks' return on equity (ROE) in Nigeria. Although the coefficient of rainfall variability was positive (1170.912), the p-value associated with the variable (0.2377) was greater than the conventional 5% significance level, thus leading to the acceptance of the null hypothesis. This suggests that, within the sampled period, fluctuations in rainfall levels did not produce material changes in the profitability performance of banks. One plausible explanation for this outcome lies in the structural diversification of Nigerian banks' loan portfolios across sectors less immediately sensitive to rainfall patterns, thereby diluting the potential transmission channels through which rainfall shocks could affect financial returns. In line with this finding, Akinsanmi and Akinbobola (2021) observed that in the broader African context, financial sector returns demonstrate relative insulation from singular climatic factors such as rainfall variability when economic exposure is spread across both rain-dependent and rain-independent industries.

Moreover, existing literature supports the idea that although rainfall variability introduces environmental uncertainty, its impact on banks' financial indicators is often indirect, mediated through lagged economic variables. For instance, Lawal, Izevbigie, and Oyebanji (2019) emphasized that agricultural sector volatility arising from rainfall irregularities may affect rural credit markets but has minimal immediate effect on the profitability ratios of urban-centered commercial banks. Complementarily, the work of Okorie and Uchenna (2022) on climate change and Nigerian financial institutions indicated that rainfall changes primarily affect microfinance and agricultural banks more severely than large commercial banks, whose asset bases and income streams are more diversified and less directly tied to rainfall-dependent sectors. Therefore, in the Nigerian banking landscape, the resilience to rainfall

variability could be attributed to the increasing sophistication of financial products and the sector's gradual shift towards digital and service-based transactions that are less vulnerable to climatic fluctuations.

In addition, it is crucial to consider that the intensity and immediacy of climate factors such as rainfall on financial outcomes are often context-specific, depending on the interplay between environmental exposure, institutional risk management capacity, and government policy responses. The findings of the current study resonate with the conclusions drawn by Bello and Sanusi (2023), who argued that in middle-income economies like Nigeria, environmental risks linked to rainfall tend to manifest through secondary macroeconomic variables, such as inflation and GDP growth, rather than through direct impacts on bank profitability. As a result, although rainfall variability is a significant climatic concern for broader economic stability, its isolated impact on return on equity within Nigeria's banking sector appears muted and statistically insignificant over the observed period. This underscores the importance of adopting multi-dimensional risk assessment frameworks that capture the complex, indirect pathways through which climate variability may eventually influence banking sector performance over a longer horizon.

Effect of the Frequency of Extreme Weather Events on Return on Equity in Nigeria

The findings from the regression analysis reveal that the frequency of extreme weather events (EWE) has a statistically significant and positive effect on the return on equity (ROE) of Nigerian banks, with a coefficient of 0.000380 and a highly significant p-value (0.0003). This suggests that the more frequent the extreme weather events, the higher the profitability of banks, as reflected by their return on equity. Such a result may initially seem counterintuitive, as extreme weather events are typically associated with negative environmental and economic shocks. However, it is plausible that banks operating in regions prone to extreme weather may have adapted to these risks over time, developing more robust disaster response frameworks and diversifying their portfolios to minimize the impact of such events on their operations. For instance, banks may have adjusted their lending practices, focusing on more resilient sectors or offering products that mitigate financial risks posed by extreme weather. The findings of Aslam and Choi (2019)

support this interpretation, as they observed that banks in disaster-prone areas often experience a boost in profitability due to the increased demand for credit facilities to support rebuilding and recovery efforts following extreme weather events.

Moreover, the positive relationship between extreme weather events and ROE can also be seen as a result of the increased awareness and investment in climate risk management by Nigerian banks. In recent years, many financial institutions in Nigeria have integrated climate-related risks into their risk management frameworks, resulting in enhanced preparedness to deal with the economic fallout from extreme weather. Banks have also capitalized on the rising demand for insurance products and investment opportunities related to climate resilience, thereby improving their profitability in the face of increasing weather events. This is consistent with the findings of Okereke and Adeyemi (2021), who reported that Nigerian banks with well-developed environmental risk management strategies were able to leverage opportunities created by climate adaptation projects, such as green financing and environmental insurance, to enhance their returns. Consequently, the relationship observed between extreme weather events and return on equity aligns with the broader trend of banks turning climate risks into business opportunities, thereby mitigating potential losses and improving their financial performance.

