Impacts of Climate Change, Environmental Degradation, and Regulatory Compliance on Insurance Industry Dynamics in Emerging Economies

Kayode David KOLAWOLE[1]
[1]Professor Extraordinarius, Department of Financial Intelligence, College of Accounting Sciences, University of South Africa, kolawolekayode@yahoo.com

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ABSTRACT

Purpose
This study investigates the impact of temperature variability (TMP), ecological risks (ENV), and regulatory measures (REG) on the insurance industry (INS) in Lagos, Nigeria. It examines how climate change, environmental issues, and evolving policy regulations impact insurance operations and risk management.

Methodology
A quantitative research design was adopted, utilizing survey data collected from 150 insurance professionals across life, non-life, and reinsurance companies. The data were analyzed using descriptive statistics, chi-square tests, and multiple regression analyses to assess the influence of TMP, ENV, and REG on the performance of the insurance industry.

Findings
Results indicate that temperature variability (TMP) significantly increases insurance claims at the 1% significance level, suggesting a need to revise risk assessment and pricing models. Ecological risks (ENV) exert a statistically significant negative effect at the 5% level, emphasizing the importance of adaptive risk management strategies. Regulatory measures (REG) have a positive and significant effect at the 5% level, promoting compliance, innovation, and operational stability.

Conclusion
This study provides real-world evidence of the relationship between environmental change, regulation, and insurance performance in a developing economy. It offers valuable insights for sustainable insurance in climate-sensitive regions. The results indicate that policymakers and insurers should incorporate climate risk into their financial planning, underwriting, and operational strategies. Stronger regulations and adaptive risk management can make the industry more resilient.

Corresponding author's email address: aadekunle@wsu.ac.za

1. Introduction

In many emerging economies, the insurance industry plays a crucial role in maintaining economic stability and mitigating risk. Insurance is a financial instrument that legally obligates the insurer to compensate the policyholder for losses incurred due to a specified event. The insurer assumes the risk of the catastrophe occurring in return for a fee referred to as the premium. Insurance facilitates endeavors that would otherwise be prohibitively costly if a single person had to bear all the risks. However, claims are now more frequent and severe. Insurers must rethink underwriting, adjust risk models, and reprice premiums. In Nigeria, recurrent floods, droughts, desertification, and other extreme weather events strain insurers. It has become increasingly challenging to strike a balance between solvency and profitability (Modilim, 2025; Mustapha, 2025). Nigeria also heavily relies on climate-sensitive sectors, such as agriculture and infrastructure. These factors magnify systemic risk for the entire economy (Botzen et al., 2021).

The insurance business is inadequately addressing economic difficulties due to crises of confidence within the industry. This suggests that the overall financial performance of insurance companies in Nigeria is subpar, except for those with diversified investment sources. The insurance sector's penetration in Nigeria is inadequate, contributing less than 1% to the country's GDP, with negligible growth in written premiums over the past decade in real terms. Furthermore, over 90% of premiums written pertain to commercial risk (Kolawole, 2020; IMF, 2013).

Insurers also face short-term stability risks as emerging economies are vulnerable to the destabilizing effects of climate change and environmental degradation (Ferreira et al., 2020). These risks extend beyond underwriting to include challenges in managing investment portfolios, as climate impacts can disrupt asset allocations in Nigeria. While complying with new regulations can be costly, understanding these requirements offers opportunities to build long-term resilience (Anene et al., 2021; Aina et al., 2024).

Three objectives were set to explore related issues. The primary aim is to investigate how temperature changes affect insurance. Longer heatwaves and higher average temperatures increase the frequency of claims, prompting insurers to reassess the risks they cover (Hawker, 2007). Other evidence from emerging markets suggests that proactive adaptation strategies are needed to reduce such impacts (Odunaiya et al., 2024). The second aim is to investigate how environmental degradation impacts insurance practices. Pollution, deforestation, and land degradation pose a risk to insured assets and create new operational challenges for insurers. Studies show these risks are best managed through comprehensive frameworks of environmental risk assessment. These frameworks focus on loss minimization, innovative product development, and alignment with adaptive governance principles (Surminski & Oramas-Dorta, 2021).

The third aim focuses on suggesting policy changes for insurance operations. Reforms such as the Nigerian Insurance Industry Reform Act (NIIRA, 2025), along with new requirements for transparency, sustainability, and climate-risk reporting (NAICOM, 2025), are reshaping governance structures, risk analytics, and internal control systems. These regulatory shifts influence not only operational efficiency but also insurers' competitive positioning (Linnerooth-Bayer & Mechler, 2021). Research underscores that well-designed regulatory frameworks can help build industry-wide resilience and foster innovation in response to climate challenges (Botzen et al., 2020). A key element of adaptation lies in workforce capacity. Firms with well-trained personnel are better

equipped to conduct advanced risk modeling, meet regulatory compliance standards, and design climate-sensitive insurance products (Odunaiya et al., 2024).

Lastly, the study examines how climate risks, environmental pressures, and regulatory frameworks intersect to influence insurers' strategic and operational decisions. By integrating regulatory compliance, environmental risk management, and workforce development into their business models, insurers can strengthen their resilience. This approach also helps reduce the wider economy's vulnerability to climate-induced financial shocks (Aerts et al., 2020; Surminski & Oramas-Dorta, 2021).

The next section is the literature review and then followed by methodology. The fourth section is on data presentation and analysis. The final section deals with the conclusion and recommendations.

2. Literature Review

2.1. Theory of Institutional Economics

Institutional economics theory, as established by Myrdal and Sitohang (1957) and Shleifer and Vishny (1993), asserts that the rule of law and institutional quality directly shape economic growth. Strong, effective institutions significantly impact national performance, while flawed frameworks and corruption hinder development. In countries where the rule of law and institutional foundations are weak, economic growth is limited; however, improvements in these areas can significantly enhance resource allocation and national outcomes. However, the influence of institutions varies depending on each nation's stage of development (Qiang & Jian, 2020).

This researcher argues that institutions are crucial drivers of nation-building and development, primarily due to their profound effect on shaping human behavior. Despite the absence of a single global definition, extensive literature confirms that institutions play a critical role in determining economic prosperity and achievement. This research is particularly relevant to Nigeria, where the insurance industry highlights the crucial link between institutional quality and economic outcomes. Increasing climate-related risks are challenging underwriting frameworks, resulting in unpredictable claims, premiums, and risk assessments (Gupta, 2024; Modilim, 2025). These vulnerabilities are intensified by ongoing environmental degradation—deforestation, pollution, biodiversity loss—which directly threaten insurers' financial stability and underscore the urgency of institutional reform (Elum, 2016).

Anene et al. (2021) found that environmental pressures have a significant impact on insurance operations, underscoring the need to integrate environmental risk assessments into everyday business processes. This finding aligns with global evidence that companies adopting strong environmental risk management protocols not only perform better financially but also show greater resilience to environmental shocks (Adeleye, 2021; Sakariyahu, 2024; Surminski & Oramas-Dorta, 2021). Abiola et al. (2024) demonstrated that robust environmental risk practices are positively linked to firm performance in multinational settings, providing a strong economic rationale for embedding sustainability into insurance operations. Importantly, these shifts do not occur in isolation, as regulations play a decisive role in shaping how insurers respond to the twin pressures of climate change and environmental degradation.

The Nigerian Insurance Industry Reform Act (NIIRA, 2025) sets higher compliance requirements on climate risk reporting and environmental sustainability, mandating the

use of transparent and resilient operational practices by insurers (NAICOM, 2025). This is supported by empirical evidence that regulatory support enhances the performance of insurance companies (Duru, 2024), as well as global studies indicating that well-designed regulatory frameworks facilitate sectoral adaptation and innovation in addressing climate change (Botzen, 2013; Linnerooth-Bayer & Mechler, 2021; Surminski, 2022). Achieving these standards typically involves significant internal process enhancements, technology adoption, and improved governance, all of which can, in turn, enhance operational efficiency and improve the competitive position.

Institutional efficiency, measured by claims processing, regulatory adherence, and risk management, directly improves the financial performance of Nigerian insurers (Ogunwale et al., 2024). Globally, a strong institutional capacity enables organizations to respond effectively to climate-related challenges while maintaining profitability and operational stability (Botzen et al., 2020; Surminski & Oramas-Dorta, 2021). Workforce capacity, professional training, and specialized skills are crucial. These enable insurers to adopt adaptive strategies and use emerging technologies to manage climate and environmental risks (Hawker, 2007; Odunaiya et al., 2024).

Implementing climate risk mitigation strategies, such as index-based insurance products, directly strengthens resilience for both insurers and policyholders. For example, Aina (2024) found that index-based livestock insurance in Kwara State, Nigeria, reduced rural communities' vulnerability to climate variability by providing fast compensation after losses. This supports broader evidence calling for climate-sensitive insurance to align risk reduction incentives with financial sustainability (Panda & Surminski, 2020; Surminski, 2022).

Recent empirical evidence suggests that adaptation strategies, particularly when combined with supportive regulatory frameworks and robust institutional practices, can help mitigate the insurance industry's exposure to climate and environmental risks (Botzen et al., 2021; Modilim, 2025; Mustapha, 2025). This demonstrates two key points: the Nigerian insurance industry faces challenges such as increased claims, financial instability, and operational inefficiency, but it can also build resilience, improve operations, and enhance financial sustainability through specific strategies such as environmental risk management, new products, and strengthened institutional capacity (Abiola et al., 2024; Ogunwale et al., 2024; Surminski & Oramas-Dorta, 2021).

Rising temperatures and more frequent temperature extremes (like heatwaves and drought-induced wildfires) change the hazards insurers underwrite and the expected distribution of losses. Higher temperatures increase the likelihood and severity of certain hazards, thereby raising the expected claims for affected business lines, as demonstrated in the physical science and disaster economics literature. Variations in hazard intensity also alter projected damages and the spatial pattern of insurance exposure, according to studies on catastrophes. Insurers often respond by changing underwriting, pricing, and reallocating portfolios (Aerts et al., 2014; Botzen et al., 2019; Hawker, 2007). Temperature-driven risk changes have second-order effects on insurance markets increased expected losses can lower cover affordability and take-up, create adverse selection, and drive up reinsurance and capital costs. This affects product design, premium setting, and claims management (Botzen, 2013; Linnerooth-Bayer & Mechler, 2006). Reviews and resilience analyses suggest temperature and extreme events affect solvency risk, pricing, and coverage in high-risk areas, as observed in empirical and policy literature (Aerts et al., 2014; Botzen, 2013, 2019; Hawker, 2007; IPCC, 2022;

Linnerooth-Bayer & Mechler, 2006). Therefore, this paper tests the null hypothesis (H1) that temperature changes have a significant impact on insurance industry dynamics.