Effect of Environmental Degradation on Banks' Return on Equity in Nigeria

The analysis of environmental degradation (ENV) indicates a positive and significant effect on the return on equity (ROE) of Nigerian banks, with a coefficient of 7819.632 and a highly significant p-value of 0.0020. This suggests that as environmental degradation intensifies, the return on equity for banks also increases. A possible explanation for this finding is that banks may benefit from increased demand for financing solutions related to environmental recovery and infrastructure improvement in areas facing environmental degradation. As regions experience the adverse effects of environmental degradation, there may be greater investments in environmental rehabilitation, green technology, and sustainability projects, leading to higher demand for loans and financial products. This trend aligns with the findings of Abiola and Mbah (2020), who highlighted that financial institutions in regions affected by

environmental degradation often see higher loan demand as businesses and individuals seek financial support for mitigation and adaptation strategies.

Furthermore, the positive impact of environmental degradation on bank profitability could be attributed to the growing interest in sustainable finance and environmental projects within Nigeria. As environmental concerns escalate, there is a rising awareness among banks of the importance of integrating sustainability into their financial offerings. Nigerian banks have increasingly funded projects aimed at reducing the impacts of environmental degradation, such as renewable energy investments, pollution control projects, and climate adaptation efforts. This increased focus on sustainability has allowed banks to tap into new markets, leading to improved profitability and enhanced ROE. Similar findings were noted by Akinlo and Akinboboye (2019), who observed that banks investing in green and sustainable projects in Nigeria not only contributed to environmental improvement but also experienced improved financial performance due to growing demand for such initiatives. Therefore, the positive relationship between environmental degradation and ROE can be interpreted as an opportunity for Nigerian banks to align their financial strategies with the need for environmental remediation, thereby enhancing both their societal impact and profitability.

Summary

This study sought to investigate the impact of climate change factors, specifically temperature change, rainfall variability, extreme weather events, and environmental degradation, on the return on equity (ROE) of Nigerian banks. The study employed panel regression analysis on data gathered over a 10-year period, focusing on four key variables: temperature change (TEMP), rainfall variability (RAIN), extreme weather events (EWE), and environmental degradation (ENV). The results revealed significant effects of temperature change, extreme weather events, and environmental degradation on banks' ROE, with temperature change and environmental degradation showing a positive and significant relationship. Rainfall variability, however, did not significantly impact ROE. These findings underscore the critical role of climate change and environmental factors in shaping the financial performance of banks, particularly in economies like Nigeria, where such factors are

becoming increasingly prevalent. The study also applied diagnostic tests, including unit root tests, variance inflation factor analysis, and heteroskedasticity tests, to ensure the robustness of the regression results.

The analysis found a positive and significant effect of temperature change on banks' return on equity. This suggests that higher temperatures correlate with better financial performance in the banking sector, possibly due to increased demand for financing related to climate adaptation and mitigation projects.

Rainfall variability was not found to significantly affect banks' ROE in Nigeria. While this might seem counterintuitive given the significant impact of rainfall on agriculture and the economy, it suggests that banks may have adopted risk management strategies that mitigate the financial risks associated with rainfall fluctuations.

Extreme weather events exhibited a strong positive effect on ROE, indicating that Nigerian banks may benefit from increased demand for financial products and services related to disaster recovery and adaptation projects. This highlights the growing need for financial products tailored to climate-related risks.

Environmental degradation was found to have a positive and significant effect on ROE. This result suggests that banks in Nigeria could capitalize on the growing demand for financing solutions to address environmental challenges, such as green projects, renewable energy initiatives, and environmental remediation efforts.

Conclusion

The study concludes that climate change factors, including temperature change, extreme weather events, and environmental degradation, significantly influence the return on equity (ROE) of Nigerian banks. This underscores the need for banks to consider environmental factors in their risk management and investment strategies. The positive impact of temperature change and environmental degradation on ROE could indicate a growing market for financing environmental sustainability initiatives. On the other hand, the insignificant effect of rainfall variability suggests that its impact on bank profitability may be mediated by other factors, such as effective risk management strategies.

Recommendations

1. Nigerian banks should integrate climate risk into their strategic planning and risk management frameworks to ensure sustainable growth and profitability. This can be done by developing financial products and services tailored to climate change adaptation and mitigation projects.
2. Banks should increase their focus on green financing and environmental sustainability initiatives. This can include offering loans for renewable energy projects, funding for climate resilience, and promoting sustainable investments, which could not only benefit the environment but also improve the banks' financial performance.
3. Nigerian banks should invest in climate risk assessment tools and data analytics to better understand and manage the financial risks associated with climate change.

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