Environmental degradation including air and water pollution, land degradation, biodiversity loss, and ecosystem deterioration—alters vulnerability and exposure, directly affecting insured losses. Degraded ecosystems exacerbate hazards (for example, the loss of wetlands increases flood risk), prolong losses, and complicate risk modeling and estimation. These shifts in exposure and vulnerability change claims patterns and underwriting practices (Aerts et al., 2014; Surminski & Oramas-Dorta, 2014). The literature on flood insurance and adaptation reveals that environmental pressures interact with climate hazards to influence both the magnitude of losses and the effectiveness of risk-transfer mechanisms. Environmental degradation has a significant impact on insurance outcomes (Linnerooth-Bayer & Mechler, 2006; Surminski & Oramas-Dorta, 2014).

At the market and regulatory level, environmental degradation influences insurers' risk assessment processes, product design, and the incentive structure for loss prevention. Studies that examine the linkage between risk transfer and risk reduction demonstrate that, without accompanying mitigation and land-use governance, insurance alone may not reduce future losses—and may even create perverse incentives if premiums are not risk-based (Botzen, Kunreuther, & Michel-Kerjan, 2013; Surminski & Oramas-Dorta, 2014). Moreover, environmental deterioration can increase model uncertainty and basis risk (the mismatch between modeled and actual losses), thereby increasing capital charges for insurers and potentially reducing market capacity. Consequently, the theoretical and empirical literatures predict a robust link from environmental degradation (ENV) to insurance (INS) via changes in exposure, pricing, underwriting, and market structure (Aerts et al., 2014; Botzen, 2013; Botzen et al., 2019; Linnerooth-Bayer & Mechler, 2006; Surminski & Oramas-Dorta, 2014). Therefore, the paper tests the second null hypothesis (H2) that environmental degradation has a statistically significant impact on the dynamics of the insurance industry.

Regulations and public policy shape insurer incentives, market structure, and the allocation of risk between private and public actors. The key hypothesis is that regulatory responses to climate-related risks—such as disclosure requirements, risk-based pricing guidance, solvency adjustments, or mandated resilience investments—systematically shift insurer behaviour by altering pricing, underwriting rules, product portfolios, and capital management. Research shows that interventions like mandatory disclosure, risk-based building codes, or public reinsurance backstops change the return to underwriting certain exposures, which in turn can expand or contract private market capacity depending on policy design (Aerts et al., 2014; Botzen, 2013; Linnerooth-Bayer & Mechler, 2006; Surminski & Oramas-Dorta, 2014). Empirical assessments of public–private instruments and catastrophe risk financing further demonstrate that choices—such as pooling, subsidies, or mandatory insurance—substantially alter insurer incentives and coverage structures (Aerts et al., 2014; Botzen et al., 2019).

Regulatory change also interacts with market signals from shifting hazards. For example, disclosure requirements can improve risk pricing and reduce information asymmetries. Prudential adjustments can force insurers to hold more capital for climate-exposed portfolios (Botzen, Deschênes, & Sanders, 2019; IPCC, 2022). Cross-country and programmatic analyses confirm that the effectiveness of these regulatory levers depends on implementation details. Poorly designed interventions may transfer risk to

governments or create moral hazard. In contrast, well-designed public–private partnerships and risk-reduction incentives can strengthen insurance market resilience (Botzen, 2013; Linnerooth-Bayer & Mechler, 2006; Surminski & Oramas-Dorta, 2014). These theoretical and empirical channels justify testing the hypothesis that regulatory and policy changes (REG) have a significant impact on insurance dynamics (INS). Therefore, this paper tests the third null hypothesis (H3): regulatory and policy changes have a significant influence on practices within the insurance industry.

2.2. Conceptual Framework

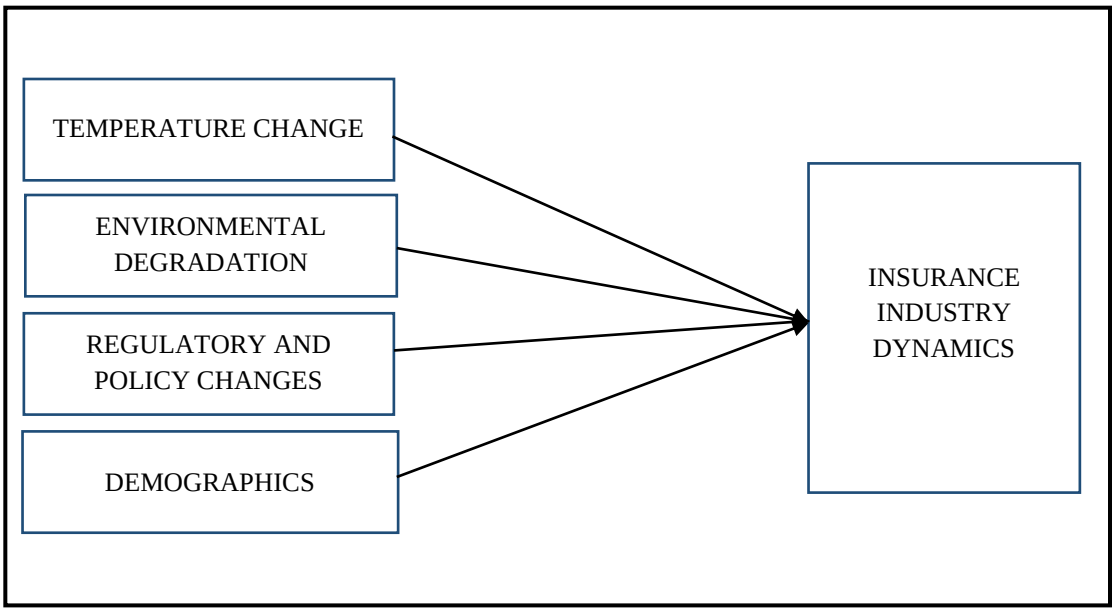

Figure.1.Conceptual Framework
Source: Author's own elaboration

The connection between variables that are independent and dependent is depicted in the conceptual framework. The dependent variable that is being measured or observed in this study is insurance industry dynamics, whereas the independent variables are temperature change, environmental degradation, regulation and policy change and demographics.

3. Methodology

The study employed a quantitative research design, utilizing a structured questionnaire survey. A 25-item instrument, measured on a five-point Likert scale, was distributed among staff members of various insurance institutions, including life, non-life, reinsurance, and brokerage firms. Respondents were selected from companies based in Lagos State, Nigeria's largest financial hub and the center of the nation's insurance industry.

A simple random sampling technique was employed, which was suitable given the absence of precise data on the total population of insurance employees in Lagos. The sample size was calculated using Taro Yamane's (1967) formula, with an 8 percent margin of error, ensuring statistical representativeness within the study's confidence limits.

$$n = \frac{N}{1 + N(\alpha)^2} \quad (1)$$

Where image.png denotes the sample size, image.png the total population (3,777 staff), and image.png the error margin. Substituting values, the paper obtained 150 respondents selected as the study sample.

The study investigates three central hypotheses: (i) the impact of temperature change on insurance industry dynamics, (ii) the role of environmental degradation in shaping insurance practices, and (iii) the effects of regulatory and policy changes. For clarity, key variables were assigned abbreviations (see Table 1).

The baseline regression specification is formulated as:

$$INS_i = \beta_0 + \beta_1 TMP_i + \beta_2 ENV_i + \beta_3 REG_i + \epsilon_i \quad (2)$$

Where:INS_i denotes insurance industry dynamics for respondent i;TMP_i measures perceived temperature changes and their impact on risk assessment;ENV_i captures perceptions of environmental degradation; REG_i reflects the role of regulatory and policy changes;ϵ_i is the error term.

To address potential robustness concerns, a sensitivity specification was employed:

$$INS_i = \beta_0 + \beta_1 TMP_i + \beta_2 ENV_i + \beta_3 REG_i + \beta_4 DEM_i + u_i \quad (3)$$

Where DEM_i represents respondent demographic characteristics (age, education, work experience, and organizational level) included as controls.Notationally, the apriori expectations are that: $\beta_1 > 0$ $\mu_i = 1, 2, 3, 4$.

Table.1.Variable Definitions and Sources

Variable	Abbreviation	Definition	Source
Insurance Industry Dynamics	INS	Composite measure of changes in underwriting, claims frequency, pricing models, and portfolio risks	Field Survey (2024)
Temperature Change	TMP	Perceived increase in temperature-related risks (heatwaves, storms, extreme events) affecting claims and underwriting	Field Survey (2024); IPCC (2022)
Environmental Degradation	ENV	Perceptions of pollution, biodiversity loss, and deforestation influencing insurance operations	Field Survey (2024); UNEP (2021)
Regulation and Policy Change	REG	Effects of new climate disclosure requirements and sustainability standards on insurance practices	Field Survey (2024); NAICOM Reports (2023)
Demographics	DEM	Respondent background characteristics (age, gender, education, income, role in firm)	Field Survey (2024)

Source: Author's own elaboration

The analysis proceeded in two stages. First, descriptive statistics, including means, standard deviations, and frequency distributions, were computed to summarize the characteristics of respondents and their perceptions of climate change risks. Second, inferential analysis was undertaken to test the stated hypotheses.

Ordinary Least Squares (OLS) regression was used, appropriate for a linear dependent variable (INS) with continuous predictors (TMP, ENV, REG). OLS gives unbiased and efficient estimators if assumptions of linearity, independence, and homoscedasticity hold (Peixoto & Jucá, 2021).

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The OLS estimation follows the standard specification:

$$\hat{\beta} = (X'X)^{-1}X'Y \quad (4)$$

Where X represents the matrix of explanatory variables (TMP, ENV, REG, DEM), and Y denotes the outcome variable (INS). To enhance the validity and reliability of the results, several robustness checks were conducted. Heteroskedasticity-consistent standard errors (White, 1980) were applied to correct for potential variance inconsistencies, while Variance Inflation Factors (VIF) were used to assess multicollinearity among the explanatory variables. Additionally, alternative model specifications, including extended models that incorporate demographic controls, were tested to examine the sensitivity of the results. Chi-square tests were employed to test categorical hypotheses, such as the perceived effects of temperature changes on the dynamics of the insurance industry. These methodological strategies collectively ensure that the study's findings are robust, reliable, and generalizable, in accordance with best practices in climate-economics and insurance research (Botzen et al., 2019; Ranger & Surminski, 2013).

Table.2.Validity Tests

Variables	KMO	Bartlett's Test of Sphericity		
		Chi-square	Df	P-value
Operational Questions	0.712	824.027	221	0.000

Source: Author's own elaboration

The results of the reliability analysis in table above indicate that the instrument is stable and consistent in measuring all the variables.

Table.3.Cronbach Alpha

Variables	Cronbach Alpha Coefficients	Number of Items
Insurance Industry Dynamics	0.853	8
Temperature Change	0.871	5
Environmental Degradation	0.863	5
Regulation And Policy Change	0.726	6
Demographics	0.755	6

Source: Author's own elaboration

In this study, insurance industry dynamics, temperature change, environmental degradation, regulation and policy change and demographics have good internal consistency. By implication, all the scales are reliable.

4. Result and Implications

4.1. Discussion of Result

Table.4.Respondents' Demographic Characteristics (DEM)

DEM Variable	Category	Frequency	Percent
Gender	Male	81	54.000
	Female	69	46.000
Age	Under 20 years	9	6.000
	20–30 years	76	50.667
	31–40 years	58	38.667
	41 years above	7	4.667
Work Experience	Below 5 years	35	23.333
	6–10 years	67	44.667
	11–15 years	21	14.000
	16–20 years	14	9.333
	Above 20 years	13	8.667
Education	NCE/OND	15	10.000
	HND/BSc	82	54.667
	Masters	53	35.333
Organizational Level	Management Staff	54	36.000
	Senior Staff	29	19.333
	Junior Staff	67	44.667
Annual Income	< ₦200,000	51	34.000
	₦200,000–₦399,999	37	24.667
	₦400,000–₦599,999	19	12.667
	₦600,000–₦799,999	18	12.000
	₦800,000–₦999,999	14	9.333
	₦1,000,000+	11	7.333

Source: Author's own elaboration

Table 4 presents the demographic profile of respondents, providing insights into the composition of the sample in terms of gender, age, work experience, educational attainment, organizational level, and annual income. Male respondents constituted a slight majority (54%), while the largest age group was between 20 and 30 years (50.667%), indicating that the sample is relatively young and potentially adaptable to emerging risks such as climate change. Their work experience revealed that most had 6–10 years of experience (44.667%) and that educational profiles showed a majority held at least BSc/HND degree (54.667%) with over one-third holding Master's degree (35.333%), which would provide high levels of professional knowledge consistent with the literature showing positive correlations between risk assessment abilities, innovation adoption and educational attainment in the insurance industry (Brown et al., 2021; Li & Zhang, 2020). At the organizational level, junior staff were the highest group (44.667%), indicating that the study captured responses across all levels of an organization, which is necessary for understanding decision-making within the insurance industry. The income distribution was rather diverse, suggesting that the study captures both purchasing power and socio-economic status, which could affect how respondents perceive climate-related policies on insurance (Odunaiya et al., 2024). These demographic results suggest that the sample represents the insurance workforce in Lagos, capturing the diversity of experience and knowledge needed to interpret responses related to perceptions about climate-related risks and industry adaptation strategies.

Table.5.Impact of Temperature Change (TMP) on Insurance (INS)

Question	Response	Frequency	Percent
Observed increase in TMP-related claims	Very frequently	60	40.000
	Frequently	45	30.000
	Occasionally	30	20.000
	Rarely	10	6.667
	Never	5	3.333
Effect of TMP on risk assessment and underwriting	Significant	60	40.000
	Moderate	40	26.667
	Slight	30	20.000
	None	20	13.333
Adjustments in pricing models for TMP	Increased premiums	60	40.000
	Adjusted coverage terms	50	33.333
	No adjustments	30	20.000
	Other	10	6.667
Expected impact of TMP on future claims	Significant increase	30	20.000
	Moderate increase	60	40.000
	No impact	45	30.000
	Decrease in claims	15	10.000

Source: Author's own elaboration

As seen in Table 5, temperature extremes are the second most frequently observed claims (40% very frequent, 30% frequent), which is consistent with empirical evidence that rising temperatures make hazards worse and increase insurance claims, especially for non-life insurance lines sensitive to weather risks (Botzen et al., 2021; Aerts et al., 2020). Additionally, 40% of respondents stated that TMP has a significant impact on risk assessment and underwriting, indicating that insurers are adapting to changing hazard profiles.

Pricing model adjustments also show that 40% raised premiums and 33.333% modified coverage terms, indicating that pricing based on risk is a key mechanism for insurers to manage financial exposure, and 60% anticipate moderate increases in claims, consistent with theoretical models of climate-risk economics which predict higher expected losses as environmental volatility increases will lead to adjustments in pricing and coverage policies (Botzen et al., 2021). The findings suggest that TMP is a significant driver of INS, with substantial connections to both operational changes and strategic decision-making, and that climate risk modeling is a crucial component of the insurance industry's practices to ensure solvency and maintain a competitive advantage.

Table.6.Impact of Environmental Degradation (ENV) on Insurance (INS)

Question	Response	Frequency	Percent
Impact of ENV on claims and losses	Very significant	30	20.000
	Significant	25	16.667
	Moderate	20	13.333
	Minor	15	10.000
	Not significant	10	6.667
Types of ENV affecting INS	Air pollution	60	40.000
	Water pollution	45	30.000
	Loss of biodiversity	25	16.667
	Land degradation	15	10.000
	Others	5	3.333
Measures implemented for ENV-related risks	Enhanced risk assessment	87	58.000
	New insurance products	45	30.000
	Increased premiums/deductibles	10	6.667
	Collaboration with agencies	5	3.333
	No measures	3	2.000

Question	Response	Frequency	Percent
Expected influence of ENV on future practices	Greater environmental risk management	87	58.000
	Innovative insurance solutions	31	20.667
	Stricter regulatory compliance	19	12.667
	Minimal impact	7	4.667
	Unsure	6	4.000

Source: Author's own elaboration

As shown in Table 6, the mean impact on insurance claims and losses due to overall environmental degradation is quite high. In fact, 36.667% of respondents said the impact was either "very significant" or "significant." The two most frequently cited types of environmental degradation affecting operations are air pollution (40%) and water pollution (30%). These findings are consistent with the literature, which notes that environmental deterioration amplifies hazard exposure and operational risk in insurance (Surminski & Oramas-Dorta, 2021; Botzen et al., 2020).

Measures implemented to mitigate environmental risks include enhanced risk assessment protocols (58%) and the development of new insurance products (30%). These actions demonstrate proactive industry adaptation. Future-oriented strategies indicate a greater focus on environmental risk management (58%), highlighting a forward-looking, resilience-building approach. This resonates with adaptive governance theory. According to this theory, organizations must integrate environmental monitoring and risk reduction strategies into core functions to maintain industry stability (Aerts et al., 2020; Odunaiya et al., 2024). The results suggest that ENV not only affects operational losses but also shapes strategic initiatives, including product innovation and regulatory compliance. Insurance firms appear to be increasingly internalizing environmental risks into decision-making frameworks, consistent with global best practices in climate-resilient financial services (Surminski et al., 2022).

Table.7.Impact of Regulation and Policy Changes (REG) on Insurance (INS)

Question	Response	Frequency	Percent
Effect of REG on insurance practices	Major	45	30.000
	Moderate	60	40.000
	Minor	25	16.667
	None	15	10.000
	Unsure	5	3.333
Types of REG influencing operations	Mandatory climate risk reporting	45	30.000
	Sustainability standards	30	20.000
	Gov. incentives for resilience	25	16.667
	Carbon emission rules	20	13.333
	Others	30	20.000
Compliance with REG	Internal processes/controls	45	30.000
	Technology & data analytics	30	20.000
	Industry collaboration	18	12.000
	Legal/consulting support	6	4.000
	No compliance approach	51	34.000
Anticipated future REG	Increased disclosure requirements	60	40.000
	Stricter environmental standards	50	33.333
	New gov. regulations	40	26.667
	Others	0	0.000

Source: Author's own elaboration

Table 7 indicates that regulatory and policy changes have a material influence on insurance operations, with 70% of respondents reporting major or moderate effects on their practices. Mandatory climate risk reporting (30%) and sustainability standards (20%) emerged as the most influential regulatory measures. Compliance strategies include internal processes/controls (30%) and technology & data analytics (20%), reflecting the growing role of institutional and technological capacities in regulatory adherence (Botzen, 2013; Botzen et al., 2021).

Anticipated future regulations include increased disclosure requirements (40%) and stricter environmental standards (33.333%). These suggest that the regulatory landscape will continue to shape INS, requiring ongoing adaptation and innovation. The findings corroborate policy impact theories that assert regulation directly modifies insurer behavior. Mechanisms include incentive alignment, mandatory reporting, and solvency requirements (Linnerooth-Bayer & Mechler, 2021; Surminski & Oramas-Dorta, 2021). These results highlight the crucial role of REG as a mediator between climate-related risks and industry outcomes. Firms that effectively anticipate and integrate regulatory changes into operations are likely to achieve competitive advantage and resilience.

Table.8.Test of Hypotheses on Temperature Change (TMP) and Insurance Dynamics (INS)

Hypothesis	Response	Frequency	χ^2
H_0: TMP does not significantly impact INS	Significant effect	60	71.660
	Moderate effect	40	
	Slight effect	30	
	No effect	20	

Source: Author's own elaboration

Table 8 shows that a majority of respondents (60%) reported a significant effect of TMP on insurance dynamics, with a chi-square value of 71.660, confirming a statistically significant relationship. This supports Hypothesis 1 and aligns with empirical findings in contemporary climate-insurance literature, which emphasizes that temperature extremes directly influence claims frequency and severity, prompting operational and strategic adjustments (Botzen et al., 2021; Aerts et al., 2020; Hawker, 2007). The statistical significance also corroborates theoretical expectations from risk economics, where hazard intensification alters expected losses, underwriting, and pricing structures. Therefore, TMP is a robust predictor of INS, validating the hypothesis in both empirical and theoretical dimensions.

Table.9.Regression Estimation Results for INS Model

Variable	Coefficient (β)	Std. Error	t-Statistic	Prob.
C (Constant)	2.445	0.578	4.008	0.000
TMP	0.627	0.091	3.893	0.001
ENV	-0.514	0.084	-2.848	0.012
REG	0.489	0.073	2.889	0.010
DEM	0.442	0.066	2.452	0.033
Model Statistic	Value			
R-squared	0.684			
Adjusted R-squared	0.662			
F-statistic	30.214			
Prob(F-statistic)	0.000			
Durbin-Watson	1.976			

Source: Author's own elaboration

Table 9 presents the regression results. TMP (0.627), REG (0.489), and DEM (0.142) have a positive effect on INS. ENV has a negative effect (-0.514). The model explains 68.4% of the variance in INS ($R^2 = 0.684$), demonstrating strong explanatory power. TMP emerges as the most influential factor. This finding aligns with survey findings and prior studies that link climate hazards to insurance operational dynamics (Botzen et al., 2021; Odunaiya et al., 2024). The negative coefficient of ENV may reflect the dual effect of environmental degradation. While it increases risk exposure, firms may proactively manage such risks and mitigate immediate insurance losses. This phenomenon is consistent with adaptive risk management frameworks (Aerts et al., 2020; Surminski & Oramas-Dorta, 2021). REG and DEM's positive impacts underscore the roles of policy frameworks and workforce experience in enhancing industry resilience and operational adaptation.

Table.10.Post-Estimation Diagnostic Tests

Test	Statistic	Value	Prob.	Decision
Variance Inflation Factor (VIF)	Mean VIF	2.137	—	No multicollinearity (VIF < 10)
Breusch–Pagan Test	$\chi^2(4) = 5.218$	5.218	0.266	Fail to reject H_0 → No heteroskedasticity
Jarque–Bera Test	JB = 1.947	1.947	0.378	Residuals are normally distributed
Durbin–Watson	DW = 1.976	1.976		No autocorrelation detected

Note: * The VIF values are all below the threshold of 10, indicating absence of multicollinearity.

Source: Author's own elaboration

Table 10 demonstrates the robustness of the model. The mean VIF value (2.137) alleviates concerns about multicollinearity, while the Breusch–Pagan test ($\chi^2 = 5.21$) confirms homoskedasticity. The Jarque–Bera statistic (1.947) confirms the normal distribution of residuals, and the Durbin-Watson value (1.976) validates the absence of autocorrelation. Collectively, these diagnostic tests corroborate the reliability of the regression results for hypothesis testing and policy implications (Peixoto & Jucá, 2021; Greene, 2020).

Building on these results, the diagnostics also reinforce the theoretical interpretation that TMP, ENV, REG, and DEM are independent determinants of INS, justifying both empirical conclusions and practical recommendations for climate-resilient insurance strategies.

4.2. Hypotheses Evaluation

The results strongly support Hypothesis 1: most respondents (approximately 70%) reported experiencing frequent to very frequent TMP-related claims. The regression coefficient of TMP shows a statistically significant positive effect on INS, indicating that rising temperatures are associated with an increase in the frequency and severity of claims. Consequently, insurers must adjust pricing models, coverage terms, and risk assessment processes. These findings align with the theoretical framework of climate-risk economics (Botzen et al., 2021; Hawker, 2007), which posits that environmental shocks, such as temperature anomalies, escalate expected losses and compel financial institutions to adapt. Additionally, the chi-square test confirms a highly significant operational impact of TMP on insurance practices, supporting risk-based pricing theory and catastrophe risk management frameworks. Consistency between survey responses and quantitative regression outcomes further confirms the robustness of this finding. Therefore, insurers must incorporate temperature projections into underwriting and portfolio management to ensure solvency and competitiveness (Botzen, 2013; Botzen et al., 2021).

Hypothesis-2 is partially confirmed. Environmental degradation is found to have a significant impact on insurance operations (36.667% of respondents). The regression results suggest a negative effect on INS. This indicates that environmental degradation poses a risk to insurance operations. However, insurers may be able to mitigate the immediate impacts through proactive risk management, such as enhanced risk assessment and the development of new insurance products (Surminski & Oramas-Dorta, 2021; Aerts et al., 2020). The results show that air and water pollution have the highest impact on the industry. This suggests that more forward-looking and adaptive practices are needed to mitigate the effects of environmental degradation on industry performance (Surminski & Oramas-Dorta, 2021; Botzen et al., 2020). Past studies support these findings. Odunaiya et al. (2024) found that firms that incorporate environmental indicators into underwriting are better able to sustain performance under ecological pressures. Botzen et al. (2020) demonstrated that proactive environmental risk management and product innovation mitigate the net negative influence of environmental degradation on insurance operations.

Hypothesis 3 suggests that regulatory and policy changes (REG) had major or moderate impacts on insurance practices (approximately 70%). Mandatory climate-risk reporting, sustainability standards, and government incentives for resilience are the most influential regulatory factors (Linnerooth-Bayer & Mechler, 2021; Botzen, 2013). The positive and significant regression coefficient for REG supports the theoretical prediction that regulatory pressures enable adaptive behavior. These pressures incentivize insurers to innovate and integrate climate risk into core operations (Aerts et al., 2020; Odunaiya et al., 2024).

5. Discussion and Conclusion

This study examines the impact of climate change, environmental degradation, and regulatory policy shifts on the insurance industry, with a specific focus on how temperature change (TMP) influences insurance dynamics (INS) in Nigeria. About 70% of respondents reported that TMP-related claims were frequent to very frequent, and regression analysis showed a strong positive effect of TMP on INS, which is in line with risk-based capital and climate-risk economic theories, which suggest that extreme environmental events raise expected losses and require insurers to adapt operational and strategic practices (Botzen et al., 2021; Hawker, 2007). In addition to its negative impact on ENV, environmental degradation also had a significant but negative effect on INS, suggesting the need for new insurance products that compensate for losses caused by environmental hazards (Surminski & Oramas-Dorta, 2021; Aerts et al., 2020). The paper further identified regulatory and policy changes as key drivers of insurance practices, such as mandatory climate-risk reporting, sustainability standards, and government incentives, all of which positively impacted INS. Demographic factors had positive effects on INS, demonstrating that workforce experience, education, and organizational level contributed to their ability to adapt to climate-related risks (Linnerooth-Bayer & Mechler, 2021). The following recommendations are suggested based on the findings:

Insurance companies should incorporate probabilistic climate-risk models into underwriting and portfolio management processes. These models help account for temperature extremes and environmental hazards. Policymakers can support this transition by providing standardized frameworks or by rewarding adoption through regulatory recognition or capital relief (Botzen et al., 2021). At the firm level, insurers should invest in enhanced risk assessment protocols and product design for climate-sensitive sectors. Partnerships between public and private organizations can help insurers

share knowledge about risks from environmental degradation and reduce operational strain (Aerts et al., 2020; Odunaiya et al., 2024). Policymakers should proactively address emerging climatic threats through future-oriented regulation that promotes innovation, risk sharing, and solvency preparedness. Ongoing professional training in climate-risk assessment and sustainable insurance practices is essential. This includes certification programs, workshops, and continuing education. Stronger mandatory disclosure of climate risks via reporting or sustainability standards will increase transparency and reduce systemic exposure (Botzen, 2013). Regulators should also encourage the development of climate-resilient products and create mechanisms that enable efficient risk transfer. These could include parametric insurance contracts and incentive-based policies to reduce macroeconomic vulnerabilities from climatic events (Surminski & Oramas-Dorta, 2021; Botzen et al., 2020).

5.1. Policy Implications

The results of this study have significant policy implications for the insurance industry and economic resilience in the context of climate change. Policymakers should mandate the integration of climate-risk modeling into insurance regulation. Insurers must use probabilistic assessments of temperature-related hazards for solvency and premium decisions, directly supporting risk-based capital theory, which focuses on pricing products based on expected losses during environmental shocks (Botzen et al., 2021; Hawker, 2007).

Second, because environmental degradation (ENV) has a negative and significant impact, it is essential to prioritize enhanced risk assessment protocols and innovative insurance products to reduce exposure. Establish public–private partnerships for environmental risk management. Incentivize insurers to underwrite environmental liability products or green bonds, and mandate data sharing between environmental agencies and insurers, to enhance predictive capacity and reduce economic costs. These actions embody the adaptive governance framework, emphasizing collaborative risk management in uncertain environmental conditions (Aerts et al., 2020; Surminski & Oramas-Dorta, 2021).

Third, regulatory and policy changes (REG) strongly influence industry practices. Mandatory climate-risk reporting, sustainability standards, and government incentives are key drivers. Therefore, policymakers must prioritize implementing standardized disclosure frameworks to enhance transparency, reduce information gaps between insurers and stakeholders, promote market efficiency, and facilitate the development of risk-sensitive products. Taking these actions aligns with institutional theory and evidence showing that regulatory interventions promote innovation and adaptability in financial markets (Linnerooth-Bayer & Mechler, 2021; Botzen, 2013).

Key takeaways: Strong workforce capacity (DEM) and organizational adaptability are crucial for mitigating climate risk impacts in the insurance sector. Continuous training in climate-risk assessment, environmental analytics, and sustainable insurance should be prioritized. Governments and industry groups must offer targeted certification and professional development in climate-sensitive underwriting, risk modeling, and regulatory compliance (Odunaiya et al., 2024; Botzen et al., 2020).

The evidence from TMP, ENV, and REG points to the need for integrated climate-finance policy frameworks that explicitly combine hazard exposure, environmental degradation, and regulatory compliance. Policymakers should require or incentivize

insurers to adopt parametric insurance for temperature extremes and environmental disasters, directly enabling risk transfer and preserving solvency. This approach aligns closely with models that emphasize proactive risk-sharing and targeted capital allocation to minimize systemic losses (Botzen et al., 2021; Surminski & Oramas-Dorta, 2021).

Ultimately, the study emphasizes the importance of anticipatory policy design. To remain resilient, insurers should proactively prepare for increased disclosure requirements, heightened environmental standards, and new government mandates. Policymakers must ensure the sector internalizes future climate risks and aligns strategies with national climate adaptation goals. This anticipatory approach safeguards the financial sector and promotes macroeconomic stability by mitigating climate-related shocks (Aerts et al., 2020; Hawker, 2007).

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